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ENVIRONMENT CANADA AVIAN MONITORING REVIEW

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EXECUTIVE SUMMARY

AVIAN MONITORING IN CANADA

Birds in Canada have high ecological, scientific, economic, cultural and aesthetic values. However, they face numerous threats which must be addressed through effective conservation actions. Canada's federal government has responsibility for the stewardship, conservation and management of migratory birds, as populations and individuals, through the Migratory Birds Convention (1916) with the United States, and the enabling Migratory Birds Convention Act (MBCA; 1917, 1994 and subsequent amendments). This responsibility is further supported by the Species at Risk Act (2003). Monitoring data are required at relevant scales and time periods to assess the status of bird populations, to advise on management and science priorities, as well as to guide and evaluate conservation actions.

UNDERTAKING MONITORING PROGRAMS

Population status information is required for all regularly occurring bird species in Canada to ensure their effective conservation and management. Overall, 658 species of birds have been recorded in Canada (excluding extirpated and extinct species), of which 427 regularly breed in Canada and an additional 26 species regularly visit or migrate through Canada in their non-breeding season. Environment Canada (EC) has jurisdictional responsibility, under the MBCA, for 555 of these species, including 388 species that regularly occur in Canada (363 as breeders and 25 as non-breeders).

The wide diversity of bird species, and the broad range of landscapes where they occur, necessitates a diverse suite of monitoring programs. Species can be grouped into five categories: landbirds, seabirds, shorebirds, inland waterbirds, and waterfowl. Each group generally requires a different suite of monitoring programs, although some programs provide information on multiple species groups. The "flagship" monitoring programs for each species group are generally large scale efforts contributing status information on multiple species across broad landscapes. These are complemented, where required, by more specialized monitoring efforts aimed at single species or small groups of species that are not adequately monitored by the flagship programs. In addition, more intensive monitoring may be required in particular regions where higher levels of information are required, such as to support particular management actions including conservation or recovery of species at risk.

To monitor these species across their ranges, many programs rely on the contributions of skilled volunteers to increase temporal and geographic data coverage (e.g., Breeding Bird Survey, breeding bird atlases, checklist programs), while others are largely undertaken by professionals (e.g., remote seabird colony surveys, arctic shorebird surveys, waterfowl aerial surveys). Most monitoring programs depend on collaborative arrangements including with other government agencies, other levels of government, other countries, non-governmental organizations, and university researchers.

SCOPE OF THE REVIEW

This review was focussed on bird population monitoring, defined as the long-term, repeated collection of population-related information to detect and quantify changes in numbers (population size, relative abundance), distribution (range), or key vital rates (e.g., survival or recruitment). It also considered "inventories", defined as surveys that provide information on the status of bird populations at one particular point in time (generally numbers and/or distribution, often limited in geographic area). In some cases, it may be possible to turn an inventory into a monitoring program by repeating it, although the survey design may not be optimized to detect trends. The term "survey" is used as a general term to include monitoring and inventory programs as well as any other programs that provide some level of information on the status of birds or factors that may affect them, and may or may not be repeated over time. After initial assessment, this review excluded four categories of surveys which did not fit its scope: surveys using birds as indicators of environmental toxins; habitat surveys; research projects aimed at answering specific questions (why is something changing); and, wildlife disease surveys.

THE REVIEW PROCESS

The overarching goal of this review was to ensure that bird population monitoring programs supported by EC meet the current needs of the Department in ways that are cost-effective and scientifically rigorous; that provide readily accessible, timely and meaningful results; and that take advantage of modern technology. The review involved (i) describing and documenting current monitoring programs; (ii) clarifying the needs for avian monitoring information; (iii) evaluating the effectiveness and efficiency of current programs in meeting those needs; and (iv) identifying gaps in current monitoring programs and their associated risks.

The review was directed and largely undertaken by an Avian Monitoring Review Steering Committee, made up of experts from Environment Canada's Wildlife and Landscape Science Directorate (Science and Technology Branch) and Canadian Wildlife Service (Environmental Stewardship Branch). EC monitoring specialists and practitioners were engaged to obtain their expertise in ways that ensured continued objectivity. Further impartiality and transparency of the process were ensured by engaging an external expert review panel, which oversaw the monitoring review, provided ongoing direction, feedback and advice, and endorsed the process followed upon its conclusion.

WHY DOES ENVIRONMENT CANADA REQUIRE AVIAN MONITORING INFORMATION?

Effective bird monitoring programs reduce risks to bird populations and to EC by providing sound information to assist prioritization, planning, and conservation and management actions to protect or restore bird populations. Eleven primary areas within the Migratory Bird program outcomes benefit from effective monitoring data, of which three particularly depend on high quality monitoring data:

Managing landscape conditions to accommodate Migratory Birds demands data on the distribution and relative abundance of birds as well as information on long-term trends, in order to prioritize species, habitats and areas and to evaluate the effectiveness of management actions.

Managing sustainable Migratory Bird harvests requires information on population sizes and how they change over time, combined with information on survival, harvest rates, and productivity in order to ensure that hunting does not jeopardize harvested populations.

Assessing whether a species is at risk of extinction requires accurate information on population trends, distribution, and overall population size to ensure that species are accurately categorized; i.e., to reduce the risks of failing to list species facing serious problems or incorrectly listing species that are not at risk.

Monitoring information also contributes to minimizing incidental mortality of birds and their nests; reducing threats to migrants in other countries; protecting and managing priority sites for migratory birds; reducing population-level effects of toxic substances; protecting migratory birds in land claim areas; and reducing economic and public threats related to migratory birds. Finally, monitoring information is required to assist with recovery of species at risk and to evaluate the effectiveness of specific conservation, management or policy actions.

EVALUATION OF EXISTING MONITORING PROGRAMS

The comparison of the suite of current surveys against Migratory Bird program outcomes revealed that most existing monitoring programs contribute appropriate results that support EC's program needs. Only a few programs, mostly small-scale, were identified as no longer being required. Nevertheless, many surveys could be improved, with improvements ranging from enhanced survey design to better coordination among regions to improved data management, analysis and reporting.

Approximately half of total monitoring resources were directed towards programs supporting waterfowl management, due in part to the historical emphasis on harvest management. Several major waterfowl monitoring programs were intensively reviewed, revealing that most surveys continue to be important because of the high information needs required to support decision-making for harvest management. A few small programs were assessed as no longer necessary. There were some opportunities for scaling back some of the major breeding waterfowl surveys with minimal increase in risk. However, other waterfowl programs, particularly those for sea ducks (e.g., eiders and scoters), were deemed insufficient to meet information needs, and thus present substantial risk to EC in managing these species. Approaches were identified to improve the design of these surveys with current levels of funding, but success in implementing these will strongly depend on attracting sufficient partner funding.

Detailed evaluations of major monitoring programs for other species groups revealed key areas requiring additional investment or improved design. Shorebird monitoring requires new resources to expand breeding surveys and to develop improved protocols for migration monitoring. Effective seabird monitoring needs improved coordination of breeding colony surveys across the country and improved survey designs for pelagic monitoring. For colonial waterbirds, marshbirds and boreal landbirds, the development of substantial new suites of programs is required, beginning with the identification and evaluation of appropriate survey methods.

GAPS AND RISKS

A detailed gaps and risks analysis revealed major gaps in the current suite of monitoring programs that pose significant risks for bird populations and for EC. Most of the gaps relate to program outcomes in remote areas (boreal, northern British Columbia and Arctic) and other countries (Latin America and Caribbean). There are insufficient monitoring data for 30% of all bird species in Canada to determine reliably whether they should be listed as threatened under COSEWIC criteria. These include at least a few species in all bird groups, but with the largest numbers among shorebirds in the arctic, and landbirds in the boreal and the west. Some of these gaps are associated with high residual risks including biological, economic and credibility risks associated with insufficient data for effective landscape planning and management, particularly in remote areas with strong development pressures. This insufficient data also poses risks for the appropriate identification and listing of many species at risk and identification and implementation of conservation actions, particularly in other countries. The highest risk gaps are logistically and financially challenging, demanding extensive work in remote locations (e.g., Arctic or Boreal biomes, far from communities and roads). Resolving these deficiencies can only be achieved through some level of on-the-ground monitoring and substantial new investments, and not simply through redirection of current resources.

Strategies need to be developed for filling the high risk gaps, considering options at various investment levels and the extent to which each would reduce risks. Proposed strategies should consider new technologies and techniques to the extent feasible, though even with new techniques, most options will require significant new resources from EC and its partners.

NEED TO IMPROVE PROGRAM DOCUMENTATION

EC needs to continue and complete its work on developing and implementing metadata standards to facilitate awareness of what data exist (i) to make optimal use of the data collected through monitoring programs, (ii) to understand better the value and limitations of the data collected, and (iii) to reduce the risk of data loss. The current review process collected considerable metadata on current monitoring programs, but these need to be integrated into an effective metadata management system to ensure they can be well managed, readily updated, effective queried, and disseminated as required.

ENHANCING DATA MANAGEMENT, ANALYSIS AND REPORTING

Although most monitoring data sets are now in electronic format, many are not readily accessible nor securely backed up. The management of monitoring data should be integrated into a secure and accessible national data management system, such as WildSpace, that is managed to modern standards of quality control and that ensures access to data by all appropriate staff. Well-documented digital archiving of existing information is needed to reduce the risks of losing data through staff retirements or administrative changes.

While most data sets are currently analysed to some degree, analyses often do not use modern techniques, and the analysis results are not necessarily well-communicated. Procedures need to be developed to ensure that data sets are analysed with the most appropriate rigorous methods, that analytical approaches are consistent across regions, and that results are reported regularly. Reporting should also account for the wide diversity of information needs for monitoring data, e.g., ranging from raw GIS data needed for landscape planning to publicly-accessible trend summary information displayed on, for example, the EC Status of Birds in Canada website.

IMPLEMENTATION OF RECOMMENDATIONS

The primary responsibility for implementing recommendations on individual survey programs lies with those responsible for the programs – the regional directors, managers and biologists. Recommendations must be discussed with all program partners to ensure that any changes meet the needs of survey stakeholders. The Avian Monitoring Committee (see next section) should oversee the implementation of these recommendations, including making any necessary updates to reflect changing circumstances. This committee should work with the Information Management and Information Technology (IM-IT) Working Group to implement data management recommendations. Any new approaches, strategies or programs developed as a result of these recommendations should be brought to the Avian Monitoring Committee for review and endorsement prior to implementation.

ENSURING EFFECTIVE FUTURE MONITORING

Governance. A permanent Avian Monitoring Committee is needed within EC to oversee the recommendations of this review and to ensure that regular reviews become part of the operational procedures of the program. Roles of the Avian Monitoring Committee include: (i) verifying that needs and programs continue to be well-aligned and that resources are effectively directed to address the highest priorities; (ii) ensuring that nationally-consistent collaborative approaches are used for all bird species groups to address specific program needs; and (iii) improving avian monitoring program governance by linking the managers who identify the program needs with the biologists and practitioners who design and deliver the monitoring programs.

Regular review of existing and new programs. The Avian Monitoring Committee should develop a schedule to ensure that all surveys are reviewed regularly and at appropriate intervals. Surveys that are critical for decision-making, those involving major investments, and those presenting significant challenges or uncertainties should be reviewed most frequently, but all surveys should be reviewed at least every 5-10 years to ensure they remain relevant, efficient and effective. Review standards need to be developed to evaluate survey objectives, data requirements, survey design, focal parameters, and possible alternatives for collecting the same information. Although the current review was not designed to assess new or anticipated gaps, a similar approach could be undertaken to evaluate ongoing changes in Migratory Bird program needs and thus the extent to which the gaps, and consequently the risks, might change with modifications to existing monitoring programs.

Habitat monitoring. While outside the scope of this review, an overall assessment of bird habitat monitoring programs within EC remains a high priority. Effective habitat monitoring is essential for appropriate landscape management and can complement bird population monitoring by helping to reduce risks resulting from monitoring gaps. A review of existing habitat monitoring should involve a joint team of bird program managers and habitat program managers and should serve as a first step towards developing an effective habitat monitoring program in support of bird conservation activities, complementing avian population monitoring programs.

Ongoing collaborations. Many of the surveys reviewed here are highly dependent on partnerships with provincial and territorial governments, non-governmental organizations, and similar bodies in the USA. EC must continue to promote close collaborations with Canadian and US partners, including collaboration on program design to ensure that the needs of all partners can be met by surveys. Incorporation of monitoring data from the Caribbean and Latin America will improve understanding of hemispheric bird conservation needs and help develop collaborative relationships in those countries to enhance on-the-ground conservation. Additionally, the participation of volunteer data-collectors greatly increases geographic coverage across Canada and the power of the resulting data to detect population changes. Ongoing efforts are required to build and maintain the base of volunteer survey participants, including development of training materials and tools.

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FOREWORD

When we initiated this review four and a half years ago, we had no idea of the enormity and complexity of the task at hand, nor of the importance that the review would have in changing how we consider and manage bird population monitoring programs within Environment Canada (EC). This review was prompted by the North American Bird Conservation Initiative report, “Opportunities for Improving Migratory Bird Monitoring”, and a desire to optimize the monitoring programs that support conservation and management activities within the Department’s Migratory Bird Program. This initiative resulted in a comprehensive and scientifically-rigorous review of the majority of migratory bird population monitoring programs in Canada. It has been a project of discovery and innovation, with many false starts, but has ultimately proven to be very productive, informative and relevant.

In reviewing the many monitoring projects undertaken by staff from EC and its partner organisations, the contributions and dedication of innumerable survey coordinators, managers, analysts and participants – both past and present – were readily apparent. We dedicate this review to those professionals and amateurs who have been the mainstay of our bird survey programs, ensuring that information on trends in bird abundance and distribution has been available to support Canada’s bird conservation initiatives.

We hope that you share our enthusiasm for the honourable pursuit of counting birds effectively, and find this report useful in your activities to monitor and conserve the birds of Canada and North America.

ACKNOWLEDGEMENTS

The production of this report is due in large part to a small team of very dedicated individuals who have spent many days, weeks and indeed months reviewing and assessing the 190 different survey programs considered in this report. We gratefully acknowledge the dedication and commitment of the following individuals who worked with us on the Steering Committee for various periods over the four-year process: Dr. Luc Belanger, Dr. Peter Blancher, Mr. Dale Caswell, Dr. Bob Clark, Ms. Kathy Dickson, Mr. Garry Donaldson, Ms. Patricia Edwards, Dr. Bob Elner, Dr. Charles Francis, Mr. Joel Ingram, Dr. Jim Leafloor, Dr. Martin Raillard, Dr. Eric Reed, Dr. Greg Robertson, Dr. Fiona Schmiegelow, Dr. Samantha Song and Dr. Dan Wicklum. We thank Dr. Anna Calvert for her efforts in assembling and editing this report. Matthew Mahoney kindly prepared all the maps.

We also deeply appreciate the contributions of all individuals who were asked to provide feedback, analyse surveys or produce background documents which form much of the foundation for this report. These include Dr. Anna Calvert, Dr. Mark Drever, Dr. Paul Smith, and the members of the five EC Migratory Bird Technical Committees: Landbirds, Seabirds, Shorebirds, Inland Waterbirds, and Waterfowl.

Finally, one of the fundamental objectives of this project was to ensure that the process and results were objective and scientifically rigorous. The Expert Review Panel that was established to address these aspects and to help guide the project has endorsed the methods and procedures used in this Review. For this we thank the following members of the Panel for their thoughtful and insightful advice and feedback throughout the duration of the project: Dr. Ken Abraham, Ontario Ministry of Natural Resources; Dr. Brad Andres, US Fish and Wildlife Service; Dr. George Finney, Bird Studies Canada; Dr. David Howerter, Ducks Unlimited Canada; Dr. Bruce Peterjohn, US Geological Survey; Dr. Jake Rice, Department of Fisheries and Oceans; Dr. Phil Taylor, Acadia University; and Dr. Stephen Woodley, Parks Canada.

Co-Chairs, Environment Canada Avian Monitoring Review

Mr. Doug Bliss, P. Eng.
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Dr. Richard Elliot
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Environment Canada

“Birds are indicators of the environment. If they are in trouble, we know we'll soon be in trouble”

Roger Tory Peterson (1908-1996)

CHAPTER ONE – Introduction

BIRDS IN CANADA

From iconic loons and Canada Geese to warblers breeding in remote boreal forests, birds in Canada are valuable from a number of perspectives. Their worth is at once ecological (e.g., as important pollinators and essential links in natural food webs), scientific (e.g., as indicators of environmental change), economic (e.g., as part of long-standing sport harvests and non-consumptive recreational activities such as bird-watching), cultural (e.g., as food sources and spiritual icons to Aboriginal peoples), and aesthetic (e.g., integral to Canadians' appreciation of their natural environment), yet numerous threats leave many bird populations at risk. Appropriate conservation actions are required to maintain healthy populations in the face of habitat change, climatic fluctuations and mortality directly related to human activities. Game species need to be carefully managed to ensure that harvests are sustainable. To be effective in decision making, to set priorities appropriately, and to plan use of resources efficiently, avian conservation and management demand monitoring data that are accurate, precise, comprehensive and representative of population change.

THE ROLE OF BIRD MONITORING IN CONSERVATION

***Monitoring in support of conservation*.** Understanding changes in important characteristics of bird populations, such as population abundance, population distribution and basic vital rates (e.g., productivity and survival), is essential to direct effective conservation and management. Monitoring generates fundamental information upon which policy, conservation and management decisions rely, and is therefore integral to directing conservation policies and actions guiding regulatory activities. By providing insight into how specific bird populations are changing over time, monitoring – sometimes supplemented by specific studies and research – allows for reliable assessments of the biological significance of the change and the development of an appropriate management response. For many monitoring programs, by directly involving the participation of citizen scientists of all ages across the country, bird monitoring further benefits conservation by introducing the public to natural environments, educating them about ongoing threats to birds and their habitats, and training a future generation of bird banders and naturalists.

***Definition of monitoring*.** For the purposes of this review, monitoring is defined as the long-term, repeated collection of population-related information to detect and quantify changes in numbers (population size, relative abundance), distribution (range), or key vital rates (e.g., survival, mortality, harvest, productivity). This review also considered "inventories", defined as surveys that provide information on the status of bird populations at a particular point in time (generally numbers and/or distribution, often limited in geographic area), but which were not designed to be repeated. In some cases, it may be possible to turn an inventory into a monitoring program by repeating it, although the survey design may not be optimized to detect trends. The term "survey" is used as a general term to include monitoring and inventory programs as well as any other programs that provide some level of information on the status of birds or factors that may affect them, and may or may not be repeated over time.

Monitoring data, and to a lesser extent inventories, provide information on the current status of bird populations in relation to population objectives, and can help to (i) understand the health of bird populations and the habitats that support them, (ii) identify priorities for conservation actions, (iii) assist in understanding the causes of population declines and changes, and (iv) support and evaluate conservation and management actions, including regulatory activities.

After initial assessment, this review excluded four categories of surveys which did not fit its scope: surveys using birds as indicators of environmental toxins; habitat surveys; research projects aimed at answering specific questions (why is something changing); and, wildlife disease surveys. Although all of these types of surveys can contribute to bird conservation, their objectives are broader and extend beyond those considered in this review.

Monitoring science. Monitoring is a rigorous scientific tool that can be used to answer specific questions about the population status of birds - e.g., is the size of this population changing over time and if so, in what direction and at what rate? Appropriate statistical analysis methods, based on well-designed monitoring programs, allow for testing of scientific hypotheses and rigorous statistical inference about the current status of populations with measurable precision and confidence. Clear articulation of the question being addressed is required to ensure (i) appropriate design of the monitoring program, and (ii) subsequent achievement of useable results.

Monitoring as part of the management cycle. Science-based natural resource conservation and management relies on an understanding of the amount, distribution and health of the resource in question, and of changes to these general parameters over time. When the degree of change exceeds some acceptable limits, specific activities are undertaken to try to reverse the trend. The selection of the appropriate intervention, such as policy development or on-the-ground action, and tracking of its success, are important science-based components of the management cycle. Monitoring enters this cycle at two key points: firstly in tracking key parameters through status monitoring, and secondly in evaluating conservation progress through effectiveness monitoring (see steps A1 and F in Figure 1.1).

Adaptive management. Monitoring is an integral component of adaptive-management, a science-based approach to managing populations in the presence of uncertainty. Due to the complex character of interactions among wildlife species and stressors within natural systems, prediction of population trends is usually imprecise. Nevertheless, management decisions often need to be taken even when there is considerable uncertainty about causes of change or consequences of particular actions. Monitoring is required to evaluate the consequences of management actions and to determine whether they are consistent with the original predictions. Well-designed monitoring can be used to update the predictive models and to modify the conservation actions accordingly to ensure that they are both effective and cost-effective. The role of monitoring in the adaptive management cycle is illustrated schematically in Figure 1.1.

RESPONSIBILITY FOR BIRD CONSERVATION

Conservation of birds. Canada's federal government has the responsibility for the stewardship, conservation and management of migratory birds, as populations and individuals, through the treaty with the United States, the *Migratory Birds Convention* (1916) and the enabling *Migratory Birds Convention Act* (MBCA; 1917, 1994). The responsibility is exercised through the monitoring of species in all five bird groups – shorebirds, landbirds, seabirds, waterfowl and inland waterbirds -- with a focus on those species regularly occurring in Canada. Similar responsibility for additional bird species, those not identified in the MBCA, remains with provincial and territorial governments. However, as both groups of species often occur in the same locations and habitats, many multi-species, large-scale monitoring initiatives, such as the continental Breeding Bird Survey or regional breeding bird atlases, cover species that fall within both federal and provincial/territorial jurisdiction. Multiple levels of government cooperate in delivery of some programs such as breeding bird atlases. Canada also has a long history of collaborative monitoring with United States government agencies and non-government organizations, including long-term continental-scale monitoring programs such as the Breeding Bird Survey, Christmas Bird Counts, banding programs and many waterfowl surveys. Canada often cooperates with the U.S. in analysis of the data, including coordinated population status assessment undertaken through Partners in Flight (PIF), the North American Waterfowl Management Plan (NAWMP) or other pillars of the North American Bird Conservation Initiative (NABCI) and the incorporation of monitoring results into conservation, management and policy decisions and actions.

Results Management Accountability Framework. The Migratory Bird Results Management Accountability Framework (RMAF, see Chapter Three) identifies the objective or outcome of EC's migratory bird programs to be the maintenance of migratory bird populations at healthy levels. In order to meet this objective, it is essential to understand their population status, trends and impact of various stressors and interventions. Monitoring programs include those focused on determining the current status of bird populations in Canada (*population status monitoring*), those aimed at understanding the population dynamics of populations (*demographic monitoring,* including *survival* or *productivity monitoring*), those that target populations of significant conservation concern, , and those that undertake and evaluate the success of particular conservation actions.

Recovery of species at risk. The federal Species at Risk Act (SARA; 2003) addresses, amongst other things, the identification and recovery planning of nationally important species at risk, and it thus places additional responsibility on the federal government for the protection and recovery of listed migratory birds. It calls for the identification and assessment of species at risk, including birds, with specific reference to determining the magnitude and significance of declining population trends, and monitoring the effectiveness of recovery actions. These activities may overlap with broad-scale population monitoring, but often take the form of more localised programs designed to support single-species conservation. Furthermore, monitoring programs for species at risk may involve efforts to census entire populations, rather than surveys which only sample representative portions of bird populations.

Habitat conservation. Responsibility for the management of habitats and landscapes falls largely within the jurisdiction of the provinces and territories, although the Canada Wildlife Act (1973) and other federal legislation such as the Canada National Parks Act (2000) give federal jurisdiction over wildlife habitats in federally-protected areas. These acts also promote close federal-provincial/territorial cooperation in addressing needs for the conservation of wildlife habitats throughout Canada. Monitoring changes in the quality, quantity and distribution of bird habitat is an important challenge often undertaken through partnership initiatives that address a range of needs.

CHALLENGES OF MONITORING BIRDS

Diversity of monitoring programs. Unlike most environmental monitoring programs (e.g., weather conditions, air quality, water quantity, water quality programs) which often use standardized automated instruments, monitoring of birds requires a diversity of approaches, reflecting differences in the ecology, distribution and behaviour of different bird species. Birds are living, moving, complicated animals, and thus although some aspects can be addressed through instruments, remote sampling and automatic data collection, many demand direct human involvement or present important logistical obstacles, such as:

- identifying individuals by song (e.g., forest songbirds) or by sight, often at a distance (e.g., pelagic seabirds)
- detecting individuals present in complex or challenging habitats (e.g., remote areas of the arctic, burrow-nesting species on offshore islands) or which are active at different times of day (e.g., cryptic marshbirds, whip-poor-wills)
- counting or estimating numbers in huge flocks (e.g., tens of thousands of roosting or flying shorebirds)
- combining observations made from the air (e.g., from a helicopter or light aircraft),from the ground (e.g., point counts, fixed observation stations) and from the sea (e.g., boat-based counts)
- detecting systematic population change against a background of considerable natural variability
- adjusting survey timing and analysis to account for changes in season, day or even tides
- accounting for the influence of confounding factors (e.g., effect of habitat change over time)
- capturing, storing and analyzing large quantities of detailed data

Monitoring of individual species. Effective conservation of birds in Canada requires some level of population status information for every regularly occurring bird species in Canada. Unlike other types of monitoring where indices may be considered representative of overall environmental conditions (e.g., the monitoring of a few pollutants may provide sufficient indicators of air quality), the ecological and demographic diversity of birds means that the monitoring of a few selected “indicator” species is not sufficient to represent changes occurring in populations of other species. Indeed, populations of closely-related species breeding in similar areas may show highly divergent trends in response to the same threats, perhaps due to subtle differences in their ecology, migration routes or wintering areas.

This supports the need for detailed long-term monitoring of as many individual species as possible within each of the species groups. There are 658 species of birds presently known to occur in Canada (excluding extirpated and extinct species), of which 427 regularly breed in Canada and an additional 24 species regularly visit or migrate through Canada in their non-breeding season (Kennedy 2011). EC has jurisdictional responsibility, under the MBCA, for conservation of 555 of these, including 388 species that regularly occur in Canada (363 as breeders and 25 as non-breeders). In order to accurately measure population change of a given species, monitoring data must be specific to that species, and ideally representative of the entire population of interest of the species.

Many different programs are required to monitor every species for which EC has responsibility. For example, early morning point count surveys (such as the Breeding Bird Survey) are effective for sampling many species of widespread songbirds, but different programs are required to sample species such as waterfowl, nocturnal species, colonial waterbirds or secretive marshbirds. In many southern parts of Canada, volunteers can be used

to assist with surveys, but specialized surveys are required for species nesting in remote or inaccessible areas such as arctic-nesting shorebirds or colonial seabirds. Many species at risk are too rare to be detected in adequate numbers by omnibus surveys and require special targeted surveys. As EC has jurisdictional responsibility for each species of migratory bird occurring in Canada under the MBCA, population status information derived from monitoring is required to some extent for each species.

Long-term monitoring. Migratory bird monitoring entails repeatedly measuring abundance, distribution, or vital rates, using standard methods to determine population status and trends. While monitoring programs vary in their species coverage (e.g., single- vs. multi-species surveys), frequency, geographic scope, parameters measured, and power of detecting change, one common feature is the requirement for long-term data collection. Imprecision in measurements, influence of external factors such as weather on counts, small sample sizes for rare species, and naturally-occurring fluctuations all increase data demands such that most programs require monitoring over at least ten years (or often much longer) in order to derive statistically-valid estimates of trend or other parameters of acceptable precision.

The human dimension. As a result of these demanding conditions, considerable emphasis is placed on human abilities and skills to meet these monitoring challenges. For instance, many monitoring programs require experts to work in difficult locations (e.g., in seabird cliff colonies), remote sites (the high Arctic) or specialized situations (aerial waterfowl or shorebird surveys), or necessitate the participation of skilled observers, volunteers or contractors who act as detection instruments spread across the country (e.g., Breeding Bird Survey, breeding bird atlases). This requires considerable training, experience, standardization, and attention to occupational health and safety considerations, with associated high human resources management costs (rather than instrument costs). Although opportunities are being sought for automated detection and counting of birds (e.g., remote song detection, radar detection of night migrants), these approaches still require considerable human involvement for deploying instruments and interpretation of results.

DELIVERY OF MONITORING PROGRAMS IN CANADA

Collaboration. Although EC is involved to some extent in each of the programs discussed here, only a small percentage of programs are delivered entirely by EC. Most major programs involve essential collaboration with external agencies, with other levels of government, with non-governmental organizations, and with university researchers, and over half the total financial investment in avian monitoring programs comes from these external sources. For example, many waterfowl programs are delivered in coordination with both the US Fish and Wildlife Service and provincial governments, with funding support from variable sources and often coordinated through Flyway Councils. Additionally, some key monitoring programs are delivered in collaboration with universities, such as the long-term research and monitoring programs for Greater Snow Geese and several seabird species. Finally, NGOs such as Ducks Unlimited and Bird Studies Canada play a major role in the implementation of several monitoring programs (e.g., waterfowl surveys and many different citizen science monitoring programs, respectively).

Citizen scientists. A unique aspect of avian monitoring is the important contribution made by “citizen scientists” – volunteer naturalists who are skilled in bird identification and willing to contribute to bird conservation programs. Many programs are highly dependent on citizen science contributions to increase the temporal and geographic coverage of data collection in a relatively standardized manner. For instance, volunteer-driven programs such as the continental Breeding Birds Survey enable standardized monitoring over huge geographic areas at relatively moderate cost. Although data collection by professionals can often facilitate implementation of more scientifically rigorous survey designs (e.g., fully randomized sampling in remote areas), their intensive scope is limited by the number of professionals and resources available. Some volunteer-based programs, such as the Breeding Bird Survey, are statistically rigorous based on a formal survey design, although their region of coverage may be limited. Other volunteer surveys lack a formal design, such as Christmas Bird Counts or checklist programs, but nevertheless can provide high statistical power due to the large quantities of data available. Indeed, more than three-quarters of all personnel-time invested in avian monitoring derives from partner contributions and volunteers, the bulk of which comes from volunteer-driven surveys such as breeding bird atlases and the Christmas Bird Count. As a result, the required outreach and provision of specific training materials and data-recording protocols are more than compensated by the benefits of citizen science programs.

EVOLVING CONTEXT OF BIRD MONITORING

Constraints to monitoring. EC's migratory bird monitoring programs are confronted with considerable challenges. Despite growing internal and public concerns for the health of bird populations, the population status and trends of many bird species remain uncertain, creating regulatory and other associated risks to the department. Implementing adequate sampling regimes in key regions, particularly in remote areas such as the boreal forest or the Arctic, and for rare or elusive species, presents logistical problems that are difficult to surmount with limited resources. Partial solutions may be found by balancing available resources, harnessing and developing new technologies, and optimizing the frequency and allocation of sampling effort.

Monitoring of species groups. The ways in which birds are monitored depend to a large degree on the intended use of the results. Historically, the need for effective monitoring of bird populations focussed on understanding trends and population dynamics of migratory game birds – particularly waterfowl (ducks, geese and swans) – in order to ensure that established hunting regulations maintained harvests within sustainable levels. Preliminary monitoring programs during the 1940s to 1960s evolved significantly during the 1970s and 1980s, creating the sophisticated programs undertaken today by Canadian and US partners to monitor populations and harvest levels of North American game birds. Monitoring programs for seabirds, shorebirds and landbirds were developed during the 1960s and 1970s as increasing concerns were raised over risks to their populations and over declines resulting from direct impacts of human activities, including habitat changes, although some species still present challenges for effective monitoring.

Birds as indicators of ecosystem health. As long-term data began to accumulate from these monitoring programs, it became evident that when interpreted appropriately, the monitoring of change in bird populations could also provide (i) significant insight into broader ecosystem change, and (ii) surrogate indicators of the degree of change for certain other components of Canada's natural biodiversity. Increasing concern over the effects of changing climates on Canadian biodiversity, and indications that climate change is already impacting the health of many Canadian bird populations (e.g., important directional changes in migration timing or species range that have been linked to broad-scale climatic shifts), have recently added to the need for effective monitoring.

Monitoring in support of new conservation priorities. From EC's perspective, several emerging initiatives require a detailed understanding of the sizes and trends of bird populations and of the impact of human activities in contributing to population declines. One important example is the need to understand and minimise the effects of incidental take, the unintentional destruction or mortality of birds and their nests as a result of industrial activities such as energy development, forest harvesting, commercial fishing or agriculture. Monitoring information is needed to identify the affected populations and the likely impacts of human activities and infrastructure on these populations, as well as to design and assess the success of mitigation measures in addressing these population-level concerns.

THE AVIAN MONITORING REVIEW

IMPETUS

Regular program assessments. EC decision-makers are committed to improving program and policy performance over time, and to responding confidently to changing legislation and regulations, socioeconomic and environmental conditions and risks, and associated demands on Natural Capital (Environment Canada 2007). Effective operation of science-based conservation agencies like EC requires regular program reviews to ensure that evolving objectives continue to be met in scientifically-defensible and cost-effective ways. Periodic assessments also help to determine whether program goals and assumptions remain valid, and allow for integration of new priorities and approaches. Although many specific surveys have been reviewed at the project-level, a comprehensive review of all avian monitoring programs by EC and its partners, including an assessment of their effectiveness in providing information needed for conservation of migratory birds and of species at risk, had never previously been undertaken.

Making efficient use of limited resources. Because environmental monitoring programs in many countries have been criticized for being expensive, uninformative and potentially wasteful, several proponents have identified features of successful programs (e.g., Lovett et al. 2007). Cost-effective monitoring is best achieved by designing programs that assess specific program or policy hypotheses (Nichols and Williams 2006), and indeed this is a key component of the emerging EC science priority of implementing adaptive resource management to evaluate programs and policies (Walters 2001, Environment Canada 2007; see also Figure 1.1). Priority needs and related gaps in information must therefore be identified in order to make the most efficient use of limited resources.

Population monitoring costs account for a significant portion of the Canadian Wildlife Service annual operating budget, and it is imperative to ensure that these funds are used appropriately.

Ongoing changes in Environment Canada needs. Each of the initiatives in EC's current suite of migratory bird monitoring programs was initially developed to address a particular need or to fill an identified information gap. However, strategic drivers of EC's wildlife conservation policies and programs change over time, in some cases quite rapidly. New environmental challenges and stressors may require a greater emphasis on different aspects of the program. For example, when the Canadian Wildlife Service was formed 65 years ago, the dominant concern was ensuring sufficient information for management of waterfowl harvest. While this remains important today, new challenges are also demanding attention, such as management responses to impacts of incidental take (nest destruction or bird mortality due to human activity or infrastructure on the landscape), green energy projects such as wind farms, and bird-borne diseases (e.g., pathogenic avian flu). Increasing numbers of species appear to be declining, and many are being listed as "at risk" under the Species at Risk Act, necessitating effective monitoring to understand the causes of population change. Within EC, there is also a strong desire to advance a more integrated, predictive modeling framework to guide decision-making. In the context of these diverse and ever-changing roles of bird monitoring, this review also aimed to identify and prioritize any gaps in EC's existing suite of programs that result in the current priority program needs not being fully met.

GOALS AND OBJECTIVES

Objectives. The overarching goal of this review was to refine, develop and implement a well-focused and cost-effective Canadian bird population monitoring plan that meets the current needs of EC. Specifically, the objective was to ensure that bird-related monitoring programs undertaken by EC or its partners provide all the necessary information to support EC's Migratory Bird Results Management Accountability Framework [RMAF] and other departmental priorities, in a timely manner and in ways that:

- are results-driven,
- are cost-effective,
- are scientifically-rigorous,
- provide readily accessible results, and
- take advantage of modern technology.

Questions. Elements of EC's wildlife monitoring programs have been assessed periodically, but a complete evaluation of migratory bird monitoring had not previously been conducted. Given conceptual and technical advances in monitoring and modeling, a thorough review and modernization of migratory bird monitoring was considered to be timely. Therefore, these four broad questions were posed:

- What programs have been established to monitor migratory birds in Canada and elsewhere?
- Does the information acquired explicitly inform decisions made by EC and its partners?
- Are programs using the most up-to-date and cost-effective methods and technologies?
- What steps are required to improve these monitoring systems, data management, data analysis and reporting, and use of the data for model development, testing and refinement?

Steps. The main components of this review consequently focused on identifying program outcomes supported by monitoring, evaluating existing programs against the monitoring needs for these outcomes, and identifying remaining Gaps and Risks posed to EC by these gaps. The key steps were:

1. Conduct a "**Needs** assessment" (linked to the Migratory Birds RMAF), aimed at identifying the principal bird-related monitoring needs of EC and partners.
2. Determine what monitoring programs were being undertaken by EC staff and partners (focusing on programs being undertaken, supported by or relevant to EC between 2007 and 2010), and assess how well they were meeting current EC needs and whether there were potential areas of overlap or redundancy .
3. Identify areas where additional or more efficient monitoring is needed (**Gaps**) and assess the **Risks** of not filling these gaps.

The primary desired end-products of this review process were (i) increased efficiency and effectiveness of current programs and (ii) identification of potential improvements to the current suite of monitoring programs. This could enable some re-assignment and re-investment of resources in other bird monitoring programs to reduce the risk to EC of identified priority information gaps, and would result in a more effective, targeted monitoring program appropriately focused to support priority EC conservation needs. This also provides a basis for identifying areas that cannot be filled with existing resources and the associated risks of not enhancing investment to fill these gaps.

SCOPE OF THIS REVIEW

Environment Canada needs. The primary purpose of this review is to promote the development and implementation of a comprehensive, coordinated and effective Canadian bird population and distribution monitoring plan and program. In the context of EC's specific conservation-oriented needs for bird-related monitoring information, it identifies areas of potential overlap or redundancy, as well as areas where additional or more effective monitoring is needed.

Partner needs. Such an assessment is also of direct benefit to EC's partners in avian conservation, including other countries in the Americas which have shared responsibility for populations of North American migratory birds, and the provinces and territories which have primary responsibility for the conservation of bird habitat. Additionally, many non-governmental organizations are directly involved with the implementation of numerous monitoring programs and have their own needs for monitoring data. Coordination of monitoring and sharing of monitoring data among these organizations are facilitated by networks such as the North American Bird Conservation Initiative (NABCI). The United States NABCI committee conducted a high level review of current bird monitoring programs in North America, and developed a 2007 document entitled "Opportunities for Improving Avian Monitoring", which provided some of the impetus for this Review.

The scope of monitoring within this review. The primary emphasis of this review is monitoring programs intended to support the conservation of birds, and focussed on tracking parameters related to bird populations themselves, such as the abundance and distribution of individuals, or the magnitude of key life history characteristics or vital rates, such as productivity or survival. Surveys aimed at understanding particular stressors on the size or health of bird populations are also included, especially those related to human activities such as the harvest of game birds, and conducting beached bird surveys to document trends in the impacts of oil at sea on bird populations.

Three main categories of surveys identified in the initial round of assessments were not included in the subsequent detailed evaluations. Surveys using birds as indicators of environmental toxins are excluded from detailed review, as they are not aimed at measuring toxin impacts on bird populations. Similarly, although habitat monitoring programs are critical to bird conservation, their detailed assessment was beyond the capacity of this review and should instead be evaluated in a separate process. Finally, surveys which were primarily research projects aimed at answering specific research questions, usually on a local scale, were not evaluated in detail. A few surveys monitoring wildlife disease were also excluded; although they do provide some information on potential population level impacts on birds, their main motivation has been related to evaluating the risks of transmission of diseases such as West Nile Virus or Avian Influenza to human or domestic animal populations and impacts on the birds themselves are a secondary consideration.

Contextual components. This review was carried out jointly by the Canadian Wildlife Service (CWS) of the Environmental Stewardship Branch and the Wildlife and Landscape Science Directorate (WLSD) of the Science and Technology Branch of EC. Renewed emphasis on the effective use of science in support of management and conservation within EC led to the creation of the Science and Technology Branch in 2005, and the completion of the Environment Canada Science Plan in 2007. Within the context of the EC wildlife program, science includes a range of research, monitoring, analytical, modelling, interpretive and predictive approaches that enable the application of scientific findings to policy, regulation and conservation. CWS has primary responsibility for delivery of bird monitoring programs within EC, as well as coordination and delivery of management activities, including regulatory activities, which make use of monitoring data. WLSD has responsibility for providing science support to the program, including research to understand the causes of observed changes in bird populations and development of new monitoring techniques and protocols.

REPORT ORGANIZATION

This report summarizes the approach and findings of the Avian Monitoring Review process. It begins with a description of the methodology adopted for this review, including the people involved in this process and the information that was requested from them (Chapter Two). Next, we consider Migratory Bird Program Needs (Chapter Three), with linkages to a Government of Canada Results-Based Accountability Framework, which is essentially a logic diagram of EC's migratory bird program. Subsequently, the basic components of EC's migratory bird program for each of the five main species groups (landbirds, shorebirds, seabirds, inland waterbirds, waterfowl) are described, together with the kinds of monitoring and associated resources being invested in each component (Chapter Four). Evaluations of surveys, including detailed assessments of some large monitoring programs, are provided in Chapter Five, while Chapter Six outlines important data management

and analysis considerations. Chapter Seven identifies gaps and risks resulting from discrepancies between existing monitoring activities and current program requirements. The overall conclusions of this review and resulting recommendations for the future of avian monitoring programs are presented in Chapter Eight. References, a glossary of terms and acronyms, and other supporting documents (e.g., supplementary tables) are included as appendices.

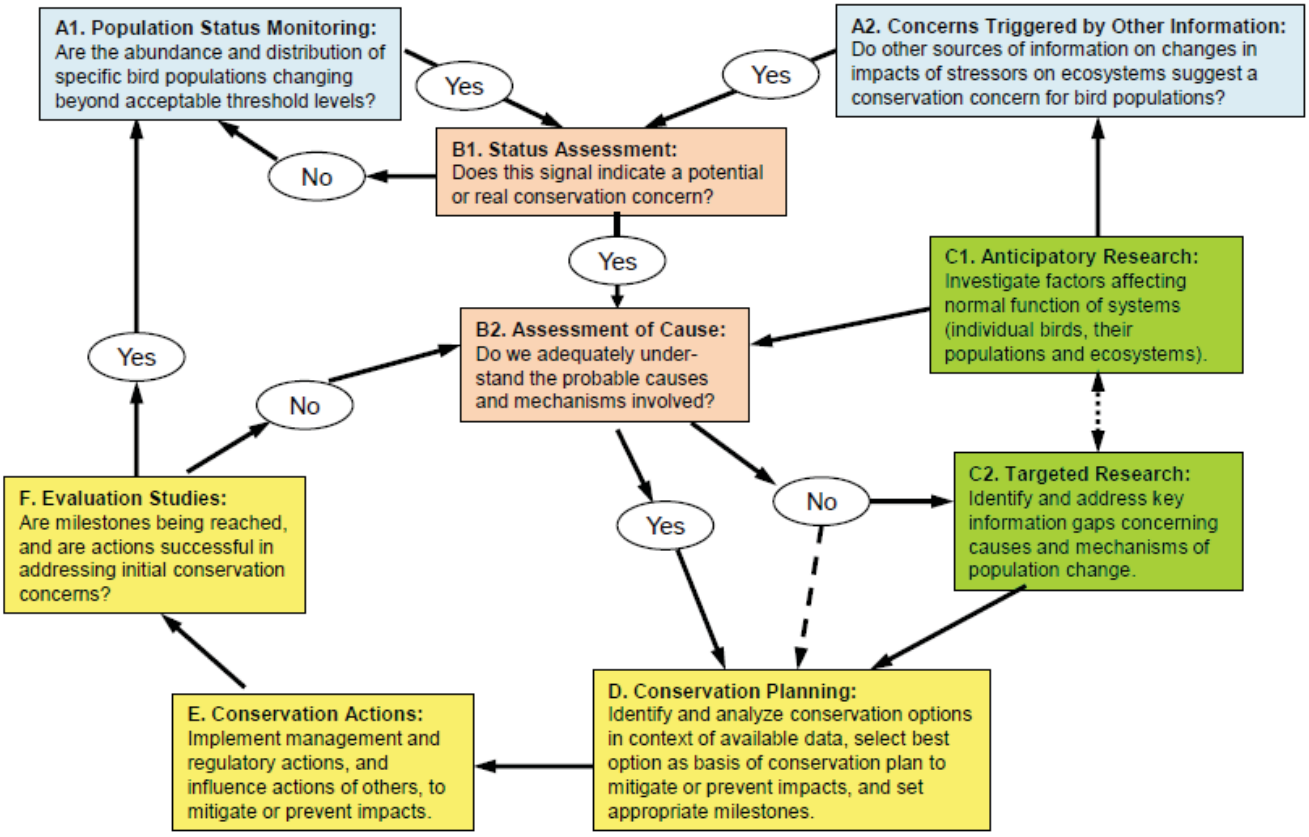

FIGURE 1.1. Schematic representation of the science-based Adaptive Management approach used for wildlife conservation by EC. This iterative cycle incorporates science, policies and societal factors as the basis for management and conservation, aimed at being *science-based*, *anticipatory*, *responsive*, *precautionary*, *comprehensive*, *efficient* and *parsimonious*. Its interconnected steps focus on: (A) "What is changing?", (B/C) "Why is it changing?", (D) "What should be done?", (E) "Taking action", and (F) "Is it working?". Initially, bird populations of conservation concern are identified, most often through changes in population and abundance detected through population monitoring (A1), although other relevant sources of information are also used as indicators of potential conservation concerns (A2). Next, the significance of the observed signal (e.g., population decline) is assessed relative to population and conservation objectives (B2). If it is deemed to be a conservation concern, potential causative factors are assessed (B2). This assessment process is often facilitated by research, which may either be directed at general population and ecosystem characteristics prior to identification of specific conservation needs (C1) or targeted toward specific conservation needs identified during the assessment (C2). Monitoring data derived from the assessment steps are then combined with research findings, in the context of management concerns, policy requirements and societal issues, to produce a conservation plan (D). Once the conservation plan is identified, the appropriate management actions (which may include changes in regulations, direct conservation action or habitat protection, or indirect effects through partnerships and influences) are implemented (E). Finally, the critical evaluation step (F) is specifically designed to assess progress toward the desired population-level outcome as a result of undertaking selected conservation actions. It is intended to measure the effectiveness of the management action, and indicate when the desired result has been achieved. It serves as the basis for an evaluation of the effectiveness of specific management actions, such as changes in harvest of a declining species, in moving towards the ultimate conservation objective in terms of changes in population levels of the species. In cases where the desired population-level results or objectives are not being achieved at the desired rate, the evaluation step is essential in identifying the need to re-enter the iterative process at the assessment step, and to re-assess the conservation concern and management response through a subsequent iteration of the adaptive management cycle. The revised assessment again considers the available information, including the results of the conservation interventions and any new information available, in assessing the population status, identifying necessary research and planning further conservation interventions.

CHAPTER TWO – Methods

GENERAL APPROACH

Review philosophy. The approach adopted in this review was intended to ensure an objective, critical, transparent and defensible process. By engaging the direct participation of staff members, internal EC specialists and external experts, the process covered numerous perspectives and identified monitoring needs from a variety of sources. A review of this scale had not previously been undertaken by EC, and thus the process needed to be developed and to some extent modified throughout the review period. Nonetheless, the review was enhanced by methodological advice from the panel of external experts, while the recent report from the North American Bird Conservation Initiative-US entitled "Opportunities for Improving Avian Monitoring" (NABCI-US 2007) provided a valuable template from which to work.

Program coverage. In the context of this review, "survey" is a general term used to describe any project designed to collect information on the status of bird populations. Any type of survey that involves repeatedly collecting data over time to identify change can be considered a monitoring program. Monitoring programs can evolve from the repetition of inventories (i.e., one-time surveys intended to determine the current status and distribution of populations). For the purpose of this review, the following types of monitoring were mainly considered:

- *Status or surveillance monitoring*: a widespread activity conducted at regular intervals, often annually, to determine population status and to detect changes in population components, generally at the regional or national level (i.e., monitoring the status of the overall population). This may involve monitoring population size, or an index of population size, distribution, or demographic parameters such as productivity, mortality or survival.
- *Effectiveness or evaluation monitoring*: intended to evaluate the effectiveness of a conservation intervention, often involving repeated counts at regular intervals, in specified areas, using standardised techniques. This often takes place at a smaller scale than status monitoring (i.e., at the scale of the management activity).
- *Research monitoring*: targeted tracking of population or demographic information, usually at a local scale, aimed at evaluating or understanding causes of population changes

The Avian Monitoring Review was focused primarily on status monitoring, although many monitoring activities can potentially contribute to one or more of these categories at the same time. The review also considered some inventories, especially those with the potential to evolve into monitoring programs in the future. Some research monitoring programs were considered, but the AMR did not make recommendations on these unless they also contributed to status monitoring.

Committee members. The review was directed and largely undertaken by the Avian Monitoring Review Steering Committee, made up of experts from EC's Wildlife and Landscape Science Directorate (Science and Technology Branch) and Canadian Wildlife Service (Environmental Stewardship Branch). Over the course of the review there was some turnover in the membership, as indicated by the arrows:

- Doug Bliss (CWS co-chair)
- Dr. Dan Wicklum (WLSD co-chair until June 2008)
- Dr. Richard Elliot (WLSD co-chair from July 2008)
- Dr. Bob Elner (WLSD, Scientist Emeritus)
- Dr. Bob Clark (WLSD)
- Dale Caswell → Dr. Samantha Song → Dr. Jim Leafloor → Joel Ingram (CWS)
- Dr. Charles Francis (CWS)
- Dr. Eric Reed (CWS)
- Garry Donaldson (CWS)
- Dr. Greg Robertson WLSD
- Dr. Fiona Schmiegelow (WLSD, until 2009)
- Dr. Luc Belanger (CWS, until 2010)
- Dr. Martin Raillard (WLSD) → Patricia Edwards (CWS) (AMR coordinator)

Other experts also led specific survey evaluations and technical committees. A major ongoing working group was the Monitoring Needs Team, which was made up of Dr. Peter Blancher, Kathy Dickson, Dr. Richard Elliot (Chair), Dr. Charles Francis, Dr. Eric Reed and Dr. Greg Robertson.

External Review Panel. In order to further guide the review process in an objective manner, the participation of expertise external to EC was also enlisted. Members of the AMR External Review Panel included representatives of federal and provincial agencies (Dr. Jake Rice, Department of Fisheries and Oceans; Dr. Stephen Woodley, Parks Canada; Dr. Ken Abraham, Ontario Ministry of Natural Resources), NGOs (Dr. George Finney, Bird Studies Canada; Dr. David Howerter, Ducks Unlimited Canada), academia (Dr. Phil Taylor, Acadia University), and US agencies (Dr. Bruce Peterjohn, US Geological Survey; Dr. Brad Andres, US Fish and Wildlife Service).

ASSESSMENT PROCESS

QUESTIONNAIRES

The first step in the process was to gather information on the existing suite of bird surveys in Canada that could potentially provide information on status or trends of bird populations (see "*Programs Overview*" in Figure 2.1). This included surveys run or supported by EC, as well as a number of surveys not currently supported by EC but potentially relevant to EC programs.

Two main questionnaires were used to collect information on each survey covered in this review. The choice of survey programs assessed in these questionnaires – and thus the total number of survey programs considered in this review – was based partly on the discretion of staff members; when in doubt about whether a survey was a 'monitoring program', staff members were instructed to complete a questionnaire, and the AMR evaluated whether it qualified based on the information provided.

The first questionnaire, provided in Microsoft Excel format, requested descriptive survey information such as species coverage, chronology, geographic coverage, and resource requirements (see sample in Table 2.1). The second questionnaire, provided in Microsoft Word format, requested a self-assessment of each survey, including questions about the application of monitoring data to management needs and decision making, and about the management and analysis of data collected (see sample in Table 2.2). These questionnaires were generally filled out by the coordinator of the survey, but with guidance and input from selected EC staff with expertise in each particular bird group – the names of people involved in collecting or assessing the information on each survey were included in the questionnaire.

A few programs missed in the first round of questionnaires were subsequently identified, and in most cases a questionnaire was later completed, although there were a few for which a second round questionnaire was never completed. A few pilot programs that began during the review process were not formally assessed.

In total, 186 sets of questionnaires were completed through this process, though the scope of each survey varied greatly in scale and coverage. In some cases, separate questionnaires were filled out for each of several regional surveys (e.g., each of the 5 main regional nest records schemes has a separate questionnaire, and an additional one was completed for a more recently developed national scheme), while in other cases a single questionnaire was completed for an entire suite of closely related but distinct projects (e.g., Arctic goose banding). Furthermore, a number of the surveys were determined to be research programs, rather than monitoring, or were considered outside of the scope of the review (e.g., using birds as indicators for monitoring of toxic chemical levels in the environment). These were included in the initial questionnaires, but were not evaluated in detail. As such, although 186 surveys were considered in this review, this number cannot be considered a reliable measure of the number of different programs being carried out for each bird group.

REVIEW COMPONENTS

Needs assessment. Prior to a formal assessment of individual surveys, the information needs for EC and its partners had to be identified ("*Outcomes & Information*" in Figure 2.1). This process involved (1) the identification of components of the Migratory Bird Program requiring information, (2) consideration of the role that monitoring plays in each program area, and (3) description of the characteristics of monitoring required to support each program outcome. From the total of 11 primary program areas identified through this process, a final list of 34 detailed outcomes (sub-components of the 11 primary outcomes) which require monitoring data were characterized in detail. The needs identification process is fully described in Chapter Three.

Survey assessments. Next, each survey program was assessed against various criteria as follows ("*Survey Assessments*" in Figure 2.1):

(i) is it a monitoring program?
(ii) what is its relevance to the identified needs?
(iii) is it cost-effective for EC?
(iv) does the design provide reliable data?
(v) are the data being used for decision making?
(vi) are the data being used in the way for which the survey was designed?

This assessment was carried out by members of the Steering committee, based on a combination of the information provided in the questionnaires along with the expert knowledge of the committee members, which included biologists and managers with expertise in each of the five major bird groups. Initially, all surveys were divided among the steering committee, with each survey being reviewed in detail by at least two members of the team; members closely-related to a particular survey stepped back from the detailed review process, to maintain objectivity. Each reviewer read all of the supporting material and prepared a preliminary set of recommendations and comments with respect to the assessment criteria. The team then met together for several days at the National Wildlife Research Centre during March 2009, continuing into a series of video conference calls, to discuss the assessment for each survey and reach consensus on the recommendations. In a few cases, further information was sought to complete the assessment, but in most cases, the information provided was sufficient to come up with a preliminary recommendation. Note that because this first assessment stage occurred several years before the review process was completed, budgetary estimates and other details refer to ~2007-08 values.

Detailed evaluations. Based on this initial set of assessments, a number of surveys were identified as high priority for a more in-depth evaluation. These included (i) any surveys which appeared to be no longer required (candidates for termination), (ii) surveys for which the current effort appeared to be greater than required or for which a substantial redesign could improve the survey, and (iii) a few surveys for which the current effort was thought to be insufficient to meet the information needs. In several of these cases, multiple surveys (as represented in the questionnaires) were assessed together as they formed a connected program. For example, six surveys related to Greater Snow Geese were assessed together to facilitate the detection of potential synergies and/or redundancies. Detailed evaluations of these surveys or suites of surveys were commissioned from post-doctoral experts and/or internal experts from the migratory bird technical committees.

These reviews varied in their depth and scope, depending upon the survey(s) being addressed, and the particular questions raised. One or more members of the AMR Steering Committee worked closely with the assessment team to ensure that the most appropriate questions were being addressed. Once the assessment was complete, a final recommendation document was developed by the AMR Steering Committee, including specific recommendations and a detailed assessment of the impact of any proposed changes on the ability of the survey(s) to meet EC monitoring information needs.

Final recommendations. A summary of the final evaluations for each of the surveys is presented in Chapter Five. For surveys subject to a Detailed Evaluation, these present the major recommendations based upon that evaluation. For the remaining surveys, these are based largely on the preliminary recommendations, although in some cases these have been updated based on more recent information provided from the survey, or based on changes in the survey over the course of the evaluation.

Data management. Aspects of data management, analysis and reporting were also considered as part of the assessment of each survey. The steering committee developed a list of criteria that surveys should be expected to meet, specifically focusing on metadata (i.e., description of surveys), management of data (e.g., the use of formalized databases), data analysis and reporting. Each survey was assessed against these standards, and the results were used both to assess the overall contribution of the survey and to develop recommendations for future changes. As with the review of the survey itself, these assessments were based largely on information provided in the questionnaires, although additional information based on the personal expertise of the review team was incorporated if available. The data management assessment is described in detail in Chapter Six.

***Gaps and Risks analysis*.** For each of the 34 specific avian monitoring outcomes identified, the current gaps in monitoring needs for these outcomes and the associated risks of not filling these gaps were identified ("*Needs, Gaps, Risks*" in Figure 2.1). The five bird groups (landbirds, seabirds, shorebirds, inland waterbirds, waterfowl) were subdivided based on the types of monitoring required to address their needs, and gaps in monitoring programs were rated on a scale from 0 (no gap) to 3 (high gap) for each relevant monitoring need, largely based on the detailed survey evaluations. Risks incurred by EC by having each of these gaps were then similarly ranked on a scale from 0 to 3; by definition, a given risk could never be ranked higher than its associated gap, but could

be equal or smaller. Finally, strategies for most effectively mitigating identified risks (e.g., additional monitoring, targeted research, directed conservation action) were also highlighted for each program need and each species group. The gaps and risks identified, as well as suggested mitigation methods, are described in detail in Chapter Seven.

Conclusions. Based on these broad-scale assessments and detailed evaluations, a number of general conclusions and recommendations for the future of avian monitoring in Canada were developed ("*Recommendations*" in Figure 2.1); these are presented in Chapter Eight.

External expert panel. The roles of the external expert panel were (i) to advise on the review process and on the criteria used; (ii) to ensure that the approach adopted was as objective and effective as possible; and (iii) to oversee the development and completion of the comprehensive review work plan and to guide and review progress. Members of the panel were all experienced science managers involved in overseeing wildlife monitoring programs and applying their results, and brought considerable practical experience and a rigorous perspective to bear on the review. The experts met twice in person, and four times by conference call over the course of the review. They provided valuable input on the process but did not directly assess individual surveys.

Challenges faced during the review process. Undertaking such a comprehensive review of the complex suite of internal programs presented numerous challenges. EC staff involved took on their roles in the assessment in addition to their regular responsibilities, and the time demands were particularly high for members of the Steering Committee and other specialized teams. Although a part-time coordinator was available to assist with some of the activities, most actions were undertaken by scientists and managers on the Steering Committee. Several steps, such as design of questionnaires, compilation and analysis of results, and developing the novel needs-gaps-risk evaluation process took considerable periods of time. The review process was therefore a long one, though this allowed time to consider the results at each key step, to seek feedback from the external panel, selected partners and senior EC management at the ADM level, to consider a range of scenarios, and to complete detailed survey assessments, often with input from EC's collaborators.

TIMELINE

The Avian Monitoring Review process began in June 2007, and continued to the fall of 2011 when responsibilities were transferred to the newly formed Avian Monitoring Committee. The first recommendations from the review process were implemented during the 2010 and 2011 field seasons, and final discussions are ongoing. Briefly, the timeline was:

June 2007 – March 2008	Development of the review process
April 2008 – May 2009	Assessment of current monitoring programs • Initial inventory and summary of 186 survey programs • Description of EC's monitoring needs • Qualitative comparison against needs (including Gaps/Risks assessment)
July 2009 – July 2011	Detailed analyses of selected programs (completed for 16 suites of surveys), and defining/refining the monitoring framework for each of the five bird groups
2010 – (ongoing)	Discussions with partners on review conclusions, redesigning programs Implementation of EC monitoring program shifts • Discussions and planning with partners to achieve desired monitoring end-states • Implementation of recommendations
Fall 2011 – (ongoing)	Implementation of new governance regime to address • Ongoing assessments and reassessments of programs • Supporting new program developments (e.g., improved data management and reporting) • Identifying and recommending options to fill gaps and improve programs

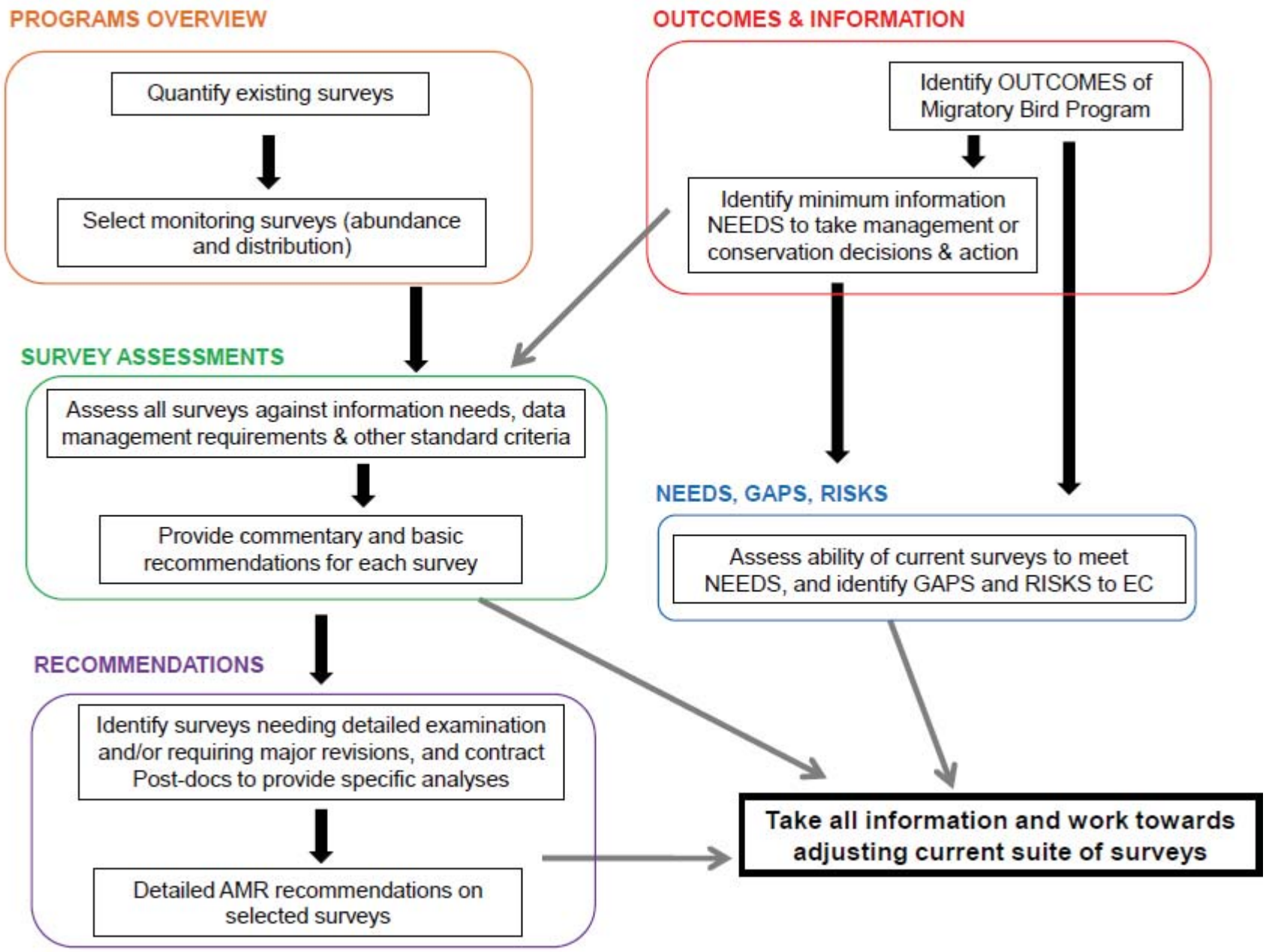

FIGURE 2.1. Approach used in the Avian Monitoring Review; see text for detailed descriptions of each step in this process.

TABLE 2.1. Questionnaire used to collect information on each of the programs covered in this review; information on the Arctic PRISM summary is shown as an example. Guidelines were: "*The following questionnaire is intended to develop a national snapshot of the work that is or has been done as a first step in the development of a comprehensive national approach to bird monitoring. If you feel that your program is not properly described in the response options, please briefly provide the missing information in the comments column. Many questions are answered in drop-down boxes - note that if more than one parameter applies, insert row below and copy and paste row from above that to include additional information*". An accompanying questionnaire sheet (not shown) listing all Canadian bird species was also provided to respondents, with the following instructions: *"Please indicate the species that are recorded in this survey as follows: (i) if quantitative information on species occurrence per study unit (e.g., point count, transect, route) is readily available indicate proportion of units in which the species is recorded in the "Quantitative" column below (e.g., birds/transect or birds/route). If necessary this can be supplied as a separate spreadsheet or data table; (ii) if quantitative information is not available please indicate how well each species that is picked up by this survey is captured from the drop down list in the "Captured?" column [well-captured vs. not well-captured].*"

Bird Monitoring Programs in Canada *(Arctic PRISM example)*

Question	Response	Comments
Survey Identification		
please type information into column C		
Survey Name	Arctic PRISM	
Coordinating Agency	Canadian Wildlife Service - PNR/NCD	
Principal Contact Name	Jennie Rausch	
Contact phone	(867) 669-4709	
Contact email	Jennie.Rausch@ec.gc.ca	
web url	n/a	partners are currently tasked with developing a web-based presence for PRISM on USFWS servers
Technical Description		
type in or indicate from drop-down menu		
Survey description:		
overall objective (indicate briefly)	develop baseline information on shorebird distribution and abundance in the Canadian Arctic	
What is being monitored?	population trend population size distribution	
survey habitat	tundra	wet tundra:dry tundra:unvegetated surveyed in a ratio of 10:3:1
Is more detailed habitat data collected?	Y	
Does survey contribute directly to Species at Risk (assessment/recovery)	N	when second 10 year cycle is complete, trend data can be used in assessments for COSEWIC
Does survey contribute to broader monitoring program?	Y	
If yes, indicate briefly	PRISM for shorebirds nationally/rangewide	
EC/CWS bird committee jurisdiction (principle)	shorebird	
other bird committee interest (if any)	inland waterbirds	waterbirds surveyed on aerial transects between plots and if on plots
other bird committee interest (if any)	waterfowl	waterfowl surveyed on aerial transects between plots and if on plots
other bird committee interest (if any)	landbirds	recorded if on plots
Survey chronology:		
time of year	breeding	
start year (indicate)	2002	

Bird Monitoring Programs in Canada *(Arctic PRISM example)*

Question	Response	Comments
survey program duration	ongoing	
within-year location survey interval	one time	
Same sites surveyed each time?	N	
If N then indicate repeat interval	10 years	
Methodology:		
has methodology been peer reviewed?	Y	
if yes indicate review		
Has a statistical power analysis been completed?	Y	
if yes, indicate review		
Is bias, e.g., precision considered in protocol?	Y	
methodology	area search - double sampling	
data management platform	PC database	
reports available	Y	
If Y, indicate reference	available on request	
Geographic coverage		
note BCR map at right for reference	indicate "Y" in regions where survey is active	
Domestic:		
Marine Atlantic		
coverage		
Marine Arctic		
coverage		
Marine Pacific		
coverage		
Aquatic Great Lakes		
coverage		
BCR 3	40 16ha rapid survey plots/year	four rapid plots surveyed intensively
coverage	largely representative	
[other BCRs … not shown]		
International:		
USA	Y	related but different protocol - results combined for range-wide analyses
Mexico		
other Americas		
other outside of Americas (specify)		
Does Canada supply funding for international components?	N	
If Y indicate average annual expenditure.		
Resources		
type in or indicate from drop-down menu		
Annual financial resource requirements (not including staff):		
Environment Canada	$20,000	
contribution - non-Environment Canada		
other federal government (please specify in comments)	$215,000	IPY: 130K + PCSP: 85K
provincial/territorial (please specify in comments)		
international (please specify in comments)		

Bird Monitoring Programs in Canada *(Arctic PRISM example)*

Question	Response	Comments
non-government	$40,000	land claims funding
in-kind equivalents (cash equivalent not included above)		
annual budget	**$275,000**	
Employee time for survey administration (person years)		
EC participants for survey period	2	
non-EC paid participants in survey	0	
Total FTEs	**2**	
During-survey human resource requirements (person days):		
EC participants for survey period	98	numbers are for 2007 and will vary some between years
non-EC paid participants in survey	140	
volunteers	70	
total (for survey period)	**308**	
Links to Conservation and Management type in or indicate from drop-down menu		
who uses it	EC/CWS management, USFWS, other PRISM partners	
primary use	information is used to define baseline status of shorebird populations, information can be used to flag species that require management actions to prevent consideration for SARA and, if listed, effectiveness of recovery efforts	
secondary use(s) if applicable		
how is information used?:		
identifies conservation concerns/priorities	Y	feeds continental level shorebird conservation planning
contributes to BCR planning and implementation	Y	
measures response to SARA recovery actions		
measures response to other management actions		
linked to targeted research	Y	SRGA - cause of shorebird declines
measures response in an adaptive management cycle		
other (indicate in response column)		
Management decisions are made over time: is this an immediate management approach or longer term: indicate time scale	very long term	
List key challenges for implementation	stable core funding, large geographic coverage with few people to participate in survey	
why? how?		

TABLE 2.2. Individual survey assessment form completed for each program covered in the review; information on the Arctic PRISM summary is shown as an example.

Avian Monitoring Review
Individual Survey Assessment

SURVEY NAME: Arctic PRISM (Program for Regional and International Shorebird Monitoring)
Names of people who initially completed this assessment form: Vicky Johnston
Names of people who provided additional input/review: _____
Survey Overview (1-2 sentence brief description of what survey is):
Population estimates and trends for Arctic-breeding shorebirds

CATEGORY	Questions	Narrative answers (point form)
Management/ Policy Needs	1. Which EC management needs does the survey address? Carefully select the relevant categories from the list of "program needs" in the separate document "EC Monitoring Needs – Dec 2008" and indicate clearly how this survey contributes to each relevant one.	1. Assessing the status of migratory bird populations: • *Tracking abundance and distribution to identify species or areas of conservation concern* • *Arctic PRISM has already provided population estimates for 3 regions of the Canadian Arctic, and will provide continental estimates for 17 Arctic-breeding species by 2015, IF ADEQUATE FUNDING IS PROVIDED.* • *Arctic PRISM has also greatly improved distribution maps for most Arctic breeding shorebird species.* • *Note that Arctic PRISM also produces statistically reliable population estimates for a number of Arctic-breeding songbird species too.* 2. Providing essential input to regulatory processes: • *Documenting trends in populations, harvests, etc. needed for effective regulation of game bird harvest, incidental take, or other types of permit issuance* • *Data from PRISM surveys is regularly used by northern permitting personnel when reviewing applications for scientific permits, Sanctuary and Wildlife Area permits.* 3. Providing essential support for departmental programs: • *Providing information to programs such as environmental assessment, including assessing changes in environmental stressors* • *Data from PRISM surveys were key pieces of the dataset used in the recent Mackenzie Gas Project environmental assessment.* • *PRISM data is regularly used in environmental screenings by EC; and in fact, PRISM 'rapid' surveys are becoming a standard protocol for companies to use as part of their contribution to regional cumulative effects monitoring.* 4. Using the health of bird populations as environmental indicators: • *Providing input to assessments of trends in biodiversity, the impacts of toxics, effects of climate change, and overall ecosystem health* • *Arctic PRISM data was recently used in the information gathering for SOE reporting for the Arctic ecozone.*
	2. List any factors that might elevate the priority of this particular survey to EC or to other partners supporting this survey.	Further shorebird population declines; increased development in the North.
	3. What other monitoring programs are required to complement this survey, in order to meet the management needs (e.g., surveys that cover other	Ideally to meets EA and ecosystem health information needs, Tier 2 of PRISM needs to be operational. Tier 2 will consist of regularly-surveyed sites where more detailed trend information will be available for species on a regional basis. There are currently no funds to

CATEGORY	Questions	Narrative answers (point form)
	parts of the geographic range of a species, or that provide information on other population parameters)?	implement Tier 2 of Arctic PRISM. Please also note that Tier 2 sites are supposed to provide logistic support for the research portion of continental shorebird conservation programs- places where shorebird researchers will be able to tackle the 'why' questions that are raised when species population declines are detected. Tier 1 is not collecting data quickly enough to meet its goal of producing population estimates and trends every 7 to 10 years, because of a lack of funds
	4. What other surveys (managed by EC or others) provide similar information to any components of this survey? In what ways does the information provided by this survey differ from, or go beyond that collected by other surveys?	No. To my knowledge there are no surveys in North America whose objective is to produces absolute population estimates of Arctic-breeding shorebird species (as opposed to indices). Arctic PRISM is complemented by data that comes from shorebird migration counts in eastern and central north America. I also note that this is the only monitoring program in Canada that addresses Arctic-breeding songbirds.
	5. What modifications are required to this survey to enhance its ability to meet management needs?	Because Arctic PRISM surveys are meant to operate at three levels (Tier 1- itinerant across the Arctic at many different sites; Tier 2- across the Arctic at a smaller number of constant sites; and Tier 3- many sites for very short periods of time, via the NWT/Nunavut Bird Checklist Survey), this program could potentially provide logistic support for a number of other CWS initiatives, for example: -boundary surveys for CWS conservation areas; -support for EC enforcement patrols in the area, if its in or near a CWS conservation area, industrial development, or other area of concern -targeted monitoring and research into specific species, both shorebird and non-shorebird; -aerial surveys for species other than shorebirds In addition, because the PRISM Tier 1 intensive camps are up to six weeks in one location, short-term research projects on any number of species in the camp location could be (and have been) supported.
Decision making	6. How are data from this survey incorporated into conservation/management decisions? Are they used qualitatively, or quantitatively, e.g., through formal predictive models, or with specific thresholds that trigger actions? Please give details.	1. Environmental assessment. PRISM data is used to recommend terms and conditions, mitigation measures, changes to project scope and/or design. PRISM methods are used to guide proponents in acceptable collection of baseline and regional cumulative effects data. 2. Regional land use planning. PRISM data are being used to inform zoning decisions in the Nunavut General Land Use planning process. 3. Permit terms and conditions. PRISM data is the basis on which certain terms and conditions are attached to scientific and Sanctuary/Wildlife Area permits in the North. 4. At the end of the first round of Tier 1, PRISM population estimates will be used to update status rankings of shorebirds in the Canadian and American Shorebird Conservation Plans. We provide regional population estimates and density comparisons for Environmental Assessment reviews and MBS/NWA permitting. There are no defined 'triggers' or 'thresholds' in Arctic PRISM. I'm not sure this is the right place for them. I would think that such things should be determined by species working

CATEGORY	Questions	Narrative answers (point form)
		groups- they, as the experts, define upper/lower thresholds from a biological perspective, managers etc. create policies with thresholds incorporated into them, and then programs like PRISM provide the data that feeds into the trigger process. Maybe green, yellow, red categories, where certain things happen when a species enters a certain category? Or maybe you could do it by species groups? Or even by habitat? This is actually a very important question, and one that is not done justice by quick responses in a questionnaire. We're spending lots of money (or I hope we will be after this review is finished!) to collect good data- then what? Some intense thought should be put into linking the output of our monitoring to conservation/regulatory/policy/management action.
	7. Have data from this survey actually been used to inform policy or regulatory changes or conservation actions? If so, describe. If not, is this likely to happen?	Yes, a number of times for environmental screenings right up to panel reviews. The most well-known of these is the Mackenzie Gas Project environmental assessment, where PRISM-originated data and analyses comprised a very important portion of CWS' input to the process (because of the Mackenzie Delta's importance for shorebirds and the proponent's lack of decent baseline information). I certainly anticipate that when the first round of population estimates come from Tier 1 that they should prompt a) research into causes of decline for particular species; b) re-ordering of the priority rankings (and thus conservation priority) for Arctic-breeding shorebirds; c) prompt the recommendation of new candidate conservation areas in the Canadian Arctic.
	8. How could use of the data be improved to better inform decision making (consider whether people who could or should use the data for decision-making have input into survey design, management, and reporting; whether they have sufficient access to survey results; whether reporting is in an appropriate format, etc.)?	Yes, but it could be improved by having quicker analysis and public dissemination of results, as Arctic regions are surveyed.
	9. Are the results of this survey considered in relation to other types of non-survey information (e.g., Traditional Ecological Knowledge) and, if so, how are they considered together?	There is not a lot of TK for Arctic shorebirds, as they are not a hunted species. However habitat data collected at the time of surveys is complementary, and will allow us to build a comprehensive shorebird habitat map of the Arctic. We are putting a lot of effort into developing remote-sensed habitat classification methods that are suitable to map habitat as it really is in June, during the period of nest initiation. Intensive plot information such as time of adult dipteran emergence, first, median, and last date of nest initiation, nest success, and level of predation. This auxiliary info helps us to track effects of changing climate on shorebird breeding phenology.
Understanding Population Change	10. What information does the survey provide that might be relevant to understanding mechanisms or causes of population change? Is this information relevant at a national or regional population scale or only locally?	Partly. From intensive plots we are gaining a better understanding of the impact of nest predation on population cycles. We should get some data on climate effects on populations, particularly if we can get the Tier 2 sites going. Many agents of change, however, will lie outside of the Arctic and so will not be discernable from Arctic PRISM.
	11. Are there appropriate mechanisms in place for the survey to trigger additional research to provide information on mechanisms or causes of population change? Has this happened? Could the mechanisms be improved?	No, but there should be. I think that the species working groups should be supported and nurtured- they seem to be a cost-effective way to ensure that monitoring biologists and researchers can stay in touch. The semi-annual shorebird science/monitoring gathering is also an excellent forum for this. I feel that our CWS Shorebird Committee is largely ineffective for this purpose. It could be that we simply don't have a critical mass of shorebird biologists in the CWS ??
	12. Does the survey gather data on any additional	Changes in species range, habitat descriptions.

CATEGORY	Questions	Narrative answers (point form)
	variables (covariates) that might help to understand population changes (are these appropriate or should others be considered)?	
Survey Methodology	13. What are the statistical objectives of the survey (e.g., questions being asked, scope over which inferences are to be made, precision required, etc.)? Please give details.	Yes. To estimate a change in Arctic-wide population size (for each of 18 species) occurring during 20 years with power of 80% to detect a 50% decline
	14. What are the parameters being estimated by the survey (e.g., population size, index to population size, survival, productivity, etc.) and are they appropriate for the management needs / survey objectives?	Population size. We believe that this is achievable.
	15. Is the sampling protocol based on standard, statistically sound approaches (e.g., published methods), and are these appropriate for the parameters being estimated? Please give details.	Yes.
	16. What is the geographic area over which the survey is intended to make inferences? How are sample sites selected within this area (e.g., complete sample, random, systematic, observer selected, etc.)? What limitations are there in the sample selection process?	Geographic coverage is the entire North American Arctic. Don't know what you mean by spatial sampling level.
	17. Has the power/precision of the survey been analysed to determine whether it meets required survey objectives? If so, please provide details.	Yes.
	18. Please list potential biases or limitations in the survey, as currently implemented, and how these are being, or should be, addressed in design or analysis	Yes and Yes.
Data Management	19. What system is used for storing and managing data from this survey, and where are the data stored (both the data base and the original field data)?	PRISM data is stored in an Excel database at CWS Yellowknife. All files are backed and stored on a separate drive.
	20. Who is responsible for housing and managing the data, and is this appropriate?	CWS Yellowknife houses and manages the Canadian data. We believe this is appropriate
	21. How are the data archived and backed up? If the survey coordinator retired or left, what mechanisms are in place to ensure that somebody else could locate and take over data management?	Yes. Backed up through standard EC computer procedures, plus on extra drives stored in a fire-proof safe at an external location (CWS Yellowknife Warehouse).
	22. What Quality Assurance/Quality Control QA/QC) procedures are in place for this survey (consider both field data collection and data management)? Is this sufficient, or would it be preferable to enhance this?	Historic data has been checked. Current data is proofed upon entry. Database is investigated whenever unusual results show up during analysis
	23. What metadata are available describing the survey (e.g., documentation of data base structure, sample methods, survey locations, etc.)? In what format are	Yes

CATEGORY	Questions	Narrative answers (point form)
	they available (e.g., readily accessible computerized format)?	
	24. Are data collection protocols, including any historical changes, adequately documented and readily available?	We have made all of the adjustments to survey design that will be necessary for the foreseeable future. Changes to protocol over the first five years of data collection need to be documented soon before they are lost.
	25. How accessible are the raw data to EC employees and/or the public (e.g., are they accessible through the Internet)? If the survey data are not managed by EC, is there a cost to obtaining the data or a data sharing agreement already in place?	Data are not openly available over the Internet. Data are freely available on request to CWS Yellowknife, provided that we are told in what way the investigator intends to use the data, and obtain a commitment to receive a copy of any product.
	26. Are mechanisms in place to track use of data?	No, other than as described above.
	27. Are data accessible (including metadata, documentation, etc.) in both official languages? If not, would it be appropriate to change this?	No. We would be happy to if funds were made available for translation.
Data Analysis and reporting	28. Who carries out the analyses of the data and what types of analyses are used? Are these appropriate for the data, sufficient to meet the stated management needs and statistically sound? How are they documented? What improvements are needed?	Yes. We have a paper in journal review
	29. Are survey results readily accessible (e.g., posted on the Internet or published in peer-reviewed journals) and in a form that is readily understood and appropriate for the target audiences?	Yes. Interim results from first five years are coming out soon in a journal article. We have yet to find an appropriate internet conduit for our results- though it may well be through the American Shorebird Conservation Plan website, or some similar shorebird-oriented site.
	30. How often are the data analyzed and reported and is this appropriate relative to management needs and/or the survey interval?	Data are analysed by region, when surveys are complete in a given region. The first all-Arctic analysis and population estimates will take place upon completion of all regions – and that is dependent on funding.
	31. Do data analyses consider survey data in combination with other data (e.g., modeled in relation to changes in habitat or other stressors)? If not, would this be appropriate?	No. It would be very interesting to do this with relation to changing breeding habitat conditions, related to climate.
	32. Are the data available for and used in research or other activities to address questions that go beyond than the primary survey objectives?	Not yet. I sure hope they will be though.
Survey Evaluation	33. Has there been a recent internal or external review of the survey, considering survey objectives, linkages to decision-making, survey design and analysis protocols, ability to detect change, etc.? If so, give details. If not, is it a priority to carry out such a review?	We went through an exhaustive peer review of the survey design and power analysis. Linkages to decision-making should be made clear, though. It is a weakness of most of our shorebird work in Canada that we have no clear link to decision makers.

<table>
<tr><th>CATEGORY</th><th>Questions</th><th>Narrative answers (point form)</th></tr>
<tr><td>Cost effectiveness</td><td>34. How much does this survey cost (include details on paid staff time, volunteer days, operating costs; indicate contribution from EC and from other sources) – summarize details provided in original questionnaire</td><td>
<table>
<tr><th></th><th colspan="2">Contributions from EC</th><th colspan="4">Contributions from Non-EC sources</th><th></th></tr>
<tr><th>Fiscal Year</th><th>within Migratory Birds OPP</th><th>external to Migratory Birds OPP</th><th>other Canadian federal depart.</th><th>Provincial or territorial gov'ts</th><th>Non-gov't orgs</th><th>USA</th><th>Annual Budget</th></tr>
<tr><td>2005</td><td>$40,000</td><td>$50,000</td><td>$130,000</td><td>$0</td><td>$0</td><td>$0</td><td>$220,000</td></tr>
</table>
<table>
<tr><th colspan="4">Survey Administration Staff (Person Years)</th><th colspan="4">Field Work Staff (Person days)</th></tr>
<tr><th>EC staff</th><th>Non-EC paid staff</th><th>Volunteers</th><th>Total PYs</th><th>EC field staff</th><th>Non-EC field staff</th><th>Volunteers</th><th>Total person-days (for survey period)</th></tr>
<tr><td>1.0</td><td>0.2</td><td></td><td>1.2</td><td>272</td><td>40</td><td>100</td><td>412</td></tr>
</table>
</td></tr>
<tr><td></td><td>35. What evidence is there that the survey is cost-effective, i.e., that the results of the survey are worth the overall cost (considered both from the perspective of EC and other funding partners)? Has cost-effectiveness been considered in relation to other options for obtaining the same data?</td><td>as part of the peer review reviewers were asked to state other ways to get the same data that they thought were appropriate. The only other way suggested (via avian productivity over the long term at a number of sites) was considered by us to be more expensive and more difficult to carry out over the scale of the entire Arctic.</td></tr>
<tr><td></td><td>36. Does the EC contribution seem appropriate relative to the value of the survey to EC?</td><td>So far, EC has contributed staff time and a small amount of O&M to this program. I feel that EC’s contribution is inadequate, as we are a major user of the data.</td></tr>
<tr><td></td><td>37. Would a different level of survey intensity lead to different management decisions (e.g., would reduced sampling intensity or less frequent sampling provide essentially the same information)? If the survey were missed for one or more years, could it be resumed in the future? Would increased sampling significantly enhance the quality of the data for decision making?</td><td>Different level of survey intensity- if population estimates from Tier 1 of Arctic PRISM were derived on a longer time frame, the data would not be accessible in time to make medium-term management decisions. If they were derived from fewer sampling points (= rapid survey plots), the estimates would not be as accurate.

Without Arctic PRISM, I don’t believe that we will ever have reasonable population estimates for Arctic breeding shorebirds. Every time another Arctic survey is completed, the world population estimate for one or more species goes up. It is not possible to accurately prioritize species (or their habitats) for conservation action we don’t know their current population level.</td></tr>
<tr><td>Survey Management</td><td>38. Who is primarily responsible for delivering the survey (person and organization)? Is this appropriate, or could it be delivered more effectively by another group (e.g., EC, NGO, industry)?</td><td>Vicky Johnston, Canadian Wildlife Service
This survey could be effectively delivered by any organization with the money, staff and motivation to do it properly. Right now, EC is the only entity that comes close to fitting that description, even with our chronic funding and staffing shortfalls.</td></tr>
<tr><td></td><td>39. What partners are involved in managing/funding the survey?</td><td>U.S. Geological Survey, Manomet, U.S. Fish and Wildlife Service, Committee for HolArctic Shorebird Monitoring (CHASM)</td></tr>
<tr><td></td><td>40. What mechanisms are in place to ensure that all supporting partners are adequately involved in decision making with respect to survey management, design, reporting, etc.?</td><td>There are few Canadian partners in Arctic PRISM.</td></tr>
</table>

CHAPTER THREE – Describing the Needs of Environment Canada's Migratory Bird Program for Avian Species Monitoring Information

THE ROLE OF THE MONITORING INFORMATION NEEDS ASSESSMENT

To assess the degree to which current bird-related monitoring programs meet the information needs of Environment Canada (EC) and its partners, it is essential to have a well-articulated and objective understanding of these information needs and their characteristics. Once these information needs are fully described, they provide a baseline against which to assess the value of existing monitoring activities in terms of providing the required monitoring information. This understanding also enables EC to identify those monitoring information needs which are not adequately addressed by the current suite of surveys, and the risks to which EC is exposed as a result of these gaps within the overall avian monitoring program.

This chapter describes the process that was followed to describe the types of avian monitoring required by EC in order to deliver key components of the Migratory Bird Program, and the spatial and temporal characteristics of monitoring programs that would meet those needs. The following three-step process was used in describing these needs:

1. identification of the components of the Migratory Bird Program that require information obtained from monitoring bird populations;
2. consideration of the role that monitoring plays in support of the delivery of each program area;
3. description of the specific characteristics of monitoring needed to support each outcome (e.g., estimation precision, survey frequency) based on the monitoring role identified through this process.

As a consequence of the breadth of EC's Migratory Bird Program, and the complexity of the monitoring required to support its many components, a working spreadsheet (summarized in Table 3.1) was developed to track the characteristics of the avian monitoring information needs. Each of the 11 program outcomes (i.e., primary needs) eventually identified were recorded as rows within the spreadsheet, and the characteristics and parameters related to each outcome were recorded as columns. Annotations in the descriptions below refer to the corresponding spreadsheet columns. A further sub-division of these 11 outcomes into 34 sub-component outcomes for EC's Migratory Bird Program formed the basis for the detailed Gaps and Risks analysis presented in Chapter Seven.

MONITORING NEEDS IDENTIFICATION PROCESS

DESCRIBING THE MIGRATORY BIRD PROGRAM

The components of the EC Migratory Bird program that might depend on monitoring information were extracted from the integrated Results-based Management and Accountability Framework and Risk-Based Audit Framework (RMAF/RBAF) for the Migratory Birds Program, which was completed in 2008. This provides an objective analysis of the structure of the program, following Treasury Board program description guidelines, which already have departmental approval. It also ensures that the assessment of monitoring information needs responds to current program requirements, and not just those that may have been in place when monitoring programs were established (which may have been 3-4 decades ago in some cases). The RMAF/RBAF identifies monitoring as one of the key foundation activities of the Migratory Birds Program, but does not itself further define the specific needs for this information.

The RMAF/RBAF framework includes a detailed Logic Model for the Migratory Birds Program (Figure 3.1), which objectively considers the program's foundation activities, outputs (services and products), target audiences, and direct, intermediate and final outcomes. The nine intermediate outcomes identified for the Migratory Birds Program (Table 3.1, item numbers 1 through 9 in *Column A*) together culminate in the final outcome of maintaining migratory bird populations at healthy levels, with consequent benefits to Canadians that can be considered in seven different categories.

The intermediate outcomes in the RMAF/RBAF are those bird conservation results that EC hopes to achieve, either through its direct actions or by influencing the actions of others. Avian monitoring also provides information which has proven useful in supporting other areas of EC priority, such as broad objectives for maintaining healthy ecosystems and ecosystem function. Although these secondary uses were important, they do not generally drive the design of the avian monitoring programs themselves. A significant exception is the overlap between the Migratory Birds and Species at Risk programs, particularly for migratory birds which are listed as SAR, or are potential candidate species for listing. For this reason, in addition to the nine program outcomes within the Migratory Birds Program, two outcomes were added for the SAR program (item numbers 10 and 11 in Table 3.1, *Column A*), based on the Species at Risk RMAF/RBAF, for which monitoring of migratory birds plays an essential role in delivery.

This exercise led to a total of eleven program outcomes (Table 3.1, *Column A*):

1. *Landscape conditions* accommodate Migratory Bird requirements
2. *Incidental take* is minimized and long-term conservation is supported
3. Threats to *migrants in other countries* are reduced
4. Migratory Bird *harvests* are maintained at sustainable levels
5. *Priority sites* for Migratory Birds are protected and improved
6. Population-level effects of *toxic substances* are reduced
7. Populations of Migratory Birds under *particular threat* are conserved
8. Migratory Birds in *land claim areas* are conserved
9. *Threats due to Migratory Birds* to public and economy are reduced
10. Avian *Species at Risk are assessed*, identified and listed
11. Populations of avian *Species at Risk are recovered*

Note that this last program outcome, related to Species at Risk recovery, was assessed as part of this monitoring needs identification process but was not included in the Gaps and Risks analysis (Chapter Seven), given that monitoring needs for listed species are highly specific to each recovery strategy. Gaps for this need should instead be assessed through a separate process as part of the implementation of the Species at Risk program.

THE ROLE OF MONITORING INFORMATION IN DELIVERING EACH PROGRAM OUTCOME

The next step was to examine each of the 11 main program outcomes to understand the extent to which they depend on monitoring information and the context for its use. Consideration was first given to the way in which EC – in most cases, the Canadian Wildlife Service -- delivers the program area (Table 3.1, *Column B*), either:

- **directly** within EC, for example using a regulatory or permitting approach
- **indirectly** through partnerships with others, e.g., through environmental assessment, participation in joint ventures, or provision of stewardship funding, or
- by **influence** on the actions of others, including the many agencies who have more direct control over landscape use and management of bird habitats, e.g., through the development of best management practices.

The importance of monitoring to the delivery of each outcome was also categorized as high, medium or low (Table 3.1, *Column C*). The outcomes to which monitoring is of the highest importance are those related to landscape conditions, incidental take, threats in other countries, migratory bird harvest, and Species at Risk assessment (i.e., numbers 1-4 and 10 in the above list and *Column A*).

Several program outcomes in the list above were sufficiently complex that further breakdown of sub-components within the program area was required, in order to effectively evaluate the contribution of monitoring to the outcome (see Table 3.1, *Column D*):

- Influencing landscape conditions: sub-divided into seven groupings of the ecosystem-based Bird Conservation Regions (see Figure 3.2).
- Incidental take: broken down into five groups of industrial sectors
- Migrants in other countries: three regional categories (USA, Latin America/Caribbean, Europe/Asia/Africa)
- Migratory game bird harvests: sub-divided according to seven levels reflecting harvest pressure, competing demands for the harvest, and implicit risks to populations
- Toxic substances: separated into four categories by toxin (oil, pesticides, lead, other)
- Protecting populations under threat: predator control separated from emergency response

The monitoring information needs for the resulting 34 sub-component program outcomes were assessed in detail, and each is represented by one row in Table 3.1; these same 34 outcomes were used for the Gaps and Risks analysis in Chapter Seven.

For each of these 34 identified outcomes, the relative importance of having timely access to monitoring results was then considered, using a risk-assessment approach which considered the degree and type of risk involved if appropriate monitoring results were not available to support the delivery of the program outcome (Table 3.1, *Column E*). For example, management of migratory game bird harvests could involve unacceptable risks without a sufficient understanding of annual changes in target populations (and harvest) recorded by monitoring, in comparison to the more limited risks of operating a protected areas program without this type of monitoring information. Additionally, the role that monitoring plays in support of each of these 34 outcomes was clearly articulated and summarized (Table 3.1, *Column F*).

THE TYPE AND AMOUNT OF MONITORING INFORMATION NEEDED BY EACH PROGRAM OUTCOME

The assessment of the use of monitoring for each outcome was linked to where the monitoring results would be used in the management cycle (Table 3.1, *Column G*; see Figure 1.1 for a diagram of the management cycle). For example, it was determined whether the information was used to detect long-term trends at a relatively high level, or whether results were applied in a more intensive way to verify the effectiveness of a specific conservation or management action. In recognition that the higher the degree of intensity or precision, the more costly it usually is to run the monitoring program, this process identified the lowest level of intensity that was considered to reduce risk to an acceptable level. The overall process resulted in recommendations which should be viewed as guidelines, rather than prescriptions.

Finally, the characteristics required of suitable monitoring activities to meet that role were described. The following key characteristics were described for each monitoring program, to be reflected in relevant survey protocols to ensure effective delivery of relevant results (Table 3.1, *Column H*):

- the appropriate geographical scale
- the frequency and duration, and
- a qualitative assessment of the required level of accuracy and precision.

USE OF THE RESULTS: EVALUATING EXISTING MONITORING PROGRAMS

As each existing monitoring program was reviewed, either individually or as part of a suite of related programs, it was assessed against the list of monitoring needs to determine whether, and to what extent, it matched and delivered on EC's current monitoring needs. At the program or species level, this allowed the identification of redundancies when multiple programs were determined to be meeting the same needs in similar ways. This program assessment process is described in more detail in Chapter Five.

The assessment of the fulfillment of monitoring needs from the suite of current monitoring programs also led to an evaluation of gaps in the program. In turn, those gaps were used to assess the risk EC is incurring by having those current gaps. This process is described in Chapter Seven.

TABLE 3.1. Environment Canada's Avian Monitoring needs (see text description above) for each of 34 identified program outcomes. The rows in this table correspond directly to those in the Gaps and Risks chapter (Tables 7.1 and 7.2), except for the last row in this table (i.e., the 11th outcome was not covered in the Gaps/Risks analysis; see text). **Note that in column G, letters in bold correspond to components of the adaptive management cycle diagram (Figure 1.1): A1 - Population status monitoring, A2 - Concerns triggered by other information, C1 - Anticipatory research, C2 - Targeted research, F - Evaluation studies.*

A	B	C	D	E	F	G	H
RMAF Logic Model Intermediate Outcomes (*corresponding EC Mig Bird Conservation program areas*)	**EC approaches to achieve outcome**	**Importance of monitoring to deliver outcome**	**Program Components (incl. sub-sets of Intermediate Outcomes)**	**Risk related to insufficient monitoring to deliver outcome**	**Need for monitoring results**	**What should be monitored and how are results to be used?***	**Characteristics of monitoring and survey needs to support this outcome**
1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Arctic (BCR 3)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	Influence land use planning (resource extraction, protected areas planning, implement Land Claims…)	[*Tundra birds, seabirds*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR + periodic at finer scales Frequency and duration: at least every 5 years for population status – less frequent for distribution Accuracy and precision: high for focal species, medium for others
1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Boreal/ Northern Forest (BCRs 4, 6, 7, 8, 12)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	For effective input to forest management plans, typically revisited every 5 yrs, with large implications for forest birds, also influence land use decisions by other actors on the landscape	[*Birds by forest type, wetland birds*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR + periodic at finer scales Frequency and duration: at least every 5 years Accuracy and precision: high for focal species, medium for others
1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Marine coasts (marine BCRs)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	Influence aquaculture siting, pollution prevention, coastal development (bird colonies addressed in priority sites below)	[*Pelagic and coastal birds*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR; periodic at finer scales Frequency and duration: periodic Accuracy and precision: high for focal species, medium for others

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1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Western mountains (BCRs 5, 9, 10)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	Further influence land use decisions made at finer scales - e.g., municipal, private landowners, implement Land Claims	[*Birds by forest type, grassland birds, riparian and wetland birds*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR + periodic at finer scales Frequency and duration: annual Accuracy and precision: high for focal species, medium for others
1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Prairies (BCR 11)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	Further influence land use decisions made at finer scales - e.g., municipal, private landowners, implement Land Claims	[*Grassland birds in native and agricultural lands, wetland birds*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR + periodic at finer scales Frequency and duration: annual Accuracy and precision: high for focal species, medium for others
1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Great Lakes – St. Lawrence (BCR 13)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	Further influence land use decisions made at finer scales - e.g., municipal, private landowners	[*Wetland birds, forest birds, birds in agricultural dominated landscapes*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR + periodic at finer scales Frequency and duration: annual Accuracy and precision: high for focal species, medium for others

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RMAF Logic Model Intermediate Outcomes (*corresponding EC Mig Bird Conservation program areas*)	**EC approaches to achieve outcome**	**Importance of monitoring to deliver outcome**	**Program Components (incl. sub-sets of Intermediate Outcomes)**	**Risk related to insufficient monitoring to deliver outcome**	**Need for monitoring results**	**What should be monitored and how are results to be used?***	**Characteristics of monitoring and survey needs to support this outcome**
1. Landscape conditions accommodate Migratory Bird requirements (*Influencing Landscape Management*)	INDIRECT - EA, Habitat JVs, Bird Conservation Plans, Stewardship Funds, Co-mgt Boards, Science, and INFLUENCE - Best practice advice, M/P/T/A governments	High	**Maritimes (BCR 14)**	Unable to make effective arguments that, a) species warrant conservation attention, b) landscape planning will improve conditions for birds. Unable to evaluate cost-effectiveness of conservation actions.	Further influence land use decisions made at finer scales - e.g., municipal, private landowners	[*Wetland birds, forest birds, birds in agricultural dominated landscapes*] **A1**: population abundance and distribution trends; **A2**: land-use and habitat trends; **C1** or **F**: productivity and survival information, tracking against objectives, explanatory and predictive models	Geographical or jurisdictional scale: provincial boundaries within each biome or BCR + periodic at finer scales Frequency and duration: annual Accuracy and precision: high for focal species, medium for others
2. Incidental Take is minimized and long-term conservation is supported (*Minimizing Incidental Take*)	DIRECT (avoidance guidelines, compliance promotion, enforcement), and INDIRECT (via OGDs, provinces and territories, EA)	High	**Forestry**	Without information on species status and trend, unable to a) prioritize activities to be regulated and permitted, b) set appropriate permit conditions, and c) evaluate the impact of incidental take and effectiveness of mitigative measures	Monitoring needs to be at the scale of broad forest management planning (provincial and forest type), in order to be most convincing and effective	Monitor impacts of changes in landscape due to forest practices on bird populations to test habitat models in an adaptive management framework. Need comparison data from BCR level. **C1 and/or F**: estimates of numbers of birds/nests taken per forest type; **A2**: area of forest harvested by forest type	Geographical or jurisdictional scale: provincial by BCR Frequency and duration: periodic Accuracy and precision: low
2. Incidental Take is minimized and long-term conservation is supported (*Minimizing Incidental Take*)	DIRECT (avoidance guidelines, compliance promotion, enforcement), and INDIRECT (via OGDs, provinces and territories, EA)	High	**Agriculture**	Without information on species status and trend, unable to a) prioritize activities to be regulated and permitted, b) set appropriate permit conditions, and c) evaluate the impact of incidental take and effectiveness of mitigative measures	Monitoring needs to be at the scale of agricultural land-use planning (provincial), in order to be most convincing and effective	Main need is to monitor impacts of different practices on bird populations; may want phenology information (e.g., nest records) for timing of harvests, etc. Need information on land area in each crop / landuse type. **C1 and/or F**: estimates of nos. of birds and nests taken per crop area; **A2**: land in each crop	Geographical or jurisdictional scale: provincial by BCR Frequency and duration: periodic Accuracy and precision: low

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2. Incidental Take is minimized and long-term conservation is supported (*Minimizing Incidental Take*)	DIRECT (avoidance guidelines, compliance promotion, enforcement), and INDIRECT (via OGDs, provinces and territories, EA)	High	**Fisheries**	Without information on species status and trend, unable to a) prioritize activities to be regulated and permitted, b) set appropriate permit conditions, and c) evaluate the impact of incidental take and effectiveness of mitigative measures	Monitoring needs to be at the scale of each fishery, as different fisheries take different species , in order to be most convincing and effective	**C1 and/or F:** estimate of total numbers of birds taken by species and fishery. Relation to total population size and other threats of species	Geographical or jurisdictional scale: by fishery Frequency and duration: periodic Accuracy and precision: low
2. Incidental Take is minimized and long-term conservation is supported (*Minimizing Incidental Take*)	DIRECT (avoidance guidelines, compliance promotion, enforcement), and INDIRECT (via OGDs, provinces and territories, EA)	High	**Collisions**	Without information on species status and trend, unable to a) prioritize activities to be regulated and permitted, b) set appropriate permit conditions, and c) evaluate the impact of incidental take and effectiveness of mitigative measures	To understand cumulative impacts of all structures, monitoring required at the level of the flyway.	**C1 and/or F:** estimates of birds taken per structure; **A2:** quantity and distribution of structures; **A2 or C1:** distribution of migrating birds. Need data on bird populations to estimate impacts.	Geographical or jurisdictional scale: flyway Frequency and duration: periodic Accuracy and precision: low
2. Incidental Take is minimized and long-term conservation is supported (*Minimizing Incidental Take*)	DIRECT (avoidance guidelines, compliance promotion, enforcement), and INDIRECT (via OGDs, provinces and territories, EA)	High	**Linear structures and roads**	Without information on species status and trend, unable to a) prioritize activities to be regulated and permitted, b) set appropriate permit conditions, and c) evaluate the impact of incidental take and effectiveness of mitigative measures	To understand cumulative impacts of all structures, monitoring required at the level of the flyway.	**C1 and/or F:** estimates of nos. of birds taken per structure; **A2:** quantity and distribution of structures; **A2 or C1:** distribution of migrating birds. Need data on bird populations to estimate impacts.	Geographical or jurisdictional scale: flyway Frequency and duration: periodic Accuracy and precision: low

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RMAF Logic Model Intermediate Outcomes (*corresponding EC Mig Bird Conservation program areas*)	**EC approaches to achieve outcome**	**Importance of monitoring to deliver outcome**	**Program Components (incl. sub-sets of Intermediate Outcomes)**	**Risk related to insufficient monitoring to deliver outcome**	**Need for monitoring results**	**What should be monitored and how are results to be used?***	**Characteristics of monitoring and survey needs to support this outcome**
2. Incidental Take is minimized and long-term conservation is supported (*Minimizing Incidental Take*)	DIRECT (avoidance guidelines, compliance promotion, enforcement), and INDIRECT (via OGDs, provinces and territories, EA)	High	**Other (e.g., cats)**	Without information on species status and trend, unable to a) prioritize activities to be regulated and permitted, b) set appropriate permit conditions, and c) evaluate the impact of incidental take and effectiveness of mitigative measures	Sector dependant.	**C1 and/or F:** estimates of nos. of birds taken per source type; **A2:** quantity of those sources	Geographical or jurisdictional scale: provincial by biome Frequency and duration: periodic Accuracy and precision: low
3. Threats to migrants in other countries are reduced (*Minimizing Threats in Other Countries)*	INFLUENCE - via Science, NABCI, Trinational Committee, MB Treaty, Bird Conservation Initiatives, Resourcing, Training, etc.	High	**USA**	Unable to effectively argue that, a) species warrant conservation attention at specific sites, and b) conservation planning in other country will improve conditions for birds	To engage other countries in treaties and conservation planning, need to identify priority species and quantify migratory links to other countries. To influence conservation actions, need to identify limiting parts of life cycle and important migration and over-wintering links for priority species.	**A1:** trends in population abundance; **A2, C1 or F:** mortality and survival rates, distribution outside Canada and migration links to other countries, knowledge of threats in other countries	Geographical or jurisdictional scale: range-wide Frequency and duration: periodic for most species, short-term or annual for focal species Accuracy and precision: high for focal species, medium for others

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RMAF Logic Model Intermediate Outcomes (*corresponding EC Mig Bird Conservation program areas*)	**EC approaches to achieve outcome**	**Importance of monitoring to deliver outcome**	**Program Components (incl. sub-sets of Intermediate Outcomes)**	**Risk related to insufficient monitoring to deliver outcome**	**Need for monitoring results**	**What should be monitored and how are results to be used?***	**Characteristics of monitoring and survey needs to support this outcome**
3. Threats to migrants in other countries are reduced (*Minimizing Threats in Other Countries)*	INFLUENCE - via Science, NABCI, Trinational Committee, MB Treaty, Bird Conservation Initiatives, Resourcing, Training, etc.	High	**Latin America/ Caribbean**	Unable to effectively argue that, a) species warrant conservation attention at specific sites, and b) conservation planning in other country will improve conditions for birds	To engage other countries in treaties and conservation planning, need to identify priority species and quantify migratory links to other countries. To influence conservation actions, need to identify limiting parts of life cycle and important migration and over-wintering links for priority species.	**A1:** trends in population abundance; **A2, C1 or F:** mortality and survival rates, distribution outside Canada and migration links to other countries, knowledge of threats in other countries	Geographical or jurisdictional scale: range-wide Frequency and duration: periodic for most species, short-term or annual for focal species Accuracy and precision: high for focal species, medium for others
3. Threats to migrants in other countries are reduced (*Minimizing Threats in Other Countries)*	INFLUENCE - via Science, NABCI, Trinational Committee, MB Treaty, Bird Conservation Initiatives, Resourcing, Training, etc.	High	**Europe/Asia/ Africa**	Unable to effectively argue that, a) species warrant conservation attention at specific sites, and b) conservation planning in other country will improve conditions for birds	To engage other countries in treaties and conservation planning, need to identify priority species and quantify migratory links to other countries. To influence conservation actions, need to identify limiting parts of life cycle and important migration and over-wintering links for priority species.	**A1:** trends in population abundance; **A2, C1 or F:** mortality and survival rates, distribution outside Canada and migration links to other countries, knowledge of threats in other countries	Geographical or jurisdictional scale: range-wide Frequency and duration: periodic for most species, short-term or annual for focal species Accuracy and precision: high for focal species, medium for others
4. Migratory Bird harvests are maintained at sustainable levels (*Managing Migratory Game Bird Harvests*)	DIRECT - via Hunting Strategies & Regs, Permits, Enforcement, Science, Compliance Promotion, Consultation with Stakeholders, Co-mgt Boards	High	**Overabundant waterfowl**	Overabundant species allowed to grow uncontrollably. Hunting opportunities unnecessarily restricted or liberal. Legal challenges.	Needed to evaluate management actions (e.g., special conservation measures) implemented	**A1, C1, F:** estimates of population abundance, survival, productivity, and/or harvest rate	Geographical or jurisdictional scale: population-level Frequency and duration: annual until goals achieved Accuracy and precision: very high

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				Unable to evaluate progress towards objectives of special conservation measures and other management actions	Evaluate progress towards habitat recovery	**F:** impacts of overabundance	Geographical or jurisdictional scale: area of impact Frequency and duration: periodic until goals achieved Accuracy and precision: medium
4. Migratory Bird harvests are maintained at sustainable levels (*Managing Migratory Game Bird Harvests*)	DIRECT - via Hunting Strategies and Regs, Permits, Enforcement, Science, Compliance Promotion, Consultation with Stakeholders, Co-mgt Boards	High	**Heavily-hunted species, and those with concerns about harvest allocation**	Unsustainable harvests are allowed to proceed, leading to undetected population decline. Hunting opportunities unnecessarily restricted. Legal challenges.	All essential to support AHM models, some essential to support agreed-upon prescriptive harvest strategies	**A1, F:** estimates of population abundance, survival, productivity, habitat index, and/or harvest rate	Geographical or jurisdictional scale: all parameters at level of population of concern Frequency and duration: annual Accuracy and precision: very high
4. Migratory Bird harvests are maintained at sustainable levels (*Managing Migratory Game Bird Harvests*)	DIRECT - via Hunting Strategies and Regs, Permits, Enforcement, Science, Compliance Promotion, Consultation with Stakeholders, Co-mgt Boards	High	**Species with substantial harvest but no allocation concerns**	Unsustainable harvests are allowed to proceed, leading to undetected population decline. Hunting opportunities unnecessarily restricted. Legal challenges.	Ensure substantial harvest is sustainable	**A1, F:** estimates of population abundance or trend and harvest level	Geographical or jurisdictional scale: population level Frequency and duration: annual Accuracy and precision: medium
4. Migratory Bird harvests are maintained at sustainable levels (*Managing Migratory Game Bird Harvests*)	DIRECT - via Hunting Strategies and Regs, Permits, Enforcement, Science, Compliance Promotion, Consultation with Stakeholders, Co-mgt Boards	High	**Lightly-harvested species**	Unsustainable harvests are allowed to proceed, leading to undetected population decline. Hunting opportunities unnecessarily restricted. Legal challenges.	Ensure light harvest remain slight, or move to another category	**A1, F:** estimates of population abundance or trend and harvest level	Geographical or jurisdictional scale: flyway Frequency and duration: periodic (1-10 years) Accuracy and precision: medium

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4. Migratory Bird harvests are maintained at sustainable levels (*Managing Migratory Game Bird Harvests*)	DIRECT - via Hunting Strategies and Regs, Permits, Enforcement, Science, Compliance Promotion, Consultation with Stakeholders, Co-mgt Boards	High	**Species that are harvested but with uncertain impact**	Unsustainable harvests are allowed to proceed, leading to undetected population decline. Hunting opportunities unnecessarily restricted. Legal challenges.	Assess harvest impact and potentially move to another category	**A1, F:** estimates of population abundance or trend and harvest level	Geographical or jurisdictional scale: flyway Frequency and duration: periodic (until status determined) Accuracy and precision: medium
4. Migratory Bird harvests are maintained at sustainable levels (*Managing Migratory Game Bird Harvests*)	DIRECT - via Hunting Strategies and Regs, Permits, Enforcement, Science, Compliance Promotion, Consultation with Stakeholders, Co-mgt Boards	High	**Species harvested for Aboriginal subsistence use**	Unsustainable harvests are allowed to proceed, leading to undetected population decline. Hunting opportunities unnecessarily restricted. Legal challenges.	For some areas and some species, Aboriginal harvest is significant but poorly measured. Estimation of total allowable harvest required by some Agreements (also requires knowledge of sport harvest).	**A1, F:** estimates of population abundance or trend and harvest level	Geographical or jurisdictional scale: regional Frequency and duration: periodic Accuracy and precision: medium
5. Priority sites for Migratory Birds are protected and improved (*Managing Protected Areas*)	DIRECT (Protected Areas - MBS/NWAs, Stewardship and JV funds), and INFLUENCE - Parks, Provinces, NCC, Private	Medium	**Sites including EC-established National Wildlife Areas (land and marine) and Migratory Bird Sanctuaries; other priority habitats for birds (e.g., IBAs) and protected areas (national parks, provincial parks)**	Priority sites not identified and protected. Unimportant sites needlessly protected	To identify important bird areas. For long-established protected areas to determine if they still are important.	**A1 or A2:** distribution of species relative abundances and concentrations	Geographical or jurisdictional scale: fine-scale Frequency and duration: infrequent Accuracy and precision: low

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6. Population-level effects of toxic substances are reduced (*Minimizing Effects of Toxic Substances*)	INDIRECT - e.g., via BOAS, REET oil spill response, advice to regulators re: pesticides, metals, etc; DIRECT - e.g., non-toxic shot regulations	Medium	**Chronic Oiling**	Severe impacts on bird populations continue, arguments to control unconvincing (not linked to bird population trends)	Influence regulations and release of toxins into the environment to minimise impacts, and evaluate effectiveness of regulatory and policy initiatives	**A1:** trends in population abundance; **A2:** knowledge of trends in levels and distribution of toxins; **C1:** demonstrate toxicity; demonstrating impacts of toxins on birds (i.e., amount of mortality)	Geographical or jurisdictional scale: regional Frequency and duration: periodic (but might vary with severity of impact) Accuracy and precision: dependent on impact
6. Population-level effects of toxic substances are reduced (*Minimizing Effects of Toxic Substances*)	INDIRECT - e.g., via BOAS, REET oil spill response, advice to regulators re: pesticides, metals, etc; DIRECT - e.g., non-toxic shot regulations	Medium	**Pesticides**	Severe impacts on bird populations continue, arguments to control unconvincing (not linked to bird population trends)	Influence regulations and release of toxins into the environment to minimise impacts, and evaluate effectiveness of regulatory and policy initiatives	**A1:** trends in population abundance; **A2:** knowledge of trends in levels and distribution of toxins; **C1:** demonstrate toxicity; demonstrating impacts of toxins on birds (i.e., amount of mortality)	Geographical or jurisdictional scale: regional Frequency and duration: periodic (but might vary with severity of impact) Accuracy and precision: dependent on impact
6. Population-level effects of toxic substances are reduced (*Minimizing Effects of Toxic Substances*)	INDIRECT - e.g., via BOAS, REET oil spill response, advice to regulators re: pesticides, metals, etc; DIRECT - e.g., non-toxic shot regulations	Medium	**Lead shot & sinkers**	Severe impacts on bird populations continue, arguments to control unconvincing (not linked to bird population trends)	Influence regulations and release of toxins into the environment to minimise impacts, and evaluate effectiveness of regulatory and policy initiatives	**A1:** trends in population abundance; **A2:** knowledge of trends in levels and distribution of toxins; **C1:** demonstrate toxicity; demonstrating impacts of toxins on birds (i.e., amount of mortality)	Geographical or jurisdictional scale: regional Frequency and duration: periodic (but might vary with severity of impact) Accuracy and precision: dependent on impact
6. Population-level effects of toxic substances are reduced (*Minimizing Effects of Toxic Substances*)	INDIRECT - e.g., via BOAS, REET oil spill response, advice to regulators re: pesticides, metals, etc; DIRECT - e.g., non-toxic shot regulations	Medium	**Other toxic substances**	Severe impacts on bird populations continue, arguments to control unconvincing (not linked to bird population trends)	Influence regulations and release of toxins into the environment to minimise impacts, and evaluate effectiveness of regulatory and policy initiatives	**A1:** trends in population abundance; **A2:** knowledge of trends in levels and distribution of toxins; **C1:** demonstrate toxicity; demonstrating impacts of toxins on birds (i.e., amount of mortality)	Geographical or jurisdictional scale: regional Frequency and duration: periodic (but might vary with severity of impact) Accuracy and precision: dependent on impact

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7. Populations of Migratory Birds under particular threat are conserved (*Protecting Populations Under Threat*)	DIRECT - via management interventions (e.g., predator control) and Science (Research, evaluation) and INDIRECT (e.g., Emergency response)	Low	**Predator control**	Substantial proportions of vulnerable species can be impacted without immediate action. Unnecessary actions (e.g., predator control) undertaken.	Most impacts of this nature are highly localized, but require information on context and effectiveness of response	**A2:** baseline inventories to establish vulnerable species and areas (**C2:** identifies vulnerable species; **A1:** population trend; **F:** surveys to determine whether actions are effective	Geographical or jurisdictional scale: local Frequency and duration: infrequent (dependent on characteristics of impact) Accuracy and precision: high for vulnerable species and locations, otherwise low
7. Populations of Migratory Birds under particular threat are conserved (*Protecting Populations Under Threat*)	DIRECT - via management interventions (e.g., predator control) and Science (Research, evaluation) and INDIRECT (e.g., Emergency response)	Low	**Emergency Response (chemical spills, oil spills)**	Substantial proportions of vulnerable species can be impacted without immediate action. Unnecessary actions (e.g., predator control) undertaken.	Most impacts of this nature are highly localized, but require information on context and effectiveness of response	**A2:** baseline inventories to establish vulnerable species and areas (**C2:** identifies vulnerable species; **A1:** population trend; **F:** surveys to determine whether actions are effective	Geographical or jurisdictional scale: local Frequency and duration: infrequent (dependent on characteristics of impact) Accuracy and precision: high for vulnerable species and locations, otherwise low
8. Migratory Birds in land claim areas are conserved (*Conserving Birds in Land Claim Areas*)	INDIRECT (advice to negotiators, etc.), co-management boards INFLUENCE (science etc.)	Medium	**Land claim agreements**	Inappropriate conservation planning, if species in claim area not well-known	Obligation to ensure migratory bird conservation undertaken, long-term commitment.	**A1 or A2:** distribution of species, relative abundances and concentrations, presence of vulnerable species	Geographical or jurisdictional scale: claim area Frequency and duration: infrequent Accuracy and precision: medium for vulnerable species and locations, otherwise low
9. Threats due to Migratory Birds to public and economy are reduced (*Minimizing Socio-economic Impacts*)	DIRECT (take and airport permits, fund crop damage prevention) and INDIRECT (science, EA)	Low	**Includes a variety of different issues (e.g., Bird-borne disease, Crop damage, Airplane strikes, other impacts)**	Control measures could impact species of conservation concern. Ineffective control measures implemented.	Determine location and extent of threats, and effectiveness of control measures being implemented	**A2:** knowledge of trends in levels and distribution of impact (e.g., disease); **C1:** research or **F:** short term evaluation surveys	Geographical or jurisdictional scale: dependent on issue Frequency and duration: dependent on issue Accuracy and precision: dependent on issue

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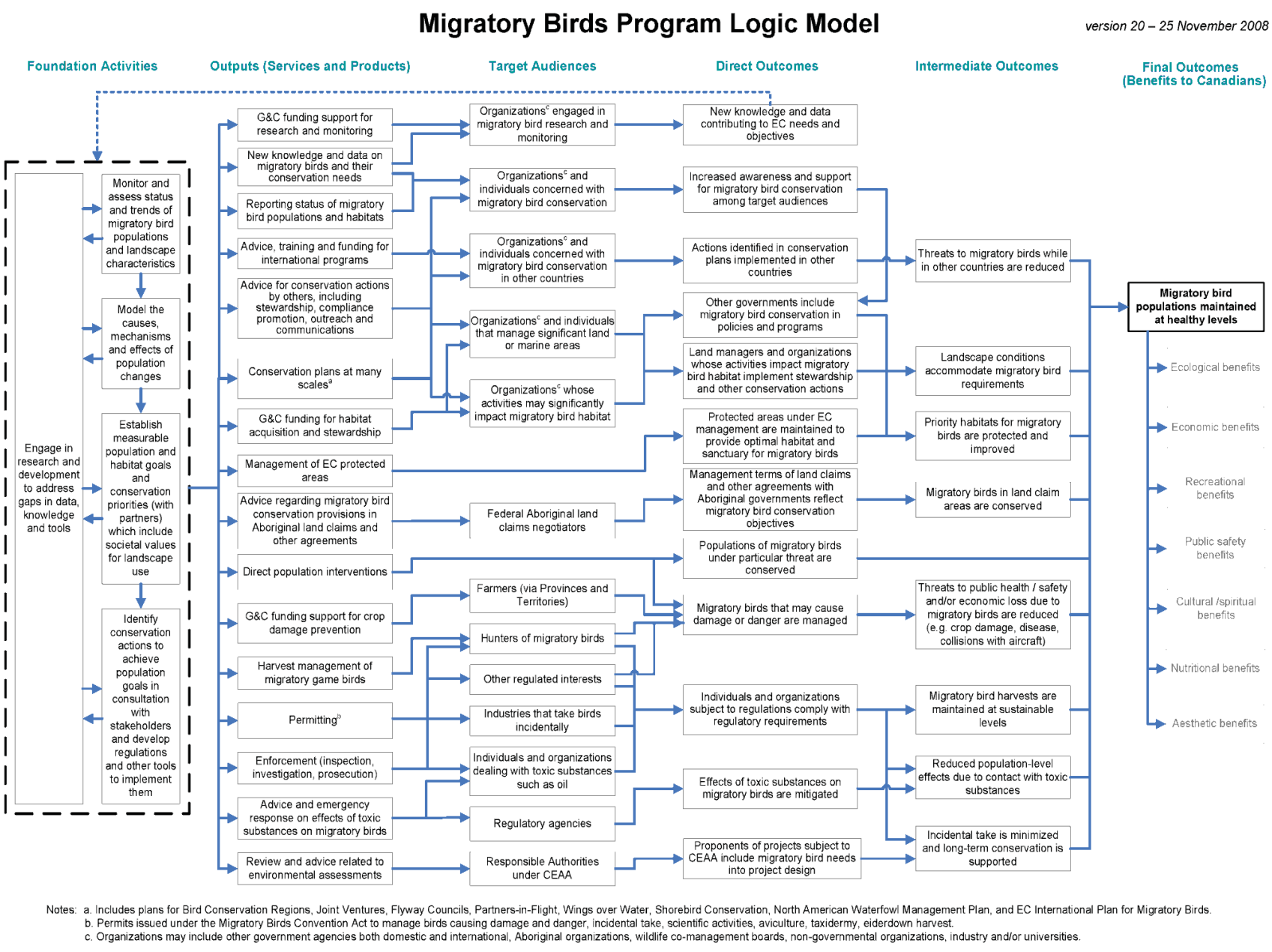
10. Avian Species at Risk are assessed, identified and listed (*Species at Risk Assessment and Listing*)	DIRECT via General Status Assessment, COSEWIC, Science	High	**Status of all wild species, including COSEWIC status assessments**	Missing species that should be further assessed, and assessing species not at risk; Not listing and recovering species in need, listing species not in need; legal challenges.	Basis for joint General Status assessment of all wildlife in Canada, with provinces/ territories; set priorities for further consideration of status. Essential in identifying species at risk (must be sufficient to detect COSEWIC criteria of 30% decline in 3 generations)	**A1 or A2:** population size and trend, distribution extent and change	Geographical or jurisdictional scale: national for assessed populations, otherwise provincial/ territorial Frequency and duration: re-assessments every 10 years for listed species, otherwise every 5 years Accuracy and precision: generally low, but high for first assessment and reassessments
11. Populations of avian Species at Risk are recovered (*Species at Risk Recovery*)	DIRECT for migratory birds via recovery teams, plans, permits, regulation and Enforcement, EA, and INFLUENCE through plan implementation	High	**Species at Risk Recovery**	Not recovering species at risk, and potentially extinction. Undertaking inappropriate recovery actions. Inability to effect multispecies conservation.	Determine effectiveness of conservation measures being implemented, in order to monitor progress and adjust recovery actions as needed	**C1:** to identify key limiting factors, and critical habitat; **F:** surveys to measure success of recovery activities (could include abundance, vital rates, resources, key threats)	Geographical or jurisdictional scale: fine scale, local Frequency and duration: annual or seasonal, until recovery goals reached Accuracy and precision: high



Notes: a. Includes plans for Bird Conservation Regions, Joint Ventures, Flyway Councils, Partners-in-Flight, Wings over Water, Shorebird Conservation, North American Waterfowl Management Plan, and EC International Plan for Migratory Birds.
b. Permits issued under the Migratory Birds Convention Act to manage birds causing damage and danger, incidental take, scientific activities, aviculture, taxidermy, eiderdown harvest.
c. Organizations may include other government agencies both domestic and international, Aboriginal organizations, wildlife co-management boards, non-governmental organizations, industry and/or universities.

FIGURE 3.1. Intermediate outcomes of the Migratory Birds Program as identified in the RMAF/RBAF Migratory Birds Program Logic Model.

FIGURE 3.2. Canada's Bird Conservation Regions (BCRs).

CHAPTER FOUR – Program Frameworks and Summaries

INTRODUCTION

Great variation in the ecology, breeding distribution and migration patterns among Canadian bird species mean that even closely related species may show highly divergent population trends or be subject to very different threats. As such, monitoring programs are required that capture as many species as possible throughout much of their ranges. To achieve this, EC's avian monitoring programs are both numerous and diverse in their methods, target species, geographic coverage and applications.

The diversity of monitoring programs also reflects the underlying needs that gave rise to their development. Major landbird surveys such as the Breeding Bird Survey, for instance, developed in response to perceived songbird declines due to the prevalence of DDT pesticides. Similarly, the need to manage the ecological and legal implications of sport-harvest drove the development of numerous waterfowl programs and intensive long-term investment in these surveys.

In light of such divergent monitoring and management needs, as well as important ecological differences among species, this review has separated surveys according to five principal species groups: landbirds, shorebirds, seabirds, waterbirds [inland colonial and marshbirds], and waterfowl. Although some programs have broad coverage across several groups (e.g., Breeding Bird Surveys), many survey methods are specific to a particular group: for instance, landbirds are often surveyed by point-count methods during the breeding season, while waterfowl can be randomly sampled over large areas from the air. Other groups often require specialized survey methods (e.g., seabird colony monitoring, marsh monitoring, shorebird migration counts). Large scale volunteer-based data collection (e.g., Christmas Bird Counts, checklists) provides at least some information on all species groups, but not necessarily with sufficient precision or accuracy for all needs.

The following section provides summaries on the current monitoring programs in place for birds in Canada. For each of the five species groups, framework tables and accompanying text highlight the main programs providing information on:

1. *population abundance*: primary focus on trends, often based on indices (usually monitored at annual intervals), and secondary focus on population size estimates. Population size is of particular relevance to game birds, as rate of take (harvest) is an important component in the choice of management actions.
2. *population distribution:* primary focus on current distribution, secondary focus on trends (changes normally tracked at 5-20 year intervals)
3. *population parameters*: primary focus on survival, productivity, or mortality from specific sources (e.g., due to harvest, incidental take, oiling, etc); importance varies by species group

Monitoring programs providing information in these three areas are differentiated into two main types:

a. *primary (flagship) monitoring program(s):* relatively large, long-term programs usually at national or continental scale, usually with a rigorous survey design.
b. *supplementary programs:* programs that address geographical or species-related gaps in information provided from flagship programs, or that provide species-group-specific information for program needs.

LANDBIRDS

	Population Abundance	Population Distribution	Population Parameters
Primary flagship programs	- Breeding Bird Survey [BBS] (primarily southern Canada) - breeding bird atlases (quantitative sampling but only at ~20-year intervals)	- breeding bird atlases - BBS	
Secondary supplementary programs	- habitat-specific or regional surveys (e.g., Alberta Biodiversity Monitoring) - Breeding Bird Census - migration monitoring (Canadian Migration Monitoring Network [CMMN]) - winter bird counts (e.g., Christmas Bird Count [CBC], Project FeederWatch [PFW]) - checklists** - Species At Risk [SAR] surveys	- checklists (year-round) - CBC, PFW (wintering distribution) - CMMN (limited to selected migration routes) - other point count programs (breeding)	- species-specific SAR and other surveys - CMMN (potential) - Monitoring Avian Productivity and Survival [MAPS] offer indices of productivity and survival - Nest Record Schemes (few species with adequate data)

** - Note: “Checklists” refer to surveys in which birders, mostly volunteers, record the numbers of each species of bird detected at a particular date and location. Most checklists are collected opportunistically, wherever a birder happens to be out, and are recorded through programs such as eBird or Études des populations d’oiseaux du Québec (ÉPOQ). The same methodology is sometimes used as part of more rigorously designed surveys such as breeding bird atlases.

Population Abundance

- BBS provides fairly comprehensive data for most landbirds and many other species within the area surveyed; but coverage and roadside limitations must be considered.
- Geographic coverage of BBS is limited mainly to southern Canada (little Boreal, Arctic coverage).
- Species coverage of BBS is limited largely to diurnal, conspicuous birds detectable near roadsides.
- Breeding bird atlases fill some geographic gaps, but sampling is only repeated every 20 years, and many first round atlases did not have quantitative sampling.
- Supplementary data are provided by region- or habitat-specific breeding surveys (e.g., Alberta Biodiversity Monitoring, Ontario Forest Bird Monitoring, grassland bird survey, High Elevation Landbird Program).
- Species / geographic gaps are partially addressed by migration monitoring (e.g., boreal species), Christmas Bird Count (e.g., northern breeders), or targeted Species At Risk surveys.
- The potential of checklists (see definition above) to fill gaps has not been fully explored.

Population Distribution

- Breeding bird atlases describe distribution at appropriate scales in well-covered regions, but some areas are not yet covered (SK, NL, territories) or are only on their first round of atlasing (BC, MB). Coverage in northern parts of range is often limited.
- Atlases can provide trends in population distribution at 20-year intervals (if effort is appropriately standardized – some methodology concerns remain).
- Checklists are the primary source of information in some areas (territories), but with limited coverage.
- Non-breeding distribution data derives from checklists (including eBird), CBC, PFW.

Population Parameters

- Currently there are no major programs successfully providing demographic parameters for most species, except a few Species At Risk [SAR], and local populations of some species subject to intensive research programs (e.g., Tree Swallow).
- MAPS (constant effort mist-netting and banding) has the potential to provide indices of productivity (age ratios) and survival (mark-recapture), but coverage and sample size are currently inadequate. CMMN may be able to provide information on changes in age ratio, but there are some limitations.
- Nest records schemes have been proposed for monitoring productivity, but sample size, data quality, and geographic coverage are currently insufficient for most species.

SEABIRDS

	Population Abundance	Population Distribution	Population Parameters
Primary flagship programs	- colony monitoring	- colony monitoring - pelagic surveys (Atlantic, Pacific, eastern Arctic)	- colony monitoring
Secondary supplementary programs	- BC Coastal Waterbird Survey - single-species surveys (Species At Risk; pelagic)	- Arctic PRISM (e.g., gulls, jaegers) -checklists (NWT, NU) - Breeding bird atlases - local pelagic surveys - seabird atlassing	- murre harvest survey

Population Abundance

- Colony surveys of breeding seabirds are well-established and provide coverage for colonial breeding species in the Atlantic, Gulf of St Lawrence, Pacific and Arctic, but some low-density species are missed, and some major colonies, especially in remote areas, are surveyed at very intermittent intervals; thus important species and geographic gaps remain.
- Additional abundance data for Pacific species come from the BC Coastal Waterbird Survey, but some species are still poorly covered (and vulnerable to both inshore and offshore stressors).
- Supplementary abundance and trend data come from species-specific monitoring (non-colonial breeders; Species At Risk e.g., Ivory Gull, Marbled Murrelet) and pelagic surveys (e.g., for austral breeders).

Population Distribution

- Colony surveys provide primary breeding distribution information for colonial species.
- Pelagic surveys provide distribution information on numerous species of seabirds in their dispersed, non-breeding phase, but there are some concerns about survey frequency, geographical coverage, and protocol variation.
- Supplementary distribution information comes from the Arctic breeding component of PRISM (for gulls, jaegers), checklists in the territories, atlases and local pelagic surveys.

Population Parameters

- Colony monitoring during the breeding season provides estimates of demographic parameters for a few key colonial breeders in Canada (with some species-variation in detail of parameter estimates); there are no surveys for non-colonial species.
- A special harvest survey for murres and seaducks provides additional demographic data for murres.

SHOREBIRDS

	Population Abundance	Population Distribution	Population Parameters
Primary flagship programs	Program for Regional and International Shorebird Monitoring [PRISM]: - Arctic surveys - migration monitoring - winter surveys	- Arctic PRISM	- Arctic PRISM demographic studies
Secondary supplementary programs	- migration monitoring - single-species surveys (e.g., Species at Risk) - PRISM temperate breeding - BBS (for some species) - CBC	- Breeding bird atlases - checklists (territories, QC) - BBS (for some species) - CBC - single-species surveys	- National Harvest Survey (for woodcock, snipe) - migration monitoring (productivity indices) - single-species SAR surveys

Population Abundance

- PRISM is designed for shorebird monitoring on a range-wide scale, targeting species where they are most effectively monitored (i.e., the breeding season in Arctic, boreal or temperate latitudes; on migration; or on wintering grounds).
- The Arctic breeding component of PRISM is proposed to serve as the primary source of shorebird population data for Arctic nesting species, including estimates of total abundance and long-term trends; however, the first round won't be completed for several years, so range-wide abundance estimates are not yet available for most species, and long-term trends will not be available until the survey is repeated, possibly 10-15 years later. There is very limited coverage of temperate habitats, and no current boreal coverage.
- Migration monitoring, the main survey approach currently available, has serious limitations due to potential bias in trend indices, and provides no information on breeding distribution. Nonetheless, it still serves to fill temporal gaps (e.g., between 10- to 20-year Arctic surveys) and geographical gaps (e.g., boreal areas), and provides particularly important data on use of key migration sites (Bay of Fundy, Fraser Delta).
- Other species are covered by species-specific surveys conducted regularly (e.g., Piping Plover, Mountain Plover, woodcock survey, South American Red Knot survey) or opportunistically (e.g., Long-billed Curlew), BBS (temperate breeders like Killdeer, Upland Sandpiper), CBC (e.g., Purple Sandpiper, Dunlin).

Population Distribution

- The Arctic breeding component of PRISM will provide primary data on distribution for Arctic nesting species.
- Migration/staging distribution data derive mainly from migration monitoring.
- Some additional distribution data (mainly regional or species-specific) come from atlases, regional checklists, BBS, CBC, and limited breeding surveys in boreal and temperate habitats.

Population Parameters

- Productivity indices are derived from regional shorebird migration monitoring programs (when age ratio data are collected), and are also measured as part of the Arctic breeding component of PRISM.
- The National Harvest Survey provides data on sport-hunting mortality of snipe and woodcock.
- Regional and species-specific demographic data come from Species At Risk surveys (e.g., for Piping Plover).

WATERBIRDS (INLAND/MARSHBIRDS)

	Population Abundance	Population Distribution	Population Parameters
Primary flagship programs	- Great Lakes Colonial Waterbird Survey - Marsh Monitoring Programs [MMP] (Great Lakes, parts of Québec, parts of prairies) - BBS (few species) - Waterfowl breeding ground surveys (coots, grebes, loons)	- Breeding bird atlases - Arctic checklists (NWT/NU)	
Secondary supplementary programs	- QC heronries 5 yrs census - Ontario heronry inventory - single-species surveys (e.g., SAR, regional inventories)	- QC heronries 5 yrs census - Ontario heronry inventory - aerial waterfowl surveys - regional checklists - single-species SAR surveys	- Canadian Lakes Loon Survey

Population Abundance

- The Great Lakes Colonial Waterbird Survey (10-year intervals) is the core program for inland colonial species in the Great Lakes region; it complements similar marine surveys (e.g., gulls, cormorants in St. Lawrence, Atlantic).
- The Great Lakes MMP gives abundance and trend estimates within the Great Lakes basin, and the Quebec program covers much of the southern region of that province, but both are focused near populated areas and thus the sampling design is potentially biased for inferences over larger areas.
- The Prairie MMP was established in 2008 with an emphasis on evaluation of habitat management actions.
- Atlas data have the potential to supplement MMP if adequate quantitative sampling is incorporated into the atlas sampling protocol, but only provide trend information at 20-year intervals.
- Other species are picked up by some aerial waterfowl surveys (e.g., loons, grebes, coots), Breeding Bird Survey (e.g., Common Loon, Pied-billed Grebe), checklist programs, atlases and other multi-species monitoring, but only over parts of their ranges.
- Dispersed-nesting species and secretive marsh birds represent a significant monitoring challenge.
- Supplementary data for some colonial species derive from the Quebec region heronry census (at 5-year intervals); a similar program in Ontario was run at 10-year intervals but was discontinued.
- Additional data come from Species At Risk surveys (e.g., King Rail, Yellow Rail, Least Bittern), and from various regional species-specific surveys (e.g., Bonaparte's Gull migration at Saguenay, Black Tern and Ring-billed Gull in Quebec, Mono Lake Eared Grebe photo counts, Franklin's Gull and Western Grebe in prairies).

Population Distribution

- Breeding bird atlas projects provide distribution data at 20-year intervals, often with additional data on colonies.
- Checklists are the best source of Arctic distribution data; other checklists provide additional regional data (e.g., ÉPOQ, eBird).
- Heronry surveys, aerial waterfowl surveys and species-specific SAR surveys add supplementary data.
- Arctic waterbirds (cranes, loons, gulls) are picked up on Arctic PRISM surveys and during transects flown between survey plots.

Population Parameters

- There is currently no primary survey targeting the estimation of population parameters.
- The Canadian Lakes Loon Survey includes productivity estimates but only samples some areas.
- Hunted species are poorly monitored (Virginia Rail, Sora, American Coot) so little demographic data exists (the Canadian harvest is relatively low, but harvest is higher in the US where most Canadian breeders winter).

WATERFOWL

	Population Abundance	Population Distribution	Population Parameters
Primary flagship programs	- continental-level breeding waterfowl surveys (Eastern/Prairie-Parkland/BC) - white goose colony surveys - Greater Snow Goose spring survey - Canada Goose surveys - Mid-Winter Inventory	- breeding waterfowl surveys (Eastern/Prairie-Parkland/BC) - white goose colony surveys - Greater Snow Goose spring survey - Canada Goose surveys - Mid-Winter Inventory - recoveries from banding programs	- National Harvest Survey [NHS] - banding programs (pre-season ducks, Arctic geese, Canada goose)
Secondary supplementary programs	- regional breeding surveys - species-specific migration, breeding, winter surveys - single-species SAR surveys - directed regional surveys (for anthropogenic threats, joint venture/BCR planning, environmental assessments)	- Breeding bird atlases - species-specific breeding, winter surveys - directed regional surveys (for anthropogenic threats, joint venture/BCR planning, environmental assessments)	- supplementary harvest surveys (e.g., sea ducks, BC snow goose, BC brant) - sea duck banding - productivity surveys (e.g., BC/SK waterfowl) - native harvest surveys

Population Abundance

- Highest priority dabbling and diving ducks are covered by the Waterfowl Breeding Population and Habitat Survey (WBPHS, central/western Canada) and Eastern Waterfowl Surveys (which are especially good for early-nesting waterfowl); regional breeding surveys also provide local abundance data.
- Most Arctic-nesting geese are monitored through large-scale breeding or wintering surveys; these are typically colony-specific for white geese and transect surveys for other species.
- Additional surveys are conducted for Greater Snow Goose (spring staging), Canada Goose (regionally).
- Species-specific surveys during migration (Canvasback, White-fronted Goose), breeding (eiders, scoters, long-tailed ducks, swans), and winter (brant in BC) supplement other surveys.
- The mid-winter survey (mainly in US except for Ontario Great Lakes) provides the only information for Atlantic Brant, and is a primary tool for measuring lesser snow goose trends; swans are also monitored [recent changes to survey include reduced range, focus only on a few priority species].
- Species At Risk surveys provide additional information for eastern Barrow's Goldeneye, eastern Harlequin Duck; Trumpeter Swan (which is no longer listed so survey has been redesigned)
- Harvest survey results, combined with estimates of harvest rates, can be used to estimate continental population sizes for monitoring large, geographically widespread, remote populations like Arctic geese.
- Regional surveys cover populations facing anthropogenic risks (e.g., forestry, mining, gas/oil, agriculture), and are used in Joint Venture/BCR planning, environmental assessments (e.g., ground surveys in PEI, ON & BC, roadside breeding and migration monitoring in YK, boreal aquatic birds, aquaculture survey).

Population Distribution

- All primary abundance surveys are based on random stratified sampling, so they all contribute to monitoring changes in population distribution; refer to population abundance details above.
- Banding programs and regional breeding bird atlases also supplement distribution data.

Population Parameters

- Survival, productivity, demographic trends, harvest rates, migration timing, and harvest distribution are assessed through band recoveries resulting from the various banding programs (ducks, interior and temperate-nesting Canada geese, Arctic-nesting geese). Variation in band reporting and retrieving rates has been estimated through reward-banding.
- Formerly there were extensive productivity surveys (brood counts) in the prairies, but these are now reduced to more limited surveys in specific geographic areas. Also some age ratio data on migration or wintering grounds. Additional data from many long-term research projects (e.g., arctic geese).
- The NHS provides estimates of regular season harvest of most migratory game birds; not well captured are species harvested late or in limited geographic areas (e.g., seaducks – supplemented by special harvest surveys) or with low harvest (e.g., Brant and Snow Geese in BC, Barrow's Goldeneye).
- Harvest surveys can provide a productivity index, particularly if age-ratios are corrected for vulnerability.
- Additional population and harvest monitoring come from native harvest surveys in Nunavut, Inuvialuit.

MAPS

The following maps highlight the sampling locations for the primary flagship programs described above, as well as for some secondary programs. The surveys illustrated in Figures 4.1 and 4.2 apply across all five species groups, whereas surveys targeted at a specific group are illustrated in Figures 4.3 through 4.10.

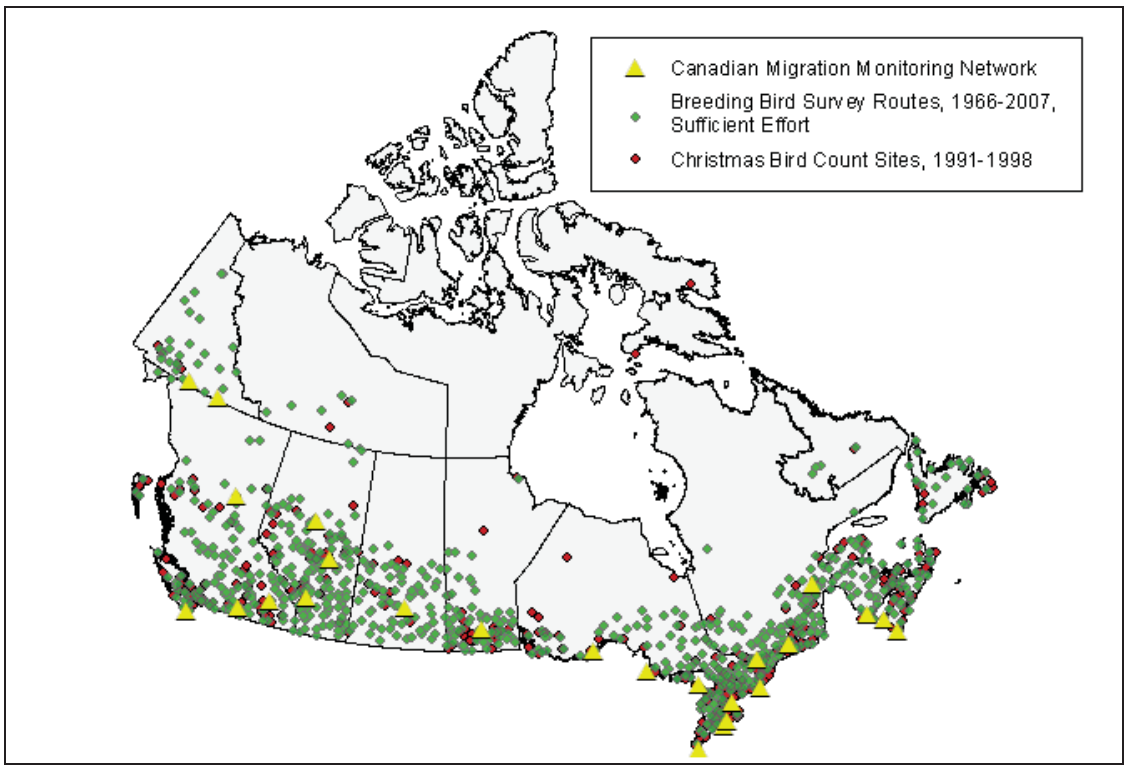


FIGURE 4.1. Canadian distribution of major annual surveys for landbirds: Breeding Bird Survey routes, Christmas Bird Count sites, and stations of the Canadian Migration Monitoring Network.

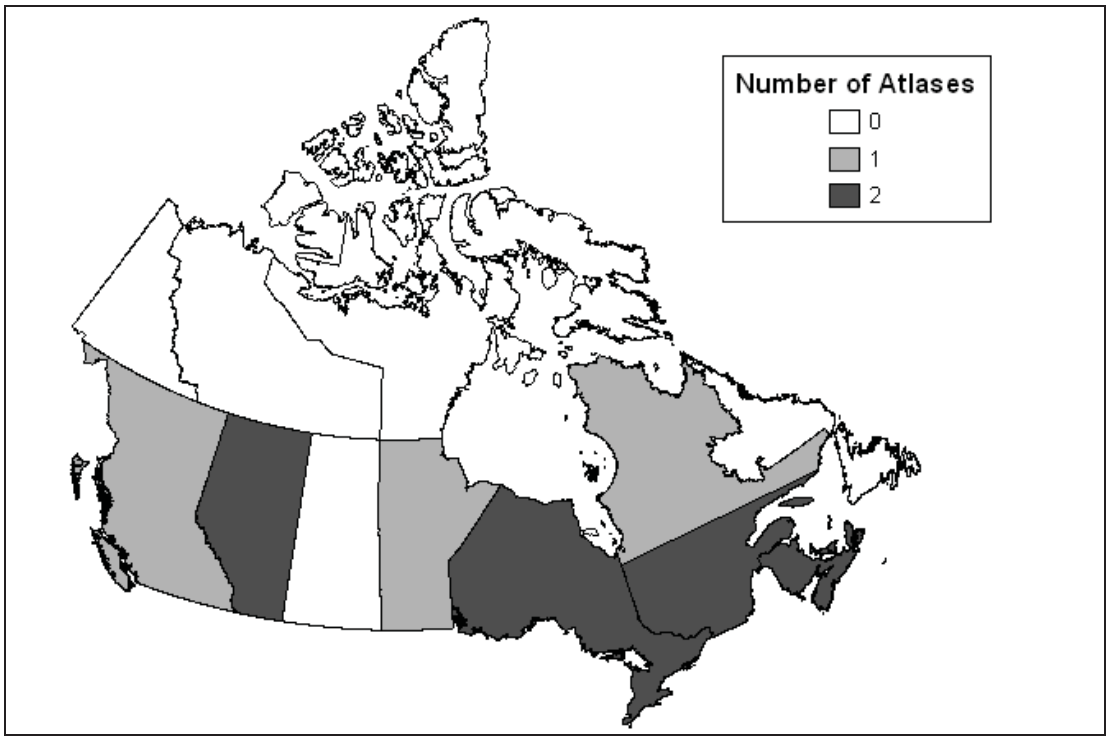


FIGURE 4.2. Current coverage of Canadian Breeding bird atlases. Only Alberta, Ontario and the Maritimes have completed two atlases. The first atlas for B.C. (2008-2012), Manitoba (2010-2014), and the second atlas for Quebec (2010-2014) are not yet complete. As yet, very little coverage has been achieved in northern Quebec.

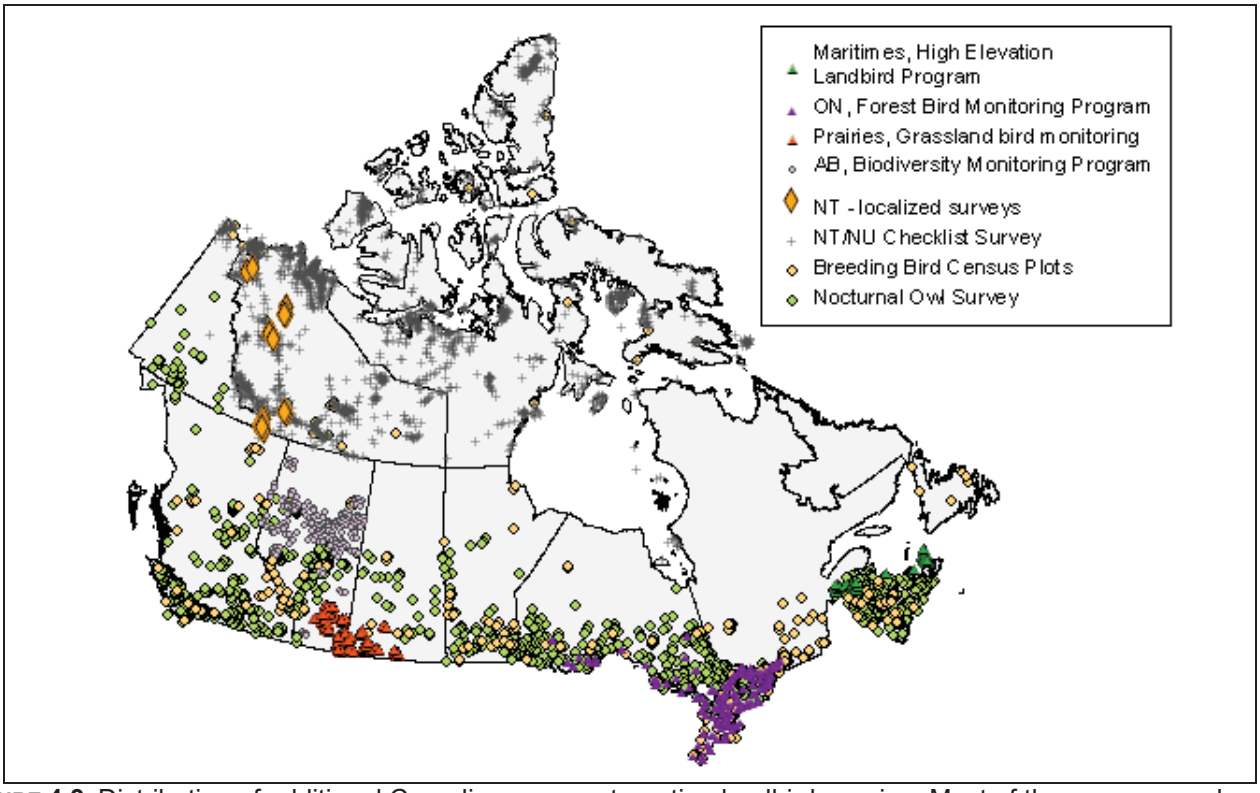


FIGURE 4.3. Distribution of additional Canadian surveys targeting landbird species. Most of these are annual, except the checklist surveys, and most target only a limited suite of species or habitats.

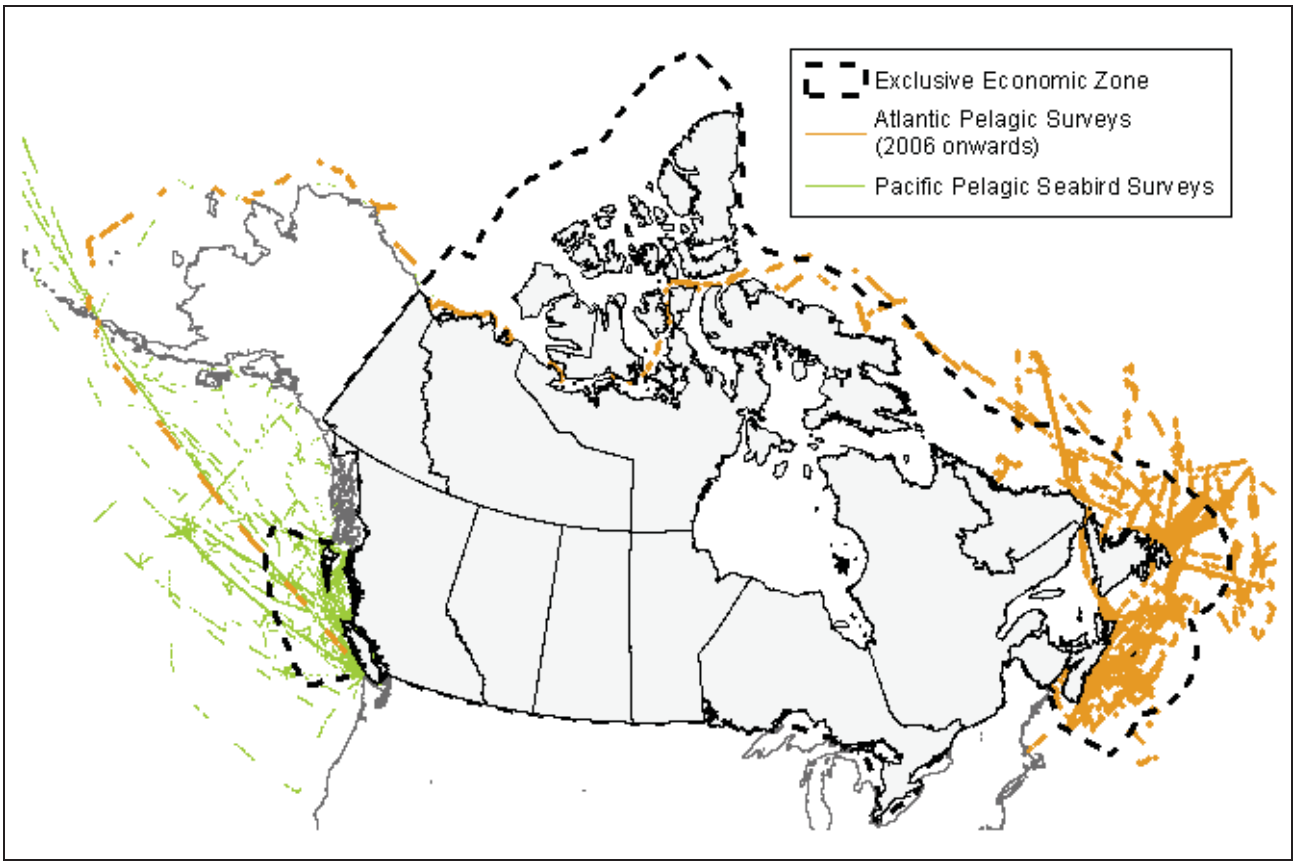


FIGURE 4.4. Distribution of Canadian pelagic survey routes. These are opportunistic surveys which put observers on ships conducting regular business; most have only been surveyed once.

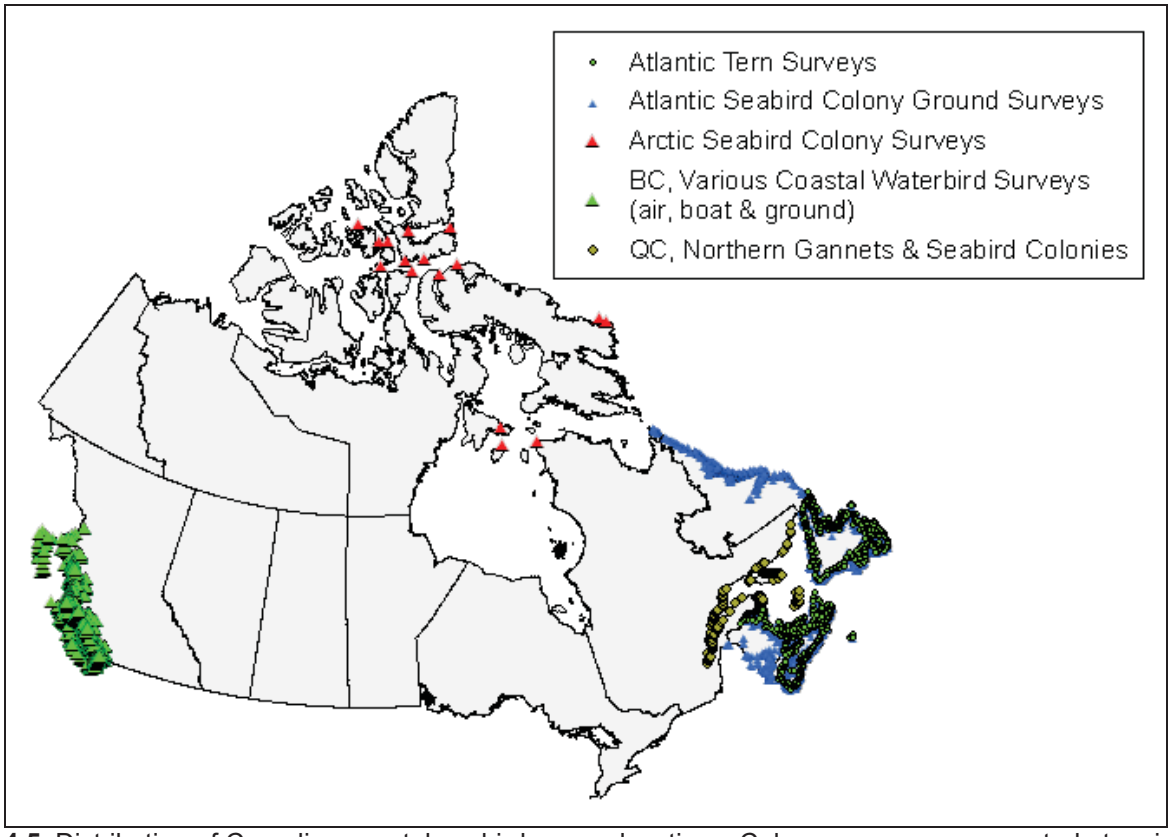


FIGURE 4.5. Distribution of Canadian coastal seabird survey locations. Colony surveys are repeated at variable intervals, mostly from 5-20 or more years apart, although a few are surveyed annually.

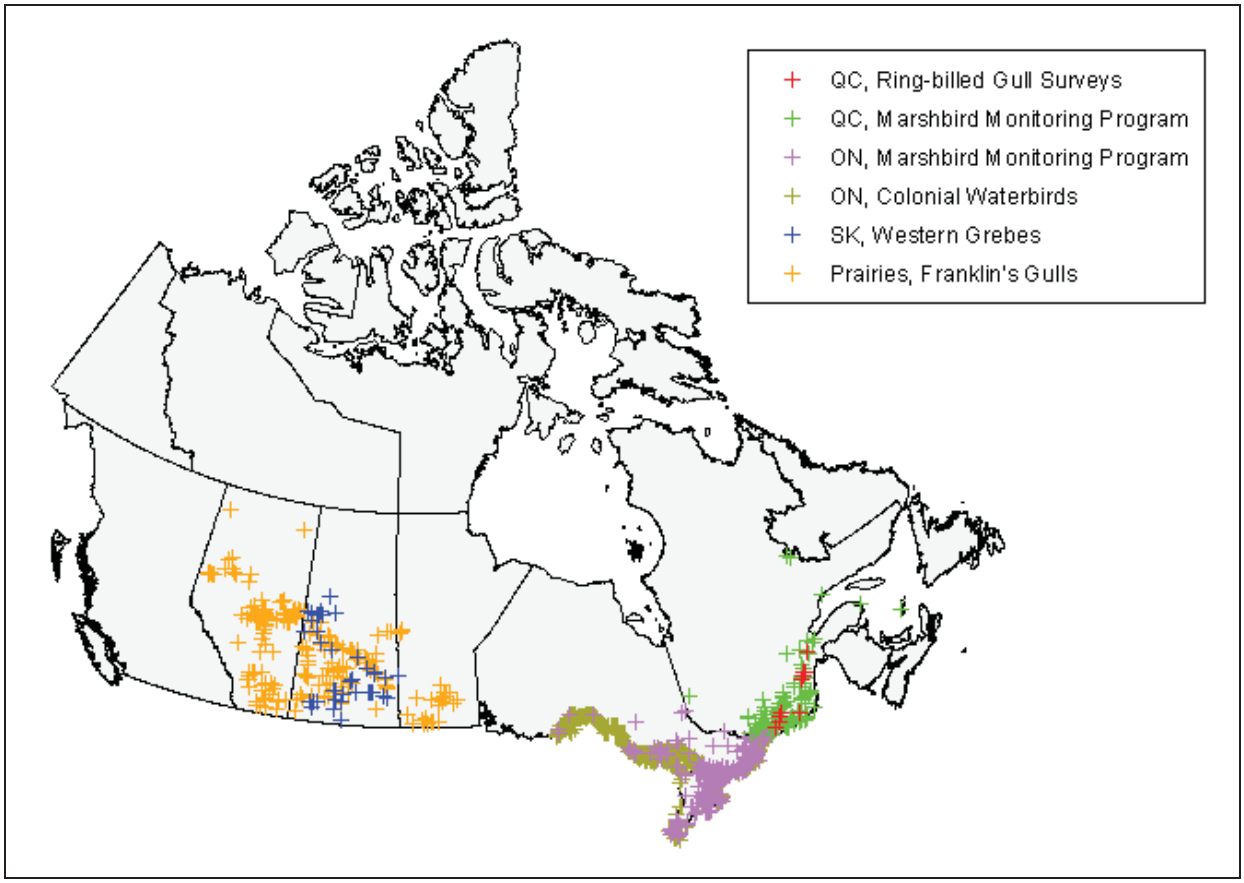


FIGURE 4.6. Distribution of inland colonial waterbird survey locations. Some sites are surveyed at 5-10 year intervals; others have only been surveyed once.

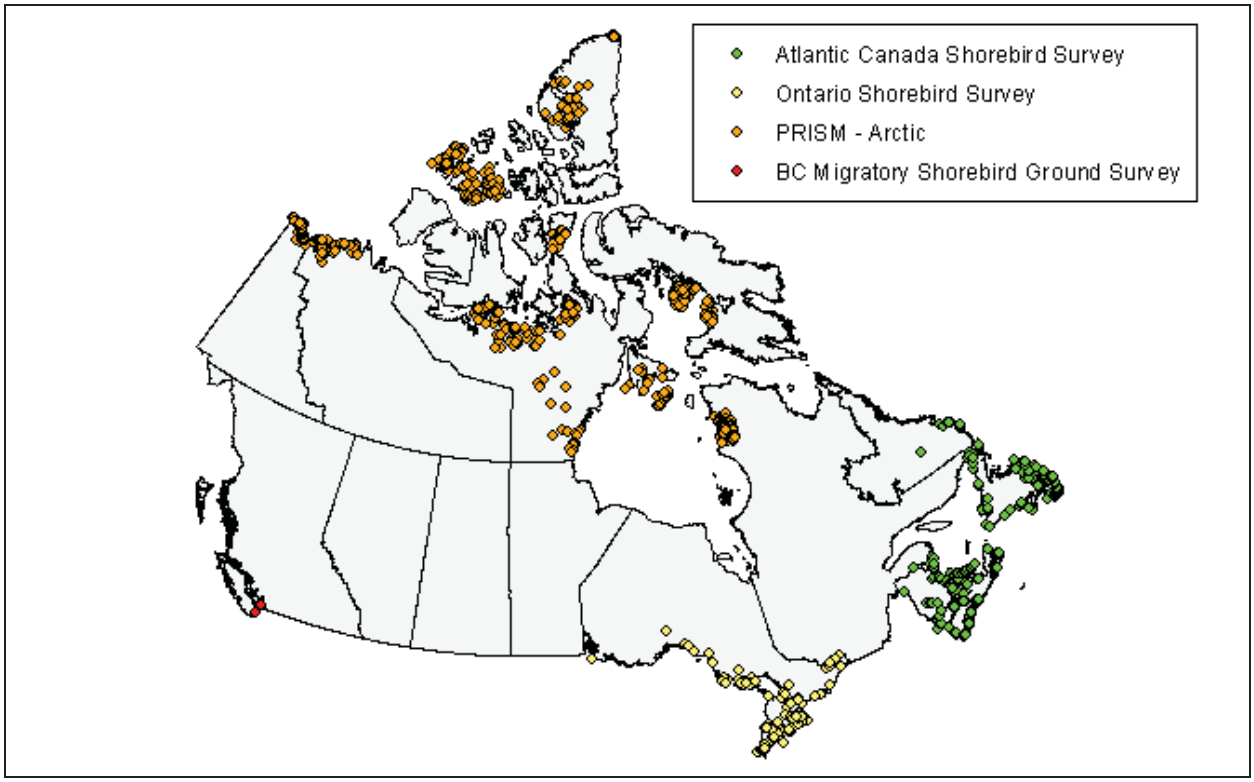


FIGURE 4.7. Distribution of Arctic PRISM breeding surveys, and migration surveys in Canada for shorebirds. Most migration sites are surveyed annually; most Arctic breeding sites have only been surveyed once so far.

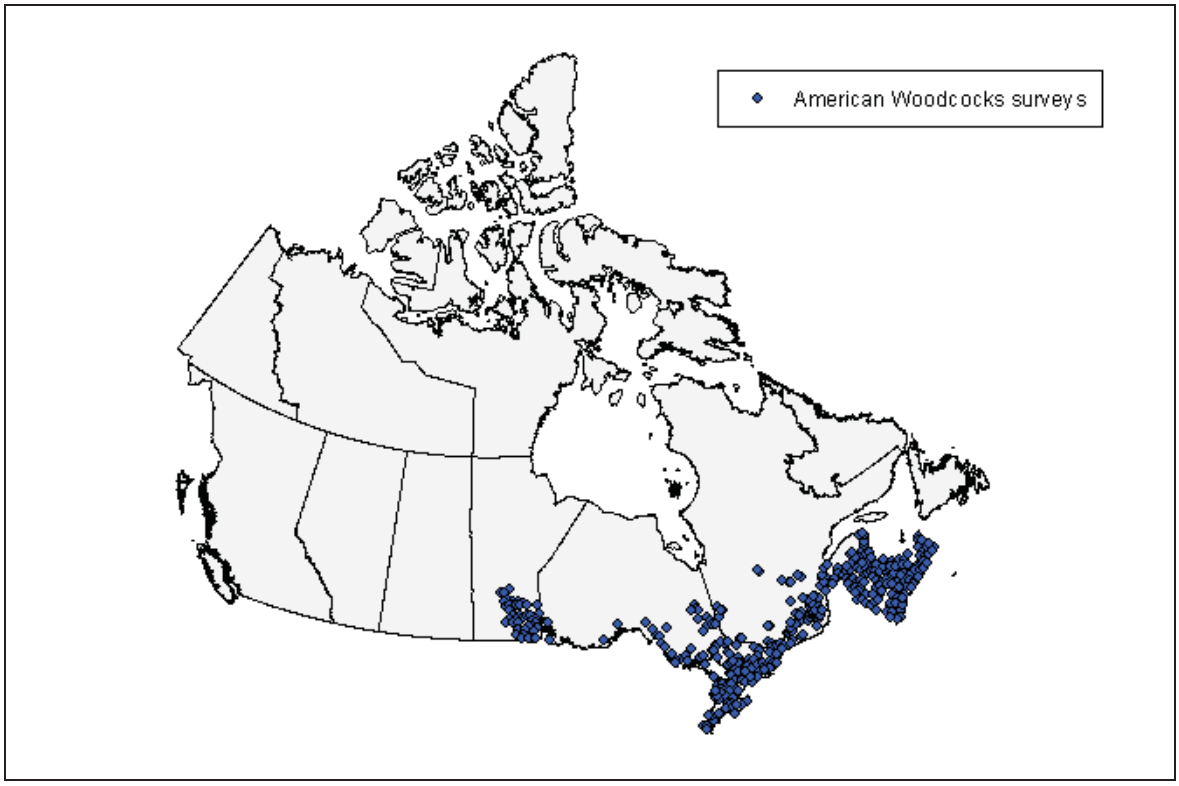


FIGURE 4.8. Distribution of American Woodcock breeding ground survey. Sites are surveyed annually for this harvested species.

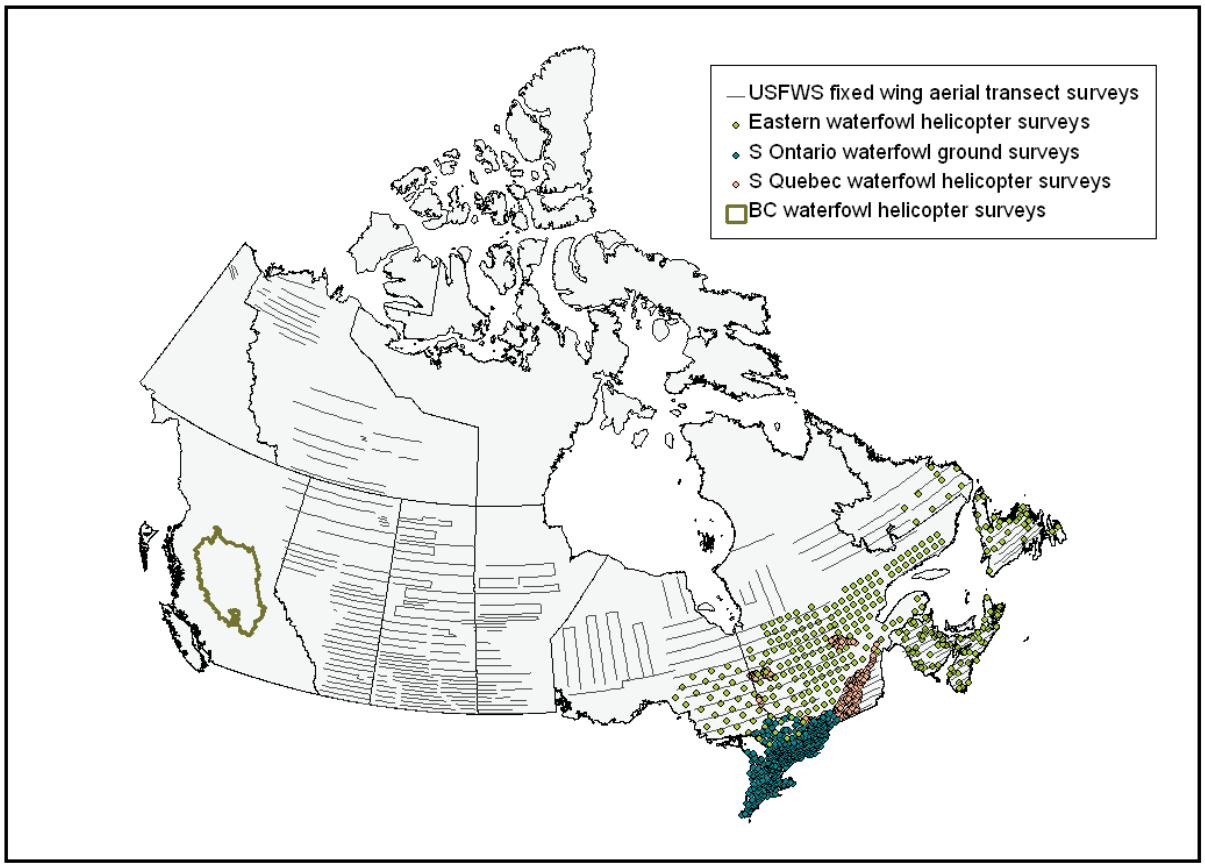


FIGURE 4.9. Distribution of major annual waterfowl aerial and ground surveys providing population status on most species of ducks and southern breeding Canada geese.

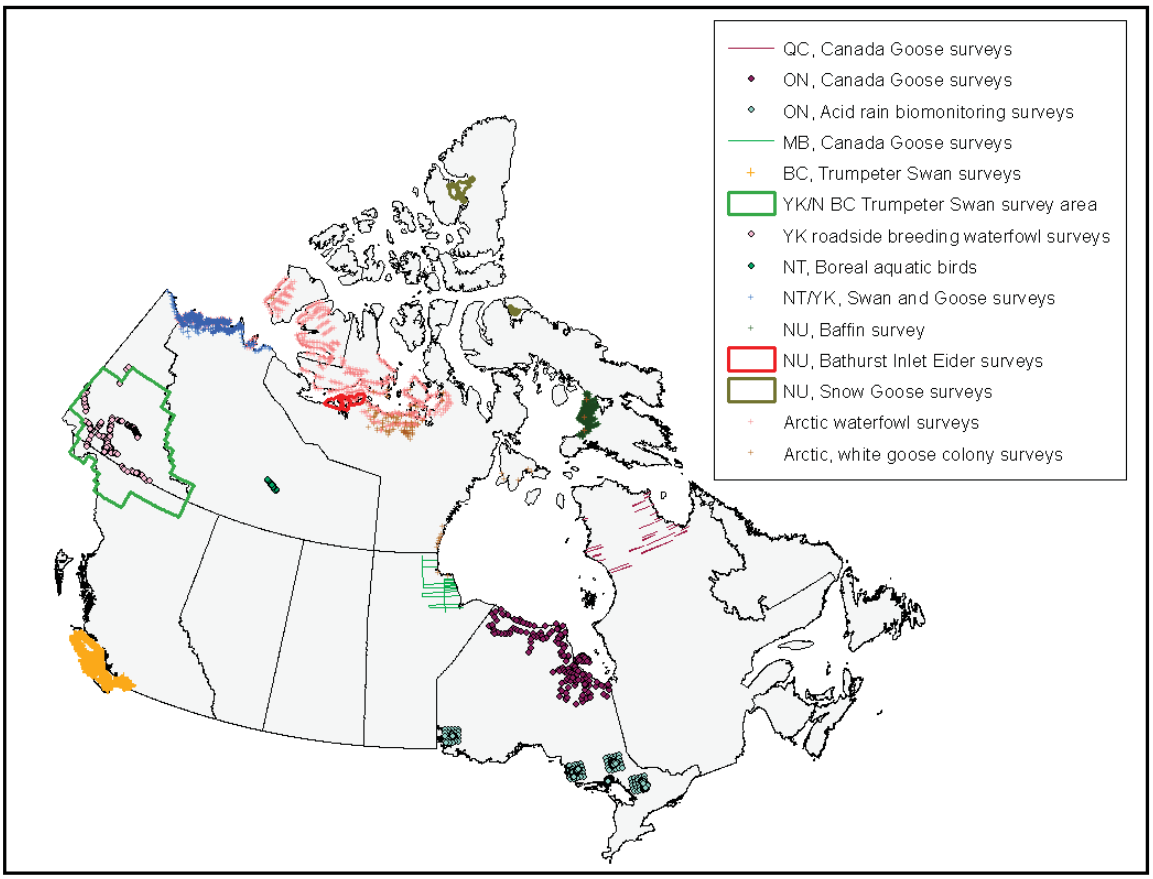


FIGURE 4.10. Distribution of other ongoing waterfowl surveys repeated at various intervals, mostly multi-year.

SUMMARY OF CURRENT MONITORING PROGRAMS

Details of all reviewed monitoring programs, including information on start date, frequency and budgets (both cash and staff time), are summarized in Table 4.1. Within each of the five main species groups, surveys are further organized according to season, scale, or type of data; note that programs outside the scope of avian monitoring (i.e., those specifically designed to answer research questions or whose primary objective is not to detect changes in population parameters over time) are listed separately at the end of each group.

The total annual estimated costs, in cash and personnel time, of all monitoring programs described in Table 4.1 (based on estimated average annual values from 2002-2007) can be summarized as follows:

	Cash contributions			Personnel contributions (person-years)		
Species group	**EC cash**	**Non-EC cash**	**Total cash**	**EC Staff**	**Non-EC Staff and Volunteers**	**Total Personnel**
Landbirds	$1,290,000	$2,340,000	$3,630,000	13	264	277
Shorebirds	$450,000	$300,000	$750,000	4	6	10
Seabirds	$190,000	$230,000	$420,000	6	10	16
Waterbirds	$350,000	$490,000	$840,000	7	21	28
Waterfowl	$2,820,000	$4,560,000	$7,380,000	47	57	104
Total	**$5,100,000**	**$7,920,000**	**$13,020,000**	**77**	**358**	**435**

Note: these data are only estimates of expenses and effort derived from the questionnaires completed by monitoring program managers in 2007 – they have not been validated against financial records.

These summary values highlight the high monetary value placed on the monitoring of Canadian bird populations, and on certain bird groups in particular. The average total annual investment in avian monitoring programs between 2002-07 was approximately $13 Million, of which 39% ($5.1 Million) was funded by EC. Over half the money was invested in waterfowl monitoring, both in funds internal to EC as well as investments by partners, while the smallest monetary investment was made in shorebird monitoring.

Personnel investment in avian monitoring also varied greatly among species groups. For instance, 61% of EC personnel time was dedicated to waterfowl programs but only 8% to shorebird monitoring. In contrast, non-EC personnel time was largely dedicated to landbird programs (74%), while shorebird monitoring received the least non-EC personnel investment (3%).

These figures further illustrate the critical role of partnerships and volunteers to avian monitoring, as over half of the financial contributions (61%) and more than three-quarters of personnel time (82%) derive from outside of EC. The relative importance of external contributions varies among species groups; for instance, external funding is particularly important to landbird and waterfowl surveys, representing 64% and 62% of costs for those groups respectively. Moreover, external involvement of partner staff and volunteer time is greater than EC staff involvement for every species group and represents the vast majority of personnel investments for landbirds (95%). This major non-EC investment in landbirds reflects primarily volunteer-driven programs such as the Breeding Bird Survey, regional Breeding bird atlases, the Christmas Bird Count, Project FeederWatch, and eBird.

TABLE 4.1. Summary information for all surveys considered during the Avian Monitoring Review, sorted by species group (Landbirds LB, Shorebirds SB, Seabirds SE, Inland Waterbirds/Marshbirds WB, Waterfowl WF), with primary "flagship" programs highlighted in **bold**. Within species groups, surveys are categorized according to season, scale or type of data. Note that programs that are not monitoring avian populations (e.g., programs directed primarily at research or at monitoring of toxins; i.e., those whose primary objective is not to detect changes in bird population parameters over time) are listed separately (at the end of each species group), as they were not the focus of the Avian Monitoring Review. Note also that most broad-scale multi-species surveys (e.g., Breeding Bird Survey, Christmas Bird Count, checklists, breeding bird atlases) have been listed under the 'Landbirds' category, although they also contribute data to some other species groups. Some other surveys aimed primarily at one species group also provide data relevant to another group (e.g., aerial breeding waterfowl surveys provide additional data on distribution of some waterbirds). Budgetary values are estimates of average annual values from 2002-2007. Most of these have not been validated against actual expenditure records, and there may be some inconsistencies in the way that budgets are recorded for periodic surveys that take place every few years. These were requested as an annualized average (e.g., a $50K survey every 5 years would be recorded as an average of $10K per year), but in some cases the amount recorded may be closer to that of a maximum year. Furthermore, many of these values may have changed in the past few years.

						Estimated average annual budget 2002-07			
Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
LANDBIRDS									
National breeding season surveys									
LB-31	**North American Breeding Bird Survey (BBS)**	Monitoring	breeding	1966	annual	$16,000	$17,500	1.35	3.51
LB-10	Breeding Bird Census Plots	Monitoring	breeding	1929	other	$0	$0	0.00	Not available
LB-35	Parks Canada Surveys	Monitoring	breeding	2005	annual	$0	Not available	Not available	Not available
Regional breeding season surveys									
LB-1	Alberta Biodiversity Monitoring Program	Monitoring	breeding	2007 (pilot '03)	5-yr	$50,000	$371,800	0.00	1.55
LB-3	B.C. Band-tailed Pigeon Survey	Monitoring	breeding	2001	annual	$1,000	$0	0.02	0.00
LB-4	Baseline Bird Densities in Mackenzie Valley, NWT	Inventory	breeding	2002	bienniel	$212,000	$0	0.00	0.46
LB-17	Fort Liard, NWT Point Counts	Monitoring; Research	breeding	1998	other	$25,000	$0	0.66	0.00
LB-18	Grassland Bird Monitoring	Monitoring	breeding	1996	annual	$2,000	$0	0.26	0.22
LB-34	Ontario Forest Bird Monitoring Program	Monitoring; Research	breeding	1987	annual	$12,000	$0	0.20	0.97
LB-50	Suffield National Wildlife Area Monitoring	Monitoring; localized	breeding	2000	annual	$3,600	$0	0.36	0.00
LB-56	Southern Quebec Shrub Birds Survey	Inventory; Potential Monitoring	breeding	2006	triennial	$2,000	$0	0.13	0.00
Breeding bird atlases									
LB-6	**Breeding Bird Atlas - Alberta**	Monitoring	breeding	2000	other	$0	$15,000	0.20	3.69

						Estimated average annual budget 2002-07			
Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
LB-7	**Breeding Bird Atlas - B.C.**	Monitoring	breeding	2008	other	$62,000	$60,000	0.98	11.39
LB-8	**Breeding Bird Atlas - Maritimes**	Monitoring	breeding	2006	other	$80,000	$208,000	0.00	14.27
LB-9	**Breeding Bird Atlas - Ontario**	Monitoring	breeding	1981	other	$104,000	$182,000	1.12	23.35
LB-55	**Breeding Bird Atlas - Quebec**	Monitoring	breeding	2010	other	$30,000	$5,000	0.50	0.10
LB-60	**Breeding Bird Atlas - Manitoba**	Monitoring	breeding	2010	other	$50,000	$168,000	0.10	4.00
Migration surveys									
LB-22	Migration Monitoring Program	Monitoring	migration - spring/fall	1960	annual	$106,000	$652,000	0.68	54.10
LB-58	Visual Counts of Boreal Migrants	Monitoring	migration – fall	1996	annual	$40,000	$13,600	0.53	4.77
Winter surveys									
LB-13	Christmas Bird Count (CBC)	Monitoring	winter	1900	annual	$0	$45,000	0.00	23.88
LB-41	Project Feeder Watch	Monitoring	winter	1976 ON, ‘87 N. Am	annual	$0	$90,000	0.00	39.26
Checklist surveys									
LB-2	Alberta Birdlist Program	Monitoring	year round	2000	other	$0	$3,000	0.00	0.40
LB-15	eBird Canada	Monitoring	year round	2005 (2002 US)	annual	$10,000	$12,700	0.00	48.41
LB-32	**NWT/NU Bird Checklist Survey**	Monitoring	year round	1995	annual	$12,000	$0	0.30	0.01
LB-43	Quebec Bird Population Surveys (ÉPOQ)	Monitoring	year round	1955	annual	$30,000	$0	0.20	16.46
Nest records									
LB-24	Nest Records Scheme - B.C.	Potential Demographic Monitoring (productivity)	breeding	1998	annual	$0	Not available	Not available	Not available
LB-25	Nest Records Scheme - Maritimes	Potential Demographic Monitoring (productivity)	breeding	1960	annual	$200	$0	0.10	0.17
LB-26	Nest Records Scheme - Ontario	Potential Demographic Monitoring (productivity)	breeding	1956	annual	$2,500	$0	0.00	0.00

						Estimated average annual budget 2002-07			
Survey #	Survey Name	Type of Program	Time of year	Start year	Frequency	EC cash	Non-EC cash	EC Staff (Person-years)	Non-EC Staff & Volunteers (Person-years)
LB-27	Nest Records Scheme – Prairies	Potential Demographic Monitoring (productivity)	breeding	1960s	annual	$0	$1,000	0.05	0.20
LB-28	Nest Records Scheme - Project Nest Watch	Potential Demographic Monitoring (productivity)	breeding	2001	annual	$0	$6,000	0.00	3.95
LB-29	Nest Records Scheme - Quebec	Potential Demographic Monitoring (productivity)	breeding	1969	annual	$0	$0	0.00	0.01
Species At Risk surveys									
LB-11	Breeding Savannah Sparrows on Sable Island	Monitoring	breeding	2006	5-yr	$13,000	$15,000	0.52	0.10
LB-12	Burrowing Owl Survey	Monitoring; non-MBNA SAR	breeding	1988, 2002 (2 areas)	annual	$10,000	$2,000	0.10	0.10
LB-14	Eastern Loggerhead Shrike Nest Monitoring	Monitoring	breeding	early 1990s	annual	$38,000	$11,000	0.00	0.30
LB-16	Ferruginous Hawk Management Planning	Monitoring; non-MBNA SAR	breeding	2003	5-yr	$15,000	$10,000	0.53	0.08
LB-19	High Elevation Landbird Program	Monitoring	breeding	2002	annual	$23,000	$12,800	0.00	0.77
LB-20	Hooded Warbler and Acadian Flycatcher Survey	Monitoring	breeding	1999	annual	$40,000	$0	0.00	0.74
LB-36	Peregrine Falcon Monitoring	Monitoring; non-MBCA SAR	breeding	1965/ 1970 (by area)	5-yr	$25,000	$75,000	0.21	1.06
LB-37	Prairie Loggerhead Shrike 5-Year Surveys	Monitoring	breeding	1987	5-yr	$5,000	$6,000	0.20	0.13
LB-38	Prairie Loggerhead Shrike Grassland Surveys	Inventory	breeding	2002	one time	$82,000	$0	1.24	0.00
LB-39	Prairie Loggerhead Shrike Roadside Surveys	Inventory	breeding	2003	one time	$55,000	$0	1.08	0.00
LB-40	Prairies Sage Thrasher Survey	Inventory	breeding	2006	annual	$3,000	$0	0.10	0.00
LB-42	Prothonotary Warbler Monitoring	Monitoring	other	1997	annual	$22,000	$18,000	0.18	1.38
LB-44	Quebec Bird Populations at Risk (POPS)	Inventory; Potential Monitoring	breeding	1994	annual	$50,000	$3,000	0.05	1.25

						Estimated average annual budget 2002-07			
Survey #	Survey Name	Type of Program	Time of year	Start year	Frequency	EC cash	Non-EC cash	EC Staff (Person-years)	Non-EC Staff & Volunteers (Person-years)
LB-45	Quebec Chimney Swift Survey	Potential Monitoring	other	1998	annual	$14,000	$0	0.05	0.00
LB-49	Spotted Owl Monitoring Program	Monitoring; non-MBCA SAR	breeding	1992	annual	$35,000	$256,000	0.10	0.51
Other demographic surveys									
LB-23	Monitoring Avian Productivity and Survivorship (MAPS)	Demographic Monitoring	breeding	1995-2005 (by station)	annual	$10,000	$80,000	0.60	2.70
Programs not monitoring MBCA bird populations (e.g., Research, Toxics, non-MBCA species)									
LB-5	Boreal Avian Modelling Project (BAM)	Research	other	2005	Other	$200,000	$200,951	0.50	4.00
LB-21	Laskeek Bay Hole-nesting Birds	Research	breeding	1991	Annual	$0	$5,000	0.00	0.56
LB-30	Nocturnal Owl Survey	Monitoring; non-MBCA species	breeding	variable by location	Annual	$0	$100,000	0.00	6.35
LB-33	Okanagan Valley Yellow-Breasted Chat Survey	Research	breeding	2001	Annual	$15,000	$0	0.31	1.12
LB-46	Residential Development and Forest Birds	Research	breeding	1998	Annual	$19,000	$18,000	0.95	0.00
LB-47	Southern Ontario Bald Eagle Monitoring Program	Other (Toxics monitoring)	breeding	1983	Annual	$6,500	$57,500	0.10	2.44
LB-48	Shrub-Steppe Breeding Birds	Research	breeding	1997/ 1998	Other	$38,000	$30,000	0.30	0.95
LB-51	Tree Swallow Demography	Research; Demographic Monitoring	breeding	1990	Annual	$8,000	$34,000	0.19	0.40
LB-52	Vulnerability of Birds to Climate Change	Research	breeding	2006	one time	$40,000	$0	1.41	0.60
LB-53	Long Point Tree Swallow Surveys	Research	breeding	1968	Annual	$0	$7,000	0.00	1.42
LB-54	Long Point Breeding Bird Census Plots	Research; Evaluation Monitoring	breeding	1991	Annual	$0	$7,000	0.00	0.70
LB-57	Ottawa Breeding Bird Count	Research	breeding	2007	Annual	$0	$13,975	0.00	0.85
LB-59	Raptor Population Index program (RPI)	Monitoring; non-MBCA species	migration –spring/fall	2004	Annual	$0	Not available	Not available	Not available
SHOREBIRDS									
National breeding season surveys									
SB-7	**PRISM (Arctic; temperate & boreal planned)**	Monitoring	breeding	2004 (pilot '01)	annual	$90,000	$130,000	2.05	0.74

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Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
Migration surveys									
SB-9	**Shorebird Survey – Atlantic Canada**	Monitoring	migration - spring/fall	1974	annual	$1,500	$0	0.75	0.38
SB-10	**Shorebird Survey – Ontario**	Monitoring	migration - spring/fall	1974	annual	$1,000	$0	0.10	0.58
SB-11	Shorebird Survey BC	Monitoring; Research	migration - spring/fall	1991	annual	$1,000	$0	Not available	Not available
SB-12	Shorebird Survey – NF (now combined with SB-9 : "Atlantic Canada Shorebird Survey"	Monitoring	migration - spring/fall	2000	annual	$1,500	Not available	Not available	Not available
Winter surveys									
SB-8	South American Red Knot Survey	Monitoring (Species at Risk)	winter	1982 (ongoing: 2000)	annual	$18,000	$0	0.30	0.00
SB-13	Purple Sandpiper – NF and Maritimes	Potential Monitoring	winter	2006	annual	$5,000	$0	Not available	Not available
Species At Risk surveys									
SB-2	Eastern Canada Piping Plover Census	Monitoring	breeding	1994	annual	$5,000	$22,625	0.14	0.83
SB-3	International Piping Plover Census	Monitoring	breeding	1991	5-yr	$29,000	$77,000	0.14	2.27
SB-5	Mountain Plover Survey	Inventory	breeding	2002	annual	$5,000	$0	0.10	0.00
SB-6	Piping Plover Critical Habitat Survey	Inventory	breeding	2007	other	$17,400	$0	0.40	0.00
Other targeted surveys									
SB-1	American Woodcock Survey	Monitoring	breeding	1968 (1970 QC)	annual	$15,000	$1,000	0.28	0.76
Programs not monitoring MBCA bird populations (e.g., Research, Toxics, non-MBCA species)									
SB-4	Mingan Islands Shorebirds Survey	Research	migration – fall	2006	annual	$20,000	$40,000	3.04	2.52
SEABIRDS									
Colony monitoring programs									
SE-2	**Eastern Arctic Seabird Monitoring**	Monitoring	breeding	1975	other	$105,000	$80,000	0.70	0.78
SE-3	Atlantic Canada Tern Surveys	Monitoring	breeding	1999	5-yr	$20,300	$20,000	0.20	0.02
SE-4	**Atlantic Region Seabird Colony Ground Surveys**	Monitoring	breeding	1970s (by colony/ spp.)	other	$30,000	$5,000	0.54	0.04

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Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
SE-13	**BC Colonial Seabird Monitoring Program**	Monitoring	breeding	1984	annual	$15,000	$2,000	0.70	0.14
SE-25	Northern Gannets in North Atlantic	Monitoring	breeding	1976	5-yr	$20,000	$0	0.07	0.00
SE-30	**Quebec Seabird Colonies**	Monitoring	breeding	1925	annual	$20,000	$0	0.70	0.11
SE-32	St. Lawrence Seabirds as Indicators	Demographic Monitoring	breeding	1996	other	$20,000	$0	0.66	0.13
Pelagic monitoring programs									
SE-14	Eastern Canada Seabirds at Sea	Inventory; Potential Monitoring	year round	2006	other	$30,000	$70,000	1.00	0.00
SE-21	Laskeek Bay Seabird Monitoring	Monitoring; localized	breeding	1984	annual	$15,000	$30,000	0.18	1.63
SE-26	Pelagic Surveys - North Pacific and Arctic	Inventory; Potential Monitoring	other	1996-2007 (by location)	annual	$21,000	$55,000	0.50	0.00
SE-37	Quebec Seabirds at Sea	Inventory; Potential Monitoring	year round	2006	annual	$60,000	$0	0.40	0.00
Beached bird surveys									
SE-6	Beached Bird Survey	Demographic Monitoring (Mortality)	year round	1986 (BC)	annual	$30,000	$10,990	0.00	1.33
SE-35	Beached Bird Survey – Newfoundland	Demographic Monitoring (Mortality)	year round	1984	other	$2,000	$15,000	0.03	0.08
SE-36	Beached Bird Survey – Quebec	Demographic Monitoring (Mortality)	year round	2009	annual	$22,500	$0	0.06	Not available
Harvest surveys									
SE-31	**Seaduck/Murre Harvest Survey**	Demographic Monitoring (Harvest)	migration - fall	1997-98, 1990-91	other	$4,000	$0	0.60	0.00
Other non-breeding surveys									
SE-12	**Coastal Waterbird Survey (BC)**	Monitoring	year round	1999	annual	$35,000	$7,800	0.00	5.22
Programs not monitoring MBCA bird populations (e.g., Research, Toxics, non-MBCA species)									
SE-1	Arctic Seabird Egg Monitoring Program	Other (Toxics monitoring)	breeding	1975	other	$0	$64,300	0.33	0.00

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Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
SE-5	Atlantic Seabird Egg Contaminants Monitoring Program	Other (Toxics monitoring)	breeding	1968	4-yr	$30,000	$0	1.06	0.14
WATERBIRDS (INLAND/MARSHBIRDS)									
Breeding colony surveys									
WB-17	**Great Lakes Colonial Waterbird Survey**	Monitoring	breeding	1976/77	other	$30,600	$10,000	1.34	0.13
WB-27	Quebec Black Tern Surveys	Potential Monitoring	breeding	2005	annual	$12,000	$1,000	0.26	0.10
WB-29	Quebec Ring-billed Gull Colonies	Monitoring	breeding	1991	triennial	$5,000	$1,000	0.20	0.02
Marsh monitoring surveys									
WB-10	Breeding and Staging Waterbirds on Delta Marsh, MB	Inventory	breeding	2005	annual	$500	$6,000	0.00	3.66
WB-16	Great Lakes Coastal Wetland Monitoring Program	Monitoring	breeding	2004	other	$31,500	$13,500	0.78	0.35
WB-18	**Great Lakes Marsh Monitoring Program**	Monitoring	breeding	1994	annual	$65,000	$385,300	0.40	10.54
WB-28	**Quebec Marsh Monitoring Program**	Monitoring	breeding	2004 (pilot '03)	annual	$30,000	$9,000	0.00	0.64
WB-33	Waterbird Conservation Monitoring - Prairie & Parkland	Inventory	breeding	2005	annual	$30,000	$0	1.94	0.04
Migration surveys									
WB-8	Bonaparte's Gull Migration at Saguenay-St-Laurent	Potential Monitoring	migration – fall	2005	annual	$2,000	$11,000	0.18	0.45
WB-23	Mono Lake Eared Grebe Photo Count	Monitoring	migration – fall	1996	other	$500	$1,000	0.07	0.12
Species At Risk surveys									
WB-19	King Rail Monitoring Program	Potential Monitoring	breeding	1997, 1998-2000	other	$2,000	$0	0.32	0.00
WB-22	Least Bittern Monitoring Program	Potential Monitoring	breeding	2004	annual	$58,000	$0	1.22	0.00
WB-34	Yellow Rail Monitoring Program	Potential Monitoring	breeding	2007 (pilot)	one time	$5,000	$0	0.21	0.00
Other targeted surveys									
WB-7	Beaufort Sea Red-throated Loons as Indicators	Inventory	breeding	1985-1989; re-start 2007	other	$80,427	$20,000	0.22	0.00

						Estimated average annual budget 2002-07			
Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
WB-11	Canadian Lakes Loon Survey	Demographic monitoring (Productivity)	breeding	1981	annual	$0	$27,700	0.00	5.22
Programs not monitoring MBCA bird populations (e.g., Research, Toxics, non-MBCA species)									
WB-9	Boreal Waterbirds in Relation to Fire and Forestry	Research	breeding	2004	one time	$30,000	$306,000	0.10	0.52
WB-15	Great Lakes Herring Gull Egg Contaminants	Other (Toxics monitoring)	breeding	1974	annual	$54,000	$0	1.31	0.08
WB-20	Lake Ontario Botulism Surveys	Other (Disease monitoring)	other	2004	annual	$3,000	$0	0.20	0.00
WATERFOWL									
Multi-species breeding season surveys									
WF-24	**Waterfowl Breeding Population and Habitat Survey**	Monitoring	breeding	1955	annual	$165,000	$205,000	2.33	4.08
WF-29	Central and Western Arctic Waterfowl Survey	Potential Monitoring	breeding	2005	annual	$30,000	$97,000	0.12	0.23
WF-30	Central Arctic Helicopter Survey	Potential Monitoring	breeding	1992	other	$41,000	$183,500	1.19	0.60
WF-33	**E. Waterfowl Breeding Ground Survey**	Monitoring	breeding	1990	annual	$270,000	$0	1.27	0.00
WF-3	**Aerial Surveys of B.C. Interior**	Monitoring	breeding	2000	annual	$25,000	$130,000	0.40	0.33
Arctic breeding goose & swan surveys									
WF-1	**5-year Breeding Greater Snow Goose Survey**	Monitoring	breeding	1983	5-yr	$20,000	$20,400	0.26	0.02
WF-5	Declining Snow Geese and Brant at Anderson River	Monitoring; Research	other	1996 aerial/ 2005 ground	annual	$42,000	$0	0.78	0.20
WF-9	**Arctic Greater Snow Goose Survey**	Monitoring; Research	breeding	1989Bylot / 2006 Ellesmere	annual	$136,000	$207,200	1.12	1.08
WF-39	Inuvialuit Geese/Swan Survey	Inventory	other	1989	annual	$100,000	$0	0.26	0.00
WF-45	Karrak Lake	Demographic Monitoring; Research	breeding	1991	annual	$30,000	$130,000	2.08	19.38
WF-48	Mackenzie Delta Tundra Swans as Indicators	Inventory	breeding	2001	annual	$120,000	$0	0.25	0.00
WF-64	Snow Goose Photo Survey - Baffin Plains	Monitoring	breeding	1993	annual	$0	$25,000	0.04	0.02

						Estimated average annual budget 2002-07			
Survey #	Survey Name	Type of Program	Time of year	Start year	Frequency	EC cash	Non-EC cash	EC Staff (Person-years)	Non-EC Staff & Volunteers (Person-years)
WF-65	Snow/Ross's Goose Photo Survey	Monitoring	breeding	1973	other	$25,000	$25,000	0.54	0.14
Other breeding surveys									
WF-7	Arctic Eider Productivity and Survival	Demographic Monitoring	breeding	2001	other	$18,000	$125,000	1.57	0.19
WF-7B	Arctic Eider - East Bay surveys	Demographic Monitoring; Research	breeding	1996	annual	$85,000	$160,000	Not available	Not available
WF-7C	Arctic Eiders - Community Based colony surveys	Monitoring	breeding	1998	annual for 3yrs, every 10 years	$60,000	$0	Not available	Not available
WF-11	AP Canada Goose Productivity Survey	Monitoring	breeding	1996	annual	$5,000	$15,000	0.22	0.06
WF-12	AP Canada Goose Survey	Monitoring	breeding	1993	other	$10,000	$50,000	0.20	0.39
WF-13	Atlantic Flyway Mute Swan Survey	Monitoring	breeding	1986	triennial	$3,000	$1,500	0.12	0.01
WF-15	Atlantic Spring Eider Survey	Potential Monitoring	breeding	variable by location	bienniel	$60,500	$58,500	0.09	0.03
WF-19	Bathurst Inlet Eider Breeding Pair Survey	Potential Monitoring	breeding	2006 (also 1995)	other	$30,000	$75,000	0.41	0.00
WF-21	Boreal Forest Aquatic Birds	Monitoring; Research	breeding	1985	annual	$19,500	$0	0.78	0.00
WF-37	Ground Surveys of B.C. Interior	Monitoring; Research	breeding	1987	annual	$20,000	$20,000	0.28	0.16
WF-43	James Bay Canada Goose Breeding Pairs	Monitoring	breeding	1990	annual	$11,000	$13,000	0.04	0.14
WF-51	Mississippi Valley CAGO Breeding Pairs	Monitoring	breeding	1989	annual	$11,000	$17,000	0.05	0.15
WF-55	PEI Breeding Ground Plot Survey	Monitoring	breeding	1983	annual	$4,000	$0	0.09	0.53
WF-58	Southern Ontario Ground Plot Survey	Monitoring	breeding	1971	annual	$20,000	$0	0.70	0.04
WF-59	Southern Quebec Highlands Waterfowl Survey	Monitoring	breeding	1990	annual	$30,000	$30,000	0.24	0.00
WF-60	Southern Quebec Lowlands Waterfowl Survey	Monitoring	breeding	2004, also 1998-99	annual	$40,000	$0	0.08	0.00
WF-61	Saskatchewan Waterfowl Production Survey	Demographic Monitoring (Productivity)	breeding	2005	annual	$5,000	$33,000	0.33	0.20

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WF-69	St. Lawrence Waterfowl Survey	Monitoring	breeding	2004	annual	$60,000	$0	0.08	0.00
WF-70	Surf Scoter Reproduction Monitoring Program	Potential Monitoring	breeding	1994	annual	$5,000	$2,000	3.05	1.00
WF-71	Trumpeter Swan Survey - Ontario	Monitoring	breeding	1980	5-yr	$1,500	$1,000	0.12	0.04
WF-72	Trumpeter Swan Survey - Western	Monitoring	breeding	1968	5-yr	$95,000	$48,000	0.71	0.15
WF-75	Yukon Roadside Breeding Waterfowl Survey	Monitoring	breeding	1991	annual	$16,000	$0	0.36	0.06
WF-82	Developmental Surveys for Breeding Scoters	Potential Monitoring	breeding	2008	other	$0	$116,000	0.25	0.18
Moult surveys									
WF-44	James Bay Moulting Black Scoters	Potential monitoring	other	2008	annual	$1,550	$11,550	0.12	0.02
WF-62	Scoter Moult Surveys	Potential Monitoring; Research	other	J.Bay 1986; Lab./Gulf 1998	one time	$30,000	$38,000	0.14	0.06
WF-63	Seaduck Moult Banding	Demographic Monitoring	other	variable by location	annual	$15,000	$15,000	0.31	0.24
Migration surveys									
WF-4	Alaskan Eider Migration Count	Survey/incipient monitoring	migration - spring	1953	other	$8,000	$159,000	0.13	0.73
WF-27	Canada Goose Staging Survey - PEI	Monitoring	migration – fall	1969	annual	$2,000	$0	0.00	0.01
WF-28	Cap Tourmente Snow Goose Survey	Demographic Monitoring	migration – fall	1975	annual	$3,000	$0	0.18	0.00
WF-31	Continental Canvasback Survey	Monitoring	migration – fall	1974	annual	$4,500	$0	0.12	0.00
WF-34	Fall White-fronted Goose Survey	Monitoring	migration – fall	1992	annual	$8,500	$8,500	1.23	0.25
WF-42	James and Hudson Bay Migrant Survey	Potential Monitoring	migration - spring/fall	1976	other	$50,000	$100,000	0.41	0.00
WF-46	Long Point Aerial Surveys	Monitoring; localized	migration - spring/fall	1971	other	$0	$15,000	0.00	0.11
WF-47	Lower Great Lakes Migrant Survey	Monitoring	migration - spring/fall	1968	other	$25,000	$0	0.41	0.00
WF-67	**Spring Snow Goose Survey**	Monitoring	migration – spring	1965	annual	$25,000	$5,000	0.22	0.10

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Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
WF-76	Yukon Spring Migration Monitoring	Phenology monitoring	migration – spring	1986	annual	$15,000	$7,000	0.39	0.00
WF-79	Snow Goose Fall Productivity	Demographic Monitoring	migration – fall	1973	annual	$3,000	$500	0.18	0.12
Winter surveys									
WF-6	Aquaculture Coastal Block Survey	Survey	fall / winter	2000	annual	$30,000	$0	0.43	0.04
WF-17	BC Coast Aerial Wintering Waterbird Survey	Inventory	winter	1998	one time	$5,000	$7,000	0.43	0.03
WF-20	Belcher Islands Aerial Seaduck Survey	Monitoring	winter	1998	other	$40,000	$35,000	0.24	0.12
WF-36	Fraser-Skagit Mid-winter Snow Goose Count	Monitoring	winter	1950	annual	$4,000	$4,000	0.14	0.30
WF-49	Mid-winter Fraser River Brant Survey	Monitoring	winter	1992	annual	$4,000	$0	0.20	0.10
WF-50	**Mid-winter Waterfowl Survey**	Monitoring	winter	1935	annual	$12,000	$253,000	0.16	0.01
WF-73	Atlantic Winter Eider Survey	Monitoring	winter	1974	triennial	$26,000	$0	0.43	0.00
WF-74	Wintering Trumpeter Swans - B.C. Coast	Monitoring	winter	1970	triennial	$10,000	$10,000	0.23	0.04
WF-78	Wintering Black Duck Survey	Survey, to become monitoring	winter	2006	triennial	$20,000	$0	0.20	0.00
WF-80	Atlantic Winter Black Duck Banding	Demographic Monitoring	winter	2006	annual	$4,000	$0	0.22	0.00
Harvest / hunter surveys									
WF-35	Fraser River Brant/Snow Goose Harvest Survey	Demographic Monitoring (Harvest); some outreach	other	1984	annual	$1,000	$0	0.12	0.00
WF-41	Inuvialuit Harvest Study	Demographic Monitoring (Harvest)	year round	1989	annual	$10,000	$20,000	0.20	0.00
WF-52	**National Harvest Survey**	Demographic Monitoring (Harvest)	year round	1969	annual	$186,000	$0	3.90	0.33
WF-57	Quebec Aboriginal Harvest Survey	Demographic Monitoring (Harvest)	other	2005	annual	$29,300	$13,200	0.45	0.38
WF-66	Spring Conservation Harvest Survey	Monitoring	migration - spring	1999	annual	$3,500	$0	0.06	0.00

						Estimated average annual budget 2002-07			
Survey #	**Survey Name**	**Type of Program**	**Time of year**	**Start year**	**Frequency**	**EC cash**	**Non-EC cash**	**EC Staff (Person-years)**	**Non-EC Staff & Volunteers (Person-years)**
Duck banding programs									
WF-16	B.C. Duck Banding	Monitoring	other	1970s on/ off,1980s annual	annual	$17,000	$10,000	0.23	0.68
WF-23	Breeding Atlantic Eider Banding	Demographic Monitoring	breeding	variable by location	annual	$3,500	$61,000	0.04	1.49
WF-32	**E. Canada Pre-season Duck Banding**	Demographic Monitoring	other	1948 (maybe earlier)	annual	$35,000	$355,000	4.63	4.24
WF-56	Prairie Duck Banding	Demographic Monitoring	other	pre-1970	annual	$185,000	$245,000	5.15	8.85
Goose banding programs									
WF-8	**Arctic Goose Banding**	Demographic Monitoring	other	pre-1970	annual	$193,500	$491,000	1.73	1.55
WF-10	**AP Canada Goose Pre-season Banding**	Demographic Monitoring	breeding	1997	annual	$10,000	$150,000	0.59	0.50
WF-25	**Canada Goose Banding - Interior**	Demographic Monitoring	other	pre-1970	annual	$53,000	$513,000	0.84	1.87
WF-26	**Canada Goose Banding - Temperate**	Demographic Monitoring	breeding	1989-2007 (by location)	annual	$50,000	$15,000	1.37	3.34
WF-40	Impacts on Inuvialuit Goose Populations	Demographic Monitoring	other	1990	annual	$10,000	$28,500	0.22	0.04
WF-77	**North Atlantic Population Goose Banding**	Demographic Monitoring	breeding	1987	annual	$24,500	$45,040	0.41	0.08
WF-81	Greater Snow Goose Telemetry Survey	Research; in support of monitoring program	year round	2006	annual	$10,800	$152,500	0.26	2.12
Species At Risk surveys									
WF-18	Wintering Barrow's Goldeneye Survey	Monitoring	winter	1999	triennial	$30,000	$0	0.11	0.00
WF-38	Harlequin Duck Survey	Monitoring	winter	1995	annual	$5,000	$0	0.08	0.01
Programs not monitoring MBCA bird populations (e.g., Research, Toxics, non-MBCA species)									
WF-2	Acid Rain Biomonitoring	Research	breeding	1983	other	$60,000	$0	0.28	0.00
WF-14	Atlantic Hunter Survey	Other (Opinion Survey)	other	mid 1980s	5-10-yr	$5,000	$0	0.15	0.00

						Estimated average annual budget 2002-07			
Survey #	Survey Name	Type of Program	Time of year	Start year	Frequency	EC cash	Non-EC cash	EC Staff (Person-years)	Non-EC Staff & Volunteers (Person-years)
WF-22	Boreal Forest Lesser Scaup Survey	Research	breeding	Yellowknife 2000-05, Inuvik 2002-07	annual	$10,000	$30,000	0.16	0.23
WF-53	Nesting Snow Geese at the Cape Henrietta Maria	Research	breeding	1997	annual	$3,000	$22,000	0.14	0.02
WF-54	Parksville-Qualicum Spring Brant Survey	Research	migration - spring	1989	annual	$5,000	$0	0.20	0.40
WF-68	St. Denis Waterfowl Survey	Research	breeding	1983 (1968 for wetlands)	annual	$10,000	$8,000	0.15	0.04

CHAPTER FIVE – Program Evaluations

INTRODUCTION

Following the needs identification (Chapter Three) and description of all relevant monitoring surveys (Chapter Four, Table 4.1), the next step in this review process was the evaluation of each survey. Two levels of evaluation were conducted. First, all surveys were subjected to a summary review, based on information provided in survey questionnaires (see Chapter Two) as well as input from the review committee. The recommendation from this summary review related to the continuation or termination of each survey or the need for further review. Next, surveys identified as high-priority for further evaluation were subjected to a detailed review, conducted either by members of migratory bird technical committees or external experts. For these surveys, more detailed recommendations and rationale were outlined, and the impact of proposed changes on the survey's ability to meet program needs was explicitly outlined as justification for the recommendation.

This evaluation step was a critical one in the review process, aimed at ensuring that monitoring programs have identifiable objectives, timelines and information deliverables, and follow standardized protocols with effective designs that meet information needs and use robust analytical techniques. All programs identified as a bird population monitoring program were subjected to this assessment, and are discussed in this chapter; those identified as research-focused or otherwise tangential to the monitoring of bird populations were not further assessed.

While documentation, data management and reporting of monitoring programs were also considered as part of this assessment (and are summarized in the tables below), the results of this analysis are discussed in Chapter Six.

EVALUATION METHODS

Summary assessments. As outlined in Chapter Two, each survey included in the Avian Monitoring Review process was first identified through the completion of questionnaires. Each identified survey program was then assessed against various criteria such as:

(i) is it an avian monitoring program?
(ii) what is its relevance to the identified needs?
(iii) is it cost-effective for EC?
(iv) does the design provide reliable data?
(v) are the data being used for decision making?
(vi) are the data being used in the way for which the survey was designed?

This assessment was carried out by members of the Steering committee, combining the information provided through the questionnaires along with the expert knowledge of the committee members, which included biologists and managers with expertise in each of the five major bird groups. Committee members initially conducted independent reviews and then met together for several days to discuss assessments for each survey and reach consensus on the overall recommendations; members closely-related to a particular survey stepped back from the detailed review process, to maintain objectivity.

The final output from this summary review included a recommendation for the future of the survey itself (e.g., termination, continuation, need for further review) and a recommendation regarding changes to the survey's data management (e.g., acceptable, need for improvement). These recommendations are outlined in Table 5.1.

Detailed evaluations. Based on this initial set of assessments, a number of surveys were identified as high priority for a more in-depth evaluation. These included (i) any surveys that appeared to be no longer required (candidates for termination), (ii) surveys for which the current effort appeared to be greater than required or for which a substantial redesign could improve the survey, and (iii) a few surveys for which the current effort was thought to be insufficient to meet the information needs. In several of these cases, multiple surveys (as represented in the questionnaires) were assessed together as they formed a connected program. For example,

six surveys related to Greater Snow Geese were assessed together to facilitate the detection of potential synergies and/or redundancies.

To assist with these detailed evaluations, a number of technical reviews were commissioned from post-doctoral experts or requested from internal experts from the migratory bird technical committees. The following unpublished reports were produced, and can be made available on demand:

Technical review	Relevant surveys
LANDBIRDS	
Blancher, Cadman, Hobson, Machtans and Russell. (Landbird Committee). 2010. EC-Landbird Review of the Ontario Forest Bird Monitoring Program (FBMP).	LB-34
SHOREBIRDS	
Smith, PA. 2009. Arctic PRISM: Goals, Approach and Efficiency.	SB-7
Smith, PA. 2009. Monitoring Shorebirds During Migration: An Assessment of Existing Programs and Opportunities for Improvement.	SB-9, SB-10
Smith, PA. 2009. Shorebird Monitoring in Canada: Current Assets and Potential Changes.	SB-7, SB-9, SB-10
Smith, PA. 2010. Environment Canada's Monitoring of Red Knots in South America.	SB-8
SEABIRDS	
Wilhelm, Rail, Mallory, Gaston, Hipfner and Bertram. (Seabird Technical Committee). 2011. Monitoring Colonial Seabirds: Working Toward a National Framework.	SE-2, SE-3, SE-4, SE-13, SE-25, SE-30
Morgan, Bolduc, Gjerdrum and Fifield. (Seabird Technical Committee). 2010. Framework for Coordinated Pelagic Seabird Monitoring.	SE-14, SE-26, SE-37
Wilhelm, O'Hara and Bolduc (Seabird Technical Committee). 2010. A Proposed National Framework for the Beached Bird Survey Program.	SE-6, SE-20, SE-35, SE-36
WATERBIRDS	
Pekarik, Meyer, Drake, Badzinski, Latendresse, Moore, Calvert, Francis, Paquet, and Weseloh. (Inland Waterbird Committee). 2010. Recommendations for the Development of a National Framework for Marsh Bird Monitoring in Canada	WB-18, WB-19, WB-22, WB-28, WB-34
Pekarik, Weseloh, Moore, Calvert, Dickson, Robertson, Gjerdrum, Rail, Wilhelm, Boyd, Meyer, Wilson, Hawkings, Rodrigue, Burgess, and Rausch. (Inland Waterbird and Seabird Committees). 2010. Recommendations for the Development of a National Framework for Monitoring Inland Waterbirds.	WB-7, WB-8, WB-10, WB-16, WB-17, WB-23, WB-27, WB-29
WATERFOWL	
Drever, MC. 2009. An Evaluation of Ground Survey Effort Necessary to Estimate Duck Population Sizes and Meet Information Needs For Management of Duck Harvests in Canada	WF-24
Drever, MC. 2009. Southern Ontario Ground Plot Survey	WF-58
Drever, MC. 2009. Evaluation of shared information between the Southern Quebec Lowlands and St. Lawrence River Waterfowl Surveys and national-level avian surveys in southern Quebec.	WF-60, WF-69
Drever, MC. 2009. PEI Breeding Ground Plot Survey: A preliminary review	WF-55
Calvert, AM. 2009. Monitoring Assessment for Greater Snow Geese.	WF-1, WF-9, WF-28, WF-67, WF-79, WF-81
Calvert, AM. 2010. Review of Arctic Goose Banding Programs.	WF-8
Smith, PA. 2010. An Assessment of Tundra Swan Surveys in Canada.	WF-39, WF-48, WF-74
Smith, PA. 2010. A Stratified Random Sampling Plan for Rocky Mountain Population Trumpeter Swans in Western Canada.	WF-72
Smith, PA. 2010. Trumpeter Swan Surveys in Canada.	WF-71, WF-72, WF-74
Gilliland, Dickson, Gilchrist, Lepage, and Bordage. (Waterfowl Committee – Eider Working Group). 2010. Common and King Eider Monitoring Strategy in Canada.	WF-4, WF-7, WF-15, WF-19, WF-20, WF-23, WF-29, WF-52, WF-73; SE-30, SE-31

These 16 sets of detailed evaluations of surveys or suites of surveys (see Appendix A) covered a total of 52 surveys, or 32% of identified monitoring programs. These reviews varied in their depth and scope, depending upon the survey(s) being addressed and the particular questions raised. Once the assessment was complete, a

final recommendation document was developed by the AMR Steering Committee, including specific recommendations (summarized in Table 5.2) and a detailed assessment of the impact of any proposed changes on the ability of the survey(s) to meet EC monitoring information needs (presented in full in Appendix A).

RECOMMENDATIONS

Summary assessments. A total of 165 surveys were identified as avian monitoring programs (i.e., excluding surveys that were primarily focused on research, directed at the monitoring of non-MBCA birds, or specific to monitoring toxics, disease or other contaminants; see Table 4.1). The recommendations derived from the summary assessment of all monitoring surveys are shown in Table 5.1.

Across species groups, overall recommendations were as follows: 48 surveys (29%) should continue with little or no immediate change; 74 surveys (45%) should be continued, but with some aspects that require further review in the future; 7 surveys (4%) should be reviewed before repeating; 13 surveys (8%) require major changes; 5 surveys (3%) were recommended for termination; 6 surveys (4%) have no direct EC support and 12 surveys (7%) are no longer active.

Recommendations varied among species groups. The number of surveys given each recommendation are as follows:

Recommendation (from Table 5.1)	Landbirds	Shorebirds	Seabirds	Waterbirds	Waterfowl	Total
Complete current survey; review before repeating	2	1		2	2	7
Continue; further review required	16	5	5	8	40	74
Continue; major changes		2	2		9	13
Continue; minor changes	7	4	5		1	17
Continue; no immediate changes	14		4	3	10	31
No EC support	3			1		4
No EC support - consider investment	2					2
Not currently active; review before resuming	3			1	8	12
Terminate					5	5
Total across monitoring programs	**47**	**12**	**16**	**15**	**75**	**165**
Not in AMR scope	13	1	2	3	6	25

TABLE 5.1. Summary of evaluations of each survey, including general comments, the type of review process conducted, and recommendations about the future of the survey and its data management. Surveys evaluated in detail are identified as such, and fully presented in Table 5.2 below. Data management recommendations are discussed in detail in Chapter Six. Note that surveys not monitoring avian populations (e.g., research programs, toxics monitoring) were not the focus of this review and are not treated here, though they are included in Chapter Four. With the philosophy that all surveys should be re-reviewed periodically, further reviews are prioritized for each survey from those to be addressed first (1st) to those to be addressed later (2nd / 3rd). A priority score of 4th is used for surveys that are currently inactive, that will finish in the near future, or that are not supported by EC, indicating they should only be reviewed if they are to be resumed in the future; NA is used for those to be terminated.

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LANDBIRDS								
National breeding season surveys								
LB-31	North American Breeding Bird Survey (BBS)	Premier landbird monitoring program in North America, despite some limitations. Recent review led to 5-year strategic plan for BBS (2006-2010). Should be up for review in 2011. Methodology may or may not be appropriate for major expansion into boreal, but some expansion possible. Consider whether use of technology (e.g., microphones) could lead to improvements. Historical stop level data not fully computerized.	Summary Review	Continue; no immediate changes	Assess progress on Strategic Plan for the North American BBS: 2006-2010 (Table 1) to enhance value of survey. Determine what features could be developed to meet additional EC needs. Assess potential for northwards expansion in context of an overall boreal bird monitoring strategy	Acceptable	Data managed on U.S. server. Historic stop level data not yet fully captured. New analysis methods being evaluated for Canadian data. Need better documentation of historical changes in stop locations to facilitate bird-habitat analyses.	3rd
LB-10	Breeding Bird Census Plots	Intensive monitoring program using spot-mapping to describe territories of all songbirds in a fixed area plot. No longer sufficiently active to be considered a monitoring program. Older data were published in various journals; Canadian data now available in a spreadsheet database. Likely some sites still being monitored, but no central coordination or data collection.	Summary Review	No EC support - consider investment	Needs evaluation to determine whether worth supporting resumption of active volunteer-based program; most likely useful in a research context for habitat association data and/or population density data. May also be appropriate methodology for small scale (single site) monitoring; improved data management would allow such data to be captured.	Improve	Existing data available in a database that was formerly available on the EC website, but is no longer posted; May be worthwhile to develop an interactive web-based data entry, storage and retrieval mechanism so that any future data collected with BBC protocols (i.e., spot-mapping) are accessible for research or management decisions. Evaluate whether worth some EC investment to achieve this, but note this was a joint U.S.-Canada program, so a joint data management system may be appropriate.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-35	Parks Canada Surveys	Surveys carried out within specific National Parks in context of evaluating Ecological Integrity of Parks. Possibly could provide useful information as controls if combined with monitoring outside of parks to evaluate causes of population change. Not evaluated in detail; no questionnaires completed.	Summary Review	No EC support	Determine location and intensity of sampling (data are available in various Parks Canada reports and plans, but would take time to extract) to see how it might assist us.	Acceptable	Managed by Parks Canada, presumably effectively	4th
Regional breeding season surveys								
LB-1	Alberta Biodiversity MP	Program managed by Alberta Biodiversity Monitoring Institute (ABMI). Limited EC investment relative to total costs. Overall project very expensive and covers many taxa besides birds, with a diverse range of funding partners. Long-term funding not secure.	Summary Review	Continue; no immediate changes	Continue current level of support pending development of a national boreal monitoring strategy to determine appropriate level of investment from boreal perspective. Need to consider whether this makes any other monitoring programs in the province redundant.	Acceptable	Managed by ABMI, with most data accessible on web	2nd
LB-3	B.C. Band-tailed Pigeon Survey	Survey is coordinated with U.S. survey. Species is harvested in Canada (short 15-day season in some districts - lower mainland, interior, Vancouver Island). Limited data from National Harvest Survey (estimated at 200 pigeons harvested recently). Species is also SARA listed as Special Concern. If a SARA species is being harvested, we have an extra obligation to understand population status of this species.	Summary Review	Continue; further review required	Review whether current survey adequate for management of species, or whether needs to be enhanced. Review should consider additional sources of data as well as risks of not having information. Needs and risks would change if harvest is discontinued, although species is also harvested in the U.S..	Improve	data managed in spreadsheet on PC	2nd
LB-4	Baseline Bird Densities in Mackenzie Valley, NWT	Survey is complete. Could potentially be repeated in future if need arose.	Summary Review	Not currently active; review before resuming	Ensure that data are available through a centrally managed and accessible database	Improve	data currently managed in spreadsheet on individual computer -- need to be managed on a central database	4th

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-17	Fort Liard, NWT Point Counts	Data valuable for research on impacts of seismic lines in boreal and for environmental assessment. Also provides data for evaluating boreal monitoring protocols, and provides trend information in an area not otherwise monitored. However, area of survey is relatively limited.	Summary Review	Continue; no immediate changes	Assess role of survey after preparation of a national boreal monitoring strategy to determine how it fits.	Improve	Should be on a central database	3rd
LB-18	Grassland Bird Monitoring	BBS supplement- Identical to BBS methods, but with increased coverage in degree blocks that contain native grasslands, thus improving trend estimates for grassland species. Similar survey may be started in USA	Summary Review	Continue; no immediate changes	Review if this provides adequate coverage for grasslands in Canada, or whether any additional (e.g., offroad) surveys would be useful	Acceptable	Data now managed as part of overall BBS database	3rd
LB-34	Ontario Forest Bird MP	Initially set up to assess habitat associations of birds within mature forest. Sites are selected non-randomly. Provides monitoring information for species in mature forest habitat; potentially biased and redundant for estimating regional population trends, but may add value to BBS in terms of helping to identify causes of population change by providing data on trends within habitats.	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Acceptable	Data in WildSpace	2nd
LB-50	Suffield NWA Monitoring	Annual survey started in 2000; in 2005 changed to rotating design. Survey is on NWA owned by DND. Many issues related to grazing and oil and gas development on site. Objective to monitor distribution and population trends within NWA and contribute to management in area. Area includes several SAR. Done by a single observer; could be issues of comparability / observer effects if a new observer takes over survey, although does involve multiple visits to address some detectability issues.	Summary Review	Continue; no immediate changes	Need to consider how long survey needs to continue, whether survey design is robust enough to accommodate observer changes	Acceptable	Data currently in WildSpace, although with access restrictions.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-56	S. Quebec Shrub Birds Survey	Intensive surveys started in 2006 of shrub habitats to get more information on distribution and status of shrub birds that are only weakly monitored by BBS.	Summary Review	Continue; further review required	Evaluate whether information at this scale (especially within only one jurisdiction - Quebec) is actually necessary for species management. Is design sufficient for reliable trend estimation; can sufficient information be obtained from other surveys (e.g., atlas).	Improve	Ensure data nationally integrated	3rd
Breeding bird atlases								
LB-6	Breeding Bird Atlas - Alberta	2nd atlas was completed a few years ago. Did not follow standards being developed for other Canadian atlases. Used alternative checklist based approaches for analyses which are statistically less robust. Coverage was less complete than some other atlases.	Summary Review	Not currently active; review before resuming	Any EC support for future atlases in Alberta (or elsewhere) should be contingent on ensuring methods (and data management) are consistent with atlases elsewhere in country. Would be worth evaluating how well ABMI (LB 1) and other quantitative surveys complement atlas, and whether they fills some of the gaps in not having point counts on the Alberta atlas.	Acceptable	Need to ensure that data adequately accessible to EC	4th
LB-7	Breeding Bird Atlas - B.C.	Started first round atlas in 2008. Incorporates point counts. Coverage in remote areas unlikely to be as high as originally hoped, owing to limited funding. Intention is to repeat at 20-year intervals as a monitoring program.	Summary Review	Continue; no immediate changes	Maintain & continue to adhere to recommended atlas protocols. Review ability to cover remote areas with potentially available resources prior to completion and determine whether any strategies needed to fund remote field work.	Acceptable		2nd
LB-8	Breeding Bird Atlas - Maritimes	completed field work for 2nd round atlas in 2010. Atlas incorporated point counts.	Summary Review	Continue; no immediate changes	Complete analyses and publication as currently planned	Acceptable		4th
LB-9	Breeding Bird Atlas - Ontario	2nd round atlas field work completed in 2005	Summary Review	Not currently active; review before resuming	Repeat ~2020 using appropriate standards	Acceptable		4th

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-55	Breeding Bird Atlas - Quebec	2nd round atlas field work started in 2010. Incorporates point counts. Anticipate challenge achieving adequate coverage in remote areas.	Summary Review	Continue; no immediate changes	Maintain & continue to adhere to recommended atlas protocols. Review strategies to get adequate coverage of remote areas. Explore integration with other QC surveys such as checklist program (ÉPOQ), species at risk, etc.	Acceptable		2nd
LB-60	Breeding Bird Atlas - Manitoba	1st round atlas field work started in 2010. Intention is to repeat at 20-year intervals as a monitoring program.	Summary Review	Continue; no immediate changes	Complete as currently planned. Develop strategies to get adequate coverage of remote areas. Review before completion to ensure coverage is adequate	Acceptable		2nd
Migration surveys								
LB-22	Canadian Migration Monitoring Network	Program started at Long Point in 1960, and expanded to many stations in early 1990s, often with EC support, to see if can provide information on population trends of northern breeding birds. Not yet critically evaluated as to how effectively it can do so. Cannot provide information tied to specific breeding ground management actions, but may be useful at larger scale. Also has many other values including helping to define migration routes, providing information on migration phenology, stopover ecology, etc. Possibly can give information on productivity (needs evaluation). Other values recently identified by EC working group.	Summary Review	Continue; further review required	Carry out a formal review of the program's ability to detect national / regional population trends, through a combination of simulations and analysis of existing data. In particular, need to identify methods to integrate data from multiple stations. Also consider whether data can help understand population fluctuations/cycles and/or obtain reliable productivity indices. Evaluate results in context of alternative monitoring approaches including checklist-type migration monitoring and breeding season monitoring within the boreal. on-the-ground monitoring strategies.	Improve	Data generally managed by individual stations - only some data centrally accessible. BSC working to improve this; EC could encourage more central data management as condition of funding support.	1st

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-58	Visual Counts of Boreal Migrants	Visual counts of diurnal migrants at one CMMN station (Tadoussac); value of data likely to be similar to other types of CMMN data, though focussed on only selected species.	Summary Review	Continue; further review required	Evaluate in context of CMMN evaluation. Are standardized visual counts more or less suitable for population monitoring than other approaches? Is a single station on north shore of St. Lawrence providing sufficient information for decision making? Can comparable information be obtained from checklists?	Improve	Data set fully funded by EC so should be made fully publicly available on a central server	2nd
Winter surveys								
LB-13	Christmas Bird Count	Originally designed as recreational activity, but now treated as a survey. Has received recent critical peer review; would be useful to evaluate progress towards meeting recommendations of peer review. International in scope, managed by Audubon in USA, BSC in Canada.	Summary Review	No EC support - consider investment	Evaluate role of CBC in monitoring species not adequately covered by breeding surveys. Determine whether value could be enhanced with EC investment, particularly in support of data analysis, or data reporting	Acceptable	Management of raw data OK (Cornell), but need to ensure that results of statistical analyses, as well as analysis programs are adequately accessible to EC, and others to allow for flexibility of analyses. Need strategy to ensure analyses can be updated regularly.	3rd
LB-41	Project Feeder Watch	Provides information throughout the winter season (from Nov to Apr); supplements Christmas Bird Counts (CBC) for species that use feeders, to understand species dynamics and movements throughout the winter. Published analyses show that patterns correlate well with CBC. Has potential to contribute to many research questions related to bird movements through winter, climate change, etc.	Summary Review	No EC support	Review potential to use PFW to supplement CBC, particularly to evaluate whether changes in abundance on CBC are related to changes in timing of movements and degree of southward movement of species, through analysis of data from other times of year, especially for irruptive boreal species.	Acceptable	Central server at Cornell; results web-accessible	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
Checklist surveys								
LB-2	Alberta Birdlist Program	Checklist program, similar to eBird, ÉPOQ, etc.	Summary Review	No EC support	Review in context of general review of value of checklist programs in general (see eBird, ÉPOQ, NWT checklist) for EC needs. If, in future, EC decides to provide funding support for Alberta checklists, should only do so if data are fully accessible in a consistent format to other checklist programs (e.g., through eBird).	Improve	Coordinated and managed by Alberta Naturalists; Would have greater value if data integrated with eBird to ensure accessibility for integrated analyses	3rd
LB-15	eBird Canada	Not a designed monitoring program -- instead a data management system for informally gathered data from amateur birders. Hence, more challenging to analyse than data from a scientifically rigorous program, but has potential to compensate in quantity of data. Potential to provide very extensive coverage at many different times of year for Canadian birds both in Canada and elsewhere. Effective use of data could encourage even more data collection / submission. Could supplement more formal monitoring programs, especially migration monitoring for boreal migrants; could also incorporate some standardized approaches.	Summary Review	Continue; no immediate changes	Encourage integration of data management for various existing checklist programs (Alberta, NWT/Nunavut, Arctic, ÉPOQ) with eBird to ensure all data accessible for use in monitoring (and other types of analyses) and to take advantage of shared analysis tools. Need to develop analysis methods for estimating trends from checklist data; carry out evaluation of limits and values of checklist data for meeting EC needs; and determine whether to encourage more standardized approaches to checklists.	Acceptable	Managed by BSC jointly with Cornell; integrated with AKN	2nd
LB-32	NWT/NU Bird Checklist Survey	Only available data on population status for many bird species in much of arctic (not just landbirds). Data have been copied into e-bird.	Summary Review	Continue; no immediate changes	See Ebird entry for checklist evaluation in general.	Possible Improvement	Data have been imported into eBird; would it be more efficient to manage entirely through eBird?	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-43	Quebec Bird Population Surveys (ÉPOQ)	Most extensive checklist program in Canada with long history. Checklist program, similar to eBird, but data maintained completely independently. Despite substantial EC investment, no requirement has been made to ensure that data are fully and easily publicly accessible.	Summary Review	Continue; minor changes	Review potential to work more closely with eBird to ensure data fully publicly accessible, especially considering heavy EC investment. Also would have advantages to volunteers, because eBird has many tools. Could make this a condition of future EC funding.	Improve	Use of shared data bases such as eBird would increase cost-effectiveness and data accessibility. EC could use level of investment to encourage this.	2nd
Nest records								
LB-24	Nest Records Scheme - B.C.	See comments under Project NestWatch; not well coordinated with Project NestWatch.	Summary Review	Continue; minor changes	Need to encourage greater integration and cooperation between BC nest records scheme and national schemes such as Project NestWatch. See LB 28 for issues regarding use of data.	Improve	Efforts underway to digitize a subset of historical records and integrate into Nestwatch database. Need strategy to obtain additional data.	3rd
LB-25	Nest Records Scheme - Maritimes	See comments under Project NestWatch. Historical data being captured in Project NestWatch	Summary Review	Continue; minor changes	See LB 28 (Nestwatch) for issues regarding use of data.	Improve	A subset of historical records are being computerized into NestWatch-- need resources to ensure all are digitized. New records should be encouraged in digital form. Assuming Project NestWatch is a sufficient data management system, should encourage its use for future data collection.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-26	Nest Records Scheme - Ontario	See comments under Project NestWatch; Historical data partially captured in Project NestWatch	Summary Review	Continue; minor changes	see LB 28 (Nestwatch)	Improve	A subset of historical records are being computerized into NestWatch-- need resources to ensure all are digitized. New records should be encouraged in digital form. Assuming Project NestWatch is a sufficient data management system, should encourage its use	3rd
LB-27	Nest Records Scheme - Prairies	See comments under Project NestWatch. Data not currently captured by Project NestWatch - evaluating appropriateness of that data base for PNR needs	Summary Review	Continue; minor changes	see LB 28 (Nestwatch)	Improve	Many records already computerized. Assuming Project NestWatch is a sufficient data management system, should encourage its use for future data collection.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-28	Nest Records Scheme - Project Nest Watch	Nest records data currently being used by EC to evaluate phenology (nesting seasons). In UK nest records used to monitor productivity of many species to help understand causes of population change, but this use in Canada has been limited because few nests have multiple visits. Has potential value for monitoring changes in nesting phenology in relation to incidental take reduction, climate change, etc. Also provide data on nesting habitat and distribution. Individual data sets may have potential to help understand causes of population change for selected species (e.g., TRES in context of declines in aerial insectivores). The potential value for productivity monitoring for other species in Canada needs investigation, as requires sufficient nests monitored with multiple visits - which is not currently being achieved. Could this be improved with additional investment? Could a concerted effort be made to gather baseline data on a selection of species, which could then be monitored through intensive efforts at periodic intervals, perhaps focussed on species showing declines? Schemes in various regions variable coordinated with national Project NestWatch which is managed by BSC.	Summary Review	Continue; no immediate changes	Evaluate whether increased EC investment in nest records would be worthwhile to encourage more participation, enhance values of data to EC, and enhance data management. Also, determine whether current Project NestWatch framework sufficient to serve as a central data management scheme for all nest record projects in Canada or whether needs any revision.	Acceptable	Need to ensure data structure can capture desired information for all nest records schemes across Canada.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-29	Nest Records Scheme - Quebec	See comments under Project NestWatch. Historical data being captured in Project NestWatch	Summary Review	Continue; minor changes	see LB 28 (Nestwatch)	Improve	A subset of historical records are being computerized into NestWatch-- need resources to ensure all are digitized. New records should be encouraged in digital form. Assuming Project NestWatch is a sufficient data management system, should encourage its use for future data collection.	3rd
Species At Risk surveys								
LB-11	Breeding Savannah Sparrows on Sable Is.	Apparently not cost-effective or appropriate to monitor other species at the same time.	Summary Review	Continue; further review required	Review in context of recovery needs for species.	Improve	Should be managed on a centrally available database	3rd
LB-12	Burrowing Owl Survey	Single species survey, but SAR listed. Not clear from questionnaire how much of the species range in Canada is covered by survey.	Summary Review	Continue; further review required	Review in context of recovery needs for species. Evaluate EC role for a non-MBCA species	Improve	Should be managed on a centrally available database	3rd
LB-14	Eastern Loggerhead Shrike Nest Monitoring	Single species survey, but SAR listed. Ontario Loggerhead Shrike program has been subject to recent intensive review.	Summary Review	Continue; minor changes	Implement recommendations of recent review of Ontario LOSH program	Acceptable	Data currently in WildSpace; should ensure all data for all LOSH surveys are shared and managed together	3rd
LB-16	Ferruginous Hawk Management Planning	"Special concern"- non-federal bird. Need to determine priority for EC to be investing in species, and how this is coordinated with provinces.	Summary Review	Continue; further review required	Review in context of recovery needs for species. Evaluate EC role for a non-MBCA species, and how EC funding relates to funding from other sources.	Improve	Should be on a central database	3rd
LB-19	High Elevation Landbird Program (and Mountain BirdWatch)	HELP survey protocol is being replaced with Mountain BirdWatch (MBW), a coordinated survey with U.S. which has more rigorous and more flexible sampling protocol.	Summary Review	Continue; no immediate changes	Review primarily in context of recovery / planning needs for Bicknell's Thrush in SAR context. Ensure that MBW protocol will be sufficient to meet EC needs.	Acceptable	Managed by BSC; archived with AKN	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-20	Hooded Warbler and Acadian Flycatcher Survey	SAR monitoring. Integrated with research into monitoring needs for species. May be lower priority than other SAR species, particularly for Hooded Warbler which is recovering.	Summary Review	Continue; further review required	Review in context of recovery needs for species. Also review in context of priority for work on these species, which are potentially lower priority than some SAR species (especially HOWA).	Acceptable	Managed by BSC; archived with AKN; also in WildSpace and NHIC	3rd
LB-36	Peregrine Falcon Monitoring	Non-MBCA SARA species. Most funding outside EC, but key coordination from EC.	Summary Review	Continue; further review required	Review in context of recovery needs for species. Evaluate EC role for a non-MBCA species, especially considering species has recently been downlisted, and whether there is ongoing need for a single species survey that only covers part of population..	Improve	Data should be centrally managed to ensure fully accessible and secure	3rd
LB-37	Prairie Loggerhead Shrike 5-Year Surveys	Survey conducted every 5 years - 5th survey was in 2008.	Summary Review	Continue; further review required	Review in context of recovery needs for species. Consider design and efficiency of survey to determine if statistically sound or should be improved. Consider if could be combined with surveys of other species.	Improve	Data scattered in multiple locations; needs central storage. Location information not fully computerized.	3rd
LB-38	Prairie Loggerhead Shrike Grassland Surveys	Inventory of shrikes on Crown lands, to identify critical habitat and recovery goals. Not clear if such an intensive survey is necessary or cost-effective for recovery (especially as Critical Habitat needs to be identified everywhere and not just on federal lands); cost $300K over 4 years. Federal land inventory may be complete, but continuing on provincial lands.	Summary Review	Complete current survey; review before repeating	Review in context of recovery needs of species; is such an intensive survey actually necessary for species recovery? Is survey covering appropriate areas? Can other species be surveyed at the same time? Do not continue beyond current round without a critical review.	Improve	Ensure all data are centrally accessible in WildSpace	3rd
LB-39	Prairie Loggerhead Shrike Roadside Surveys in Farmland Habitat	Developed to supplement 5-year survey, covering many additional areas; not clear if such an intensive survey is cost-effective or necessary (8 year survey at $40K per year so far; scheduled to complete field work in 2010).	Summary Review	Complete current survey; review before repeating	Review in context of recovery needs of species; once current round is finished, should not repeat without critical external review	Improve	Ensure all data are centrally accessible in WildSpace	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-40	Prairie Sage Thrasher Survey	Survey of a small breeding area to determine if species is still there. Only one pair currently known. Much other potential habitat not surveyed because low probability of detecting species. Current survey is piggy-backed on other field work, and hence is very low cost.	Summary Review	Continue; further review required	Review in context of recovery needs for species; potentially limited value to this survey. Are there any other viable alternatives.	Acceptable	data records in Alberta CEC; should also be in WildSpace	3rd
LB-42	Prothonotary Warbler Monitoring	Integral part of recovery strategy; costs may include monitoring of nest boxes and other recovery actions beyond simply counting birds	Summary Review	Continue; no immediate changes	Review in context of recovery needs of species	Acceptable	Data copied annually to NHIC and WildSpace so secure; internal management at BSC could be improved from spreadsheet to database	3rd
LB-44	Quebec Bird Populations at Risk (POPS)	Intensive surveys of known historical locations and some new locations for selected bird species. Less of a systematic monitoring program than an ongoing series of inventories effectively a whole series of single-species surveys. Statistical design unclear. Data managed by Regroupement Quebec Oiseaux (RQO), with copies at SCF and Quebec CDC.	Summary Review	Continue; further review required	Review in context of SAR program in Quebec and relevant recovery strategies Review survey design (e.g., site selection especially for new sites) to determine if allows reliable inferences or needs to be improved. Determine whether can be integrated with Quebec Breeding Bird Atlas -- may not need annual surveys. Re-examine relation between funding for this project and other agencies such as Quebec CDC.	Acceptable	potentially could be improved to ensure centrally managed and integrated with other, related databases; needs review.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
LB-45	Quebec Chimney Swift Survey	Survey started in 1998, involves volunteers monitoring populations at known roosting and nesting sites. Unclear whether, as a monitoring program, this is giving substantial new information to supplement BBS. Potential for bias in program. Other species can't be surveyed at the same time (focussed on roost and nesting sites for one species)	Summary Review	Continue; further review required	Value of survey should be assessed in relation to recovery needs for species. Is survey able to provide information to understand causes of population change? Is survey necessary to understand population status of species, or is information from BBS sufficient? If survey is valuable / cost effective, should consider whether to expand to rest of species range in Canada.	Improve	Currently in spreadsheet. Should be on centralized EC database	3rd
LB-49	Spotted Owl MP	Non-MBCA SARA species. Survey started in 1992. Design has changed over time, and annual funding from EC highly variable ($0K, $35K, $150K in various years). Total annual cost up to $300K or more. As very few known remaining pairs (<20), largely now an inventory of known remaining pairs.	Summary Review	Continue; further review required	Evaluate in context of recovery plan for species; is this level of expenditure necessary to conserve species? How often is it required?	Improve	Ensure data are centrally available; presumably some data (locations) are stored in CEC, but not all effort and related data	3rd
Other demographic surveys								
LB-23	Monitoring Avian Productivity and Survivorship (MAPS)	Only a limited number of MAPS stations operate in Canada - analyses of U.S. data combine data from multiple stations to obtain adequate precision. Uncertain whether cost-effective / feasible to get enough data in Canada to serve a useful monitoring role. A few stations operate with limited EC support, though often in conjunction with other programs (e.g., CMMN)	Summary Review	Continue; further review required	Carry out an analysis of the costs and benefits of a mark-recapture type demographic monitoring program for landbirds in Canada. Should consider option of continuous monitoring (current MAPS protocol) vs. option to carry out short-term (e.g., 5-year) studies that could serve as baselines in case of future declines. Currently only limited stations in Canada, and not necessarily providing sufficient data for reliable conclusions. Also determine whether MAPS methodology is most effective way to do this.	Acceptable	Data all submitted to, and managed by, Institute for Bird Populations in U.S. Archived in Avian Knowledge Network and probably fairly accessible to others	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
SHOREBIRDS								
National breeding season surveys								
SB-7	PRISM_Arctic	Several years of surveys (including pilot years) largely funded by IPY, Polar Shelf and other external funds, have provided information on methods and partial coverage of arctic -- similar effort in Alaska. Early and long-term commitment needed to ensure access to equipment etc (helicopters). Minimal survey effort in 2009 due to lack of funds. Enhanced activity in 2010.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	Ensure data are stored in an appropriate international database (involves Alaska and Canadian arctic)	3rd
Migration surveys								
SB-9	Shorebird Survey - Maritime	Migration counts being undertaken by volunteers at selected sites. Data from these surveys suggest major long-term declines in many species, but reliability is low, because of possible changes in stopover times (which have been demonstrated at some sites due to increases in predator (falcon) abundance) as well as changes in stopover locations.	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Make use of either BSC data entry portal or e-Bird portal for online data entry and data retrieval through AKN.	2nd
SB-10	Shorebird Survey - Ontario	Similar methodology and similar concerns to Maritimes shorebird survey, but more restricted coverage; data were analysed in 2010; identified need for further developments in analysis techniques.	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Data included in WildSpace, but worthwhile to integrate management with other shorebird monitoring	2nd
SB-11	Shorebird Survey BC	Daily migration counts at only a couple of sites carried out by EC staff. Important stopover sites for Western Sandpiper. Other species not well monitored, nor are other sites in region. Relates to research carried out at SFU.	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Improve	Data managed on an individual computer; plans to enter into WildSpace; should consider integration with other shorebird migration surveys.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
SB-12	Shorebird Survey - NF	Similar approach to Maritimes Shorebird Survey, and data now integrated to become Atlantic Canada Shorebird Survey. NF has a higher percentage of EC staff relative to volunteers than in Maritimes, which affects cost effectiveness.	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Ensure data nationally integrated with other shorebird survey data	2nd
Winter surveys								
SB-8	S.A. Red Knot Survey	Areal surveys undertaken by EC staff who fly to Latin America to undertake surveys. Methodology involves visual counts with no estimates of detectability or potential bias -- this means that surveys may lack repeatability if there are changes in observers (as is inevitable over time).	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure that all flock locations are georeferenced (GPS). Need to ensure that all raw data including locations for each flock are in a central web-accessible data base.	3rd
SB-13	Purple Sandpiper - NF	Specialized survey started in 2006 for species which uses different wintering habitat than other shorebirds. As with migration counts, despite weaknesses, could provide information on population change at faster time frame than Arctic PRISM, if concerns about bias can be addressed. Only sampling a limited number of sites, so changes in numbers may only partially reflect population change	Summary Review	Continue; further review required	Review importance of monitoring this species in winter and, if so, whether this survey is necessary relative to alternatives such as Christmas Bird Count or eBird. If survey is valuable, can we encourage more volunteer participation (e.g., as a winter birding activity) and should we expand survey to Maritimes or eastern USA to cover more of wintering area? Need to also consider approaches to get data on Canadian birds wintering in Europe.	Improve	Ensure data nationally integrated with other shorebird survey data	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
Species At Risk surveys								
SB-2	Eastern International Piping Plover Census	Primary survey is a complete census of all potential habitat every 5 years, across U.S. and Canada range during a 10-day window. Complemented by a winter survey of known winter range, presumably in following or preceding winter. In between the 5-year census, all known Piping Plover sites in Canada are surveyed annually. A detectability component has recently been added.	Summary Review	Continue; further review required	Review details of survey protocol for 5-year survey, especially with respect to wintering ground survey which is treated as a census, but for which accessibility and resources limit number of sites that are actually surveyed. Also review results of detectability study. Review need for annual survey between 5-year censuses, and importance of spending resources on surveys relative to other potential recovery activities. Review whether can be integrated with MSS	Possible Improvement	Data collected and managed by individual partners (provinces, NGOs, etc.) and then key information stored with USGS data base. Need to ensure consistency of QA/QC and make sure all data are fully and equally accessible to all partners in U.S. and Canada, preferably through web data base. May need to explore need for formal agreement for data-sharing with USGS	3rd
SB-3	Western International Piping Plover Census	See comments on Eastern survey - for the 5-year census, this is the same survey. Annual surveys of known sites may not occur in the same way as in Maritimes?	Summary Review	Continue; further review required	see SB 2 - many of same issues.	Possible Improvement	see SB2	3rd
SB-5	Mountain Plover Survey	Species at Risk with only one or two pairs left in Canada. Survey consists of checking to see if remaining pair(s) still present. Not necessarily used for any decision making. Not cost effective if done on its own, but apparently usually done as a low cost add-on if a researcher is carrying out other research nearby anyway.	Summary Review	Continue; further review required	Review in context of recovery needs for species	Improve	Presence data are maintained at Alberta CDC (NatureServe), but other data (e.g., search effort) may not be available outside computer of researcher	3rd
SB-6	Piping Plover Critical Habitat Survey	Survey supplements 5-yearly population wide assessment; does not provide reliable information on population change, because only samples known plover sites. Need to determine its value for managing those sites.	Summary Review	Complete current survey; review before repeating	Review the value of this survey relative to spending the resources on other potential recovery actions for the species (including on wintering areas). Is an annual survey necessary or could adequate information be obtained from a less frequent survey?	Improve	Ensure data are stored in an appropriate centrally accessible database	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
Other targeted surveys								
SB-1	American Woodcock Survey	Single species survey. Too early in the year to capture other species reliably. Carried out in coordination with U.S. survey. Some issues with management of survey and coordination among regions. Relevant to harvest management - harvest is not large in Canada, but Canadian birds are also harvested in U.S. Species not well detected by other surveys such as BBS	Summary Review	Continue; minor changes	Need to improve coordination and management of survey in Canada with better integration among regions. Need to address concerns that routes in Quebec were selected using a different protocol and may not be suitable for integration into continental program. Need to ensure French version of data management website is available. Survey efficiency and design should be reviewed in coordination with USFWS.	Possible Improvement	Managed in U.S. Need to check if data are fully accessible on web to all partners	3rd
SEABIRDS								
Colony monitoring programs								
SE-2	Eastern Arctic Seabird Monitoring	Various colonies visited at various frequencies. Some with intensive annual surveys, generally combined with research programs. Others visited less frequently on a more opportunistic basis.	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Improve	Data managed separately in each region or by individual biologists. Need to ensure all seabird colony data are managed in a central database to allow centralized retrieval and analysis	2nd
SE-3	Atlantic Canada Tern and Gull Surveys	Complete coastline (except Bay of Fundy) of NF and Maritimes flown every 5 years. Photos used to estimate colonies. A subset of colonies are visited on the ground to get more precise numbers. Not clear whether cost estimates include costs of analysis of photos.	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Need to manage as part of a central database, rather than individual researcher's computer	2nd
SE-4	Atlantic Region Seabird Colony Ground Surveys	Periodic surveys of colonies in NF and Labrador as opportunities and funds arise. Does not have formal sampling objectives.	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Need to manage as part of a central database, rather than individual researcher's computer	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
SE-13	Colonial Seabird West Coast	Periodic surveys of major seabird colonies in B.C. Sampling interval depends a bit on resources. Intensive demographic study (not included in costs) at only one site (Triangle Island).	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure all seabird colony data are managed in a central database to allow centralized retrieval and analysis	2nd
SE-25	Northern Gannets in North Atlantic	Complete survey of all 6 known gannet colonies in eastern North America every 5 years. Interval and methodology appear appropriate and cost-effective. Survey has been intensified to evaluate potential impacts of Gulf Oil spill	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Data need to be in central data base, integrated between Quebec and Atlantic	4th
SE-30	Quebec Seabird Colonies	5-year surveys of colonies of seabirds in St. Lawrence and Atlantic coasts. No comparable surveys in James/Hudson Bay or elsewhere in northern Quebec. Some colonies in Migratory Bird Sanctuaries have been surveyed every 5 years since 1925. Data managed by EC-QR in publicly accessible web-based data base.	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Acceptable	Web-based data base; however, should be integrated with other seabird data bases - perhaps using this one as a model	2nd
SE-32	St. Lawrence Seabirds as Indicators	Demographic monitoring - studies on productivity, chick diet and growth at a few colonies of selected species. Complements population surveys (SE30). Different colonies surveyed in different years on rotating design.	Summary Review	Continue; no immediate changes	Review sample strategy to determine if selection of colonies and sampling frequency for each colony is appropriate.	Acceptable	appears to be adequate, accessible database, but should be integrated nationally	4th
Pelagic monitoring programs								
SE-14	Eastern Canada Seabirds at Sea	Surveys of birds at sea, using opportunistic ships. Non-random site selection and high variance limit ability to detect long-term trends in species, but may be only available sampling method for some species. Greatest value is probably for identifying at-sea concentration areas, and monitoring how these change over time. Valuable for seascape planning (EA, offshore development, emergency response, fisheries bycatch risks, etc.). Partially funded with external funds; so long-term funding not secure.	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure at sea data, at least at the ocean basin level, are managed in a central database to allow centralized data management (to reduce costs) as well as retrieval and analysis. Consider whether a web portal and standardized protocols would allow gathering additional data from volunteers.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
SE-21	Laskeek Bay Seabird Monitoring	At sea surveys carried out by LBCS in Haida Gwaii. Part of a broad range of activities they carry out.	Summary Review	Continue; further review required	Need to review how results are being used. To what extent is this a research program or evaluation of specific conservation actions? If primary value is research, need to determine how long support should continue.	Improve	Integrate into a national data base	4th
SE-26	Pelagic Surveys - N. Pacific and Arctic	Surveys of birds at sea, using opportunistic ships. Non-random site selection and high variance limit ability to detect long-term trends in species, though may be only available sampling method for some species. Greatest value is probably for identifying major at-sea concentration areas, and monitoring how these change over time. Could be valuable for seascape planning (e.g., EA, offshore development, emergency response, fisheries bycatch risks, etc.).	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure at-sea data are managed in a central database to allow centralized access of results.	2nd
SE-37	Quebec Seabirds at Sea	Similar to SE 14 (Atlantic birds at sea) but supplements with some aerial surveys of selected species.	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Improve	Data need to be in central data base, integrated with other at-sea seabird data	2nd
Beached bird surveys								
SE-6	Beached Bird Survey - BC and Maritimes	Largely volunteer-based surveys of selected beaches at monthly intervals. Recent analysis suggests that monthly survey is not optimal for identifying causes of mortality. Additional problem is that many accessible beaches for volunteers not those where most birds expected to wash up based on modelling of ocean currents, etc.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Possible Improvement	Managed by BSC; need to ensure in a centrally accessible database (e.g., AKN).	3rd
SE-35	Beached Bird Survey - NL	Survey carried out using staff (unlike other beached bird surveys) with enhanced monitoring frequency (weekly) to maximize number of birds that are not scavenged and increase chances of identifying cause of death of any that are found	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Managed on local EC server, but should be part of national database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
SE-36	Beached Bird Survey - Quebec	survey being newly developed; planned as volunteer-based survey	Detailed Evaluation	Continue; minor changes	**Detailed Review - see Table 5.2**	Acceptable	Will likely be integrated with NatureCounts in similar fashion to other Beached Bird Surveys	3rd
Harvest surveys								
SE-31	Murre & Seaduck Harvest Survey	Murres separate from main waterfowl harvest survey, because requires special sampling frame. Species and age composition analysis has not been done in past, but methods exist and first wingbee carried out in 2011 in NF. Could potentially capture other late-season harvest in NF	Summary Review	Continue; no immediate changes	Should review effectiveness of parts survey after 1 to 2 years of operations	Acceptable	Managed with NHS data	3rd
Other non-breeding surveys								
SE-12	Coastal Waterbird Survey	Volunteer based survey of selected coastal areas at regular intervals through autumn, winter, spring. Captures sea ducks, seabirds and other waterbirds (e.g., herons, cormorants, etc.). Data used by various management groups (EC, province, etc.). Have potential value for research.	Summary Review	Continue; further review required	Survey has been reviewed by BSC. AMC needs to examine that review to determine if it adequately answers key questions for EC - e.g., is sample design (e.g., site selection, sampling frequency) adequate with respect to objectives from an EC perspective? What species are being monitored that are not otherwise adequately monitored? How are data being used to inform decision making?	Acceptable	managed on web-based database by BSC	3rd
WATERBIRDS (INLAND)								
Breeding colony surveys								
WB-17	Great Lakes Colonial Waterbird Survey	Comprehensive census of all known colonies of gulls, terns, cormorants every 10 years (takes 3 years to count). Supplemented by annual counts on lower Great Lakes of some colonies.	Summary Review	Continue; no immediate changes	Review need for additional sampling between 10-year cycle at selected colonies, though may be done in conjunction with research / contaminants programs.	Acceptable	data managed locally and also stored in WildSpace	4th

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WB-27	Quebec Black Tern Surveys	Surveys of selected known breeding colonies. Providing info on protected areas, in a limited way. Records info on other species at same time, though details of sampling protocol not available during review	Summary Review	Continue; further review required	Review in context of SAR requirements. Review priority of survey in national context, as well as management needs in Quebec -- are the information necessary for decision making? Could similar information be gathered from other surveys? Can this survey provide reliable trend information, or is it primarily of value for distribution and assessment? What is the optimal sampling frequency?	Improve	Currently in spreadsheet; planned to move to Quebec region data base. Need to ensure data accessible nationally.	3rd
WB-29	Quebec RB Gull Colonies	Complete count, through ground visits of all major Ring-billed Gull colonies along the upper St. Lawrence in Quebec, every 3 years. Data used for specific management actions.	Summary Review	Continue; further review required	Review survey frequency and timing; Does it need to be done every 3 years, given that comparable surveys on Great Lakes are every 10 years, and other seabirds in St. Lawrence are every 5 years? If frequent surveys are required, could sampling interval differ between colonies where management actions are taken and those that aren't, or would that reduce inference or have little benefit on costs?	Improve	Managed as part of Quebec region data base, but should be part of a national colonial waterbird data base	3rd
Marsh monitoring surveys								
WB-10	Breeding and Staging Waterbirds on Delta Marsh, Manitoba	Provides baseline information on distribution and abundance of birds at Delta Marsh to inform management. Includes surveys of breeding waterfowl, staging waterfowl, colonial waterbirds, and marsh birds (all separate protocols). Note that some data could potentially be incorporated into larger scale continental protocols	Summary Review	Not currently active; review before resuming	If survey is to be repeated, ensure that survey has sufficient sampling intensity to detect any changes that might be expected in response to management actions.	Improve	need to ensure data are integrated with WildSpace, so they would be available for a future comparison.	4th

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WB-16	Great Lakes Coastal Wetland MP	Relatively intensive surveys on key Great Lakes wetlands using MMP protocol (see survey # 18 Great Lakes Marsh MP), but with extra visits.	Summary Review	Continue; no immediate changes	Evaluate in context of MMP and reviewing recent statistical analysis of survey. Need to evaluate whether this more intensive monitoring is contributing to decision making in a cost-effective manner.	Acceptable	Original data in BSC server (NatureCounts). Copies with EC.	3rd
WB-18	Great Lakes Marsh MP	Largely volunteer-based survey of selected wetlands. Original protocol differed from standard for continental sampling protocol, but being modified to match. Major limitation is lack of a good sampling protocol for selecting wetlands.	Summary Review	Continue; further review required	Need to evaluate in context of national marsh bird monitoring strategy. Question to consider include the feasibility and costs of implementing a statistically sound sampling frame for assessing basin-wide trends. Also investigate how well automated recordings can monitor marsh birds - could they reduce risk of bias related to detectability and playback?	Acceptable	Original data in BSC server (NatureCounts). Copies with EC.	2nd
WB-28	Quebec Marsh MP	Similar protocol to Great Lakes MMP	Summary Review	Continue; further review required	Needs to be evaluated in context of national Marsh Monitoring & objectives (site-specific or local management vs. large scale trends) as well as whether volunteer sampling is adequate in order to draw inferences. See comments under Great Lakes MMP	Acceptable	Data managed in BSC data base (NatureCounts), with copies at EC.	2nd
WB-33	Waterbird Conservation Monitoring - Prairie and Parkland	New surveys initiated in 2005. First 3 years, surveys focussed on Franklin's Gulls; but recording other waterbirds as well. Provides baseline info that could be turned into monitoring pgm, if required	Summary Review	Complete current survey; review before repeating	Review results of first few years of data collection to determine optimal survey design for monitoring these species (complete inventory or survey of smaller random sample) and optimal sampling interval. Consider information needs for management (distribution vs. trend) and scale.	Improve	Data on biologist's computer. Plans to move to regional database, but should be in a nationally accessible database.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
Migration surveys								
WB-8	Bonaparte's Gull Migration at Saguenay-St-Laurent	Surveys of gulls along St Lawrence where a major portion of North American population stages on migration. Probably not useful for monitoring population status of species, because samples only part of population, only one site, turnover rates unknown, not known how to combine data among dates for trend analysis, etc. May have value for park management, but possibly already have sufficient data.	Summary Review	Continue; further review required	Consider terminating EC support for survey, with option to repeat if needed in the future (e.g., emergency response). Should analyse existing data to look at variability among and within years in both numbers and distribution in relation to need for data.	Improve	Managed on local PCs and with ÉPOQ. Probably secure, but if EC is investing, should ensure that on central, publicly available database.	3rd
WB-23	Mono Lake EAGR Photo Count	Survey in U.S. with some funding support from EC. Nearly whole population of species believed to moult in two sites (Mono Lake and Great Salt Lake) so censused using photo counts. Developed by EC-local collaborators trained & now run survey (photo counts)	Summary Review	Continue; no immediate changes	Need to consider approaches to evaluate whether changes in numbers counted at the moulting sites could be changes in behaviour rather than changes in populations (e.g., use of other moulting sites).	Possible Improvement	Ensure data centrally available	4th
Species At Risk surveys								
WB-19	King Rail MP	Initiated in 1997, and run intermittently since then. Similar protocols to standardized Marsh Monitoring, but more intensive surveys in areas where species anticipated or previously occurred	Summary Review	Continue; further review required	Review in context of needs for SARA; potentially should be better integrated with Great Lakes MMP once a sound sampling frame is developed; determine need for additional, more intensive surveys based on SARA recovery requirements (note that it is not necessary to count every bird in Canada for SARA purposes!)	Improve	data should be fully integrated with MMP data base	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WB-22	Least Bittern MP	Same comments as King Rail survey. Similar protocols to standardized Marsh Monitoring, but more intensive surveys in areas where species anticipated or previously occurred, because MMP apparently does not get sufficient data.	Summary Review	Continue; further review required	Review in context of needs for SARA; potentially should be better integrated with Great Lakes MMP once a sound sampling frame is developed; determine need for additional, more intensive surveys based on SARA recovery requirements.	Improve	Integrate into a national data base	3rd
WB-34	Yellow Rail MP	Pilot survey in 2007, but limited to a few sites (budget restrictions). Intent to target known locations for species as well as other sites. Protocols compatible with continental marsh-monitoring protocols. Targets habitats potentially suitable for Yellow Rail, but records all species encountered.	Summary Review	Continue; further review required	Review in context of SAR requirements. Develop program in context of national Marsh Monitoring Program, if possible, rather than single species survey.	Improve	Manage data nationally	3rd
Other targeted surveys								
WB-7	Beaufort Sea Red-throated Loons as Indicators	Localized surveys in Beaufort region for a single species with sample sites in proposed development areas as well as control sites. Involves both aerial surveys and some level of ground counts. Probably not useful for population level monitoring because only a limited area.	Summary Review	Complete current survey; review before repeating	Review value of using this species as an indicator of habitat impacts of development. Would other species or multi-species surveys be more appropriate or more cost-effective?	Improve	Managed on local PCs. Should be on centralized EC database (WildSpace)	4th
WB-11	Canadian Lakes Loon Survey	Volunteer based survey that provides information on loon productivity (but not population numbers). Data base contains extensive useful data, but has some management problems (site identifiers not always consistent; problem georeferencing some historical data) and despite considerable investment of time and resources, has not yet generated published analyses of these results. Survey was recently expanded to capture some additional bird species on same lakes.	Summary Review	No EC support	EC has previously provided extensive funding, because of potential value for evaluating impacts of acid rain. Should not provide further funding unless or until existing data are analysed, written up & published. Data still have considerable potential for understanding impacts of lake acidification on loon productivity	Improve	Need to improve data quality control so that whole data base is internally consistent; to facilitate analysis of data	4th

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WATERFOWL								
Multi-species breeding season surveys								
WF-24	Breeding Population and Habitat Survey	Most important survey for waterfowl in North America. In past, has been reviewed every 10 years, but most recent review was in 1995; a new review is proposed but has not yet started. Need to evaluate whether current levels of ground (aerial) effort are required. Also need to review value for other species.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Acceptable		1st
WF-29 & 30	Central and Western Arctic Waterfowl Survey	Proposed aerial surveys (fixed wing) in far north, to be run largely by USFWS, EC involvement yet to defined. Could potentially substitute for a number of current helicopter-based surveys. Will need to determine whether fixed wing effective for non-waterfowl species (loons, some gulls).	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Acceptable		2nd
WF-33	Eastern Waterfowl Breeding Ground Survey	Combination of Canada-led helicopter plot surveys and U.S.-led fixed wing surveys. Optimized timing for Black Ducks and Mallards (early nesters) but records information on all species. Integrated 2 surveys in 2004 from analysis perspective, but still some redundancy. Northern part of survey in Ungava (for CAGO) could be considered as part of this survey. Some information on other species - waterbirds, loons, cranes. Some challenges with analysis methods, as integrated survey has lower apparent precision than either fixed wing or helicopter alone. Also provides some information on non-target species (e.g., Common Loon), but those data have not been evaluated.	Summary Review	Continue; further review required	Budget constraints require reduction in overall survey costs by 2012; need to evaluate impacts of reductions in coverage on overall precision and risks. Consider whether more efficient ways to integrate data among surveys; must be evaluted in coordination with U.S., but on a relatively tight timescale.	Possible Improvement	Need to ensure data in a centrally accessible database.	1st

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
Arctic breeding goose & swan surveys								
WF-1	5-year Breeding Greater Snow Goose Survey	Same population being followed by a more comprehensive survey of this population in St. Lawrence whereas arctic colony survey captures only 10-15% of breeding popn. Carried out in a national park & MBS. Funded through EC contribution to AGJV & Polar Continental Shelf. Well-designed survey, but may not be necessary as specified in the Notes on survey recommendations.	Detailed Evaluation	Terminate	**Detailed Review - see Table 5.2**	Improve	Need to ensure data are placed in a centrally accessible database.	NA
WF-5	Declining Snow Geese and Brant at Anderson River	Local community pressure to ensure goose populations at Anderson River Delta are maintained- linked to Aboriginal harvest; located in Mig Bird Sanctuary	Summary Review	Continue; further review required	Evaluate in context of other Arctic goose colony surveys. Issues to consider include the use of this information in decision making, the scale at which information is being used (regional vs national) and whether information needs could be met from other sources (e.g., winter/spring counts or estimates based on banding data?). If colony counts are required, should evaluate use of automated photo-counting technology for aerial inventories.	Improve	Need to ensure data are placed in a centrally accessible database.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-9	Arctic Greater Snow Goose Survey	Program is long-term research and monitoring, undertaken in conjunction with a university. Involves both nesting studies and banding. Important to have banding done annually for survival measures. Survival & productivity estimates to justify, model & assess special measures for control & overabundant status. Gives all demographic parameters to feed into models. Only source of information for habitat monitoring in eastern high-Arctic	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure that all raw data available to EC for future analyses; currently most data maintained at university.	3rd
WF-39	Inuvialuit Geese/ Swan Survey	Helicopter surveys. Precision & power of survey was evaluated at outset.	Detailed Evaluation	Terminate	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	NA
WF-45	Karrak Lake	Large program including breeding studies and banding studies (not clear if cost estimates include everything). Initial emphasis was Snow Geese, but also now many other species. Infrastructure available to other arctic research projects. Very productive research program. Currently being used as main representative site for understanding Snow Geese; as long as special measures are being adopted for Snow Geese, probably appropriate to understand impacts. Banding component coordinated with WF-08 Arctic Goose Banding. Also includes some toxics monitoring	Summary Review	Continue; further review required	Need to consider extent to which this site can be representative of other goose colonies. Consider extent to which information on other bird groups can be gathered at same time. Should evaluate banding program as part of overall arctic goose banding review.	Improve	Need to ensure all data from project are in a centrally managed database (including nesting studies, etc.) to ensure accessibility to future researchers, etc.	2nd
WF-48	Mackenzie Delta Tundra Swans as Indicators	Expensive single species survey. Trend may be captured in other surveys (Central and Western Arctic surveys)	Detailed Evaluation	Not currently active; review before resuming	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	NA

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-64	Snow Goose Survey - Baffin Plains	Aerial transect survey carried out opportunistically during banding programs. Survey funding largely from partners, but staff from EC. Does not appear to be necessary for decision making, although has provided some useful distribution and abundance information.	Summary Review	Not currently active; review before resuming	Survey was last run in 2009 and no plans to resume survey.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	NA
WF-65	Snow/ Ross's Goose Photo Survey	Periodic photo surveys on selected major colonies. May not cover smaller colonies adequately, which comprise unknown % of total population. Provides information on geographic variation in population growth, and potential to provide more reliable estimates of overall change than winter counts, despite gaps. Uncertain whether really need this intensity of survey. Note there is a proposal from U.S. to set up a fixed wing transect program to supplement / replace this survey.	Summary Review	Continue; further review required	Evaluate in context of information needs for managing species, considering other sources of information (winter surveys; mark-recapture population estimates) and low risks of errors in population estimates. If still needed, determine appropriate frequency and sampling frame, and develop improved software analytic methods for analysing photos more efficiently and more punctually.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
Other breeding surveys								
WF-7	Arctic Eider Productivity & Survival	Survey from 2001-2007 of productivity and survival of Pacific Eiders at Bathurst Inlet. Baseline information could be valuable in future for monitoring if survey is ever repeated. Main harvest is in Russia, but also substantial aboriginal harvest	Detailed Evaluation	Not currently active; review before resuming	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-7B	Arctic Eider - East Bay surveys	provides demographic information. Has received rigorous scientific review. One of few cases for seaducks with demographic information.	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-7C	Arctic Eiders - Community Based colony surveys	Expensive and labour intensive. Travel to islands with locals and count nests. Involves community.	Detailed Evaluation	Not currently active; review before resuming	**Detailed Review - see Table 5.2**	improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-11	AP Canada Goose Productivity Survey	Focused on concerns/ issues around Atlantic Population Canada Geese. Note that U.S. would likely continue survey even if not used by EC. Should evaluate relative EC / USA investment.	Summary Review	Continue; further review required	Evaluate cost-effectiveness relative to management information needs. Evaluate in context of overall migrant Canada goose programs	improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-12	AP Canada Goose Survey	Recently reviewed in light of USA/ Eastern Canada waterfowl survey integration	Summary Review	Continue; no immediate changes	Maintain program in its current form	Acceptable		3rd
WF-13	Atlantic Flyway Mute Swan Survey	Currently coordinated with U.S. survey. Only considers Great Lakes coastal wetlands - does not capture inland areas. Christmas Bird Counts also provide information on changes in Mute Swan populations, but not for identifying high concentration areas at other times of year. Unclear whether management actions require this precision, especially if no management action is being taken.	Summary Review	Continue; further review required	Need to review whether data from survey are being used for management actions or decisions. Given low cost and potential public concern about this invasive species, may be worth retaining even if no action currently envisioned. If continues, should ensure data fully georeferenced and evaluate feasibility / usefulness of recording data on other species at same time.	Acceptable		3rd
WF-15	Atlantic Spring Eider	Count of adult males during breeding season as index of breeding numbers; may have links to surveys in Maine	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-19	Bathurst Inlet Spring Eiders BP	Current strategy is to run a 3-year survey at periodic intervals. Can we get data on any other species at same time?	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-21	Boreal Forest Aquatic Birds	Local survey near Yellowknife. Main added value relative to other waterfowl surveys is productivity information, but need for this uncertain. Gives information on some grebes not well captured elsewhere; may be more valuable for waterbirds other than waterfowl. Survey has been of value in a research context.	Summary Review	Continue; further review required	Review objectives of continuing survey (both for waterfowl and other waterbirds), and then consider appropriate survey interval if survey is worth continuing.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-43	James Bay CAGO Breeding Pairs	Aerial survey of total population size, with highest intensity on Akimiski Island, where densities are highest.	Summary Review	Continue; further review required	Review in context of overall migrant CAGO programs--need to consider whether all populations (NAP, AP, SJBP, MVP, Interior) require similar intensity of survey, risks of reducing survey frequency when populations near targets, etc.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-51	Mississippi Valley CAGO Breeding Pairs	Aerial population counts in Hudson Bay Lowlands. Most of support from Ontario MNR and U.S. Some cash from EC (for fuel - 25%). Uncertain how much data is gathered on non-waterfowl species (e.g., Sandhill Cranes). Need to improve georeferencing of observations to allow links with habitat data.	Summary Review	Continue; further review required	Review in context of overall migrant CAGO programs--need to consider whether all populations (NAP, AP, SJBP, MVP, Interior) require similar intensity of survey, risks of reducing survey frequency when populations near targets, etc.	Acceptable		3rd
WF-55	PEI Breeding Ground Plot Survey	Only waterfowl survey in PEI (A few USFWS Transects from Eastern Waterfowl Survey sample parts of PEI). Brood and pair surveys on ground.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	Need to improve data quality and ensure properly integrated into a centrally accessible, georeferenced database.	3rd
WF-58	S. Ontario Ground Plot Survey	Protocols recently changed -- used to run all plots every few years, but now using a rotating design with some plots surveyed every year. Limited overlap with aerial surveys, though results not currently integrated into Eastern Waterfowl surveys. Because of long time series, has been used for some research projects (e.g., habitat relations). Includes portion of range where ABDU has seen greatest decline.	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Acceptable		3rd
WF-59	S. Quebec Highlands Waterfowl Survey	Part of WF 33 for further details	Summary Review	Continue; further review required	See WF 33	Possible Improvement	Need to ensure data in a centrally accessible database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-60	S. Quebec Lowlands Waterfowl Survey	Objectives very precise - detect 10% population change in area. Rotating sample design -- similar design to Eastern waterfowl survey, but different plot size and more intensive survey. May be more precise than necessary.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Possible Improvement	Need to ensure data in a centrally accessible database.	3rd
WF-61	SK Waterfowl Production Survey	Was subject to extensive international review. Supports research questions, but designed as productivity monitoring. Methods developed to support BCR & joint venture planning. Also includes some habitat monitoring. Should review information need from EC perspective, especially considering how much is already known about waterfowl habitat relationships	Summary Review	Continue; further review required	Evaluate need for annual survey in relation to its main value for BCR and Joint Venture planning. Can survey provide any information on other waterbird species at same time?	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-69	St. Lawrence Waterfowl Survey	Recently added on to eastern waterfowl surveys (starting in 2004) -- particular concern about duck trends along St. Lawrence & major adjacent tributaries in areas where high human population. Local trends may be different than broader regional trends. Only a few fixed wing transects cover area. Statistically well designed. Main harvest management link is whether early season restrictions are required, but has other values.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Possible Improvement	Need to ensure data in a centrally accessible database.	3rd
WF-70	Surf Scoter Reproduction Monitoring Program	Initiated as a research program with very intense surveys in early years. A few times per year for now.	Summary Review	Continue; further review required	Need to develop coordinated Canada-wide plan for scoter monitoring, looking at objectives and optimal strategy to meet needs in relation to risks, taking into account SDJV plan.	Possible Improvement	Need to ensure data in a centrally accessible database.	2nd
WF-71 & 72	Trumpeter Swan Survey - West and Ontario	Tracking recovery of a (formerly) rare species. Internationally coordinated. Ontario survey based on ground rather than air protocols.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Possible Improvement	Need to ensure all data from project are in a centrally managed database	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-75	Yukon Roadside Breeding Waterfowl Survey	Has been running since 1991. Involves 5 visits per year to several hundred wetlands along roadside. In addition to waterfowl, detects a number of other species (e.g., waterbirds, some shorebirds, Rusty Blackbirds). Unclear how waterfowl data complement continental surveys, or how they are being used (has been used for some research projects on habitat associations, etc.)	Summary Review	Continue; further review required	Assess importance of regional vs. National needs and how this survey meets these. Analyse existing data. If data are important for EC decision making, should review power / precision of survey and optimal sampling frequency. .	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-82	Develop-mental Surveys for Breeding Scoters	Survey being developed in connection with environmental assessment of airforce activities in Labrador. Developmental survey, but evaluating methods that may be valuable for developing continental monitoring programs. Eastern waterfowl survey too early for these types of late nesters -- mostly getting migrating groups of these species. Modifications to eastern survey being considered (e.g., some later flights)	Summary Review	Not currently active; review before resuming	Need to develop coordinated Canada-wide plan for scotor monitoring, looking at objectives and optimal strategy to meet needs (and note that needs need to be considered in relation to risks). Should take advice from SDJV plan.	Possible Improvement	Need to ensure data in a centrally accessible, georeferenced database.	2nd
Moult surveys								
WF-44	James Bay Moulting Scoters	Pilot surveys of scoters when concentrated during post-breeding moult. Easier to survey at this time than on breeding grounds, but variance, etc. unknown. Unclear whether other species can be effectively surveyed at the same time. May need more research to identify most cost effective time of year /procedure to monitor these birds.	Summary Review	Complete current survey; review before repeating	Need to develop coordinated Canada-wide plan for scoter monitoring, looking at objectives and optimal strategy to meet needs in relation to risks, taking into account SDJV plan.	Possible Improvement	Need to ensure data properly georeferenced in WildSpace	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-62	Seaduck Moult Banding - Scoters	Includes a mixture of projects: Scoters in Quebec; Scoters in Labrador. Started as research, but turned into monitoring on an ad hoc basis.	Summary Review	Continue; further review required	Need to evaluate in context of information needs for scoters	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd
WF-63	Seaduck Moult Banding - Eiders	Includes a mixture of projects. Started as research, but turned into monitoring on an ad hoc basis. Many years of data that have not been well utilized.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd
Migration surveys								
WF-3	Aerial Surveys of B.C. Interior	Helicopter survey along transects, but focused on specific wetlands. Survey is optimized for Mallards, but there may be greater concerns about other species that are less well monitored (e.g., sea ducks). Fixed wing transects are apparently too dangerous in the terrain. Need to review how this meshes with ground surveys (#37). Contributes to CIJV needs. Does not have any ground work to calculate visibility correction factors	Summary Review	Continue; further review required	Need to confirm use in decision making and associated value. Should be reviewed in context of overall review of waterfowl breeding ground surveys, including prairies, eastern surveys.	Improve	Need to ensure data are placed in a centrally accessible, georeferenced database.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-4	Alaska (Point Barrow) Eider Migration Counts	These are migration counts, and hence there are some inherent concerns about variability and possible changes in the proportion of the population being sampled. Has had some work on visibility and detectability - some birds missed because farther out to sea and/or inland (but attempt to adjust for this). Not known if this could lead to bias due to change over time. Note that there is a lot of KIEI work in Alaska that is not included in the AMR review. Intermittent implementation, no plan to repeat in the near term	Detailed Evaluation	Continue; further review required	**Detailed Review - see Table 5.2**	Possible Improvement	Need to ensure data are placed in a centrally accessible database.	2nd
WF-27	Canada Goose Staging Survey - PEI	Need to evaluate whether data are being used for decision making in management or for other purposes. If so, need to determine whether survey is adequately designed to provide reliable data for those needs.	Summary Review	Continue; further review required	Need to assess as part of overall Migrant Canada Goose program. NAP population survey and banding need a thorough review to ensure they are adequate / necessary.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-28	Cap Tourmente Snow Goose Survey	Info has not been used for decision making, though has potential to be used for research.	Detailed Evaluation	Terminate	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible database.	NA
WF-31	Continental Canvasback Survey	Originally established in response to declining CANV populations. Potential for EA and habitat management use, though was not georeferenced at sufficiently fine scale. Not used for setting harvest regulation	Detailed Evaluation	Terminate	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	NA
WF-34	Fall White-fronted Goose Survey	Fall migration surveys. Not certain whether other species counted at the same time, though survey design probably not optimal for other species. Did not have information on whether survey has been reviewed previously.	Summary Review	Continue; further review required	Need to review costs, relative effectiveness and survey reliability relative to other options for gathering data on this species (e.g., breeding or wintering surveys), relative to current information needs.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-37	Ground Surveys of B.C. Interior	Ground based survey. Was reviewed in 1999 and 2008 in context of CIJV. Was re-designed in response to reviews. Gathers data related to habitat and habitat bird-relations on targetted wetlands. Need to clarify how data from this survey are actually being used for management purposes. Should consider whether might be more efficient with a rotating design (sampling different wetlands in different years), or sampling every few years, as habitat relations unlikely to change annually. Unclear whether this is also useful for providing population trend data, given limited geographic scope and availability of aerial surveys.	Summary Review	Not currently active; review before resuming	Evaluate whether survey has potential to provide useful trend information (e.g., complementing aerial surveys) as well as information on non-waterfowl species. Verify that data from survey are being used in management, and determine whether a rotating design or periodic survey could also meet needs (after examining previous reviews of this survey)	Improve	Need to ensure data in a centrally accessible, georeferenced database.	4th
WF-42	James and Hudson Bay Migrant Survey	Survey run twice (in 1970s and 1990s, both times over multiple years); no plans to run it again soon. Provided baseline info on an important waterfowl staging area (James Bay).	Summary Review	Not currently active; review before resuming	Need a detailed review of value of survey and objectives (e.g., for defining priority habitats) if any plans to repeat survey. If needs to be done again, need a serious review of protocols. Issues with protocol - no information on turnover rates, effects of tides on counts, etc.	Acceptable	WildSpace	4th
WF-46	Long Point Aerial Surveys	Survey last completed in 2006. No plans to continue survey due to cost, limited use of data, and safety issues with extensive aerial surveys over water.	Summary Review	Not currently active; review before resuming	No EC resources. Survey not currently active	Improve	Need to integrate data with other central accessible Great Lakes waterfowl databases.	NA

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-47	Lower Great Lakes Migrant Survey	Decadal survey (run over a 3-year interval). Multiple surveys throughout the year, on different lakes each year. Current series being run 2010-2012. Need to review how data from survey are being used - not necessary for trend analysis. Potential other values are Environmental Assessment (if adequately georeferenced), priority site identification. Need to consider how to analyse data to take into account unknown turnover rates, time of day effects, etc.	Summary Review	Continue; minor changes	Complete current round of surveys. Need to ensure observations are properly georeferenced to meet EA needs. Need to address issues of detectability, effects of time of day and survey conditions on counts; potential effect of turnover rates on analyses.	Acceptable		4th
WF-67	Spring Snow Goose Survey	Survey designed to estimate population size on spring migration through St. Lawrence. Recent satellite transmitter study added to estimate proportion of population being missed as colony has expanded.	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-76	Yukon Spring Migration Monitoring	Combined ground and air surveys of major waterfowl spring migration stopovers; records data on phenology (including ice break-up) waterfowl use of areas, numbers; Also data on shorebirds and other waterbirds. Probably of limited value for trend analysis (high variance; changes in population potentially confounded with changes in habitat).	Summary Review	Continue; further review required	Analyse existing survey data and determine what information needs they meet (management / research), relative to risks of not having information.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-79	Snow Goose Fall Productivity	Comparison with breeding data provides information on fledging success / migration mortality; measures realized productivity. Potentially useful to link productivity to conditions on breeding ground Complements & may duplicate some info collected on the breeding grounds	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
Winter surveys								
WF-6	Aquaculture Coastal Block Survey	Survey in Atlantic Region. Initially funded by DFO, but now all EC funded. Done in both autumn and winter -- covers a mix of species. Main value of survey has been to evaluate impacts of aquaculture on birds. Provides some information on scoters / eiders, but unclear whether this helps to fill gaps in population monitoring.	Summary Review	Continue; further review required	Assess whether investment is in balance with needs at a regional level. Does survey need to be run on an annual basis and multiple times within a year? Need to clarify objectives of survey and then evaluate design and frequency in relation to those objectives.	Improve	Need to ensure data are placed in a centrally accessible, georeferenced database.	2nd
WF-17	BC Coast Aerial Wintering Waterbird Survey	Provides potentially useful information on distributions of birds. Need to determine how / whether this can be used in conjunction with coastal waterbird survey, and whether can provide useful trend information.	Summary Review	Complete current survey; review before repeating	Need to evaluate how much effort is required; how data are being used; whether it could be improved through targetting areas of high priority and/or particular times of year.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-20	Belcher Islands Aerial Seaduck Survey	This survey is a technical challenge; highly clumped distribution makes extrapolation difficult, but evaluation suggests this is best option for this population.	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-36	Fraser-Skagit Mid-winter Snow Goose Count	Currently involves air surveys 3 times per season. Need to clarify uses of data and whether, if it is required, it is needed with this frequency. Also need to examine survey design.	Summary Review	Continue; further review required	Evaluate in context of overall LSGO program and regional needs. Is the information from this survey being used, and if so is the frequency and resulting precision in balance with needs?	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-49	Mid-winter Fraser River Brant Survey	Run opportunistically, at relatively low cost. Analyses based on maximum count over ~10-15 surveys per year. No data on how close this is to total population size. Worth evaluating whether similar results could be obtained with a smaller number of counts. Also need to clarify objectives and importance of survey which is only a tiny part of total Brant population.	Summary Review	Continue; further review required	Evaluate need for this local survey and whether frequency is appropriate.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-50	Mid-winter Waterfowl Survey	From EC perspective, survey most important for Atlantic Brant, Tundra Swans and Snow Geese which are less well monitored on breeding grounds. Canadian effort largely focussed on Great Lakes; possibly some contributions in B.C. (or done by U.S.)	Summary Review	Continue; further review required	Need to evaluate importance of Great Lakes portion of survey, and whether needs to be run every year. Can protocol be revised to improve value for other objectives (e.g., improved georeferencing to assist with Environmental Assessment)?	Acceptable		3rd
WF-73	Atlantic Winter Eider Survey	Survey has been flown when opportunity arises; photo survey (unlike other winter surveys - eiders more readily detected on photos than some species--method has been published). Can this pick up other species reliably at same time? (possibly not because of survey design) Has been flown in years when other winter surveys are not flown (every 3 years)	Detailed Evaluation	Continue; no immediate changes	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	2nd
WF-74	Wintering Trumpeter Swans - B.C. Coast	Winter surveys every 3 years covering part of BC population. Same populations monitored on the breeding grounds.	Detailed Evaluation	Terminate	**Detailed Review - see Table 5.2**	Improve	Need to ensure data in a centrally accessible, georeferenced database.	NA
WF-78	Wintering Black Duck Survey	Triennial winter surveys (last run 2010), possibly developed in response to increased numbers of wintering ducks in Canada. Unclear whether currently used or apparently necessary for ABDU harvest management. May have some relevance for BCR/EHJV planning (ABDU winter concentrations) and/or BOAS responses, but may not be required annually. Christmas Bird Count data potentially useful for evaluating winter distribution in relation to harvest allocation.	Summary Review	Continue; further review required	Need to evaluate in context of overall Atlantic winter surveys. Do other surveys give us enough information for landscape management?	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-80	Atlantic Winter Black Duck Banding	Winter banding has been running for 2 years in NB (and since ~1970 in PEI, but without clear objectives). Proposal to institute a 2-season banding program to tease apart pre- and post-season mortality patterns. Easier to get large numbers post-season.	Summary Review	Continue; no immediate changes	Need to evaluate effectiveness of program when sufficient data have been obtained.	Acceptable	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd
Harvest / hunter surveys								
WF-35	Fraser River Brant/Snow Goose Harvest Survey	Low cost survey considered regionally important for management of a small population of Brant that is recovering and not adequately sampled by national harvest survey. Less certain whether we need this survey for the snow geese.	Summary Review	Continue; further review required	Need to evaluate whether extra components of survey for LSGO in B.C. are required. Also need to re-evaluate whether sampling framework is adequate to provide a reliable survey (considered 100% survey for Brant hunters).	Improve	Data should be managed together with results of national harvest survey.	3rd
WF-41	Inuvialuit Harvest Study	Legislative requirement to do something. Currently, there is very little information on Aboriginal harvest in Canada Baseline harvest summary report has been produced	Summary Review	Not currently active; review before resuming	Should review in context of other harvest survey programs. Evaluate survey design to ensure optimal for questions considered.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	4th
WF-52	National Harvest Survey	National survey based on sampling hunters who bought migratory game bird permits. Involves questionnaire as well as parts survey (wings / tails). Survey could potentially be enhanced to provide better precision on some species through changing geographic allocation, but requires clear statement of information priorities. Value of age ratio data has been question, but these data are currently being used in AHM as an index of productivity. Potential to greatly reduce costs and improve survey (e.g., reduction of memory bias) with electronic permit sales (remove data entry costs, allow more timely sample selection, etc.)	Summary Review	Continue; no immediate changes	Encourage development of electronic permit sales as quickly as possible. This will provide opportunity to redesign and optimize survey as well as major cost savings, both for the survey and for overall delivery of hunting permits. Should investigate whether costs of wing-bee can be reduced, with greater regional processing of wings, and a smaller team to work on challenging wings.	Acceptable	Raw data accessible on intranet database; analysed results available on public internet database.	3rd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-57	Quebec Aboriginal Harvest Survey	Methods developed in Alaska & modified for use in Quebec. Protocol developed in consultation with Brian Collins. Very large harvest of CAGO in spring. Helps to fill a gap in the National Harvest Survey. Need to determine whether could / should expand to other land claim areas.	Summary Review	Continue; further review required	Determine what is appropriate frequency to run this survey? Could it be run e.g., every few years, perhaps on a rotating design in different communities?	Improve	Need to ensure data in a centrally accessible database, possibly managed together with national harvest survey.	3rd
WF-66	Spring Conservation Hunt Survey	Supplement to harvest survey to assess total harvest during special conservation measures (i.e., spring snow goose hunts).	Summary Review	Continue; no immediate changes	Should be evaluated in context of overall harvest survey, and consider whether required every yr.	Acceptable		3rd
Duck banding programs								
WF-16	B.C. Duck Banding	AMR was lacking review on extent of banding, number of sites involved, and whether they are representative of region or sufficient. If program is to continue, need to ensure that data are collected in a sufficiently rigorous manner to ensure reliable results.	Summary Review	Continue; further review required	Need to consider value of continuing at current scale. Banding review should consider distribution of effort within province and not just number of ducks per province.	Improve	OK for banding and recovery. Recapture info not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd
WF-23	Breeding Atlantic Eider Banding	Mixture of different banding programs on *dresseri* eider. Much of it run outside EC and USFWS. Needs better coordination of efforts.	Detailed Evaluation	Continue; major changes	**Detailed Review - see Table 5.2**	Improve	OK for banding and recovery. Recapture info not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd
WF-32	Eastern Canada Pre-season Duck Banding	Targets ABDU, MALL, smaller numbers of other species. Activity shared among provinces, EC and private banders. Total EC time investment not well documented.	Summary Review	Continue; further review required	Pre-season waterfowl banding program requires review of appropriate effort, info requirements. Need to ensure EC is well engaged in defining objectives, information needs, risks of not having info relative to costs, especially for species that are doing well; for some species, risk of having less information (from a management perspective) may be low.	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-56	Prairie Duck Banding	Part of continental waterfowl banding program. For ducks, see also WF 16 and 32. Not sure if cost estimates are comprehensive and accurate.	Summary Review	Continue; further review required	Pre-season waterfowl banding program requires review of appropriate effort, info requirements. Need to ensure EC is well engaged in defining objectives, information needs, risks of not having info relative to costs, especially for species that are doing well; for some species, risk of having less information (from a management perspective) may be low.	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	2nd
Goose banding programs								
WF-8	Arctic Goose Banding	Banding info is used for estimating survival rates, productivity, and movement patterns which feed into evaluation of harvest regulations, including special measure. Essential information for estimating survival to model population dynamics. Also used to estimate population size. Currently, intensive banding is conducted on some colonies, but is patchy on others. Survival analyses require multiyear banding without breaks; some other parameters can be estimated from shorter term data. No formal management framework to incorporate data (e.g., adaptive harvest management framework), but data are regularly analysed and published by researchers and feed into decision making.	Partial Evaluation	Continue; further review required	Detailed review covered one potential use of data. Next steps include: 1- Review data requirements for other information needs; 2 - Evaluate whether intensity or distribution of samples is optimal / cost-effective in relation to management decisions (for each species). 3- Assess relevance to aboriginal land claims.	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	1st

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-10 & 25	AP Canada Goose Pre-season Banding	This is an important system to understand- important species for harvest (Aboriginal & non-Aboriginal) with significant partnership component, international & Aboriginal. Data have been used by USA as well (e.g., closed seasons for AP CAGO in USA) However, do we still need to estimate survival rates for management? What is the risk to setting hunting regulations if program reduced / discontinued? Could we obtain sufficient information through periodic short-term research program?	Summary Review	Continue; further review required	Review in conjunction with review of other Arctic goose banding programs, considering other sources of information on migrant Canada geese and risks of not having information.	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	1st
WF-26	Canada Goose Banding - Temperate	Banding info will help to evaluate impacts of harvest regulations on temperate vs. northern goose populations	Summary Review	Continue; further review required	Need to review value for management of temperate Canada Goose populations. Need to ensure that program is sufficient to meet essential information needs.	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	1st
WF-40	Inuvialuit Goose Population banding studies	Banding studies of Brant and White-fronted, Canada, Snow geese (various time periods) in Inuvialuit settlement region. Coordinated with WF-08 Arctic Goose Banding	Summary Review	Continue; further review required	Review in context of other Arctic goose banding programs (see WF 8). Need to consider relevance to Aboriginal Land Claims	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	1st

#	Survey Name	General Comments	AMR Review Process	Survey Recommendation	Notes on Survey Recommendation	Data Management Recommendation	Notes on Data Management	Further Review Priority
WF-77	North Atlantic Population Canada Goose Banding	Some Greenland international issues, but uncertain whether this survey helps; U.S. concern mainly that population does not have issues that would require cutting back on their overall CAGO harvest; Labrador Black Duck surveys provide some information on CAGO populations. Need to determine whether current sampling effort is providing sufficient information. Mainly spring banding, so not ideal for tracking harvest size.	Summary Review	Continue; further review required	Evaluate cost-effectiveness in context of overall goose banding program. Compare cost-effectiveness and representativeness of banding in Labrador vs. PEI.	Improve	OK for banding and recovery data. Recapture information not necessarily adequately managed if not reported to Banding Office data base, but may be a valuable part of program. Need strategy to ensure adequately managed.	1st
WF-81	Greater Snow Goose Telemetry Survey	Satellite telemetry study that provides information on proportion of birds detected by spring survey (among other objectives), thus validating monitoring program. Most funding external to EC (from university)	Detailed Evaluation	Complete current survey; review before repeating	**Detailed Review - see Table 5.2**	Possible Improvement	Need to ensure data in a centrally accessible, georeferenced database.	NA
Species At Risk surveys								
WF-18	Wintering Barrow's Goldeneye Survey	Survey was integrated between Atlantic and Quebec. Provides useful distributional information. Unclear whether population estimates are reliable. Need to evaluate whether obtains (or could obtain) useful information on other species (e.g., other sea ducks, Purple Sandpiper).	Summary Review	Continue; further review required	Need to evaluate data on target species, as well as other species that could be detected concurrently. If survey is required, need to determine appropriate frequency.	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd
WF-38	Harlequin Duck Survey	Survey carried out in February. Christmas Bird Counts also provide some information on species, but apparently with higher variance as birds move a lot.	Summary Review	Continue; further review required	Evaluate in context of SAR monitoring. Population is increasing, so need to evaluate if OK to move to sampling every 2-3 years in a way that can get estimates at least every 5 years (for General Status). Also need to evaluate whether can be integrated with other winter surveys (e.g., Purple Sandpiper, coastal block survey), and whether it complements any similar surveys in U.S. (Maine).	Improve	Need to ensure data in a centrally accessible, georeferenced database.	3rd

TABLE 5.2. Summary of recommendations from detailed program evaluations. Full justifications for these recommendations are provided in Appendix A.

Program	Recommendation #	Recommendation	Status & Timeline
Ontario Forest Bird Monitoring Program (LB-34)	1	Continue survey LB-34, the Ontario Forest Bird Monitoring Program, at a minimal level of investment sufficient to maintain the data base and current volunteer base, pending the outcomes of recommendations 2 and 3 that critically evaluate the value of the survey.	Continue pending evaluation
	2	Analyse results of the survey by 2012, in time to inform planning for the 2013 field season, to determine whether the survey can help to understand the causes of population change among Ontario forest birds.	Analyse by 2012
	3	Consider in 2013, whether to expand the current survey beyond Ontario, or else discontinue the survey, depending on the results of the analysis.	Re-evaluate in 2013
Arctic PRISM Survey [Program for Regional and International Shorebird Monitoring] (SB-7)	1	Complete SB-7 Arctic PRISM first round of surveys in Canada as quickly as possible with available funds, and no later than 2018, to estimate current population sizes, breeding distribution, breeding habitat and densities throughout the Arctic	In progress
	2	Encourage US partners to complete their PRISM first round ground surveys in Alaska no later than 2018, to ensure that reliable range-wide information is available for Arctic nesting shorebirds.	In progress
	3	Assess, by 2012, data collected on non-shorebird species (landbirds, waterbirds and waterfowl) during PRISM ground surveys and associated surveys (e.g., helicopter transects between PRISM plots) to determine their usefulness and cost-effectiveness and to decide whether reducing or expanding this aspect of the program is required.	Assess by 2012
	4	Review, by the end of 2013, Arctic PRISM methodology to determine whether it can be modified to allow more efficient collection of population information, and whether ongoing surveys in the Arctic are still the most efficient and effective method for estimating trends in shorebird population size and/or distribution.	Re-evaluate by 2013
Shorebird Migration Monitoring Program (SB-9, 10)	1	Maintain Atlantic Canada SB-9 and Ontario SB-10 migration count programs at current levels pending development of a strategy to reduce potential bias and improve reliability of the counts.	Continue pending evaluation
	2	Improve the efficiency of SB-9 and SB-10 through improved data management systems, including web-based data entry for volunteers, preferably using an e-Bird protocol the same as, or similar to, that adopted by the International Shorebird Survey (ISS) in the U.S., with any necessary modifications to meet Canadian needs.	Adopt online system by 2012
	3	Analyse, by 2012 all available eastern North America migration count data (including SB-9, SB-10 and American surveys), using modern analysis methods (e.g., hierarchical Bayes models) to obtain best available estimates on recent trends, and to quantify the likely magnitude of bias from changes in turnover rates and stopover sites.	Analyse by 2012

Program	Recommendation #	Recommendation	Status & Timeline
	4	Assess, by 2012, the feasibility of enhancing shorebird migration monitoring to obtain more reliable population trend estimates, considering improved and expanded site selection, any necessary changes in sampling protocols, incorporation of methods to estimate stopover duration, if required, etc. The survey design should be developed at a scale that considers both Canadian and U.S. stopover locations within a single sampling frame. If economically feasible, start to implement changes by 2013.	Assess by 2012
Red Knot Monitoring Program (SB-8)	1	Maintain support for the Red Knot (*rufa*) wintering population survey in South America, to provide near-annual indices of population trends for southern portion of the *rufa* population. By 2014 the EC Shorebird Committee should review and confirm the appropriate frequency for these surveys (annual or some longer period).	Re-evaluate by 2014
	2	Implement consistent improvements to the Tierra del Fuego survey protocol to enable more effective estimation of bias, including use of consistent surveyors, ground-truthing, mark-recapture estimates etc., with analysis, archiving and reporting of survey results in accessible EC databases, annual reports and published literature.	Ongoing improvement
	3	Continue training and mentoring of South American survey biologists. Survey tasks to be shared with EC staff in the short term, with the objective of transferring the operational delivery of the Tierra del Fuego surveys to Chilean/Argentinean experts by 2014 but retaining close links and funding support from EC.	Complete by 2014
	4	Determine the sub-specific identity (*rufa* or *rosalaari*) of Red Knot populations wintering in Brazil by 2013 in cooperation with the international Red Knot Working Group	Assess by 2013
	5	Work with Brazil and the Guyanas to establish regular coastal surveys for Red Knot and other species such that data can be combined with those from other regions to provide population-wide estimates and trends.	Ongoing
	6	Assess by 2013 the possibility of using spring aerial counts in Delaware Bay to reduce the need for annual overwintering counts in Tierra del Fuego, Brazil and Florida.	Assess by 2013
	7	EC Shorebird Committee to determine the most effective approach for obtaining population estimates and trends for *islandica* and *rosalaari* populations by 2013, considering opportunities in breeding, migration and overwintering areas.	Assess by 2013
Seabird Colony Monitoring Programs (SE-2, 3, 4, 13, 25, 30)	1	Prepare, by end of 2011-12, an up-to-date national list of all seabird colonies being monitored, and a proposed sampling frequency for monitoring them over the next 20 years (i.e., 2012-2032) under various funding scenarios, assuming that all major colonies should be surveyed at least every 5-10 years.	Assess by 2012
	2	Ensure that colony surveys are coordinated and prioritized within and among regions, recognizing differences in importance (colony size), threats and survey costs associated with different colonies.	Assess by 2012
	3	Implement starting in 2012 schedule of surveys for highest priority colonies using current resources, while seeking sufficient additional funds internally or externally, to fill the gaps.	Implement in 2012

Program	Recommendation #	Recommendation	Status & Timeline
	4	Evaluate the feasibility, by 2012, of expanding current aerial surveys for terns in Atlantic (e.g., SE-3) to cover all species of dispersed seabirds (e.g., gulls and terns) in Atlantic and Quebec.	Evaluate by 2012
	5	Develop a plan to incorporate Leach's Storm-petrel into Atlantic Region Seabird Colony Ground Surveys (SE-4).	Develop by end of 2012
	6	Continue to seek opportunities, funds and/or partners to assist in surveying seabirds in accessible colonies (e.g., using existing staff in protected areas), and evaluate the feasibility and cost-effectiveness of using volunteers to survey relatively accessible sites with low risk to surveyors or birds.	Ongoing activity
	7	Coordinate surveys of species that nest both at sea and inland (e.g., gulls and terns), with any inland colonial waterbird monitoring and other relevant survey programs.	Develop plan by end 2012
	8	By 2012, develop a strategy to ensure seabird colony databases are easily integrated across regions for national and international assessments of population status and trends.	Develop by 2012
	9	By 2013, develop plans to monitor priority species in the north with little existing coverage (Sabine's, Ross' and Iceland Gull, Arctic Tern). These will be challenging species, and integration across survey programs and bird groups will be needed.	Develop by 2013
	10	Evaluate approaches for using technologies (e.g., automated photo counts, automated sensors) to improve survey methods, enhance worker safety and/or reduce costs.	Ongoing assessment
Pelagic Monitoring Programs (SE-14, 26, 37)	1	Maintain SE-26 Pelagic Surveys - N. Pacific and Arctic at current investment levels, focusing the survey pending the results of recommendation number 4.	Update by early 2012
	2	Maintain SE-37 Québec Seabirds at Sea at current levels, focusing the survey pending the results of recommendation number 4.	Update by 2012
	3	Maintain SE-14 Eastern Canada Seabirds at Sea at current levels, focusing the survey pending the results of recommendation number 4.	Update by 2012
	4	Immediately assess the relative merit and feasibility of seeking out more ships of opportunity operating in poorly covered priority areas versus surveying routes that are currently repeated regularly (i.e., Line P, Arctic Ocean Cruise and the AZMP).	Complete assessment by 2012
	5	Continue to seek opportunities, funds and/or partners to survey high priority areas with emerging threats and poor coverage.	Ongoing improvement
	6	In 2011, develop a strategy to conduct predictive modeling work to enable extrapolation to areas with no or poor coverage.	Complete by early 2012
	7	In regions where they are not currently available, produce stock maps and/or atlases to reduce work load stemming from data requests to staff in 2011, and make processed (corrected) data publically available in 2012.	Implement by 2012
Beached Bird Survey Monitoring Programs (SE-6, 20, 35, 36)	1	Maintain the Newfoundland Beached Bird Survey (SE-35); by 2012 add data from St. Pierre et Miquelon if costs are minimal. Continue to recruit volunteers to deliver this survey.	Improve by 2012

Program	Recommendation #	Recommendation	Status & Timeline
	2	Maintain pilot Beached Bird Surveys in Québec (SE-36), and implement strategically-planned and cost-effective long-term survey once pilot data are collected in 2012-13.	Improve by 2013
	3	Maintain botulism surveys in Ontario as needed (SE-20), with the understanding that this work is outside of a beached bird survey program.	No change
	4	Maintain beached birds surveys in British Columbia (part of SE-6).	No change
	5	Ensure that all surveys clearly differentiate between long-term monitoring sites, and beaches surveyed for specific purposes, including start and end dates.	Ongoing improvement
	6	Discontinue support for a Maritimes-wide Beached Bird Survey (part of SE-6).	Terminated 2011
	7	Consider developing a beached bird survey in Northumberland Strait by 2012, if other means of tracking fisheries by-catch are not available/possible.	Re-evaluate by 2012
	8	Develop a mechanism to access data collected on Sable Island by 2011.	Complete by 2012
Inland Colonial Waterbird Programs (WB-7, 8, 10, 16, 17, 23, 27, 29)	1	In 2012, complete the pilot program in Boreal Ontario and determine if there is a need for expansion into other regions in the future.	Assess in 2012
	2	By 2014, carry out inventory and identify the priority of keeping a long-term survey similar to Great Lakes on Great Slave to provide similar data from the only area in the Boreal forest with baseline. Survey methodology should allow for comparison wit data from early 1990s and incorporate any improvements stemming from the Boreal Ontario pilot.	Assess by 2014
	3	By 2014, complete design of and evaluate the costs of developing large-scale programs in the prairies (WB-33) and develop a schedule for repeatable surveys that capture as many species as is practical.	Assess by 2014
	4	By 2014 develop inland waterbird monitoring programs during the nesting season in PYR linked to WB-33. Inland areas of Ontario, Quebec and Atlantic regions should be considered for future expansion.	Develop by 2014
	5	Assess by 2013 the ability of monitoring programs designed for other species to deliver data for inland waterbirds (e.g., coastal surveys, waterfowl aerial surveys, PRISM).	Assess by 2013
	6	Determine by 2013, species that may be more cost-effective to monitor outside of the nesting season in collaboration with partners outside of Canada if necessary. Determine also species that would be better surveyed in Canada during the winter.	Assess by 2013
	7	Ensure by 2014, that accurate population information for the western population of Horned Grebe is available, preferably through existing surveys. Consider doing the same for Western Grebes	Assess by 2014
	8	Evaluate by 2012, the use of existing waterfowl and waterbird surveys to monitor loon populations.	Assess by 2012
Marsh Bird Monitoring Programs (WB-18, 19, 22, 28, 34)	1	Maintain support for WB-18 Great Lakes, WB-28 Québec and Prairie Pothole Marsh Monitoring Programs at current investment levels pending results of recommendations 4-6.	No change
	2	Maintain support for WB-19 King Rail, WB-22 Least Bittern and WB-34 Yellow Rail Monitoring Programs as required for SAR programs pending results of recommendations 4-6.	Re-evaluate end 2012
	3	Continue to seek opportunities, funds and/or partners to survey high priority areas with emerging threats and poor coverage.	Ongoing improvement

Program	Recommendation #	Recommendation	Status & Timeline
	4	In 2012, re-evaluate WB-18 and WB-28 current sampling scheme and statistical power in order to maximize value of the data collected.	Re-evaluate in 2012
	5	In 2012, complete a BCR-based gap/risk assessment where marsh bird monitoring is not currently done.	Re-evaluate in 2012
	6	In 2012, complete a National framework for marsh bird monitoring in Canada.	Re-evaluate in 2012
Prairie Waterfowl Breeding Population Survey (WF-24)	1	Maintain WF-24 (Prairie Waterfowl Breeding and Population Survey), but work towards improving the efficiency and reducing costs by 2012, including reducing ground survey effort by 25-50%.	Improve by 2012
	2	Collaborate with key partners such as the United States Fish and Wildlife Service to identify and implement changes to improve the efficiency and reduce costs, starting as soon as possible to ensure that changes can be implemented no later than 2012. Options to consider include: 1) 1. Update analytical approaches to make better use of existing data (i.e., by using Bayesian hierarchical models) to increase or maintain precision of population estimates, while allowing a reduction in field data collection. 2) Identify ways to reduce the number of ground surveys by 25-50% starting by 2012 (with, if possible, some reductions in 2011), while meeting precision targets. 3) Complete a review, by mid-2012, of management objectives and data needs for the entire survey, considering precision and survey coverage requirements to meet current and future management objectives.	Improve by 2012
	3	Analyze and Review habitat data collected in association with the ground survey by the end of 2011, to assess their value in meeting monitoring needs and to identify ways that protocol could be improved or made more efficient (e.g., changing data collection protocol or reducing frequency of data collection), starting in 2012.	Assess by 2012
	4	Evaluate the potential of the ground survey to collect reliable information on other wetland-associated bird species, with a view to implementing any options that can be accommodated within current survey protocols starting in 2011.	Ongoing assessment
EWS - Southern Quebec Lowlands & St.Lawrence Waterfowl Surveys (WF-60, 69)	1	Reduce intensity and/or frequency of Southern Quebec Lowlands (WF-60) and St. Lawrence River (WF-69) Waterfowl surveys. Implement reductions in 2012.	Reduce by 2012
	2	Evaluate the feasibility of integrating the surveys with the Eastern Waterfowl surveys, in coordination with the USFWS, to implement changes, if any, in 2012	Assess by 2012
	3	Evaluate the potential of each survey for population size and trend estimation of non-game species, particularly waterbirds by Fall 2011 and if appropriate incorporate into the survey design and implementation in 2012.	Modify by 2012
EWS - Southern Ontario Waterfowl Plot Surveys (WF-58)	1	Maintain Southern Ontario Waterfowl Plot Survey at current (2010) levels until a decision is made on designating temperate-nesting Canada geese overabundant, which is expected within two or three years.	Continue pending evaluation
	2	Evaluate the efficiency of the current survey and implement changes in survey protocols, if needed, by 2013.	Assess by 2013
	3	Evaluate the potential of the survey for population size and trend estimation of non-game species, particularly waterbirds by Fall 2011 and if appropriate incorporate into the survey design no later than in 2013.	Assess by 2013

Program	Recommendation #	Recommendation	Status & Timeline
EWS - PEI Waterfowl Plot Surveys (WF-55)	1	Re-design survey, in consultation with Prince Edward Island, such that it adequately addresses habitat and harvest management needs and allows detection of changes in breeding waterfowl and other non-game migratory bird species population trends at an appropriate level of precision. Target 2012 for implementation of re-designed survey.	Redesign for 2012
	2	In the interim, continue EC's involvement in current breeding pair survey but not the brood survey which the Department stopped supporting in 2010.	Maintain until 2012
	3	Improve management of historical database, with a thorough validation and correction of errors, and standardization with other EC datasets, and consider an analysis of the dataset to look at impacts on landscape change in relation to waterfowl productivity in PEI.	Improve by end 2012
Greater Snow Goose Monitoring Programs (WF-1, 9, 28, 67, 79, 81))	1	Terminate WF-1 Arctic breeding ground survey	Terminated 2010
	2	Terminate WF-9 Ellesmere Is. Component - Arctic productivity, banding and habitat monitoring	Terminated 2010
	3	Terminate WF-28 Fall body condition survey	Terminated 2010
	4	Delay WF-67 decision on reducing spring aerial survey frequency to fiscal year 2012-13; decision will be based on a re-evaluation of the impact of running survey every second year.	Re-evaluate in 2013
	5	Maintain WF-9 Bylot Island component - Arctic productivity, banding and habitat monitoring at current level	No change
	6	Maintain WF-79 fall productivity survey at current level	No change
	7	Maintain WF-81 satellite-telemetry study at current level for fiscal year 2010-11, then terminate in 2011-12.	Terminate in 2012
Arctic Goose Banding (WF-8)		Evaluation ongoing. Preliminary report assessed value of banding for estimation of demographic parameters, but because of need to measure other factors (e.g., migration routes), detailed recommendations are being developed by the Avian Monitoring Committee.	Complete by Feb 2012
Tundra Swan Monitoring Surveys (WF-39, 48, 74)	1 (Western Population)	Terminate WF-74 triennial winter surveys in British Columbia effective immediately and instead rely on Christmas Bird Count (CBC) data to monitor changes in swan abundance and distribution in British Columbia during winter.	Terminate in 2011 (BC)
	2 (Eastern Population)	Discontinue WF-39-Inuvialuit Geese and Swan Surveys (helicopter-based), and do not resume unless there are needs related to cumulative effects from development and/or land claims that cannot be met by other surveys.	Terminate in 2011
	3 (Eastern)	Evaluate with USFWS by autumn 2011, the costs and benefits of potential expansion of continental Waterfowl Breeding Population and Habitat Surveys (WBPHS) into the Inuvialuit Settlement Region to allow decisions regarding potential implementation in 2012.	Re-evaluate by 2012
	4 (Eastern)	Do not resume WF-48 survey, which was set up to establish Tundra Swan population baselines in the Mackenzie Delta, unless new development proceeds and a comparison is required.	Terminated
	5 (Eastern)	Ensure that all data from WF-48 and WF-39, including detailed locations of all survey plots, transects, bird observations, etc. are properly managed in a nationally accessible database.	Improve by 2013

Program	Recommendation #	Recommendation	Status & Timeline
	6 (Eastern)	Consider conducting an aboriginal subsistence harvest survey of Tundra Swan harvest in Canada only if there is a need with respect to harvest allocation issues, aboriginal management issues or treaty negotiations	On hold pending new needs
Trumpeter Swan Monitoring Surveys (WF-71, 72, 74)	1 (Pacific Coast Population)	Terminate triennial winter surveys (WF-74) effective immediately and instead rely on Christmas Bird Count (CBC) data to monitor changes in Trumpeter swan abundance and distribution in British Columbia during winter.	Terminate in 2011
	2 (Pacific Coast Population)	Terminate portions of the 5-year post-breeding survey (WF-72) covering the Canadian Pacific Coast Population areas in British Columbia.	Terminate in 2011
	3 (Rocky Mountain Population)	Modify the 5-year post-breeding surveys (WF-72) within Alberta, North West Territories, northern British Columbia and the Yukon to use a stratified random sampling approach as implemented in 2010, instead of attempting a complete census.	Modified as of 2010
	4 (Rocky Mountain Population)	Consider conducting an aboriginal subsistence harvest survey in British Columbia only if there is a need with respect to harvest allocation issues, aboriginal management issues or treaty negotiations.	On hold pending new needs
	5 (Interior Population)	Maintain WF-71 the volunteer-based survey of Trumpeter Swans in Ontario at 5-year intervals.	No change
	6 (Interior Population)	Terminate portions of the WF-72 survey in Saskatchewan and Manitoba effective in 2010.	Terminated in 2010
Eider Monitoring Strategy (WF-4, 7, 15, 19, 20, 23, 29, 52, 73; SE-30, 31)	1	Solidify EC core funding for Eiders at levels comparable to average investment over recent years to implement as many as possible of the proposed suite of monitoring programs, described below, for each of the 6 populations of Common and King eiders, recognizing that complete implementation will depend on partner funding. From the perspective of harvest management, the highest priorities are American, Northern, and Pacific common eiders, though consideration of King Eiders by COSEWIC may change their priority. *[see complete document for details on each survey]*	Implement for 2012-13 planning cycle
	2	Seek collaborative partnerships for implementation and funding from both traditional and non-traditional sources with an interest in eiders, to help implement the proposed suite of monitoring programs.	Ongoing activity
Continental Canvasback Survey (WF-31)	1	Terminate	Terminated in 2010

CHAPTER SIX – Data Management, Analysis and Reporting

INTRODUCTION

THE NEED FOR STANDARDS

Even a well-designed monitoring program will not be useful if the data are not well managed, appropriately analysed, and effectively reported. As a result, the Avian Monitoring Review examined not only the design and efficiency of each survey in relation to EC's migratory bird needs, but also the data management, data analysis and data reporting procedures. These were considered not only for individual surveys, but also across the entire suite of avian monitoring programs managed by EC, as many common features were noted.

The need for data management standards in large-scale biological monitoring is increasingly being recognized, and some of the requirements set by other organizations are equally applicable here. For instance, the US National Parks Inventory and Monitoring programs recommend that up to 30% of resources be invested in analysis and reporting. Their recent national review on data management (National Park Service 2008) emphasized four key components of sound data management: quality (identify and minimize errors at each stage of the data lifecycle); security (maintain data in environments that protect against loss, including electronic failure, poor storage conditions, unauthorized access, etc.); longevity (proper storage conditions, backups, and migration of data sets to updated platforms and software standards as required, as well as comprehensive data documentation); and availability (ensure that data are available for decision-making, research, and education).

EXISTING TEMPLATES FOR DATA MANAGEMENT

Specific to broad-scale avian monitoring, many valuable data management recommendations have been made by the North American Bird Conservation Initiative – US. Their recent report of entitled "Opportunities for Improving Avian Monitoring" (NABCI-US 2007) recommended that monitoring data be secure and accessible. In order to meet this goal, they propose the development of and adherence to a set of standards for database content, accessibility and archiving, and suggest that a team of specialists (e.g., database managers, GIS specialists, biologists, data analysts) be involved from the initial stages of survey development to the final reporting to managers and the public (NABCI-US 2007). Since the publication of that report, NABCI-US has followed up with the development of specific data management policy statements (NABCI-US 2009), and continues to meet to discuss priority measures to implement and associated costs (NABCI-US 2010).

In another recent publication, "Data Management Best Practices and Standards for Biodiversity Data Applicable to Bird Monitoring Data" (Martin & Ballard 2010), NABCI-US has made additional detailed recommendations on 'best management practices' for avian monitoring data. Their suggestions focus on the themes of 'Policy and Administration' (e.g., issues of data policy, ownership and custodianship), 'Collection and Capture' (e.g., data quality, documentation and standards), and 'Longevity and Use' (e.g., data security, access and publishing), and build upon a wide diversity of data management resources. They have also provided an associated spreadsheet tool ("UsNabciDataBaseCriteria.xls") that can be used to document database characteristics, to identify areas needing improvement, and to calculate expected costs of recommended changes.

DATA REQUIREMENTS OF ENVIRONMENT CANADA'S AVIAN MONITORING PROGRAMS

In the context of the recommendations made by these other organizations, some general standards for data management, analysis and reporting were identified by members of the steering committee as part of this review process. These criteria were then used as part of the program evaluations for each of the surveys (see Tables 5.1, 5.2).

METADATA

Surveys and their data outputs should be well described and documented in standards-based metadata, as follows:

- The purpose, methods and criteria of data collection should be properly documented and clearly articulated, including identification of needs satisfied by the survey and who is accountable.
- Data fields should be clearly identified and explained to ensure long-term usefulness.
- Every dataset should have a corresponding metadata record registered in an appropriate corporate metadata repository; records in national repositories need to appear in both official languages.

DATA MANAGEMENT

Desired characteristics of well-managed databases include the following:

- Data should be stored in electronic databases, preferably within carefully designed relational databases, and should be adaptable as technology or requirements change over time. This should include appropriate metadata and use of content standards.
- Data should be secure, through maintenance in environments that protect against loss due to electronic failure, poor storage conditions, departure of employees, etc, and through management in systems that prevent unauthorized changes.
- Any data identified as 'sensitive' should have protocols to limit access to control use of the data.
- Data should be fully accessible to all EC employees through a central or distributed and linked database system; whenever possible, while protecting sensitive data, data should be directly accessible to partners, volunteers and the public, either in their original resolution or in summarized form.

ANALYSIS

Ideally, the analysis of data collected through these avian monitoring programs would meet the following standards:

- Analytical techniques should be appropriate, clearly documented and consistently applied across data sets to ensure repeatability; methods are also to be documented or referenced in metadata
- New developments in analytical approaches, such as hierarchical Bayesian techniques, should be adopted as they become available and applied across any surveys to which they are suitable. This is important because modern methods may make better use of available data, reducing bias in estimates, improving precision and/or reducing sample size requirements for future data collection.
- Biologists and statisticians responsible for data analysis should be given the necessary tools and training to be proficient in conducting modern analyses.
- Timely analysis is necessary to ensure that data are available for use in decision making, as well as to provide feedback to all stakeholders on the value of the survey.
- Data analysis should be conducted in such a way as to ensure that the most relevant questions for decision making are being addressed.
- Evaluations of the sampling design should be made regularly. Analysis of the data targeted at providing feedback on and evaluation of the survey design should be an integral part of all monitoring programs. For instance, analysis of data can be used to estimate statistical precision for trend estimates. This knowledge can then be used to optimize sampling effort, resulting in a more efficient survey.

REPORTING

Once collected and analyzed, the reporting of data and results should meet the following standards:

- All survey results should be promptly and consistently reported.
- Survey results should be synthesized and made available to decision makers, wildlife and habitat managers, partners and the public.

REVIEW OF CURRENT DATA MANAGEMENT, ANALYSIS AND REPORTING

Current data management and analysis were assessed as part of the survey evaluations (Chapter Five; see Tables 5.1, 5.2). Each survey's data management was rated as Acceptable (i.e., no immediate need to make improvements), needing Improvement (i.e., not currently meeting criteria), or needing Possible Improvement (i.e., appear to need improvement based on limited information), considering all of the above criteria comprehensively.

Data management recommendations varied among species groups. Current data management was considered acceptable for fewer than one-third of all surveys; proportionally more landbird surveys were acceptable than for other groups (though still fewer than 50%), while all shorebird surveys likely need improvement in their data management and analysis. The fact that more than two-thirds of all surveys require improved data management highlights a critical problem with current programs, and presents an important opportunity to substantially improve the value of the information collected through an investment in improved data management systems.

The proportion (number) of surveys with each rating by species group are as follows:

Data Management Recommendation	Landbirds	Shorebirds	Seabirds	Waterbirds	Waterfowl	Total
Improve	49% (23)	75% (9)	63% (10)	67% (10)	71% (53)	**64% (105)**
Acceptable	49% (23)		31% (5)	27% (4)	16% (12)	**27% (44)**
Possible Improvement	2% (1)	25% (3)	6% (1)	7% (1)	14% (10)	**9% (16)**
Total	**47**	**12**	**16**	**15**	**75**	**165**

The way in which survey data are documented was also assessed across all programs. This overview suggested that while current technologies are now being implemented for management of most surveys (e.g., only 2% known to be still documented on paper), still only 40% are managed through formalized database systems accessible to multiple users. Many data sets are maintained on spreadsheets or databases on the computer of an individual biologist, with little or no metadata, limited security, and limited access to other users.

Data analysis and reporting was not formally assessed for individual surveys, but an overview of departmental surveys indicates a need for improvements for virtually all surveys. Only a few national surveys, such as the Breeding Bird Survey and National Harvest Survey, are analysed on an annual basis within EC and the results made publicly available through a website. Several of the major waterfowl surveys, such as the major waterfowl Breeding Population Surveys, are analysed by partners in the U.S. and summarized results made available through the annual waterfowl status reports published by both the U.S. and EC. However, for many other surveys, at best summary results are reported internally at the end of a season, with limited distribution of the reports. Formal statistical analysis is only undertaken on an irregular basis, with results sometimes published in peer-reviewed journals.

Although most monitoring data sets are now digitized, storage methods range from spreadsheets to proper relational databases. The majority are not backed up on an independent server to ensure data security. Additionally, although biologists manage the databases and should be responsible for the content and the quality control of the data, there is little evidence that most databases have been designed or maintained by experts with relational database expertise. This creates significant risks of data loss through the failure of inappropriately managed databases and through retirement or movement of staff or other administrative changes. Most data are therefore difficult to access for most users and may vary considerably in format and data organization, creating challenges for analysis and use.

While most data sets are analysed in some manner at least occasionally, standard analytical methods are not always implemented, and results are not necessarily published or widely distributed. Analysis methods vary from sophisticated hierarchical Bayes models to simple regressions which may or may not be statistically valid.

Reporting of the results of trend analyses is also inconsistent. In a few cases, data are directly incorporated into decision-making models, such as the adaptive harvest models for some species of waterfowl. In some cases, such as the Breeding Bird Survey and the national scale migratory game bird surveys, analysed trend data are regularly published (e.g., Breeding Bird Survey website and Population Status of Migratory Game Bird in Canada report). For many other surveys, however, the results of data analyses are not readily available (e.g., only in internal reports which are not widely distributed, or are produced at very irregular intervals). The new Status of Birds in Canada website provides one forum for summarized data highlighting the most reliable information available on the national status of each species, but cannot, at least in its current form, provide all of the details, particularly on regional information, which may be relevant to wildlife managers.

RECOMMENDATIONS FOR DATA MANAGEMENT, ANALYSIS AND REPORTING

The review found that major improvements are required to data management, data analysis and reporting for virtually all surveys to ensure that data are secure, analysed in a timely manner using the most appropriate available techniques, and reported to end users to ensure that the results are available to support decision making. The recommendations below extend to all migratory bird monitoring databases including those within the Species at Risk programs.

METADATA

All bird monitoring programs and databases should have metadata descriptions to departmental and governmental standards completed and accessible by the end of 2012. Metadata should include information on survey objectives, design parameters, identification (including contact, abstract for data and metadata record), constraints, data quality, spatial reference & extents, content, distribution, citation, and others. These data should incorporate the information gathered through the Avian Monitoring Review on each program.

DATA MANAGEMENT

Monitoring data should be integrated into a secure and accessible national data management system that is operated to modern standards and quality control. The following recommendations will help to achieve this:

- Continue to implement within the department a national migratory bird metadata and relational data information system or integrated systems by the end of 2012. This is currently being done through the "Wildspace" system. Ultimately, the characteristics of this system should ensure the security of all migratory bird data and accessibility firstly throughout the department, secondarily with monitoring partners and other wildlife management agencies, and thirdly with the public and academics.
- By 2012 establish data field standards and guidelines for all databases and data management activities as per the discussion earlier in this chapter. For example, all data records should include appropriate geospatial information.
- Data should be managed as a corporate asset at all phases of the project life cycle, noting that all data/information collected by EC staff are property of the Crown, although measures need to be taken to ensure the moral rights of staff collecting data are recognized, and appropriate opportunities provided to staff with respect to authorship of reports.
- Database professionals should be engaged regularly to assist with the design, improvement and maintenance of relational databases.
- By 2013, directives, guidelines and training should be provided for all EC staff who are responsible for the management and data quality of any given database.
- By 2013, all existing migratory bird databases managed by EC should be migrated within the national data management system and managed exclusively within this system beyond 2013.
- By mid-2013, all existing and appropriate archived databases should have their data quality checked to remove redundancies and erroneous data and to ensure that data and database fields meet the minimum standards. These should be incorporated as part of performance objectives of monitoring program managers.

ANALYSIS

Use of modern techniques such as hierarchical Bayes models would enhance consistency in analysis methods, and would make better use of available data by reducing bias in estimates, improving precision and/or reducing sample size requirements for future data collection. To improve the quantity and quality of information derived from databases the following should be undertaken:

- By mid-2012, a community of practice should be developed among monitoring biologists and biostatisticians to transfer knowledge on appropriate analytic methods and know how to use them. This community of practice need not be limited to EC.
- Opportunities should be provided for monitoring program biologists to keep their analytical skills current and to learn new techniques as appropriate. The Avian Monitoring Committee should, on an annual basis, establish or sponsor analytical technique workshops, webinars and other practical training opportunities for EC staff.
- Tools should be created to allow and encourage biologists and other staff to carry out exploratory analyses of databases to help reveal undiscovered patterns and information, particularly for large-scale datasets.

REPORTING

A range of reporting tools will be required to meet the wide diversity of information needs for monitoring data to ensure they are effectively used. The following activities are recommended:

- By 2013, databases once part of the national system should have "front-ends" built to allow standard queries and geo-spatial summaries to be done quickly by any EC staff. The purpose of such stock queries would be, amongst other things, to assist emergency response, environmental assessment, and other time-sensitive activities that require basic location information.
- By 2013, analyses of data and information should be broadly available and accessible on a timely basis (i.e., online). The 'Status of Birds in Canada' website, currently in development, is intended to accomplish some of this goal, by providing a summary of the best-available information on the status of each species, but additional tools will be required to display all the details.
- By 2014, for selected surveys, tools should be developed to allow the detailed results of surveys (e.g., annual indices or trends) to be annually posted electronically on the EC external website where this detailed information would be available for biologists, wildlife managers, academics, decision-makers and partners.
- Initiatives that make data and information accessible should be supported, whether through traditional publication media or other venues such as the Global Biodiversity Information Facility, or data.gc.ca. Where appropriate, the publication of data analysis in peer-reviewed external literature should be encouraged.

CHAPTER SEVEN – Gaps and Risks Associated with Environment Canada's Current Migratory Bird Monitoring Program

GAPS AND RISKS SUMMARY

This assessment highlights gaps in the current suite of EC avian monitoring programs as they relate to primary program needs for each of the five major bird species groups, and evaluates the risks associated with not filling these gaps. Gaps were identified on the basis of expert opinion, and the process was informed largely by the detailed review of existing programs (Chapter Five). The five bird groups (Landbirds, Shorebirds, Seabirds, Inland Waterbirds, Waterfowl) were subdivided based on the types of monitoring required to address their needs. Gaps in monitoring programs were then rated on a scale from 0 (low) to 3 (high) for each relevant program outcome (see Chapter Three).

The risks being incurred by EC due to the presence of each of these program gaps were then similarly ranked on a scale from 0 to 3. Note that these risks represent risks to decision making based on inadequate information, not the risk of actions themselves. For this reason, by definition, a given risk could never be ranked higher than its associated gap, but could be equal or smaller. Finally, potential strategies for mitigating identified risks were highlighted for each program outcome and for each species group. In all cases, risks of inappropriate decisions can be reduced by reducing the gap with enhanced monitoring, but in some cases it may be more practical or cost-effective to reduce risks through alternative strategies. These might include gaining information through targeted research (e.g., to measure impacts of particular stressors), or through pro-active actions such as implementation of conservation programs for a species, despite uncertainty in its status.

In addition, data for all breeding bird species in Canada were evaluated against COSEWIC status assessment criteria to identify gaps in individual species monitoring. These 'COSEWIC gaps' range from 0 to 4. COSEWIC Gap scores of 3 and 4 would be considered 'High or 3' in the previous gaps analysis.

Overall, this assessment found that the current suite of avian monitoring programs contributes to filling many EC information needs and hence reducing risk associated with decision making. Nevertheless, there are many gaps remaining, some of which present EC with high risks. It is important to recognize that this assessment did not consider the change in risk if any existing programs were to be dropped. In many cases, dropping existing programs could create new, high risk gaps.

Rankings both for gaps and risks varied among program outcomes, as follows:

1. Landscape conditions accommodate Migratory Bird requirements

Gaps: Moderate to High gaps exist for one or more bird groups, in all regions except the Great Lakes-St Lawrence.

Risks: Risks are High in the boreal region, especially for landbirds, and Moderate for one or more species groups in the Arctic, western mountains, prairies and Maritimes. The highest risks are biological (e.g., uncertainty about declines), with moderate economic and credibility risks.

Mitigation: Risks can most effectively be mitigated through improved monitoring, though habitat modeling and distributional surveys in poorly covered key areas may somewhat reduce risk.

2. Incidental Take is minimized and long-term conservation is supported

Gaps: Moderate gaps exist across most bird groups, including gaps related to forestry, agriculture, fisheries, collisions, and linear structures; very few gaps are considered to be low or absent.

Risks: Forty percent of identified gaps are deemed to be of Moderate risk, and include biological, economic, credibility and legal risks.

Mitigation: Improved monitoring would reduce risks, but targeted research into understanding of causes and consequences of incidental take may be more cost-effective.

3. Threats to migrants in other countries are reduced

Gaps: Gaps are High for boreal landbirds, Arctic shorebirds and inland colonial waterbirds in Latin America, due to lack of information on limiting factors and trends, and Moderate for other species groups and regions.

Risks: Risks are considered High for Arctic shorebirds and boreal landbirds in Latin America, from both biological and economic perspectives, and Moderate for most other groups and regions.

Mitigation: Risks best mitigated through a combination of improved monitoring, and research on causes of declines and limiting factors.

4. Migratory Bird harvests are maintained at sustainable levels

Gaps: Gaps are Moderate for some species that are heavily hunted, those for which harvest impact is unknown, and those important for Aboriginal subsistence use.

Risks: Moderate risks (legal, biological, economic, and credibility) exist for species that are heavily harvested and those for which the hunting impact is uncertain (e.g., sea ducks).

Mitigation: Risks can most effectively be reduced by improved monitoring, both of population size and harvest rates, preferably in collaboration with other countries.

5. Priority sites for Migratory Birds are protected and improved

Gaps: Gaps are Moderate for Arctic and boreal landbirds, as basic distribution data are lacking, while gaps for other species groups are Low or not applicable.

Risks: Moderate biological and economical risks are identified for boreal landbirds, but other risks are Low (for most other species groups) or none (for well-monitored waterfowl).

Mitigation: In the short term, inventories to measure current distribution, combined with bird-habitat modeling would fill information gaps, but these should eventually be repeated to become a monitoring program.

6. Population-level effects of toxic substances are reduced

Gaps: High gaps exist for shorebirds in relation to pesticides, while Moderate gaps in population trends and toxin impacts are also important for most other groups (except waterfowl).

Risks: Moderate biological and economic risks due to unknown pesticide impacts are identified for landbirds, shorebirds and waterbirds.

Mitigation: Targeted research on pesticide impacts would reduce risks in decision making most cost-effectively, although improved monitoring is needed to verify population level impacts.

7. Populations of Migratory Birds under particular threat are conserved

Gaps: Most waterbirds and seabirds have Moderate gaps associated with emergency responses and disease outbreaks, while gaps associated to predator control are Low.

Risks: Moderate biological risks for waterbirds and seabirds relate primarily to the risk of failing to act sufficiently to protect species because of insufficient data, while risks related to predator control are Low.

Mitigation: Risks could be mitigated through studies to improve predictive models of bird movements and threats such as disease outbreaks, combined with preparedness to conduct rapid on-site surveys in case of an emergency / outbreak.

8. Migratory Birds in land claim areas are conserved

Gaps: All species groups except waterfowl have Moderate gaps, largely due to the smaller spatial scales of land claims relative to the resolution of monitoring data.
Risks: Risks are Low or non-existent, as land claim agreements include consideration of wildlife issues, though not usually specific to migratory birds.
Mitigation: Although there are few risks to mitigate, aboriginal harvest surveys would provide information on take in land claims, which would allow for better regulation of species taken.

9. Threats due to Migratory Birds to public and economy are reduced

Gaps: Shorebirds and marshbirds have a Moderate gap, as basic trend and distributional data are lacking; gaps are Low or non-existent for other species.
Risks: Overall risks are Low or non-existent, as shorebirds and marshbirds rarely present a threat, and the more often-implicated waterfowl and gulls are well-monitored.
Mitigation: Few risks to mitigate. Development of improved non-lethal options for reducing threats to species such as shorebirds (e.g., of airport strikes) would reduce risk of adverse consequences to bird populations even in the absence of improved monitoring data.

10. Avian Species at Risk are assessed, identified and listed

Gaps: Gaps are High for most landbirds, most seabirds, Arctic and boreal shorebirds, and marshbirds, and Moderate for most other bird groups, largely due to poor trend information.
Risks: High biological and economic risks exist for some landbirds and shorebirds, relating to a high risk of errors in listing, while other species face Moderate biological and economic risks.
Mitigation: Most effective way to mitigate risks is to fill gaps in broad-scale trend monitoring data, though improved population estimates would reduce risks for some species.

When examined from the perspective of each bird species group, gaps and risks were identified as follows:

Landbirds

Gaps: Gaps are largest for boreal landbirds, with High gaps for several needs (landscape management, reducing threats in other countries, SAR assessment) and Moderate gaps for most others; Arctic landbirds and western mountain birds have one High and several Moderate gaps.
Risks: Overall risk is High for boreal forest birds for each of the High gaps, because of the number of species involved, extensive development pressure, and a lack of data on several fronts; there are biological, economic and credibility aspects to this risk. Risks are also High for western mountain birds and Moderate for Arctic landbirds.
Mitigation: Risks can be mitigated through implementation of a boreal landbird monitoring program, improved understanding of seasonal connectivity between breeding, migrating and wintering areas, and additional distributional surveys.

Shorebirds

Gaps: High gaps exist in relation to SAR assessment, pesticides, threats in other countries, and landscape management (Arctic/Boreal), with Moderate gaps for most other needs.
Risks: Overall risk is High for Arctic shorebirds, covering biological, economic and credibility risks, and is driven by potential threats in Latin America and the possibility of status mis-classification caused by weak data. Moderate risks remain for most other shorebirds under several needs.
Mitigation: Risks can be mitigated through improved monitoring of trends for Arctic and boreal species, combined with research to understand causes of declines and inform conservation actions.

Seabirds

Gaps: Species at Risk assessment represents a High gap for pelagic and other seabirds, and a Moderate gap for colonial-nesting seabirds; several other Moderate gaps exist for most seabirds.
Risks: Moderate biological risks remain for colonial seabirds due to the infrequency of monitoring at some major colonies, as well as for pelagic seabirds, due to the relatively coarse scale of pelagic survey data; this also presents some economic and credibility risk.
Mitigation: Risks might be mitigated through improved scheduling of colony monitoring in Canada, monitoring of colonies of pelagic species outside Canada, as well as implementing measures to reduce bycatch from fisheries and minimize risk of oil spills.

Waterbirds (inland)

Gaps: A combination of High and Moderate gaps exist for all three categories of waterbirds across many program needs due to limited systematic monitoring.

Risks: Numerous Moderate risks, largely biological, remain for marshbirds; some moderate risks exist for inland colonial species and other waterbirds, as well as a few economic risks. Many of these risks relate to poor knowledge of these species' distribution, status and trends.
Mitigation: Risks would most effectively be mitigated through improved status and trend information, though improved understanding of threats (e.g., incidental take, toxins, impacts of habitat change) would reduce biological risks.

Waterfowl

Gaps: Moderate gaps exist for sea ducks for several program outcomes, relating largely to logistical difficulties and costs associated with monitoring in remote areas; gaps for other waterfowl are lower.
Risks: Thirty percent of gaps were identified as carrying a Moderate legal, biological or credibility risk, principally for harvest management of sea ducks. Sea ducks also face biological risks related to harvests and declines in Europe/Asia, and to Species at Risk assessment; the uncertain impact of harvest on other ducks also represents a Moderate risk.
Mitigation: Long-term monitoring has reduced overall risks to waterfowl, thus requiring little mitigation, but few mitigation options are available for sea duck risks.

ASSESSMENT METHODOLOGY

GAPS AND RISKS

This assessment involved the identification of gaps associated with the current (2007-2010) suite of avian monitoring programs relative to EC's migratory bird program outcomes and associated monitoring needs, as described in Chapter Three. Risks to EC were determined to be the risk associated with not filling the identified gap. Results from this analysis are thus applicable solely to the current suite of monitoring programs and associated distribution of monitoring effort. This analysis is meant to help identify areas where additional resources are required to implement additional monitoring programs, although final decisions on resource allocation should consider a cost-benefit analysis that extends beyond the simple assessment of risk.

NOTE: The identification of an area as currently "low risk" does not necessarily mean that reductions of effort could be implemented in that area without substantially increasing risk. Most existing programs were implemented in areas that presented the highest risks to the department (e.g., monitoring in support of harvest management for waterfowl), and excessive reductions in those programs could lead to high risks. A case-by-case analysis of the impacts of any proposed reductions would need to be carried out to determine how they might influence risks. In many cases, reductions in effort in areas that are now low risk could increase risks to moderate or high.

The gap identification process was undertaken in a consistent and structured way by the members of the Monitoring Needs Team, based largely on expert opinion and informed by the review of the existing programs (Chapter Five). To facilitate this evaluation, all bird species were considered within each of the five large bird groups, and within additional subdivisions within these groups, based on the types of monitoring programs required to address their needs, as follows:

Landbirds: prairie breeding, Arctic breeding, boreal breeding, other landbirds
Shorebirds: Arctic breeding, boreal breeding, other shorebirds
Seabirds: pelagic species (non-breeding), colonial breeding, other seabirds
Inland Waterbirds: marshbirds, inland colonial waterbirds, other water birds
Waterfowl: sea ducks, geese and swans, other ducks

For each program outcome (see Chapter Three) and each bird subgroup, gaps in EC monitoring programs were assessed on a scale of 0 to 3. If a program outcome was not relevant to a particular bird subgroup (e.g., harvest management for non-game species), the cell in the gap matrix was left blank. The remaining risks that EC is incurring by having the current gaps were then assessed on a similar scale, as follows:

Gaps: 0 – very few; 1 – minor; 2 – moderate; 3 – high
Remaining Risks: 0 – very low; 1 – low; 2 – moderate; 3 - high

Since these represent the risks to which EC is exposed with current levels of monitoring, by definition the risk can never be larger than the gap, although it can be smaller than the gap. In many cases, although there may be a moderate or even high gap in monitoring, the risks of not filling the gap were deemed low. This may be either because the probability of a concern was considered low (few threats), because consequences were low (e.g., unlikely to have appreciable impact on management actions, perhaps because species occur in areas where little management response is possible), or because other sources of information can be used in place of monitoring

results (e.g., many rare species lack good trend information for COSEWIC assessment, but information on population size can be used as an alternative), or because the importance of monitoring to deliver the outcome was medium or low (see Table 3.1 for details).

RISK CATEGORIES

The nature and relative importance of risks were also determined, using the following categories (see Table 7.1):

- Legal:
  - EC is vulnerable to legal challenges on regulations (e.g., challenge to hunting regulations)
  - Information is not robust enough to stand up to a court challenge
- Biological:
  - Population decline is not detected in a timely manner such that appropriate conservation actions are not taken to reverse declines while species is still relatively common, or populations become endangered before the need for preventative measures is recognized
  - Level of regulated take is unsustainable
- Economic:
  - Improper assessment of species at risk leads to important economic consequences
  - Conservation or management actions are taken when not necessary
  - Ineffective conservation or management actions are taken because of poor understanding of population issues
- Credibility:
  - EC loses credibility with public, NGOs, aboriginal groups, or other countries by taking actions without adequate supporting information
  - Risk is highest for species with a high public profile or that are important to particular segments of Canadian society (e.g., aboriginal groups), or for activities involving international cooperation.

MITIGATION

Finally, for each program outcome and each species group, strategies for mitigating risks were also identified (e.g., additional monitoring, research, directed conservation action). Note that by definition (because these are monitoring gaps), in all cases it should be possible to mitigate the risk by developing a new monitoring program. However, in some situations, appropriate research might actually be preferable or more cost-effective than developing new monitoring programs (e.g., a small research investment might mitigate risk better than a large investment in new monitoring). In other cases, research could only partially mitigate risks and monitoring would still be required to fully address risks, or appropriate monitoring might be more cost-effective than research.

There are also circumstances where risks could be mitigated through conservation actions. For example, the biological risk of not having good data on a harvested species could be mitigated through highly conservative harvest management (or possibly cancelling the harvest), though with the possibility of increased credibility risk (e.g., complaints from hunters). The mitigation measures most likely to be effective in mitigating risks for each program outcome and species group are outlined below.

SPECIES-SPECIFIC GAPS

In order to rank the gaps for the tenth EC program outcome, “Avian Species at Risk are assessed, identified and listed”, a species-specific assessment was conducted to determine how well current monitoring programs provide data for assessment under criteria used for COSEWIC status assessments. For every Canadian bird species, a monitoring gap score (from 0-4) was assigned, based on the precision and coverage of current monitoring data, as described in Table 7.2. The gap score considered not only the number of species in each category with poor or very poor trend information, but also the likely threats, and the likelihood that good trend information would mitigate these threats.

These data are relevant not only for COSEWIC assessment but also for evaluating the quality of data for setting conservation priorities for each Bird Conservation Region and for identifying species of potential future concern. In most cases, conservation actions are more effective if taken before a species becomes rare, and species-specific monitoring data are required to meet needs related to this program outcome.

TABLE 7.1. Risk categories used in the assessment of risks posed by gaps in current monitoring programs. Note that these definitions refer only to the increased risk associated with current gaps in monitoring data to support these decisions, and NOT to the risk of taking actions or making decisions *per se*. Gaps and risks are summarized in Tables 7.3 and 7.4, and detailed explanations of each identified gap and risk are provided in Appendix B.

Category	Abbrev.	Definition
L – Legal risk		
	L-r	Regulations - risk of challenge to regulations that EC has developed
	L-a	Actions - risk of challenge to actions EC is taking, e.g., actions taken that the public challenges (such as control programs), or failed to act when public did not like it (lack of management action)
	L-t	Treaties - risk of problems with negotiating treaties, etc.
	L-c	Court - information not robust enough to stand up to court challenge (e.g., weak cases for prosecution of violators or MBCA or SARA regulations)
B – Biological risk		
	B-s	Species at risk – species not listed under SARA when it should be
	B-t	Take - level of regulated take (hunting) unsustainable
	B-d	Decline - lack of data could lead to incorrect prioritization and failing to prevent activities that lead to declines (e.g., inappropriate development, excessive incidental take), or failure to take appropriate actions to reverse declines before they are severe
	B-c	Conservation – insufficient data to influence others (other government departments, industry, etc.) to take appropriate conservation actions, leading to declines in species numbers
	B-i	International - insufficient data to persuade international partners to take appropriate action
E – Economic risk		
	E-d	Development – hindering development unnecessarily, that would not actually have unsustainable impacts on a species
	E-b	Burdens - imposing unnecessary burdens on developers (e.g., listing SAR species that should not have been listed, requiring elaborate management plans, etc.)
	E-c	Conservation dollars (EC, NGO, etc.) spent inappropriately or inefficiently with following consequences: • Inappropriate conservation or management actions are taken when species did not need them • Ineffective conservation or management actions taken because of poor understanding of population issues • Resources spent on developing plans (e.g., recovery plans, defining Critical Habitat, doing research) for species that don't require it • Not taking actions early enough, so that cost of action much higher
	E-o	Over-abundant species - letting species or populations increase to an extent that causes economic damage
C – Credibility Risk		
	C-n	Non-government organizations challenge EC for endorsing development or other activities in absence of adequate monitoring data to demonstrate they are sustainable
	C-d	Developers or private sector challenge EC for advising against development for reasons that do not have strong backing by monitoring data
	C-a	Aboriginal peoples criticize or take action against EC for endorsing or advising against development, and/or making decisions which affect communities with insufficient or inappropriate data
	C-i	International governments or agencies, including international treaty partners, criticize or protest against EC / Canada for inappropriate actions due to lack of adequate supporting data
	C-p	Public criticizes EC / government for actions, or lack of action, particularly for species with high public profile (due to iconic status, public exposure, or perceived risks of too many or too few), without adequate and appropriate supporting data (e.g., on control or lack thereof for Canada Geese)

TABLE 7.2. Criteria used to categorize species-specific monitoring gaps from 0 (lowest) to 4 (very high), based on requirements for COSEWIC status assessment (e.g., detection of decline within 10 years or 3 generations). Gap scores of both 3 and 4 would be considered 'High' in Tables 7.3 and 7.4.

Species-specific Gap	Description	Precision* 10-yr (3 gen)	Precision long-term	Coverage**
0	Precise 10-year Trend, High Coverage	<2.8%		>67%
1	Precise 10-year Trend, Medium Coverage	<2.8%		33-67%
1	Adequate 10-year Trend, High Coverage	2.8-4.2%		>67%
1	Adequate 10-year Trend, Medium Coverage	2.8-4.2%		33-67%
2	Precise 10-year Trend, Low Coverage	<2.8%		10-33%
2	Adequate 10-year Trend, Low Coverage	2.8-4.2%		10-33%
2	Poor 10-year Trend but Precise or Adequate 40-year Trend, High Coverage	>4.2%	<4.2%	>67%
2	Poor 10-year Trend but Precise or Adequate 40-year Trend, Medium Coverage	>4.2%	<4.2%	33-67%
3	Adequate or Precise 10-year Trend, Very Low Coverage	2.8-4.2%		<10%
3	Poor 10-year Trend but Precise or Adequate 40-year Trend, Low Coverage	>4.2%	<4.2%	10-33%
3	Poor 10 and 40-year Trends, at least Low Coverage	>4.2%	>4.2%	>10%
3	Poor 10-year Trend but Precise or Adequate 40-year Trend, Very Low Coverage	>4.2%	<4.2%	10-33%
4	Poor 10 and 40-year Trends, very Low Coverage	>4.2%	>4.2%	<10%
4	No 10-year Trend but 40-year Trend available	none	any	any
4	No Trend	none	none	

*Precision 10-yr (or 3 generations if longer): +/- 95% Confidence Limits on 10-year Trend (=approximately 2 x SE of trend)
*Precision long-term (~40 years for BBS or CBC): +/- 95% Confidence Limits on long-term Trend (=approximately 2 x SE of trend)

Precise Trend: 2 x SE < 2.8 %/year
Adequate Trend: 2 x SE = 2.8-4.2 %/year
Poor Trend: 2 x SE > 4.2 %/year

**Coverage: % of Canadian Population sampled by survey (% of Canadian range sampled) - for BBS, lat/long degree block sampled if one route with trend in degree block

High Coverage: at least 2/3rds of Canadian population (range) sampled
Medium Coverage: 1/3rd to 2/3rds of Canadian population (range) sampled
Low Coverage: 10% to 1/3rd of Canadian population (range) sampled
Very Low Coverage: < 10% of Canadian population (range) sampled

RESULTS OF GAP AND RISK ANALYSES

The gaps in EC monitoring identified for each program outcome across each bird subgroup are summarized in Table 7.3, and the estimated risks to EC associated with each of those gaps are summarized in Table 7.4. A discussion of the overall gaps and risks by program outcome and by species bird group is presented in the latter part of this chapter, and additional details for each outcome or bird group are provided in Appendix B.

Species-specific gaps in monitoring coverage identified using COSEWIC criteria (and subsequently used to assess the gaps for the tenth program outcome “Avian Species at Risk are assessed, identified and listed”) are summarized in Figure 7.1. Full details of species-specific gap scores are outlined in Table 7.5.

Overall, this analysis suggests that there are relatively few high-level (score 3) gaps and even fewer high risks at the level of species groups and broad information needs. This largely reflects the decisions of past managers who informally prioritized the filling of gaps in high-risk areas, even without a formal gap-risk analysis. Most of the high gaps relate to program outcomes in remote areas (boreal, northern British Columbia and Arctic), in other countries (Latin America), and related to toxic substances (pesticides). The High risks were considered to be even more infrequent than high gaps, and were limited to boreal landbirds, out-of-country risks to boreal landbirds and Arctic shorebirds in Latin America, and Species at Risk information for other landbirds (mostly British Columbia species) and Arctic shorebirds.

The remaining areas of high risk are largely those that present significant monitoring challenges (e.g., logistical and financial costs of monitoring Arctic and boreal-nesting species, or monitoring related to species in other countries such as Latin America), and reducing those risks will require substantial new investments in monitoring. Some of these risks have increased over time. For example, biological risks associated with poor information on Arctic shorebirds have increased with evidence that the majority of those species are likely declining. Efforts to start to fill gaps for Arctic shorebirds are currently underway, following recommendations made earlier in the course of the Avian Monitoring Review process.

This analysis also provides information on areas that present moderate risks, some of which can likely be mitigated in a cost-effective manner. In some cases, development or expansion of existing monitoring programs may be able to mitigate risks for multiple information needs, and this analysis should help to identify those opportunities.

These summaries also reveal that even within some groups that are generally well monitored, there are at least some species for which our data on their overall population status is poor or very poor (Table 7.3). The largest numbers of poorly-monitored species are in the Arctic shorebirds, western landbirds (part of the “other landbirds” category in the other charts), and boreal landbirds. Among boreal landbirds, the gap is much larger if one also considers species with a moderate gap – these are largely species that are relatively well-monitored in part of their range (which often extends outside the boreal) but have limited coverage. These still present significant risks, as trends within the boreal may not match those elsewhere in the country. The line “Arctic shorebirds PRISM” shows the reduction in number of species with high gaps that we would see if the Arctic PRISM program were fully operational and providing information on population trends.

The analyses presented here should be considered in the course of developing an action plan to address gaps.

TABLE 7.3. Gaps in Canada's current avian monitoring programs, presented according to program outcomes and species group.

Gaps **0 - very few** **1 - minor** **2 - moderate** **3 – high** **OUTCOME**	Landbirds - Arctic	Landbirds - Boreal	Landbirds - other	Landbirds - Prairie	Shorebirds - Arctic	Shorebirds - Boreal	Shorebirds - other	Seabirds – colonial	Seabirds - Other (e.g., jaegers)	Seabirds - Pelagic	Waterbirds - Inland Colonial	Waterbirds - Marsh	Waterbirds - Other (e.g., loons, grebes, cranes)	Waterfowl - geese and swans	Waterfowl - other	Waterfowl - Seaducks	**Grand Total**
1. Landscape Management - Arctic (BCR 3)	2				3			1	2	2			2	1		2	3
1. Landscape Management - Boreal/Northern Forest (BCRs 4,6,7,8,12)		3				3					2	3	2	1	1	1	3
1. Landscape Management - Marine coasts (west and east coasts).					2			1	2	2							2
1. Landscape Management - Western mountains (BCRs 5, 9, 10)			2	1	2	1	2	1	1		1	2	1	1	1	1	2
1. Landscape Management - Prairies (BCR 11)		1		1	2	2	2				2	2	2	1	0	1	2
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	1		1		1	1	0				0	1	1	0	1	1	1
1. Landscape Management - Maritimes (BCR 14)	1		1		1	1	1	1			1	2	1	0	0	1	2
2. Incidental Take is minimized (forestry)		2	2			2	1				1	2	1	0	0	1	2
2. Incidental Take is minimized (agriculture)			1	2			2				2	2	2	1	1		2
2. Incidental Take is minimized (fisheries)								2		2	2		2		2	2	2
2. Incidental Take is minimized (collisions)	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2
2. Incidental Take is minimized (linear structures and roads)	2	2	2	2		2	2				2	2	2	2	2		2
2. Incidental Take is minimized (other sources including cats)	2	2	2	2			2					2			2		2
3. Threats to migrants in other countries reduced (USA)	2	1	1	1	2	2	1	1	2	1	1	1	1	0	0	1	2
3. Threats to migrants in other countries reduced (Latin America)	2	3	2	2	3	2	2	1	2	2	3	2	2	1	2		3
3. Threats to migrants in other countries reduced (Europe/Asia/Africa)	1				2			1	2	1				1	1	2	2
4. Harvest Management (overabundant species - management)														0			0
4. Harvest Management (overabundant species - habitat recovery)														1			1
4. Harvest Management (heavily hunted species)														0	0	2	2
4. Harvest Management (substantial harvest - no allocation concerns)							1							0	0	1	1
4. Harvest Management (lightly-harvested species)						1						0	2	0	0	1	2
4. Harvest Management (uncertain impact)			2									2		1	2	2	2
4. Harvest Management (aboriginal)								2					2	2	2	2	2
5. Priority Site Designation and Management	2	2	2	1	1	1	1	1		1	1	1	1	0	0	1	2
6. Impacts of Toxic substances (chronic oiling)					2			1	2	2			2		1	1	2
6. Impacts of Toxic substances (pesticides)	2	2	2	2	3	3	2	1			1	3	2	1	1	1	3
6. Impacts of Toxic substances (lead shot & sinkers)													2	1			2
6. Impacts of Toxic substances (other)								1	2	2	1	2	2	1	2	1	2
7. Threats (Predator control)			1				0	1			1		1		1	1	1
7. Threats (Emergency Response)				1	1	1	1	2	2	2	2	2	2	0	1	1	2
8. Land Claim Agreements	2	2	1	1	2	2	1	1	2	2	2	2	2	1	1	1	2
9. Threats to Public and Economy	1	1	1	1	2	2	1	1	1	1	1	2	1	1	1	1	2
10. SAR Listing – COSEWIC	3	3	3	2	3	3	2	2	3	3	2	3	2	1	1	2	3
Grand Total	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**

TABLE 7.4. Risks associated with current gaps in Canada's avian monitoring programs, presented by program outcomes and species group.

Risks **0 - very low** **1 – low** **2 – moderate** **3 – high** **OUTCOME**	Landbirds - Arctic	Landbirds - Boreal	Landbirds - other	Landbirds - Prairie	Shorebirds - Arctic	Shorebirds - Boreal	Shorebirds - other	Seabirds – colonial	Seabirds - Other (e.g., jaegers)	Seabirds - Pelagic	Waterbirds - Inland Colonial	Waterbirds - Marsh	Waterbirds - Other (e.g., loons, grebes, cranes)	Waterfowl - geese and swans	Waterfowl - other	Waterfowl - Seaducks	**Grand Total**
1. Landscape Management - Arctic (BCR 3)	1				2			1	1	1			1	0		1	**2**
1. Landscape Management - Boreal/Northern Forest (BCRs 4,6,7,8,12)		3				2					1	2	1	0	1	1	**3**
1. Landscape Management - Marine coasts (west and east coasts).					1			1	1	1							**1**
1. Landscape Management - Western mountains (BCRs 5, 9, 10)			2	1	2	1	1	1	1		1	1	1	0	1	1	**2**
1. Landscape Management - Prairies (BCR 11)		1		1	2	2	2				2	2	1	0	0	0	**2**
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	1		1		1	1	0				0	1	0	0	1	1	**1**
1. Landscape Management - Maritimes (BCR 14)	1		1		1	1	0	0			1	2	1	0	0	1	**2**
2. Incidental Take is minimized (forestry)		2	2			1	1				1	1	1	0	0	1	**2**
2. Incidental Take is minimized (agriculture)			1	2			2				1	1	1	0	1		**2**
2. Incidental Take is minimized (fisheries)								1		2	0		2		1	1	**2**
2. Incidental Take is minimized (collisions)	1	2	2	2	1	1	1	1		1	1	2	1	1	1	1	**2**
2. Incidental Take is minimized (linear structures and roads)	1	2	2	2		1	1				1	2	1	1	1		**2**
2. Incidental Take is minimized (other sources including cats)	2	2	2	2			2					2			1		**2**
3. Threats to migrants in other countries reduced (USA)	1	1	1	1	2	1	1	1	1	1	1	1	1	0	0	1	**2**
3. Threats to migrants in other countries reduced (Latin America)	1	3	2	2	3	2	2	1	1	2	2	2	2	0	1		**3**
3. Threats to migrants in other countries reduced (Europe/Asia/Africa)	1				1			1	1	1				1	0	2	**2**
4. Harvest Management (overabundant species - management)														0			**0**
4. Harvest Management (overabundant species - habitat recovery)														1			**1**
4. Harvest Management (heavily hunted species)														0	0	2	**2**
4. Harvest Management (substantial harvest - no allocation concerns)							1							0	0	1	**1**
4. Harvest Management (lightly-harvested species)						1						0	1	0	0	1	**1**
4. Harvest Management (uncertain impact)			2									1		1	2	2	**2**
4. Harvest Management (aboriginal)								1					1	1	1	2	**2**
5. Priority Site Designation and Management	1	2	1	1	1	1	1	1		1	1	1	1	0	0	1	**2**
6. Impacts of Toxic substances (chronic oiling)					1			1	1	1			1		1	1	**1**
6. Impacts of Toxic substances (pesticides)	2	2	1	2	2	2	2	1			1	2	2	0	0	0	**2**
6. Impacts of Toxic substances (lead shot & sinkers)													1	1			**1**
6. Impacts of Toxic substances (other)								1	1	1	1	2	2	0	1	0	**2**
7. Threats (Predator control)			1				0	1			1		1		1	1	**1**
7. Threats (Emergency Response)				1	1	1	1	2	1	2	2	2	2	0	0	1	**2**
8. Land Claim Agreements	0	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	**1**
9. Threats to Public and Economy	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	1	**1**
10. SAR Listing - COSEWIC	1	2	3	2	3	2	2	2	1	2	1	2	1	1	1	2	**3**
Grand Total	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**3**

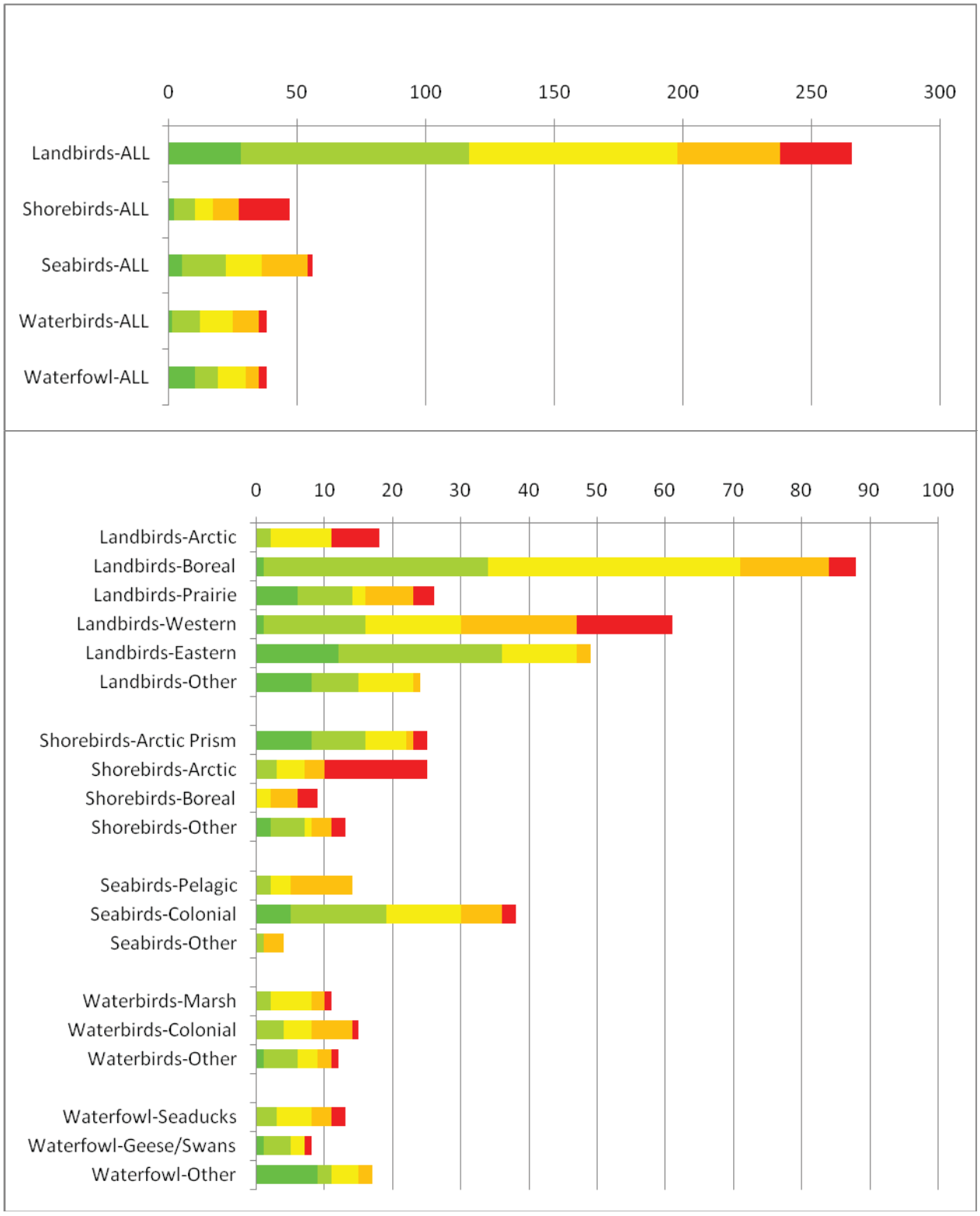

FIGURE 7.1. Summary of species-specific gaps rated between 0 (lowest gap, where current monitoring data provide high precision and coverage) and 4 (highest gap, where current monitoring data provide low precision and coverage), for each of the five major bird groups (top) and for each sub-category of the species groups (bottom). Precision and coverage criteria used were in line with COSEWIC criteria for listing Species at Risk; see Table 7.2 for details. These gap scores were used in determining overall gaps and risks for EC program outcome 10 (see Tables 7.3, 7.4). The line "Shorebirds-Arctic Prism" reflects a hypothetical situation if the Arctic PRISM program were fully operational and providing trends.

TABLE 7.5. Gap rankings reflecting the reliability of trend data for each Canadian bird species, including the primary surveys used to derive trend estimates from which gaps were estimated (i.e., those that provide the most reliable data for the species). When trends were available for both short (10-year) and longer periods (i.e., when the primary survey was BBS or shorebird surveys), precision was evaluated first using short-term trend; precision of long-term trends was only considered when precision of short-term trends was low or absent. Gaps are ranked from 0 (lowest, with high precision and coverage) to 4 (no trend available, or very low precision and coverage). Gap values were first determined from the precision and coverage categorizations (see Table 7.2 for details), but some scores were subsequently adjusted. Reasons for adjustments were typically: (i) an increase in the gap score by one or two levels (shown as '+1' or '+2' in the Primary Survey column) when there were known or expected biases of the survey that were not reflected in the precision/coverage levels but that created uncertainty (e.g., for Christmas Bird Count or migration survey data, or for atlas presence-absence data which may underestimate rates of decline); (ii) a decrease in the gap score by one or two levels ('-1' or '-2') when there was little uncertainty about which COSEWIC risk category a species would fit into, regardless of how poor the data were (e.g., for very rare species). Gap value adjustments were agreed upon through discussion among experts on the species in question. The table includes all 427 native species known to breed regularly in Canada, regardless of whether they are protected under the Migratory Birds Convention Act. Most of the 24 species that breed elsewhere, but visit Canada regularly on migration or during their non-breeding season are not adequately monitored in Canada.

Species	Scientific Name	Primary surveys	Overall Gap	Precision	Coverage
Acadian Flycatcher	*Empidonax virescens*	SAR Surveys	0	High	High
Alder Flycatcher	*Empidonax alnorum*	BBS	2	High	Low
American Avocet	*Recurvirostra americana*	BBS	3	Low	High
American Bittern	*Botaurus lentiginosus*	BBS + MMP	2	Low (High-40yr)	Medium
American Black Duck	*Anas rubripes*	WBPHS-East	0	High	High
American Coot	*Fulica americana*	WBPHS-West	1	Moderate	High
American Crow	*Corvus brachyrhynchos*	BBS	1	High	Medium
American Dipper	*Cinclus mexicanus*	CBC+1	3	High	Low
American Golden-Plover	*Pluvialis dominica*	OSS+1	4	Low	VLow
American Goldfinch	*Spinus tristis*	BBS	0	High	High
American Kestrel	*Falco sparverius*	BBS	1	High	Medium
American Oystercatcher	*Haematopus palliatus*		4		
American Pipit	*Anthus rubescens*	CBC+1	2	High	Medium
American Redstart	*Setophaga ruticilla*	BBS	1	High	Medium
American Robin	*Turdus migratorius*	BBS	1	High	Medium
American Three-toed Woodpecker	*Picoides dorsalis*	BBS	3	Low	Low
American Tree Sparrow	*Spizella arborea*	BBS	4	Low	VLow
American White Pelican	*Pelecanus erythrorhynchos*	BBS/Provincial Surveys	2	Low (Mod-40yr)	High
American Wigeon	*Anas americana*	WBPHS-West	0	High	High
American Woodcock	*Scolopax minor*	Singing-ground Survey	1	High	Medium
Ancient Murrelet	*Synthliboramphus antiquus*	Colony surveys	1	Moderate	Medium
Anna's Hummingbird	*Calypte anna*	CBC+1	4	High	VLow
Arctic Tern	*Sterna paradisaea*	Colony surveys	2	High	Low
Atlantic Puffin	*Fratercula arctica*	Colony surveys	1	Moderate	Medium
Baird's Sandpiper	*Calidris bairdii*	OSS+1	4	Low	VLow
Baird's Sparrow	*Ammodramus bairdii*	BBS / GBM	1	Moderate	High
Bald Eagle	*Haliaeetus leucocephalus*	CBC+1	2	High	Medium
Baltimore Oriole	*Icterus galbula*	BBS	0	High	High
Band-tailed Pigeon	*Patagioenas fasciata*	BBS	3	Low	Medium
Bank Swallow	*Riparia riparia*	BBS	2	Low (High-40yr)	Medium
Barn Owl	*Tyto alba*	SAR Info -1	2	Low	High

Species	Scientific Name	Primary surveys	Overall Gap	Precision	Coverage
Barn Swallow	*Hirundo rustica*	BBS	0	High	High
Barred Owl	*Strix varia*	BBS or CBC+1	3	Low	Medium
Barrow's Goldeneye	*Bucephala islandica*	SAR & CBC+1	2	High	Medium
Bay-breasted Warbler	*Setophaga castanea*	BBS	3	Low (High-40yr)	Low
Belted Kingfisher	*Megaceryle alcyon*	BBS	1	Moderate	Medium
Bewick's Wren	*Thryomanes bewickii*	BBS or CBC+1	4	None (Mod-40yr)	High
Bicknell's Thrush	*Catharus bicknelli*	HELP	3	Low	Low or Med
Black Guillemot	*Cepphus grylle*	Colony surveys	3	Moderate	VLow
Black Oystercatcher	*Haematopus bachmani*	CBC+1	3	High	Low
Black Scoter	*Melanitta americana*	CBC+1	3	High	Low
Black Swift	*Cypseloides niger*	BBS	3	Low	High
Black Tern	*Chlidonias niger*	BBS	2	Low (High-40yr)	High
Black-and-white Warbler	*Mniotilta varia*	BBS	1	High	Medium
Black-backed Woodpecker	*Picoides arcticus*	BBS or CBC+1	3	Low	Low
Black-bellied Plover	*Pluvialis squatarola*	ACSS+1	2	High	Medium
Black-billed Cuckoo	*Coccyzus erythropthalmus*	ON Atlas+1	2	High	Medium
Black-billed Magpie	*Pica hudsonia*	BBS	0	High	High
Blackburnian Warbler	*Setophaga fusca*	BBS	1	Moderate	Medium
Black-capped Chickadee	*Poecile atricapillus*	BBS	1	High	Medium
Black-chinned Hummingbird	*Archilochus alexandri*		4		
Black-crowned Night-Heron	*Nycticorax nycticorax*	BBS / GL-CWS	3	Low	High
Black-headed Grosbeak	*Pheucticus melanocephalus*	BBS	3	Low	High
Black-headed Gull	*Chroicocephalus ridibundus*	CBC	1	Moderate	High
Black-legged Kittiwake	*Rissa tridactyla*	Colony surveys	1	High	Medium
Black-necked Stilt	*Himantopus mexicanus*		4		
Blackpoll Warbler	*Setophaga striata*	BBS	3	Low (High-40yr)	Low
Black-throated Blue Warbler	*Setophaga caerulescens*	BBS	1	Moderate	High
Black-throated Gray Warbler	*Setophaga nigrescens*	BBS	3	Low	Medium
Black-throated Green Warbler	*Setophaga virens*	BBS	1	High	Medium
Blue Jay	*Cyanocitta cristata*	BBS	0	High	High
Blue-gray Gnatcatcher	*Polioptila caerulea*	ON Atlas+1	1	High	High
Blue-headed Vireo	*Vireo solitarius*	BBS	1	High	Medium
Bluethroat	*Luscinia svecica*		4		
Blue-winged Teal	*Anas discors*	WBPHS-West	0	High	High
Blue-winged Warbler	*Vermivora cyanoptera*	ON Atlas+1	1	High	High
Bobolink	*Dolichonyx oryzivorus*	BBS	0	High	High
Bohemian Waxwing	*Bombycilla garrulus*	CBC+1	2	Moderate	Medium
Bonaparte's Gull	*Chroicocephalus philadelphia*	CBC+1	2	High	Medium
Boreal Chickadee	*Poecile hudsonicus*	BBS or CBC+1	3	Low (High-40yr)	Low
Boreal Owl	*Aegolius funereus*	ON Owl Survey	2	High	Low
Brandt's Cormorant	*Phalacrocorax penicillatus*	CBC+1	2	High	Medium
Brant	*Branta bernicla*	CBC & MWS	2	Moderate	Low
Brewer's Blackbird	*Euphagus cyanocephalus*	BBS	0	High	High

Species	Scientific Name	Primary surveys	Overall Gap	Precision	Coverage
Brewer's Sparrow	*Spizella breweri*	BBS or CBC+1	3	Low	High
Broad-winged Hawk	*Buteo platypterus*	BBS	2	Low (High-40yr)	High
Brown Creeper	*Certhia americana*	BBS or CBC+1	2	Low (High-40yr)	Medium
Brown Thrasher	*Toxostoma rufum*	BBS	0	High	High
Brown-headed Cowbird	*Molothrus ater*	BBS	0	High	High
Buff-breasted Sandpiper	*Tryngites subruficollis*	Shore	3	Low	Low
Bufflehead	*Bucephala albeola*	CBC+1	1	High	High
Bullock's Oriole	*Icterus bullockii*	BBS	2	Low (Mod-40yr)	High
Burrowing Owl	*Athene cunicularia*	SAR Surveys	1	Moderate	High
Bushtit	*Psaltriparus minimus*	BBS or CBC+1	4	None (Low-40yr)	High
Cackling Goose	*Branta hutchinsii*	MWS	1	Moderate	Medium
California Gull	*Larus californicus*	BBS	2	Low (Mod-40yr)	High
Calliope Hummingbird	*Stellula calliope*	BBS	2	Low (Mod-40yr)	High
Canada Goose	*Branta canadensis*	MWS	1	Moderate	Medium
Canada Warbler	*Cardellina canadensis*	BBS	2	Low (High-40yr)	Medium
Canvasback	*Aythya valisineria*	WBPHS-West	0	High	High
Canyon Wren	*Catherpes mexicanus*	CBC+1	4	High	VLow
Cape May Warbler	*Setophaga tigrina*	BBS	3	Low (High-40yr)	Low
Carolina Wren	*Thryothorus ludovicianus*	ON Atlas+1	2	Moderate	High
Caspian Tern	*Hydroprogne caspia*	BBS or CBC+1	3	Low	Medium
Cassin's Auklet	*Ptychoramphus aleuticus*	Colony surveys	1	Moderate	High
Cassin's Finch	*Carpodacus cassinii*	BBS	3	Low	High
Cassin's Vireo	*Vireo cassinii*	BBS	1	Moderate	High
Cattle Egret	*Bubulcus ibis*	US-BBS	3	High	VLow
Cedar Waxwing	*Bombycilla cedrorum*	BBS	1	High	Medium
Cerulean Warbler	*Setophaga cerulea*	ON Atlas+1	1	High	High
Chestnut-backed Chickadee	*Poecile rufescens*	BBS	3	Low	Medium
Chestnut-collared Longspur	*Calcarius ornatus*	BBS / GBM	3	Low	High
Chestnut-sided Warbler	*Setophaga pensylvanica*	BBS	0	High	High
Chimney Swift	*Chaetura pelagica*	BBS	2	Low (High-40yr)	High
Chipping Sparrow	*Spizella passerina*	BBS	2	High	Low
Chuck-will's-widow	*Caprimulgus carolinensis*		4		
Cinnamon Teal	*Anas cyanoptera*	BBS	3	Low	High
Clark's Grebe	*Aechmophorus clarkii*		4		
Clark's Nutcracker	*Nucifraga columbiana*	BBS	2	Low (Mod-40yr)	High
Clay-colored Sparrow	*Spizella pallida*	BBS	1	High	Medium
Cliff Swallow	*Petrochelidon pyrrhonota*	BBS	2	Low (High-40yr)	Medium
Common Eider	*Somateria mollissima*	Various surveys	3	Low	Medium
Common Gallinule	*Gallinula galeata*	ON Atlas+1 / ON-MMP	2	Moderate	Medium
Common Goldeneye	*Bucephala clangula*	CBC+1	1	High	High
Common Grackle	*Quiscalus quiscula*	BBS	0	High	High
Common Loon	*Gavia immer*	BBS or CBC+1	2	Moderate	Low

Species	Scientific Name	Primary surveys	Overall Gap	Precision	Coverage
Common Merganser	*Mergus merganser*	CBC+1	2	High	Medium
Common Murre	*Uria aalge*	Colony surveys	1	Moderate	High
Common Nighthawk	*Chordeiles minor*	BBS	2	Low (High-40yr)	Medium
Common Poorwill	*Phalaenoptilus nuttallii*	CBC+1	4	Moderate	VLow
Common Raven	*Corvus corax*	BBS	2	High	Low
Common Redpoll	*Acanthis flammea*	CBC+1	2	Moderate	Medium
Common Ringed Plover	*Charadrius hiaticula*		4		
Common Tern	*Sterna hirundo*	Colony surveys	1	High	Medium
Common Yellowthroat	*Geothlypis trichas*	BBS	1	High	Medium
Connecticut Warbler	*Oporornis agilis*	BBS	2	Low (Mod-40yr)	High
Cooper's Hawk	*Accipiter cooperii*	BBS	2	Low (Mod-40yr)	High
Cordilleran Flycatcher	*Empidonax occidentalis*		4		
Dark-eyed Junco	*Junco hyemalis*	BBS or CBC+1	2	High	Low
Dickcissel	*Spiza americana*		4		
Double-crested Cormorant	*Phalacrocorax auritus*	Colony surveys	1	High	Medium
Dovekie	*Alle alle*	Pelagic surveys	3	Low	Medium
Downy Woodpecker	*Picoides pubescens*	BBS	1	High	Medium
Dunlin	*Calidris alpina*	CBC+1	2	High	Medium
Dusky Flycatcher	*Empidonax oberholseri*	BBS	2	Low (Mod-40yr)	High
Dusky Grouse	*Dendragapus obscurus*	BBS	3	Low	Medium
Eared Grebe	*Podiceps nigricollis*	Mono Lake counts	2	Moderate	Low
Eastern Bluebird	*Sialia sialis*	BBS	1	Moderate	High
Eastern Kingbird	*Tyrannus tyrannus*	BBS	0	High	High
Eastern Meadowlark	*Sturnella magna*	BBS	0	High	High
Eastern Phoebe	*Sayornis phoebe*	BBS	1	High	Medium
Eastern Screech-Owl	*Megascops asio*	ON Atlas+1	2	High	Medium
Eastern Towhee	*Pipilo erythrophthalmus*	BBS	2	Low (Mod-40yr)	High
Eastern Whip-poor-will	*Caprimulgus vociferus*	ON Atlas+1	2	High	Medium
Eastern Wood-Pewee	*Contopus virens*	BBS	0	High	High
Eastern Yellow Wagtail	*Motacilla tschutschensis*		4		
Eskimo Curlew	*Numenius borealis*	SAR Info -2	1	??	Low
Evening Grosbeak	*Coccothraustes vespertinus*	BBS or CBC+1	2	Low (High-40yr)	High
Ferruginous Hawk	*Buteo regalis*	AB FEHA Survey	1	Moderate?	Medium
Field Sparrow	*Spizella pusilla*	BBS	1	Moderate	High
Flammulated Owl	*Otus flammeolus*	SAR Info	3	Low	Low
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	Pelagic surveys	3	Low	Low
Forster's Tern	*Sterna forsteri*		4		
Fox Sparrow	*Passerella iliaca*	BBS or CBC+1	2	Moderate	Low
Franklin's Gull	*Leucophaeus pipixcan*	CWS-PNR-Census	1	Moderate	Medium
Gadwall	*Anas strepera*	WBPHS-West	0	High	High
Glaucous Gull	*Larus hyperboreus*	CBC+1	2	High	Medium
Glaucous-winged Gull	*Larus glaucescens*	Colony surveys	2	Moderate	Low
Golden Eagle	*Aquila chrysaetos*	CBC+1	2	High	Medium
Golden-crowned Kinglet	*Regulus satrapa*	BBS	1	Moderate	Medium
Golden-crowned Sparrow	*Zonotrichia atricapilla*	CBC+1	2	High	Medium
Golden-winged Warbler	*Vermivora chrysoptera*	ON Atlas+1	1	High	High

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Grasshopper Sparrow	*Ammodramus savannarum*	BBS	3	Low	High
Gray Catbird	*Dumetella carolinensis*	BBS	0	High	High
Gray Flycatcher	*Empidonax wrightii*		4		
Gray Jay	*Perisoreus canadensis*	BBS	2	High	Low
Gray-cheeked Thrush	*Catharus minimus*	BBS	4	Low	VLow
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*		4		
Gray-headed Chickadee	*Poecile cinctus*		4		
Great Black-backed Gull	*Larus marinus*	Colony surveys	1	Moderate	Medium
Great Blue Heron	*Ardea herodias*	BBS	1	Moderate	High
Great Cormorant	*Phalacrocorax carbo*	Colony surveys	3	Low	High
Great Crested Flycatcher	*Myiarchus crinitus*	BBS	0	High	High
Great Egret	*Ardea alba*	GL-CWS	1	Moderate	Medium
Great Gray Owl	*Strix nebulosa*	ON Atlas+1	2	Moderate	Medium
Great Horned Owl	*Bubo virginianus*	BBS	2	Low (High-40yr)	Medium
Greater Sage-Grouse	*Centrocercus urophasianus*	SAR Surveys	1	Moderate	High
Greater Scaup	*Aythya marila*	WBPHS-West	2	Moderate	Low
Greater White-fronted Goose	*Anser albifrons*	Fall mid-continent Surveys	2	High	Low
Greater Yellowlegs	*Tringa melanoleuca*	ACSS+1	3	Low (Mod-32yr)	Medium
Green Heron	*Butorides virescens*	ON Atlas+1	1	High	High
Green-winged Teal	*Anas crecca*	WBPHS	0	High	High
Gyrfalcon	*Falco rusticolus*	CBC+1	2	High	Medium
Hairy Woodpecker	*Picoides villosus*	BBS	1	High	Medium
Hammond's Flycatcher	*Empidonax hammondii*	BBS	1	Moderate	Medium
Harlequin Duck	*Histrionicus histrionicus*	SAR & CBC+1	3	High	Low
Harris's Sparrow	*Zonotrichia querula*	CBC+1	1	High	High
Henslow's Sparrow	*Ammodramus henslowii*	SAR Surveys / ON Atlas -2	1	Low	High
Hermit Thrush	*Catharus guttatus*	BBS	2	High	Low
Herring Gull	*Larus argentatus*	Colony surveys	1	Moderate	Medium
Hoary Redpoll	*Acanthis hornemanni*	CBC+1	2	Moderate	Medium
Hooded Merganser	*Lophodytes cucullatus*	CBC+1	2	High	Medium
Hooded Warbler	*Setophaga citrina*	SAR Surveys / ON Atlas	1	Moderate	High
Horned Grebe	*Podiceps auritus*	CBC+1	1	High	High
Horned Lark	*Eremophila alpestris*	BBS or CBC+1	2	Moderate	Low
Horned Puffin	*Fratercula corniculata*	Colony survey	3	Low	Low
House Finch	*Carpodacus mexicanus*	BBS	3	Low	High
House Wren	*Troglodytes aedon*	BBS	0	High	High
Hudsonian Godwit	*Limosa haemastica*	OSS+1	4	Low (Mod-32yr)	Low
Hutton's Vireo	*Vireo huttoni*	BBS or CBC+1	4	None (Low-40yr)	High
Iceland Gull	*Larus glaucoides*	CBC	2	High	Low
Indigo Bunting	*Passerina cyanea*	BBS	0	High	High
Ivory Gull	*Pagophila eburnea*	SAR Surveys	0	High	High
Killdeer	*Charadrius vociferus*	BBS	0	High	High
King Eider	*Somateria spectabilis*	CBC+1	4	Low	Low
King Rail	*Rallus elegans*	SAR Surveys / ON Atlas -1	2	Low	High
Kirtland's Warbler	*Setophaga kirtlandii*	SAR Surveys -1	0	Moderate	High
Lapland Longspur	*Calcarius lapponicus*	CBC+1	2	Moderate	High

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Lark Bunting	*Calamospiza melanocorys*	BBS	3	Low	High
Lark Sparrow	*Chondestes grammacus*	BBS	3	Low	High
Laughing Gull	*Leucophaeus atricilla*		4		
Lazuli Bunting	*Passerina amoena*	BBS	2	Low (Mod-40yr)	High
Le Conte's Sparrow	*Ammodramus leconteii*	BBS or CBC+1	1	Moderate	Medium
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	Colony surveys	1	Moderate	Medium
Least Bittern	*Ixobrychus exilis*	GL-MMP+1	2	Moderate	High
Least Flycatcher	*Empidonax minimus*	BBS	1	High	Medium
Least Sandpiper	*Calidris minutilla*	CBC+1	3	High	Low
Lesser Scaup	*Aythya affinis*	WBPHS-West	2	High	Low
Lesser Yellowlegs	*Tringa flavipes*	BBS	4	Low	VLow
Lewis's Woodpecker	*Melanerpes lewis*	CBC+1	3	High	Low
Lincoln's Sparrow	*Melospiza lincolnii*	BBS or CBC+1	2	High	Low
Little Gull	*Hydrocoloeus minutus*	Spring Count	3	Low	High
Loggerhead Shrike	*Lanius ludovicianus*	BBS	2	Low (Mod-40yr)	High
Long-billed Curlew	*Numenius americanus*	BBS	3	Low	High
Long-billed Dowitcher	*Limnodromus scolopaceus*		4		
Long-eared Owl	*Asio otus*	CBC+1	2	High	Medium
Long-tailed Duck	*Clangula hyemalis*	CBC+1	3	High	Low
Long-tailed Jaeger	*Stercorarius longicaudus*	Pelagic surveys	3	Low	Low
Louisiana Waterthrush	*Parkesia motacilla*	ON Atlas+1	2	Moderate	High
MacGillivray's Warbler	*Geothlypis tolmiei*	BBS	1	High	Medium
Magnolia Warbler	*Setophaga magnolia*	BBS	2	High	Low
Mallard	*Anas platyrhynchos*	WBPHS-West	0	High	High
Manx Shearwater	*Puffinus puffinus*	Colony surveys	0	High	High
Marbled Godwit	*Limosa fedoa*	BBS	1	Moderate	High
Marbled Murrelet	*Brachyramphus marmoratus*	SAR Surveys	1	Moderate	Medium
Marsh Wren	*Cistothorus palustris*	BBS	1	Moderate	High
McCown's Longspur	*Rhynchophanes mccownii*	BBS	3	Low	High
Merlin	*Falco columbarius*	CBC+1	2	High	Medium
Mew Gull	*Larus canus*	CBC+1	2	High	Medium
Mountain Bluebird	*Sialia currucoides*	BBS	2	Low (High-40yr)	High
Mountain Chickadee	*Poecile gambeli*	BBS	1	Moderate	High
Mountain Plover	*Charadrius montanus*	SAR Surveys / Info -1	0	Moderate	High
Mourning Dove	*Zenaida macroura*	BBS	0	High	High
Mourning Warbler	*Geothlypis philadelphia*	BBS	1	High	Medium
Nashville Warbler	*Oreothlypis ruficapilla*	BBS	1	High	Medium
Nelson's Sparrow	*Ammodramus nelsoni*	ON Atlas	4	Low	VLow
Northern Bobwhite	*Colinus virginianus*	ON Atlas+1	1	High	High
Northern Cardinal	*Cardinalis cardinalis*	BBS	1	Moderate	High
Northern Flicker	*Colaptes auratus*	BBS	1	High	Medium
Northern Fulmar	*Fulmarus glacialis*	Colony surveys	2	Moderate	Low
Northern Gannet	*Morus bassanus*	Colony surveys	0	High	All
Northern Goshawk	*Accipiter gentilis*	CBC+1	2	High	Medium
Northern Harrier	*Circus cyaneus*	BBS	1	Moderate	Medium
Northern Hawk Owl	*Surnia ulula*	CBC+1	3	Moderate	Low
Northern Mockingbird	*Mimus polyglottos*	BBS	3	Low	High
Northern Parula	*Setophaga americana*	BBS	1	Moderate	High

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Northern Pintail	*Anas acuta*	WBPHS-West	0	High	High
Northern Pygmy-Owl	*Glaucidium gnoma*	CBC+1	3	High	Low
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	BBS	2	Low (Mod-40yr)	High
Northern Saw-whet Owl	*Aegolius acadicus*	CBC+1	2	Moderate	Medium
Northern Shoveler	*Anas clypeata*	WBPHS-West	0	High	High
Northern Shrike	*Lanius excubitor*	CBC+1	2	High	Medium
Northern Waterthrush	*Parkesia noveboracensis*	BBS	2	High	Low
Northern Wheatear	*Oenanthe oenanthe*		4		
Northwestern Crow	*Corvus caurinus*	CBC+1	2	High	Medium
Olive-sided Flycatcher	*Contopus cooperi*	BBS	1	High	Medium
Orange-crowned Warbler	*Oreothlypis celata*	BBS	2	High	Low
Orchard Oriole	*Icterus spurius*	BBS	3	Low	High
Osprey	*Pandion haliaetus*	BBS	2	Moderate	Low
Ovenbird	*Seiurus aurocapilla*	BBS	1	High	Medium
Pacific Loon	*Gavia pacifica*	CBC+1 / FWS surveys	2	High	Medium
Pacific Wren	*Troglodytes pacificus*		4		
Pacific-slope Flycatcher	*Empidonax difficilis*	BBS	2	Low (Mod-40yr)	Medium
Palm Warbler	*Setophaga palmarum*	CBC+1	2	High	Medium
Parasitic Jaeger	*Stercorarius parasiticus*	Pelagic surveys	3	Low	Low
Pectoral Sandpiper	*Calidris melanotos*	OSS+1	4	Low	Low
Pelagic Cormorant	*Phalacrocorax pelagicus*	CBC+1	3	High	Low
Peregrine Falcon	*Falco peregrinus*	SAR Surveys	2	High	Low
Philadelphia Vireo	*Vireo philadelphicus*	BBS	1	Moderate	Medium
Pied-billed Grebe	*Podilymbus podiceps*	BBS+1	3	Low (High-40yr)	High
Pigeon Guillemot	*Cepphus columba*	BC-CWS	2	Moderate	Low
Pileated Woodpecker	*Dryocopus pileatus*	BBS	1	High	Medium
Pine Grosbeak	*Pinicola enucleator*	CBC+1	2	Moderate	Medium
Pine Siskin	*Spinus pinus*	BBS	1	Moderate	Medium
Pine Warbler	*Setophaga pinus*	ON Atlas+1	1	High	High
Piping Plover	*Charadrius melodus*	SAR Surveys	1	Moderate	High
Pomarine Jaeger	*Stercorarius pomarinus*	Pelagic surveys	3	Low	Low
Prairie Falcon	*Falco mexicanus*	CBC+1	4	High	VLow
Prairie Warbler	*Setophaga discolor*	ON Atlas+1	1	High	High
Prothonotary Warbler	*Protonotaria citrea*	SAR Surveys	0	High	High
Purple Finch	*Carpodacus purpureus*	BBS or CBC+1	1	Moderate	Medium
Purple Martin	*Progne subis*	BBS	2	Low (High-40yr)	High
Purple Sandpiper	*Calidris maritima*	CBC+1	4	Low	High
Pygmy Nuthatch	*Sitta pygmaea*	BBS or CBC+1	4	None (Low-40yr)	High
Razorbill	*Alca torda*	Colony surveys	1	Moderate	Medium
Red Crossbill	*Loxia curvirostra*	BBS or CBC+1	2	Low (Mod-40yr)	Medium
Red Knot	*Calidris canutus*	SAR Surveys	1	High	Medium
Red Phalarope	*Phalaropus fulicarius*	Shore	3	Low	Low
Red-bellied Woodpecker	*Melanerpes carolinus*	ON Atlas+1	1	High	High
Red-breasted Merganser	*Mergus serrator*	CBC+1	1	High	High
Red-breasted Nuthatch	*Sitta canadensis*	BBS	1	High	Medium
Red-breasted Sapsucker	*Sphyrapicus ruber*	BBS	3	Low	Medium

Species	Scientific Name	Primary surveys	Overall Gap	Precision	Coverage
Red-eyed Vireo	*Vireo olivaceus*	BBS	1	High	Medium
Redhead	*Aythya americana*	WBPHS-West	1	Moderate	High
Red-headed Woodpecker	*Melanerpes erythrocephalus*	ON Atlas+1	2	High	Medium
Red-naped Sapsucker	*Sphyrapicus nuchalis*	BBS	3	Low	High
Red-necked Grebe	*Podiceps grisegena*	CBC+1	1	High	High
Red-necked Phalarope	*Phalaropus lobatus*	Shore	3	Low	Low
Red-shouldered Hawk	*Buteo lineatus*	ON Atlas+1	1	High	High
Red-tailed Hawk	*Buteo jamaicensis*	BBS	1	High	Medium
Red-throated Loon	*Gavia stellata*	CBC+1 / FWS surveys	1	High	High
Red-winged Blackbird	*Agelaius phoeniceus*	BBS	0	High	High
Rhinoceros Auklet	*Cerorhinca monocerata*	Colony surveys	1	Moderate	Medium
Ring-billed Gull	*Larus delawarensis*	Colony surveys	0	High	High
Ring-necked Duck	*Aythya collaris*	WBPHS	1	Moderate	High
Rock Ptarmigan	*Lagopus muta*		4		
Rock Wren	*Salpinctes obsoletus*	BBS	3	Low	High
Roseate Tern	*Sterna dougallii*	SAR Surveys	0	High	High
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	BBS	1	High	Medium
Ross's Goose	*Chen rossii*	CBC+1	1	High	High
Ross's Gull	*Rhodostethia rosea*	SAR Surveys	1	Moderate	Medium
Rough-legged Hawk	*Buteo lagopus*	CBC+1	1	High	High
Ruby-crowned Kinglet	*Regulus calendula*	BBS or CBC+1	2	High	Low
Ruby-throated Hummingbird	*Archilochus colubris*	BBS	1	Moderate	High
Ruddy Duck	*Oxyura jamaicensis*	WBPHS-West	3	Low	High
Ruddy Turnstone	*Arenaria interpres*	ACSS+1	3	Low (High-32yr)	Medium
Ruffed Grouse	*Bonasa umbellus*	BBS	1	Moderate	Medium
Rufous Hummingbird	*Selasphorus rufus*	BBS	1	Moderate	Medium
Rusty Blackbird	*Euphagus carolinus*	CBC+1	1	High	High
Sabine's Gull	*Xema sabini*	Colony surveys	3	High	VLow
Sage Thrasher	*Oreoscoptes montanus*	SAR Surveys / Info -1	0	Moderate	High
Sanderling	*Calidris alba*	CBC+1	3	High	Low
Sandhill Crane	*Grus canadensis*	Spring Mid-Cont. SACR	1	Moderate	Medium
Savannah Sparrow	*Passerculus sandwichensis*	BBS	1	High	Medium
Say's Phoebe	*Sayornis saya*	BBS or CBC+1	3	Low	Low
Scarlet Tanager	*Piranga olivacea*	BBS	1	Moderate	High
Sedge Wren	*Cistothorus platensis*	BBS	2	Low (High-40yr)	High
Semipalmated Plover	*Charadrius semipalmatus*	ACSS+1	2	Moderate	Medium
Semipalmated Sandpiper	*Calidris pusilla*	ACSS+1	4	Low	High
Sharp-shinned Hawk	*Accipiter striatus*	BBS or CBC+1	3	Low (Mod-40yr)	Low
Sharp-tailed Grouse	*Tympanuchus phasianellus*	BBS or CBC+1	3	Low	Medium
Short-billed Dowitcher	*Limnodromus griseus*	ACSS+1	4	Low	Low
Short-eared Owl	*Asio flammeus*	BBS or CBC+1	3	Low (Mod-40yr)	Low
Smith's Longspur	*Calcarius pictus*	CBC+1	4	Low	High
Snow Bunting	*Plectrophenax nivalis*	CBC+1	2	High	Medium
Snow Goose	*Chen caerulescens*	MWS & CWS-GSGO	1	Moderate	Medium
Snowy Egret	*Egretta thula*	US-BBS	3	Moderate	VLow

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Snowy Owl	*Bubo scandiacus*	CBC+1	2	High	Medium
Solitary Sandpiper	*Tringa solitaria*	BBS	3	Low	Low
Song Sparrow	*Melospiza melodia*	BBS	1	High	Medium
Sooty Grouse	*Dendragapus fuliginosus*		4		
Sora	*Porzana carolina*	BBS	1	Moderate	Medium
Spotted Owl	*Strix occidentalis*	SAR Surveys	1	Moderate	High
Spotted Sandpiper	*Actitis macularius*	BBS	2	High	Low
Spotted Towhee	*Pipilo maculatus*	BBS	1	Moderate	High
Sprague's Pipit	*Anthus spragueii*	BBS / GBM	1	Moderate	High
Spruce Grouse	*Falcipennis canadensis*	BBS or CBC+1	3	Low	Low
Steller's Jay	*Cyanocitta stelleri*	BBS	2	Low (Mod-40yr)	Medium
Stilt Sandpiper	*Calidris himantopus*	Shore	3	Low	Low
Surf Scoter	*Melanitta perspicillata*	CBC+1	2	High	Medium
Surfbird	*Aphriza virgata*	CBC+1	3	High	Low
Swainson's Hawk	*Buteo swainsoni*	BBS	1	Moderate	High
Swainson's Thrush	*Catharus ustulatus*	BBS	2	High	Low
Swamp Sparrow	*Melospiza georgiana*	BBS or CBC+1	2	High	Low
Tennessee Warbler	*Oreothlypis peregrina*	BBS	2	Moderate	Low
Thayer's Gull	*Larus thayeri*	CBC	2	High	Low
Thick-billed Murre	*Uria lomvia*	Colony surveys	2	High	Low
Townsend's Solitaire	*Myadestes townsendi*	BBS	2	Low (High-40yr)	Medium
Townsend's Warbler	*Setophaga townsendi*	BBS	1	Moderate	Medium
Tree Swallow	*Tachycineta bicolor*	BBS	1	High	Medium
Trumpeter Swan	*Cygnus buccinator*	TRUS surveys	0	High	High
Tufted Puffin	*Fratercula cirrhata*	Colony survey	2	Moderate	Low
Tufted Titmouse	*Baeolophus bicolor*	ON Atlas+1	1	High	High
Tundra Swan	*Cygnus columbianus*	MWS	1	Moderate	High
Turkey Vulture	*Cathartes aura*	ON Atlas+1	1	High	High
Upland Sandpiper	*Bartramia longicauda*	BBS	1	Moderate	High
Varied Thrush	*Ixoreus naevius*	BBS	1	Moderate	Medium
Vaux's Swift	*Chaetura vauxi*	BBS	3	Low	Medium
Veery	*Catharus fuscescens*	BBS	0	High	High
Vesper Sparrow	*Pooecetes gramineus*	BBS	0	High	High
Violet-green Swallow	*Tachycineta thalassina*	BBS	2	Low (Mod-40yr)	Medium
Virginia Rail	*Rallus limicola*	ON Atlas+1	2	Moderate	Medium
Wandering Tattler	*Tringa incana*	CBC+1	3	High	Low
Warbling Vireo	*Vireo gilvus*	BBS	1	High	Medium
Western Bluebird	*Sialia mexicana*	CBC+1	4	High	VLow
Western Grebe	*Aechmophorus occidentalis*	BBS or CBC+1 / CWS-PNR	3	Low	High
Western Gull	*Larus occidentalis*	CBC+1	4	High	VLow
Western Kingbird	*Tyrannus verticalis*	BBS	1	Moderate	High
Western Meadowlark	*Sturnella neglecta*	BBS	0	High	High
Western Screech-Owl	*Megascops kennicottii*	SAR Info	3	Low	Low
Western Tanager	*Piranga ludoviciana*	BBS	1	High	Medium
Western Wood-Pewee	*Contopus sordidulus*	BBS	1	Moderate	Medium
Whimbrel	*Numenius phaeopus*	ACSS+1	4	Low	Medium
White-breasted Nuthatch	*Sitta carolinensis*	BBS	2	Low (High-40yr)	High
White-crowned Sparrow	*Zonotrichia leucophrys*	CBC+1	2	High	Medium

Species	Scientific Name	Primary surveys	Overall Gap	Precision	Coverage
White-eyed Vireo	*Vireo griseus*	ON Atlas+1	2	Moderate	High
White-faced Ibis	*Plegadis chihi*	US-BBS	3	Moderate	VLow
White-headed Woodpecker	*Picoides albolarvatus*	SAR Info -2	1	Low	High
White-rumped Sandpiper	*Calidris fuscicollis*	ACSS+1	4	Low	Medium
White-tailed Ptarmigan	*Lagopus leucura*	CBC+1	4	Low	Medium
White-throated Sparrow	*Zonotrichia albicollis*	CBC	0	High	High
White-throated Swift	*Aeronautes saxatalis*	CBC+1	4	Low	VLow
White-winged Crossbill	*Loxia leucoptera*	BBS	3	Low (Mod-40yr)	Low
White-winged Scoter	*Melanitta fusca*	CBC+1	2	High	Medium
Whooping Crane	*Grus americana*	SAR Surveys	0	High	High
Wild Turkey	*Meleagris gallopavo*	ON Atlas+1	2	Moderate	Medium
Willet	*Tringa semipalmata*	BBS	1	Moderate	High
Williamson's Sapsucker	*Sphyrapicus thyroideus*	SAR Info -2	1	Low	High
Willow Flycatcher	*Empidonax traillii*	BBS	1	High	Medium
Willow Ptarmigan	*Lagopus lagopus*	CBC+1	4	Low	VLow
Wilson's Phalarope	*Phalaropus tricolor*	BBS	2	Low (Mod-40yr)	High
Wilson's Snipe	*Gallinago delicata*	BBS or CBC+1	2	High	Low
Wilson's Warbler	*Cardellina pusilla*	BBS	2	Moderate	Low
Winter Wren	*Troglodytes hiemalis*	CBC+1	1	High	High
Wood Duck	*Aix sponsa*	BBS / WBPHS	2	Low (Mod-40yr)	High
Wood Thrush	*Hylocichla mustelina*	BBS	1	Moderate	High
Yellow Rail	*Coturnicops noveboracensis*	CBC	3	Low	Medium
Yellow Warbler	*Setophaga petechia*	BBS	2	High	Low
Yellow-bellied Flycatcher	*Empidonax flaviventris*	BBS	2	Moderate	Low
Yellow-bellied Sapsucker	*Sphyrapicus varius*	BBS	1	High	Medium
Yellow-billed Cuckoo	*Coccyzus americanus*	ON Atlas+1	1	High	High
Yellow-billed Loon	*Gavia adamsii*	CBC+1 / FWS surveys	1	High	High
Yellow-breasted Chat	*Icteria virens*	BBS	4	None (Low-40yr)	High
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	BBS	1	Moderate	High
Yellow-rumped Warbler	*Setophaga coronata*	BBS or CBC+1	2	High	Low
Yellow-throated Vireo	*Vireo flavifrons*	ON Atlas+1	1	High	High

GAP AND RISK ANALYSIS OF MONITORING NEEDS TO DELIVER EC PROGRAM OUTCOMES

1. LANDSCAPE CONDITIONS ACCOMMODATE MIGRATORY BIRD REQUIREMENTS

***Need for Monitoring Data*:** 1 – EC needs to identify priority bird species in each major landscape through information on distribution, relative abundance and trends, monitored with sufficient frequency to distinguish natural variation from problem declines while the species is still common, and to indicate whether change in landscape conditions is a probable cause. 2 - For priority species, EC needs sufficient data on their distribution, habitat requirements, and probable causes of population change to influence others to expend resources to effectively address their conservation needs and to evaluate the success of actions.

***Subcategories*:** Considered from the perspective of 7 regions: Arctic (BCR 3); Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12); Marine coasts (west and east coasts); Western mountains (BCRs 5, 9, 10); Prairies (BCR 11); Great Lakes - St Lawrence (BCR 13); and Maritimes (BCR 14).

***Gaps*: Moderate** to **High** gaps exist in monitoring data for one or more bird groups in all regions except the Great Lakes – St. Lawrence, even from the perspective of identifying priority species. Gaps may often be greater from the perspective of effectiveness monitoring, but were not considered in this analysis, because they need to be evaluated in the context of individual actions and activities.

***Risks*:** The overall risk was considered **High** in the boreal forest region, especially from the perspective of landbirds, which are very poorly monitored and include a large number of species. The main reasons are extensive development pressure in many parts of the boreal (energy, mining and forestry) and a lack of data for overall prioritization and strategic planning. Data are lacking for contextual analysis of environmental assessment from individual projects, to do strategic planning, or to evaluate potential cumulative impacts. Data are also insufficient to assess impacts of management activities, to determine when mitigation might be required, and to design appropriate mitigation if required. The highest risks are biological, but some economic and credibility risks also exist: *B-d* **High** – Risk of being unaware which species are declining until severe losses are evident and require dramatic and expensive action; *B-c* **High** - Uncertainty about priority species could lead to inappropriate or inadequate management of development activities and limited ability to influence others because of lack of data. *E-b* **Moderate** - Risk of inappropriate burden on industry if species listed as at risk when they should not have been, due to inadequate or inappropriate data. Also moderate economic and credibility risk: *E-c* **Moderate** - Some risk of inefficient use of conservation dollars, if uncertainty leads to a focus on regions that are not the highest priority, and somewhat lower risk to EC, because limited spending on conservation actions in region; *C-n* **Moderate** - NGO objections that Environmental Assessment, etc. not based on sufficient information; *C-d* **Moderate** - Risk that developers will argue that no need to restrict or limit development, because inadequate data to prove it will adversely impact bird populations.

Risks for this outcome (landscape management) were identified as **Moderate** for one or more bird groups in the Arctic (for shorebirds), the Western mountains (for landbirds and migrating shorebirds), the Prairies (for shorebirds, including migrating species on stopovers, and several groups of waterbirds), and in the Maritimes (for marshbirds). The categories of risk were similar to those for the Boreal.

***Mitigation of Risk*:** For areas or species groups lacking current long-term monitoring programs (many of which are remote and difficult to access, especially in the Boreal and Arctic), strategically planned periodic inventories (e.g., as part of breeding bird atlases) combined with habitat and distributional modelling to estimate distribution in gaps, should be evaluated as a potentially cost-effective way to meet needs related to this particular outcome. This approach would also provide valuable data for future planning of longer term monitoring programs required to reduce risk for other outcomes.

2. INCIDENTAL TAKE IS MINIMIZED AND LONG-TERM CONSERVATION IS SUPPORTED

***Need for Monitoring Data*:** EC requires monitoring data to identify and prioritize sources of incidental take and to evaluate the effectiveness of options for reducing incidental take or implementing mitigation options to offset impacts. Required data include information on numbers of birds impacted by the sector and how this is changing over time, estimates of population size, and trends in population size to determine whether negative population level impacts are likely.

***Subcategories*:** Forestry (i.e., all large-scale tree removal), agriculture, fisheries, collisions, destruction of birds or nests from linear developments (roads, seismic lines, transmission lines), and other sources of mortality (e.g.,

cats, but not hunting). To assess cumulative impact of these industries, it is noteworthy that the scale of monitoring required varies among these categories, from the largest flyway level to the scale of the individual fishery.

***Gaps*:** This category did not include any gaps of the highest category, but there were many **Moderate** level gaps spread across the birds groups. For every species group that was likely to be impacted by activities in one of the sectors (i.e., the subcategories listed above) the gap was considered to be **Moderate;** very few of these gaps were considered low or absent**.** For example, the impact of linear structures showed **Moderate** gaps for all but the marine species; so all but the marine species were likely to be impacted by linear structures, and all of those gaps were considered to be **Moderate**. All activities (subcategories) showed **Moderate** gaps for a subset of the species groups.

***Risks*:** Without information on species status and trend, EC will be unable to a) prioritize activities effort to develop and communicate best practices, and b) evaluate the impact of incidental take and the effectiveness of mitigative measures.

Of the large number of Moderate level gaps described above, forty percent were deemed to be of **Moderate** risk. For the Moderate gaps in the forestry context, they were deemed **Moderate** in risk for landbirds due to the large number of species, but lower for other species groups. In the agriculture sector, moderate gaps were deemed **Moderate** risk for prairie landbirds and some shorebirds. For fisheries, **Moderate** risk was predicted as a result of gaps for pelagic seabirds and other waterbirds. In the context of collisions (for which all but one bird group showed a Moderate gap), the gaps for landbirds and marsh waterbirds were deemed to carry the highest risk. For linear structures the gaps for landbirds and marsh waterbirds were similarly deemed to be **High** risk. Finally, gaps in monitoring data to support guidance for mitigating other sources of incidental take (e.g., cats) were deemed highest for landbirds, some shorebirds and marsh waterbirds. All other identified gaps were deemed to hold **Low** or **Very Low** risk.

For all subcategories, the risks were focused in 4 areas**:** 1) biological *B-d* - Risk that species may be declining due to inappropriate management due to lack of monitoring to evaluate management effectiveness, but lacking information to evaluate, 2) economic *E-b* - Risk of imposing unnecessary burden on industry to manage for species that may not require special management, and *E-c* - Risk that some conservation efforts to protect species may be ineffectively used for species not requiring management, and 3) credibility *C-i* - Risk of criticism from other international governments or agencies (e.g., UN-FAO), including international treaty partners (U.S.A.), and 4) legal *L-a* - Risk that EC cannot defend its actions in court actions alleging failure to implement the MBCA (1994).

***Mitigation of Risk*:** Ideally, monitoring information would allow estimation of both the magnitude of impact from each sector on a species by species basis, and population trends of those species to determine whether they are having an impact. The most important information for decision making relates to the magnitude of impact by sector, which can be estimated through an appropriate research program (currently underway) to estimate mortality rates. This would allow effective decision making to prioritize conservation actions; follow-up monitoring of changes in mortality would be appropriate if actions are implemented. Estimates of population size, by species, which could be estimated through broad-scale surveys focusing on bird-habitat relationships, combined with habitat maps, could be combined with demographic models to estimate likely population level impacts.

3. THREATS TO MIGRANTS IN OTHER COUNTRIES ARE REDUCED.

***Need for Monitoring Data*:** In order to effectively engage other countries in treaties and conservation planning, EC needs to identify priority species and quantify migratory links to other countries.

***Subcategories*:** This was evaluated in 3 geographical subcategories: the United States of America; Latin America and the Caribbean; and Europe, Asia and Africa.

***Gaps*: High** for boreal landbirds, Arctic shorebirds and inland colonial waterbirds in Latin America and Caribbean, due to lack of information on limiting factors and associated trends in the area, as well as a lack of waterbird distribution information. **Moderate** for most other species groups in Latin America and Caribbean and to a lesser extent in USA and Europe, Asia and Africa.

***Risks*:** The overall risk was considered **High** for Arctic shorebirds and boreal landbirds in Latin America and the Caribbean. There is a clear possibility that some species, which are apparently declining strongly, may be limited

on stopover or wintering areas in Latin America and Caribbean, but EC currently lacks data to influence, prioritize and guide conservation efforts in this region. Furthermore, lack of accurate information on limiting factors may result in inefficient conservation efforts if they are not directed toward the source of the issues.

The highest risks for Arctic shorebirds were biological and economic: *B-d* **High** - Some species may continue to decline because of lack of appropriate actions in wintering / stopover areas; risk is high because many species have strong apparent declines, *B-i* **High** - Insufficient data to identify most critical conservation actions and to persuade international partners to take appropriate action, *E-c* **Moderate** - Conservation actions to protect shorebirds may be taken in less appropriate areas.

The highest risks for boreal landbirds were also biological and economic: *B-d* **High** - Declining species may continue to decline if appropriate action not taken, *B-i* **High** - Reduced ability to influence other governments to conserve birds (although this may be only partially limited by monitoring data), *E-b* **High** - May be imposing a substantial burden on Canadian industry to conserve breeding habitat for species which are actually limited on wintering grounds, although improved breeding habitat likely to benefit some species, *E-c* **Moderate** - May direct resources to inappropriate areas, although any conservation actions in Latin America and Caribbean are likely to benefit at least some priority species.

Risks for a large proportion of other bird groups were **Moderate** in Latin America and Caribbean. Categories of risk are generally similar to that of Arctic shorebirds and boreal landbirds. In other geographic categories risks are **Moderate** for Arctic shorebirds in the USA because population declines could be exacerbated by lack of appropriate action, and by a reduced ability to influence management at stopover sites in USA because of uncertainty of magnitude and causes of declines. Risks were also **Moderate** for sea ducks in Europe, Asia and Africa due to the fact that combined harvest in North America and elsewhere may be unsustainable, some species may decline because of lack of appropriate actions internationally, and because EC lacks sufficient data to persuade international partners to take appropriate action.

***Mitigation of Risk*:** Generally, a better understanding of population trends and research on causes of declines and limiting factors are both required to substantially reduce the risk. For prairie landbirds, given the amount of habitat that has been lost or converted in both breeding and wintering areas, it may be more cost effective to take management actions to protect habitat at all stages of life cycle, rather than to spend a lot of resources trying to identify causes of declines, which may still have considerable uncertainty; this is likely to benefit other species as well. For some species, improved distributional information in wintering areas would allow improved decision making, thus reducing risk. Monitoring activities do not always need to be implemented outside of Canada for this program outcome (e.g., population trend data can be collected at any stage of the annual cycle but there may be circumstances that make it easier to collect at certain times or in certain areas). The most efficient location for monitoring activities should be determined on a case-by-case basis.

4. MIGRATORY BIRD HARVESTS ARE MAINTAINED AT SUSTAINABLE LEVELS

***Need for Monitoring Data*:** Provides a scientific basis for setting effective regulations to sustain appropriate level of harvest and populations at or near objectives. Legally, there is also a need for sufficient understanding of harvest to assign game species to appropriate subcategories below.

***Subcategories*:** Overabundant waterfowl, heavily-hunted species and those with concerns about harvest allocation, species with substantial harvest but no allocation concerns, lightly-harvested species, species that are harvested but with little information on impact, and species harvested for Aboriginal subsistence use.

***Gaps*:** This category did not include any monitoring gaps rated as **High,** but there were a small number of important **Moderate** level gaps. These were evident for several groups of species for which the impact of harvesting is unknown, namely game species of landbirds, marsh waterbirds and sea ducks. For heavily hunted species, the **Moderate** gap for sea ducks was notable. Among the lightly-harvested species, where harvest is presumed to be of low impact, the important gap was for other waterbirds. Finally, the largest number of **Moderate** gaps was related to the poorly-measured harvest by Aboriginals of seabirds, other waterbirds (i.e., loons, grebes, cranes), and all waterfowl species. This result highlights that gaps in monitoring are extensive for species taken by Aboriginal people, and for most sea ducks in general.

***Risks*:** The risks related to harvesting were judged highest (at the **Moderate** level) for those species for which the impact of hunting is uncertain, i.e., for game species of landbirds and some waterfowl. In this case the risk was identified as legal *(L-r* -Risk of legal challenges that regulating a hunt without sufficient information on impact,

especially if any species are declining), biological (*B-t* -Risk that excessive hunting could be leading to some declines), and economic (*E-b* -Some risk that unnecessary restrictions could be applied to the hunting industry, especially if species are inappropriately listed due to inadequate information). The other area of **Moderate** risk was the absence of monitoring data for managing harvests of sea ducks, which fell in the heavily-harvested and uncertain impact categories. In this case, the risks are legal (*L-r* -Risk of challenge to hunting and *L-t* -Risk of challenges in negotiating treaties), biological (*B-t* -Risk of excessive combined take [Canadian permitted, international, aboriginal] leading to declines), and credibility (*C-a* -Risk aboriginal harvest could be impacted if regulated take is unsustainable; risk of criticism for making decisions that influence aboriginal harvest with inadequate data, and *C-i* -International - risk of criticism from other international governments or agencies for failing to manage harvest, or for requesting changes in harvest without solid data). The remaining monitoring gaps were felt to hold **Low** or **Very Low** risk related to harvest management.

***Mitigation of Risk*:** In most cases, risks can only effectively be mitigated through monitoring, ideally of harvest rates, survival rates, and of population size, all of which are necessary to evaluate impacts of harvest and optimize harvest rates. Increased collaboration with other countries sharing harvested species, and additional harvest surveys of take in land claims, could allow for better regulation of some species. Within Canada, closure of hunting seasons would eliminate some risks, but would carry its own economic and credibility risks. If some monitoring information is not available (e.g., survival rates, or lower precision on population estimates), then risks can be somewhat mitigated by more conservative regulation of harvest (e.g., reducing quotas).

5. Priority sites for Migratory Birds are protected and improved

***Need for Monitoring Data*:** To identify important bird areas that warrant formal mechanisms of protection. For long-established protected areas, there is also the need to determine if they still are important for migratory birds.

***Subcategories*:** None

***Gaps*: Moderate** gaps for Arctic and boreal landbirds, as basic information on distribution is not available for many areas. Gaps for other species groups are **Low**, and the case of some waterfowl there are no apparent gaps to meet this need. This need mainly requires distributional data, rather than monitoring per se, so the gaps are relatively few.

***Risks*:** The overall risk was considered **Moderate** in the boreal forest region for landbirds, as insufficient data are available to identify the most important habitats for landbirds in the boreal. Within existing protected areas, the risk for boreal landbirds is **Low**. The highest risks for boreal landbirds were biological and economic *B-d* **Moderate** - Risk of declines due to failure to prioritize important areas for protection and *E-c* **Moderate** - Risk of directing conservation efforts to lower priority areas.

Otherwise risks were considered **Low** for most other species groups, and **Very Low** for well monitored waterfowl groups. It is noted that if conservation actions are being implemented on protected areas for migratory birds, increased monitoring will be needed to determine their efficacy (thereby increasing the gaps and risks – depending on the scale of the activity).

***Mitigation of Risk*:** Periodic inventories (e.g., breeding bird atlases) combined with habitat and distributional modelling would likely be the most cost-effective way to reduce risk for species and areas currently lacking long-term monitoring (e.g., the Boreal and the Arctic), by helping to identify critical habitats and important regions, and may provide more appropriate data to identify important bird areas that warrant formal mechanisms of protection.

6. Population-level effects of toxic substances are reduced

***Need for Monitoring Data*:** To be able to influence regulations and control the release of toxins into the environment so that impacts on migratory bird populations are minimized. To evaluate effectiveness of regulatory and policy initiatives related to toxins impacting migratory birds populations, by determining whether bird populations respond to these initiatives.

***Subcategories*:** This was evaluated in three specific areas: chronic oil pollution, pesticides, and lead shot and sinkers; a general assessment was made for other compounds.

***Gaps*:** A variety of gaps are present for this outcome. **High** gaps for shorebirds are apparent in relation to pesticides. **Moderate** gaps are present throughout most bird groups except waterfowl, with waterbirds having a notably large number of monitoring gaps to fill monitoring needs related to this outcome. Gaps exist in the precision of population trend data (with a corresponding inability to assign any declines to one source) and a lack of understanding of the impact of certain toxins (i.e., pesticides) on birds.

***Risks*:** The largest risks relate to pesticides (**Moderate**), due mainly to the unknown impacts these chemicals may be having on bird populations, especially outside of Canada. Landbirds, shorebirds and waterbirds are all identified as at **Moderate** risk from pesticides. These risks are largely biological: *B-d* **Moderate** - Risk of declines due to pesticides that are not properly managed, *B-c* **Moderate** - Reduced ability to influence pesticide management with insufficient data on impacts, and *B-i* **Moderate** - Reduced ability to influence pesticide management internationally due to insufficient solid data on impacts. There is also some economic risk, *E-b* **Moderate** - Potential significant economic impact on forest management in Canada, with respect to regulation of insecticide use (net costs of applying or not applying insecticides, as well as impact on harvest).

Risks for waterbirds are **Moderate** for other toxins, largely due to the poor information available for these species. These risks are biological and similar to those for pesticides. Current risk for chronic oil pollution and lead poisoning are **Low**.

***Mitigation of Risk*:** For pesticides, the toxic chemicals that present the largest risks, targeted research to assess impacts on various species-groups that have some risk will mitigate the need for monitoring to some degree. However, precise population estimates or annual monitoring to estimate population trends would still be needed to demonstrate population-level (rather than individual-level) impacts, if that was required to influence regulation of the chemicals, both for pesticides and for other toxins presenting risks.

7. Populations of Migratory Birds under particular threat are conserved

***Need for Monitoring Data*:** This outcome reflects actions taken by EC or its partners to conserve migratory birds when faced with an emerging or imminent threat. Most impacts of this nature are highly localized and general monitoring data are not a large component when responding to threats, but some information on context and effectiveness of response is often required. Recent inventory data is usually sought early when responding to threats that appear suddenly (e.g., emergencies and disease outbreaks). Local monitoring is needed when the effectiveness of a response needs to be evaluated, while general monitoring can inform which species should be given special consideration in planning a response to threats.

***Subcategories*:** This was evaluated in two specific areas; emergency response and, and predator control. It was felt that assessing a general threat category was not possible, as the range of possible threats is so great to make generalizations impossible.

***Gaps*:** Most waterbirds and seabirds have **Moderate** gaps for emergency responses, as the data needs for effective response are at local scales, i.e., smaller spatial scales than the level of data collection. Gaps for predator control are **Low**.

***Risks*:** As with the gaps, the largest risks are with waterbirds and seabirds (**Moderate**), as data requests on migratory bird populations in the impacted area will almost certainly be received. These risks are largely biological: *B-d* **Moderate** - Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority. There is some risk of spending excessive effort on mitigating a disaster that has low risk to birds, but most disasters require clean-up anyway for other societal values.

Current risks related to predator control are **Low**, unless an active predator control program were implemented. In that case, intensive local monitoring would be needed to measure the effect of the program on the predator and prey.

***Mitigation of Risk*:** The risks remaining for waterbirds and seabirds for emergency responses and disease outbreak can be largely mitigated by conducting real-time on-site surveys in the impacted area. Research on bird movements (e.g., using telemetry) can also inform on the migratory bird use of a particular site.

8. MIGRATORY BIRDS IN LAND CLAIM AREAS ARE CONSERVED

***Need for Monitoring Data*:** Obligation to ensure migratory bird conservation is undertaken in Land Claim Agreements, as these are long-term commitments. Monitoring is used to highlight priority sites and priority species (e.g., declining species) that may warrant special consideration when negotiating the land claim. Recent inventory data are generally most important for ensuring priority sites in the land claim are identified, but monitoring data can be used to provide larger-scale context for discussions related to migratory birds and their use (notably game birds).

***Subcategories*:** None

***Gaps*:** All species-groups except waterfowl have **Moderate** gaps for this need. These gaps are largely due to the smaller spatial scales of the land claim, compared to the resolution of the monitoring data.

***Risks*:** Unlike the gaps, there remains **Low** or **Very Low** risk for negotiating land claims. This is due to the relatively high level of these agreements, whereby specific migratory bird concerns are generally not mentioned. Overall wildlife issues tend to be well considered in land claim agreements, and migratory bird issues are not likely to go unnoticed, regardless of the state of migratory bird monitoring data.

***Mitigation of Risk*:** The low risks leave little requirement for mitigation, but harvest surveys within land claim areas could provide information on take in these areas, which would allow for better regulation of species taken.

9. THREATS DUE TO MIGRATORY BIRDS TO PUBLIC AND ECONOMY ARE REDUCED

***Need for Monitoring Data*:** Monitoring data are needed to determine the location and extent of threats, and the effectiveness of control measures being implemented. General monitoring information is used to assess whether a species can absorb losses due to control measures.

***Subcategories*:** None

***Gaps*:** The poorly monitored shorebirds and marsh birds have a **Moderate** gap for this need, as basic trend and distributional data are lacking. Gaps are **Low** for other species.

***Risks*:** Overall, there are **Low or Very Low** risks for this need. Most often implicated are waterfowl (related to crop damage, airport strikes, nuisance issues, and transmission of zoonotic diseases) and gulls (airport strikes, nuisance issues). Shorebirds and marsh birds only rarely (if ever) present a threat to the public and economy, while gulls and waterfowl are well-monitored (especially in developed areas).

***Mitigation of Risk*:** Current information on population sizes for species involved, combined with the low remaining risks for decision making, mean that little mitigation is necessary. If control measures are required for species with uncertain data, then use of non-lethal control measures (e.g., scaring birds away from areas of concern), would minimize the risk of any impacts on migratory bird populations, thus mitigating the need for improved monitoring. In the case of significant uncertainty about impacts of birds, research on the interactions between birds and the public (e.g., telemetry work to study movements) and on the most effective ways to affect their behaviour, may be more effective than improved monitoring.

10. AVIAN SPECIES AT RISK ARE ASSESSED, IDENTIFIED AND LISTED

***Need for Monitoring Data*:** The basis for joint General Status and COSEWIC assessment of population status of birds, within the broader need to assess all wildlife in Canada, with provinces and territories, to set priorities for further identification of Species at Risk. Data requirements for Species at Risk recovery were not addressed through this process, as necessary analyses to support the recovery of each species would be too specific to consider at a generic level. SAR recovery monitoring gaps and associated risks should be addressed through a separate SARA-based process with species level focus.

***Subcategories*:** None

***Gaps*:** This intermediate outcome contains the greatest proportion of **High** and **Moderate** gaps of all outcomes. There are **High** gaps for all landbirds except prairie landbirds, for all seabirds except colonial species, for Arctic

and boreal shorebirds, and for marshbirds. Every other bird group has **Moderate** gaps, with the exception of swans and geese, and other waterfowl, which have **Low** gaps. Gaps are mainly due to poor trend information, with the highest gaps representing the largest proportions of species with poor to very poor trend information.

Risks**:** There are considerable risks associated with gaps in monitoring for species assessment and status identification in Canada. Risks were considered to be **High** for other landbirds and for Arctic shorebirds. In the case of landbirds, there are many species in British Columbia with poor trend information which face important threats (forestry, urban development, climate change); there is thus a **High** risk of mistakes in listing (e.g., failing to list species that meet criteria). In the case of Arctic shorebirds, the likelihood of making erroneous listing decisions is high and could have substantial consequences. Five shorebird species are currently COSEWIC candidates and given the poor monitoring data for these, their status could be mis-categorized. Weak data would also limit recovery planning for listed species. Risks are mostly biological and economic: *B-d* failure to list species that meet criteria, due to lack of data could reduce opportunities for their conservation, both in Canada and elsewhere; even if species are listed, limited data could reduce effectiveness of recovery measures, *B-i* weak data to support listing, or failure to list species that deserve it, could reduce ability to influence international partners in conservation, *E-b* - incorrectly listing species could lead to increased burden on industry, *E-c* - listing species that do not require listing could lead to wasted resources in developing plans (e.g., recovery plans, defining critical habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized, *C-i* - risk of international criticism if species listed based on data that others perceive as inadequate.

Species groups with **Moderate** risks are boreal and prairie landbirds, pelagic seabirds, all other shorebirds, marshbirds, and sea ducks. In these cases, incorrect decisions based on poor data could have biological and economic consequences. Risks associated with sea duck assessment also include credibility and legal risks. These include the potential for significant impacts on aboriginal harvest issues, including risk of legal challenges for allowing harvest on declining species.

Mitigation of Risk**:** The most effective way to mitigate these risks is to develop programs that provide reliable range-wide trend estimates for each species. In some cases, reliable, one-off population estimates could help to reduce the risk, pending the development of longer-term trend information. Implementation of programs such as Arctic PRISM, an expanded Marsh Monitoring Program, and a range-wide boreal monitoring program would reduce the risk for those categories with the highest risks.

GAP AND RISK ANALYSIS BY BIRD GROUP

LANDBIRDS

Subcategories**:** Landbirds were assessed in four categories based on geography: Arctic, boreal, prairie and "other" regions. The "other" category encompassed both well monitored areas (Great Lakes - St Lawrence - BCR 13; Maritimes - BCR 14) and less well monitored areas (Western mountains - BCRs 5, 9, 10).

Gaps**:** The biggest gaps were for Boreal landbirds, which had **High** gaps for landscape management, reducing threats in other countries (especially Latin America and the Caribbean), and for SAR status assessment, as well as **Moderate** gaps for incidental take and several other needs. Arctic landbirds and western mountain birds both had **High** gaps for SAR assessment, and **Moderate** gaps for landscape management, incidental take management, reducing threats in other countries and some other categories.

Risks**:** The overall risk was considered **High** for boreal forest birds, especially for landscape management in the region, as well as for managing threats outside Canada, especially in Latin America/Caribbean, and for SAR assessment. The reasons for the **High** classification include the large number of species involved, extensive development pressure in many parts of the boreal (energy, mining and forestry), lack of data for overall prioritization and strategic planning, as well as extensive threats to many species in Latin America/Caribbean, but lack of data to confirm where limiting factors may occur and to identify appropriate conservation actions. There are biological, economic and credibility risks associated with this gap. The highest risks are biological: *B-d* **High** – Risk that unaware which species are declining until severe losses require dramatic and expensive action; *B-c* **High** - Uncertainty about priority species could lead to inappropriate or inadequate conservation actions and management of development activities and limited ability to influence others because of lack of data; *B-i* **High -** Reduced ability to influence other countries to conserve birds due to limited data, and lack of knowledge of appropriate actions and priority region. Also moderate economic and credibility risk: *E-b* **Moderate** - Risk of inappropriate burden on industry if species listed as at risk when should not have been, due to inadequate or

inappropriate data. *E-c* **Moderate** - Some risk of inefficient use of conservation dollars, if focus on regions that are not highest priority - somewhat lower risk to EC, because limited spending on conservation actions in region; *C-n* **Moderate** - NGO objections that Environmental Assessment, etc. not based on sufficient information; *C-d* **Moderate** - Risk that developers will argue that no need to restrict / limit development, because inadequate data to prove it will adversely impact bird populations.

Risks were also considered **High** for western mountain landbirds, especially from the perspective of SAR assessment, as many species have very poor data. The categories of risk were similar to those for the boreal. For Arctic landbirds, despite large gaps, the risks were considered **Moderate** because fewer species are involved, development pressures are less in the Arctic and less likely to strongly influence landbirds, and most species winter in Canada or the USA where better information is available. Information gaps for all landbirds present **Moderate** risk with respect to incidental take, especially for collisions, linear structures, and cats, as lack of information to prioritize and assess mitigation actions presents biological risks (that species declines may not be effectively prevented), and economic risks (unsustainable development and/or unreasonable burden on industries that are not having large impacts).

***Mitigation of Risk*:** For boreal landbirds, the most effective way to reduce risk would be to implement a national boreal landbird monitoring program, combined with research / monitoring on connectivity with Latin American/ Caribbean migration and wintering areas. The risk could be somewhat reduced with a combination of habitat and distributional modelling based on existing data, combined with extensive distributional surveys in areas that have not been surveyed (e.g., via period inventories such as breeding bird atlases). This would also provide valuable data for design and development of a longer term monitoring program. For western mountain birds, the mitigation measures are largely similar to those for boreal landbirds.

SHOREBIRDS

***Subcategories*:** Shorebirds were divided in three categories, based largely on whether they were found breeding in Canada. Arctic shorebirds and boreal shorebirds were generally monitored at migration stopover sites in Canada or on wintering grounds in Central and South America. Other shorebirds are more southerly breeders and can be monitored by the Breeding Bird Survey or specialized SAR surveys.

***Gaps*:** The **High** gaps for shorebirds were in SAR status assessment, impacts of toxic substances (pesticides), threat to migrants in other countries, and landscape management (Arctic and boreal or northern forest). **Moderate** gaps were noted in all other relevant program outcomes, with the exception of landscape management in the Great Lakes-St. Lawrence and Maritimes BCRs, harvest management, and priority site designation and management which had **Low** or no gaps.

***Risks*:** The overall risk was considered **High** for Arctic shorebirds. This assessment was driven by a **High** risk in threats to migrants in Latin America and Caribbean and in SAR status assessment. The reasons for the **High** classification include the possibility that some species, which are apparently declining strongly, may be limited on stopover or wintering areas in Latin America and Caribbean, but EC lacks data to influence, prioritize and guide conservation efforts, and mistakes in listing are likely and could have substantial consequences. Five species are currently COSEWIC candidates and it is believed their status could be mis-categorized based on current low quality information. Weak data also limit recovery planning. These risks are biological, economic and credibility: *B-d* **High** - Some species may continue to decline because of lack of appropriate actions in wintering or stopover areas; risk is high because many species have strong apparent declines, failure to list species that meet criteria, due to lack of data could reduce opportunities for their conservation, both in Canada and elsewhere; even if species are listed, limited data could reduce effectiveness of recovery measures *B-i* **High** - Weak data to support listing, or failure to list species that deserve it, could reduce ability to influence international partners in conservation, *E-c* **High** - Listing species that do not require it could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized. Conservation actions to protect shorebirds may be taken in less appropriate areas. *E-b* **High** - Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit, although wetland habitats often protected under other legislation anyway. *C-i* **High** - Risk of international criticism if species listed based on data that others perceive as inadequate.

Moderate risks exist for one or more of the three shorebird categories under various program outcomes: landscape management (all BCRs except 13, 14 and marine coasts), incidental take (agriculture and other

threats), threats to migrants in other countries, impacts of toxic substances (pesticides), and SAR status assessment.

***Mitigation of Risk*:** Mitigation of risks for shorebirds should be concentrated in two areas: better overall monitoring of trends for Arctic and boreal species, and research to understand causes of declines and inform conservation actions to stop and reverse apparent population declines. Implementation of the Arctic PRISM program will, in time, reduce risks for Arctic shorebirds, particularly as they relate to SAR status assessment and landscape management. However, trend information will not be available until two complete PRISM cycles are completed, a process which could take 15 years or more. Improvements to migration monitoring may allow a more robust assessment of trends for Arctic and boreal shorebirds under shorter timelines; evaluation of improved methods is a priority need. It will nevertheless be several years before accurate trend information is available for most shorebird species. Given this reality, EC should be proactive and initiate research to understand causes of declines and critical life stages at which species are affected. This research should be targeted at species for which evidence of declines is strongest, even if uncertain. Initiating this research soon would ensure that actions could be taken on species before SAR listing becomes necessary (more cost-effective), and that if species require legal protection under SARA, EC would possess sufficient information for recovery planning.

SEABIRDS

***Subcategories*:** Seabirds were assigned to three categories based largely on whether they were found breeding in Canada. Colonial seabirds were birds generally monitored at coastal colonies in Canada. Pelagic seabirds are birds which can only be monitored at sea in Canada, which includes some Canadian breeding birds during the non-breeding season. A third 'other seabird' category was included to account for dispersed nesting species that breed in Canada (e.g., jaegers).

***Gaps*:** The biggest gap was in SAR status assessment, which had a **High** gap for pelagic and other seabirds, and a **Moderate** gap for colonial-nesting seabirds. **Moderate** gaps were noted for marine seascape planning, threats in other countries, chronic oiling, impacts of toxins, emergency response and land claims for pelagic and other seabirds. For incidental take related to fisheries bycatch and collisions, a **Moderate** gap existed for all seabirds potentially impacted.

***Risks*:** In spite of the variety of moderate monitoring gaps presented for seabirds, there are relatively few remaining risks. A **Moderate** risk remains for pelagic seabirds for incidental take from fisheries bycatch, threats to migrants in Latin America and Caribbean, emergency response and SAR species assessment. This is largely due to relatively coarse scale of pelagic data, which rarely can provide site-specific information, and only gross trends can be estimated with the data. These risks are largely biological: *B-d* **Moderate** - Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority, *B-i* - Reduced ability to influence management outside of Canada, *B-d* **Moderate** - Lack of data on numbers of birds taken by fisheries could lead to declines in poorly-monitored species, *B-i* **Moderate** - Insufficient information could reduce ability to influence other countries to take appropriate conservation actions, *B-d* **Moderate** - Failure to list species that meet listing criteria, due to lack of data, could reduce opportunities for their conservation, both in Canada and elsewhere, *B-i* **Moderate** - Weak data to support listing, or failure to list species that deserve it, could reduce ability to influence international partners in conservation. There is some credibility and economic risk, *C-i* **Moderate** - Risk of international criticism if species are listed based on data that others perceive as inadequate, *C-i* **Low** - Risk of criticism from other international governments or agencies (e.g., UN-FAO), including international treaty partners (USA) though risk somewhat reduced because actions being taken anyway, *E-c* **Moderate** - Listing species that do not require it could lead to wasted resources developing plans (e.g., recovery plans, defining critical habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized.

The lack of risks for other seabirds is generally due to their dispersed and remote nesting habitat, which is currently assumed to be under limited or no threats, and the relatively few species in the group. Colonial seabirds tend to be relatively well-monitored and also well understood, and this understanding of their biology has helped to drive effective conservation planning and management of colonial seabirds, even when monitoring data are lacking.

***Mitigation of Risk*:** For seabirds, residual risk largely lies with species that do not breed in Canada; which can only be monitored with pelagic data. The most effective method to mitigate that risk is to enable and encourage monitoring on breeding colonies outside Canada, so that rigorous population trend data can be obtained and made available to the international community. Due to the large variability in the data, pelagic monitoring

programs will never provide trend information better than that obtained from an appropriate colony survey program. Some of the risks due to the lack of spatial coverage in the pelagic data can be mitigated with the development of robust habitat-bird use models that can predict bird use with some ability. Risks from incidental take can be mitigated with proper bird bycatch data collection programs. For colonial seabirds for which total population size is also estimated, robust estimates of total take have much more direct use than trend data which may, or may not, be a reflection of the impact of the take. Mitigation techniques are also available for reducing take in fisheries, including gear modifications, and time and area closures in areas of high seabird concentration.

WATERBIRDS (INLAND/MARSHBIRDS)

***Subcategories*:** Waterbirds were assigned to three categories of quite different birds. Inland colonial birds include freshwater breeding gulls, terns and long-legged waders (herons, egrets, etc.). The cryptic marshbirds (mostly rails) made up the second category. The final category was an 'other' category which captured birds such as loons, grebes and cranes.

***Gaps*:** Important monitoring gaps were apparent in all three categories of waterbirds, largely due to the limited or lack of systematic monitoring for this group. **High** gaps were present for inland colonial birds as they relate to threats in Latin America (little information on trends and distribution in these countries); **Moderate** gaps existed for landscape planning (boreal and the prairies), various sectors within incidental take, emergency response, land claims and SAR listing. Three **High** gaps were present for the marshbirds, landscape planning in the boreal forest impacts of pesticides, and SAR status assessment. **Moderate** gaps were present for almost every other relevant need for marshbirds, including harvest management of the rails. A wide range of **Moderate** gaps were present for the other waterbirds, similar to those seen for marshbirds.

***Risks*:** In terms of risks, the marshbirds had numerous **Moderate** risks remaining. These ranged from landscape planning in the boreal, prairies and the Maritimes, incidental take due to collisions and linear structures, threats in Latin America, impacts of pesticides and other substances, emergency response and SAR status assessment. For other waterbirds, **moderate** risks were present for incidental take from fisheries, threats in Latin American and Caribbean, pesticides and other toxins and emergency response. For inland colonials, **Moderate** risks were present for landscape planning in the prairies, threats in Latin America and emergency response.

The remaining risks are largely biological and extensive: *B-d* **Moderate** - Some species may decline because of inappropriate prioritization of wetlands for conservation actions, *B-i* **Moderate** - Insufficient data to persuade international partners to take appropriate action, *B-d* **Moderate** - Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority, *B-c* **Low** - Some risk of spending excessive effort on mitigating a disaster that has low risk to birds (but most disasters require clean-up, etc. anyway for other values). *B-d* **Moderate** - Risk that species may be declining without adequate management, *B-d* **Moderate** - Risk that collisions may be causing declines in some species, but lack data to identify appropriate mitigation actions, *B-c* **Moderate** - Insufficient data to influence others to take mitigation actions, even if potential actions are known, *B-d* **Moderate** - Insufficient information to determine whether cats are having population level impacts, *B-c* **Moderate** - Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts, *B-d* **Moderate** - Some species may decline because of lack of appropriate actions in wintering areas, *B-d* **Moderate** - Risk that pesticides could be causing or exacerbating declines, but insufficient data to take appropriate actions, *B-c* **Moderate** - Insufficient information to influence others to take appropriate action to reduce impacts of toxic substances, *B-d* **Low** - Risk that toxic substances could have population level impacts on some species without being detected, *B-d* **Moderate** - Failure to list species that meet criteria, due to lack of data could reduce opportunities for their conservation,

There are a few economic risks with waterbirds as well, *E-b* **Moderate** - Potential to be imposing unreasonable burden on developers in some sectors that are having relatively lower impact than other sectors that are not well understood, *E-b* **Moderate** - Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit, although wetland habitats often protected under other legislation, *E-c* **Low** - Conservation efforts could be more cost-effective, with better information to direct planning.

To summarize, many of these risks relate to the poor state of knowledge of these species, in terms of distribution, status and trends. Without this basic information, it is challenging to focus decision-making and prioritizing activities on the species most in need of conservation actions.

***Mitigation of Risk*:** Mitigation of most risks involves improved monitoring of status and trends for most species. For certain outcomes, targeted research may alleviate some risk, such as assessing the impacts of certain

sectors on waterbirds (e.g., are they vulnerable to various forms of incidental take or toxins?). Due to their dependence on freshwater systems which are under high development pressure, any decisions which retain or improve wetland habitat would likely benefit these species. In the absence of range-wide monitoring, improved monitoring in areas subject to management activities would help to evaluate the effectiveness of management for those species, preferably combined with targeted research to identify whether there are problems outside of the breeding season).

WATERFOWL

***Subcategories*:** Waterfowl were assigned to three categories based on generalized macro-habitat/landscape use and its implications for monitoring: 1) geese and swans – large-bodied grazers, largely Arctic-nesting, 2) ducks (other than sea ducks) – mainly "southern" nesting species in relatively well-surveyed areas, and 3) sea ducks – mainly boreal, taiga and Arctic-nesting species which tend to winter in near shore marine zones.

***Gaps*:** The largest monitoring gaps for waterfowl related to sea ducks, which showed **Moderate** gaps for Landscape Management in the Arctic, incidental take by fisheries and collisions, potential for detecting threats in other countries (Europe, Asia and Africa), managing sustainable harvests (for heavily harvested species, those for which the harvest is uncertain, and those which are taken in unmeasured harvest by Aboriginals) and for SAR status assessment. The absence of monitoring to support these needs is a result of the relative logistic difficulty and cost associated with monitoring such inaccessible species. For other waterfowl, the **Moderate** gaps were associated with instances of incidental take, some harvest management issues, and concerns about toxic substances. There were no monitoring gaps rated as High.

***Risks*:** Thirty percent of the indicated Moderate gaps in monitoring were felt to carry **Moderate** risk. The highest risk gaps were identified for sea ducks, and largely related to harvest management. These risks were legal (*L-r* - Risk of challenge to hunting, *L-t* -Risk of challenges in negotiating treaties), biological (*B-t* -Risk of excessive combined take (Canadian permitted, international, aboriginal) leading to declines), and credibility (*C-a* -Risk aboriginal harvest could be impacted if regulated take is unsustainable; risk of criticism for making decisions that influence aboriginal harvest with inadequate data, *C-i* -International - Risk of criticism from other international governments or agencies for failing to manage harvest, or for requesting changes in harvest without solid data).

Two gaps with **Moderate** risks for sea ducks related to: 1) potential threats in Europe or Asia; these risks were primarily biological, and related to unsustainable harvests and undetected declines, and 2) assessment for SAR; which carried the associated legal, biological, economic and credibility risks.

Finally, the moderate gap for other ducks for which harvest has an uncertain impact was assessed as a **Moderate** risk. The absence of significant risk for other waterfowl in many program outcomes resulted from the existing long-term partnered monitoring programs, initiated primarily for the purpose of harvest management, but also serving the other outcomes.

***Mitigation of Risk*:** The most effective mitigation measure for managing waterfowl harvest is ensuring reliable monitoring data to produce estimates of population size, trend, demographic rates and harvest rates for all species. For species with limited data for one or more of these parameters, relatively conservative harvest management (low bag limits or, in an extreme cases, closing Canadian hunting seasons) would reduce biological risk to the species, but would carry its own credibility and economic risk. In some cases, periodic estimates of population size and/or survival rates might reduce the risk, but would not necessarily be more cost-effective.

CHAPTER EIGHT – Conclusions and Next Steps

AVIAN MONITORING IN CANADA

Current avian monitoring programs in Canada form a dynamic network of specialized programs collecting key data on the status and trends of Canada's bird populations. All of these data have the potential to contribute towards more effective conservation and management of birds in Canada. Nonetheless, a review of the existing suite of monitoring programs was considered timely to ensure that the limited resources available for monitoring are well invested, that priority information needs are being met, and that monitoring programs are as effective and efficient as possible. Through an extensive and detailed process involving internal and external experts and assessments from a number of perspectives, the Avian Monitoring Review has evaluated the majority of the current suite of monitoring programs available for birds in Canada, together with EC's information needs for monitoring data. The review emphasized EC's perspective and investments, but many of the conclusions may be relevant to other organizations, both government and non-government, that deliver or make use of bird monitoring programs in Canada.

MAJOR CONCLUSIONS OF THE AVIAN MONITORING REVIEW

OVERVIEW OF CURRENT SURVEYS

A key finding was that the vast majority of existing programs, and the majority of current funding, contribute to one or more current information needs for EC. Only a handful of relatively small programs were identified as being redundant or no longer required. This result is not unexpected — EC's bird monitoring programs have been under resource constraints for many years, and individual program managers have prioritized support for those programs that provide data relevant to their information needs.

Nevertheless, most surveys, even those currently contributing towards EC needs, could do so more effectively or more efficiently, through enhancements that would not necessarily increase survey costs. These enhancements range from improved survey design and improved coordination across Canada, to enhanced data management and reporting. For example, although some major monitoring programs were developed in a coordinated way by partners from several jurisdictions over broad geographic areas, others were designed in diverse ways to reflect local situations and lack range-wide consistency. This presents challenges in linking results to infer population trends over wider geographic areas. Monitoring schemes for all five bird groups would benefit from a national overview to provide a level of standardization, optimum use of resources, and options for data-sharing and comparability.

It was also noted that resources were allocated unevenly among the bird groups, with over 50% of total EC resources (both in terms of operational costs and personnel time) invested in waterfowl programs. In contrast,

although landbirds represent the largest group in terms of number of species with nearly two-thirds of Canada's bird species, landbird monitoring received about 30% of all funding and less than 20% of all personnel time. These imbalances partly reflect the high information needs for managing the North American harvest of game bird species (primarily waterfowl) – particularly for regulation setting – as relatively precise, high quality monitoring data are required to maximize hunting opportunities while ensuring sustainability. Differences in the delivery mechanisms also affect the balance of costs. For example, waterfowl monitoring, which relies heavily on aerial surveys from fixed wing planes or helicopters, sometimes in remote areas, is expensive and requires many professional staff. In contrast, many landbird monitoring programs require little equipment and can take advantage of skilled volunteers to help collect data.

PRINCIPAL REVIEW FINDINGS AND PRIORITY RECOMMENDATIONS BY SPECIES GROUPS

Landbird population trends are relatively well-monitored in most of southern Canada by the Breeding Bird Survey (which depends largely on volunteers, like most other landbird programs), although some rare species are not adequately sampled. This survey, which also provides data on some species in other bird groups, is restricted to roadsides, a potential source of bias, and has limited coverage in remote areas, such as the boreal forests across Canada, northern B.C. and the Arctic, due both to difficulties in access and limited availability of volunteers. breeding bird atlases provide valuable information on population distribution, and can provide long-term trend information when they incorporate quantitative sampling and are repeated. Atlases tend to provide fine-scale data in heavily developed areas, where information needs are high, and relatively coarse-scale coverage in more remote areas. The latter is not usually sufficient to meet all of the information needs for remote areas. Christmas Bird Counts in Canada and the USA provide additional coverage for many northern breeding species that winter mainly in North America, but population trends cannot be matched back to specific areas on the breeding grounds, and hence don't meet all information needs. The Canadian Migration Monitoring Network collects data on many other species breeding in boreal Canada, but presents analytical challenges due to high annual variation and problems synthesizing data from multiple stations; again, trends cannot be tied back to specific breeding regions. Checklists surveys such as e-Bird or the Études des populations d'oiseaux du Québec (ÉPOQ) may be able to supplement more formal surveys, compensating in quantity of data for lack of a formal survey design. There are currently no national-scale programs monitoring demographic parameters, such as productivity or survival, for most species, and it is unclear whether it would be logistically feasible or cost-effective to develop such programs for more than a few selected species.

Major recommendations for landbirds include developing options for on-the-ground monitoring across boreal Canada; evaluating the ability of migration monitoring and checklist surveys to contribute to EC's monitoring needs; and evaluating the feasibility and cost-effectiveness of improving demographic monitoring to help understand causes of population change.

Shorebirds have been monitored largely through migration counts carried out by a mix of volunteers and professional biologists. These counts have suggested major declines for many species, prompting serious conservation concerns. However, there are also concerns that these data may not be very reliable due to many potential sources of survey bias, including possible changes in the birds' stopover behaviour (e.g., length-of-stay) with increasing numbers of predatory birds such as Peregrine Falcons. Limited demographic monitoring is taking place for some species on study plots in the Arctic, but these were not critically evaluated. Improved monitoring was considered a high priority because of conservation concerns for many species and the fact that several species have either recently been listed, or are being assessed, by COSEWIC.

Major recommendations for shorebirds include completing a first round of Arctic PRISM breeding shorebird surveys to obtain reliable population estimates and baseline distribution information across the Arctic; developing more reliable sampling methods for counting shorebirds in migration to address concerns about bias; and increasing Latin American involvement in monitoring shorebirds on the wintering grounds, including Red Knot.

Seabird programs have been managed somewhat independently across regions, presenting challenges for optimizing resource allocation. Although all major colonies in Canada have been visited at least occasionally, sampling intervals are not necessarily commensurate with the importance of the colony. Pelagic monitoring of seabirds while they are at sea, especially in the non-breeding season, provides data relevant to planning of activities in the marine environment, including emergency response. These surveys mainly provide information on distribution and relative abundance, but are the only potential source of trend information on some species.

Major recommendations for seabirds include developing a nationally-coordinated seabird colony monitoring strategy to ensure that the highest priority colonies are regularly monitored through appropriate allocation of resources among regions and colonies; evaluating improved techniques for counting seabirds, such as use of

digital photography to count colonies of conspicuous species (potentially allowing surveys using aircraft or ships that are operating in the region for other purposes); and evaluating the extent to which pelagic surveys should emphasize repeated sampling at the same locations to estimate trends versus sampling different areas each year to expand geographic coverage.

Some populations of ***Inland Waterbirds*** are well-surveyed, such as colonial species on the Great Lakes and St. Lawrence River, but many others are not adequately monitored. Marsh bird programs have been developed in parts of several regions, but some have limitations to the survey design (e.g., non-random selection of wetlands), and many areas are not monitored. It is possible that data for some species can be obtained with minimal extra costs from surveys targeting birds in other species groups, such as aerial waterfowl surveys. Breeding bird atlases may be able to help fill some gaps, especially if they incorporate specialized sampling methods for marsh birds.

Major recommendations for waterbirds include evaluating alternative strategies for filling gaps in coverage for both colonial waterbirds and marsh birds; considering both costs and potential reduction in risks; and carrying out any necessary pilot work to evaluate options.

Waterfowl surveys are typically very targeted, often monitoring at the level of individual management units. Overall, waterfowl monitoring is relatively expensive, although many surveys are delivered in partnership with, or receive significant funding from other US and Canadian agencies and organizations, increasing their cost-effectiveness. It is important to recognize that the regulation of waterfowl harvest is associated with high risks, including economic risks (hunting is a multi-million dollar industry and an important food source for aboriginal peoples), biological risks (inappropriate regulations could lead to serious population declines), and credibility and legal risks (management decisions, including regulation setting, made without sound data expose the department to legal challenge and loss of credibility). Some waterfowl species are currently considered over-abundant, creating risks to ecosystem integrity if they cannot be effectively managed. Several waterfowl surveys, or suites of surveys, received in-depth reviews. These reviews identified only a few surveys which were no longer required (mostly localized surveys), a few where a survey redesign could reduce costs while still gathering sufficient data (e.g., Trumpeter Swan surveys), and a few where reduced effort could likely still provide data with sufficient precision (e.g., the prairie and eastern waterfowl surveys). Future planning should consider (i) whether monitoring data for harvest management are required in the same detail as currently collected, and (ii) the risk involved with any proposed reductions in survey effort. It is important to note that there are still some gaps in waterfowl monitoring, particularly for sea ducks, such as eiders and scoters. Detailed reviews of current eider monitoring programs suggest that current levels of investment by EC and its partners may be sufficient to produce adequate data for eider management if some of the surveys are replaced with more efficient, regionally-coordinated surveys, and if funding can be secured early in the planning cycle to ensure efficient delivery of surveys.

Major recommendations for waterfowl include developing strategies to reduce expenditures on the prairie and eastern waterfowl breeding surveys, while retaining acceptable precision in population estimates; reviewing the information needs and expenditures for arctic goose and duck banding programs; reducing the number of Greater Snow Goose survey components; redesigning the trumpeter swan surveys; and realigning resources for eider and scoter monitoring to a more efficient suite of surveys.

Species at Risk surveys deserve special consideration, because many single-species surveys have been developed to address species-at-risk concerns. Many of these surveys were developed initially as one-time inventories to assess population size and distribution of a single rare species, but then became monitoring programs when repeated in subsequent years. Most of these surveys focus on one, or a small number of species, and consequently may be relatively resource-consumptive in relation to the data produced. Furthermore, some lack rigorously-designed protocols and hence may be biased or inefficient. Information needs should be considered carefully, as in many cases, it may not be necessary to monitor the status of a species each year. For example, if decisions on status are made only every 10 years, appropriately timed periodic surveys may be sufficient, unless specific management actions need to be evaluated. In some cases, multi-species coordination of surveys may allow for greater efficiency; in others, survey data from existing multi-species surveys such as the Breeding Bird Survey may be sufficient to meet information needs.

Major recommendations for Species at Risk include developing a strategy to prioritize monitoring needs for species at risk that considers requirements among species, and balances resources spent on monitoring against those required for research or recovery actions; and evaluating current and future monitoring programs against those priorities and criteria.

GAPS AND RISKS IN CURRENT MONITORING PROGRAMS

Despite many Migratory Bird program needs being met by current programs, a detailed gaps and risks analysis revealed some major deficiencies remaining within the current suite of monitoring programs, many of which create significant risks for bird populations, for EC, or both.

Many of the remaining risks are biological (e.g., failing to recognize population declines in a timely manner limits ability to take appropriate conservation actions to prevent more serious declines and/or to restore populations; lack of data to support land-use planning could lead to loss of priority habitats). Others have economic, legal or credibility risks associated with them. For example, having limited data to support landscape planning in northern areas can lead to economic costs (e.g., major delays in development associated with extensive data collection requirements for environmental assessment, extra costs associated with uncertainty related to status of species at risk) as well as legal or credibility risks (e.g., challenges from environmental non-government organizations if economic development is allowed without sufficient data to estimate likely consequences).

Some of the highest remaining risks result from the following major gaps in current monitoring programs:

- Lack of data on population trends and distribution of most bird species within most parts of boreal Canada, the Arctic, and northern British Columbia leading to significant economic, credibility and biological risks associated with land-use planning and development in these areas and lack of data to appropriately prioritize species and conservation actions. Risks were considered highest for landbirds due to the large number of species, but there are similar gaps for shorebirds and waterbirds.
- Lack of reliable data on population trends and potential causes of population declines (e.g., through demographic monitoring) for species wintering in Latin America and the Caribbean, especially boreal landbirds and Arctic shorebirds, creating significant risks, especially biological, associated with not being able to identify or prioritize conservation actions, nor to make a convincing case to other countries of the importance of implementing actions.
- Insufficient monitoring data for 30% of all species across all bird groups (Figure 7.1) to determine reliably whether they meet COSEWIC criteria for Not at Risk, Special Concern, Threatened or Endangered status, leading to substantial risks of inappropriate classification and subsequent legal listing under federal and provincial statutes. Gaps exist in all bird groups, ranging from 16% of waterfowl species to 25% of landbirds, 32% of seabirds, 34% of other waterbirds and 64% of shorebirds.

Addressing most of these outstanding high risk gaps will be challenging, as many occur for species breeding in remote locations which are expensive and difficult to access (e.g., Arctic or Boreal, far from communities and road systems). Others present appreciable methodological challenges (e.g., monitoring nocturnal or cryptic species which may require specialized surveys). In a few cases, developing new instruments or implementing new techniques may help to fill gaps, but this will require significant investment of resources in research and development.

Only limited opportunities were identified for realigning resources to meet these priority gaps. For example, as noted above, there were opportunities to reduce investment in some waterfowl monitoring, and to reinvest in some other areas that represent emerging priorities with high associated risks (e.g., Arctic shorebird monitoring). These opportunities are reflected to some degree in the detailed survey recommendations presented in Chapter Five, and steps towards their implementation are already underway. Such opportunities were, however, limited. Waterfowl management remains an important priority with high associated risks, and the majority of the existing programs are contributing to ongoing high priority information needs.

Filling the high priority gaps and reducing the associated risks can only be done with significant new investments in monitoring programs. For example, as noted, the status of most species of birds in the northern parts of Canada is poorly known, including the vast boreal forests across Canada, the western mountains, and the Arctic. New pressures and threats in these areas, including increased resource extraction, such as forestry, mining and energy developments, as well as wide-ranging threats such as Climate Change, are creating increased biological risks to birds, and economic and credibility risks to EC with respect to decision-making in these areas.

Improved technologies and analytical techniques can only partially fill these gaps. For example, improvements in monitoring birds away from the breeding grounds, such as migration monitoring, including technologies such as analysis of nocturnal flight calls, may provide improved information on overall population trends for individual species. However, these will be of limited value for land-use planning decisions in the north because they cannot be tied to specific breeding areas. They are also unlikely to give a good understanding of causes of population change, or the extent to which populations are influenced by factors on the breeding versus the wintering grounds. Substantially reducing these risks can only be achieved through some level of on-the-ground monitoring

in the breeding grounds, which will require substantial investment in money and personnel due to remoteness and difficulties of access.

Thus, even after changes now in progress are completed, significant additional resources will still be needed to develop new programs to address priority gaps, and consequently to reduce significant outstanding risk to which EC and the birds themselves are now exposed.

DATA MANAGEMENT, ANALYSIS AND REPORTING

The review found that major improvements are required to data management, analysis and reporting for virtually all surveys to ensure that data are secure, analysed in a timely manner using the most appropriate available techniques, and reported to end-users to ensure that the results are available to support decision-making.

Although most monitoring data sets are now digitized, the storage methods are quite variable, ranging from spreadsheets to proper relational databases. The majority are not adequately backed up to ensure data security. Additionally, although biologists manage the databases and should be responsible for the content and the quality control of the data, few databases have been designed or maintained by experts with relational database expertise. This creates significant risks of data loss through the failure of inappropriately managed databases, and through retirement or movement of staff or other administrative changes. It also means that most data are not readily accessible to all users and may vary considerably in format and data organization, creating challenges for analysis and use. The management of monitoring data should be integrated into a secure and accessible national data management system that is operated to modern standards and quality control.

While most data sets are analysed in some manner, at least occasionally, standard analytical methods are not always implemented, and results are often not published or widely distributed. Analytical methods vary from sophisticated hierarchical Bayes models to simple regressions; some may not be statistically valid. Use of modern techniques such as Bayes models would enhance consistency in analysis methods, make better use of available data, reduce bias in estimates, and improve precision or reduce sample-size requirements for future data collection.

Reporting of the results of trend analyses is also inconsistent. In a few cases, data are directly incorporated into decision-making models, such as the adaptive harvest models for some species of waterfowl. In some cases, such as the Breeding Bird Survey and most migratory game bird surveys, analysed trend data are regularly published (e.g., Breeding Bird Survey website and Population Status of Migratory Game Bird in Canada report). For many other surveys, however, the results of data analyses are not readily available (e.g., only in internal reports which are not widely distributed or are produced at very irregular intervals). The new Status of Birds in Canada website provides one forum for disseminating summarized data and highlighting the most reliable information available on the national status of each species, but cannot, at least in its current form, provide all of the details, particularly regional break-downs, which may be relevant to wildlife managers. A range of reporting tools will be required to meet the wide diversity of information needs for monitoring data, to ensure they are effectively used.

Other types of analyses may be required for particular purposes. For example, landscape planning requires synthesis and distributional mapping of large numbers of observational records from diverse sources, ideally incorporating habitat modelling. The Boreal Avian Modelling project is developing analytical tools that may help to meet some information needs, at least in the boreal regions, but these are not yet being used operationally, and appropriate mechanisms are needed to disseminate the results.

LESSONS LEARNED FROM THE AVIAN MONITORING REVIEW

This Avian Monitoring Review took more than four years since its initial stages, and required a very significant investment of time by EC skilled professional staff already juggling full workloads. The process benefited greatly from the involvement of the external expert review panel, but could have been completed much more quickly had it been conducted by a dedicated team with the expertise, dedicated time and resources for this specific task. The team was only able to commission detailed reviews of a limited number of surveys, although others were identified that would benefit from a review in the near future.

An important conclusion of this work is that ongoing, regular review of all monitoring programs would be more efficient in terms of both personnel and resources than having to repeat a similar comprehensive review in the future. This would also help to ensure that resources are well-aligned with evolving information needs.

NEXT STEPS FOR IMPROVING AVIAN MONITORING IN CANADA

CREATING A PERMANENT AVIAN MONITORING COMMITTEE

One of the most important next steps from this review is the creation of a new Avian Monitoring Committee. This committee will be responsible for:

- tracking and supporting implementation of all recommendations from this review;
- developing standards for assessing and reviewing new and ongoing surveys;
- coordinating and ensuring the ongoing review of existing surveys, and of any new surveys that may be proposed;
- encouraging development of strategies to fill high risk gaps in the monitoring programs;
- supporting development of comprehensive metadata on all surveys; and
- promoting the development and adoption of improved data management, data analysis and data reporting.

By helping to ensure that regular review becomes part of the operational procedures of each program, a permanent Avian Monitoring Committee will ensure that needs and programs continue to be well aligned and that resources are effectively directed to address the highest priorities, without another time-consuming external review.

This new EC committee was established in September 2011; its terms of reference are included in Appendix C. The membership includes the regional and national managers responsible for individual monitoring programs, as well as representatives from each of the bird group committees with expertise in monitoring their particular bird groups. The committee reports to the Directors responsible for delivery of EC's Migratory Bird program. The committee will function most effectively if some dedicated staff resources are assigned to support the committee.

This committee will ensure that nationally-consistent collaborative approaches are used for all bird species groups and are focused on addressing specific program needs. The committee will ensure that budgeting, protocol development, survey design, data collection and information management are all considered in the review of individual surveys, and will promote development, review and adoption of relevant technologies and enhancements to survey or analysis protocols.

The committee will operate largely by providing guidance and oversight to program staff responsible for individual surveys, who shall be responsible for carrying out the actual technical reviews and providing necessary information on why surveys are required, or how the information will reduce risk. EC's wildlife program includes many highly-skilled biologists, most of whom participate in one or more bird technical committees, with the expertise to carry out the technical assessment of surveys with appropriate guidance. If necessary, and if resources permit, this expertise may be supplemented by engaging external contractors. The committee shall review resultant reports to ensure they are consistent and consider all important aspects, and make recommendations to the responsible Directors for final decisions based upon the reports.

IMPLEMENTING RECOMMENDATIONS FOR EXISTING SURVEYS

The detailed review of individual surveys, carried out for selected priority surveys, identified a diverse range of recommendations for next steps. In some cases, such as the suite of programs related to Greater Snow Geese, these involved identifying components of surveys that could be dropped and others that should be retained. In a few cases, such as the Trumpeter Swan surveys, the recommendations provided details on how to redesign the survey. In other cases, the review identified a need for further analyses to determine the most efficient or effective way to improve the surveys. For example, for seabirds, recommendations included developing a national colony monitoring strategy, and evaluating the most appropriate design for pelagic surveys.

The primary responsibility for implementing most of these recommendations lies with the regional directors, managers and biologists responsible for running and delivering the surveys. In many cases, implementation of recommendations is already underway. For example, the recommendations for the Trumpeter Swan survey were completed and implemented in time for the 2010 surveys. Similarly, most of the recommendations with respect to Greater Snow Geese have already been undertaken. In other cases, implementation of recommendations may take a few years, such as development of a new suite of eider surveys.

In all cases, it is expected that monitoring program managers will have discussions and reach agreement with any partners implicated in any given survey before recommendations are implemented in whole, or in part. If partners with a substantial invested interest in a survey have major concerns with any proposed changes then the managers may come back to the Avian Monitoring Committee for further discussion.

To ensure effective implementation of recommendations, the Avian Monitoring Committee should track progress on their implementation, including making any necessary updates to reflect changing circumstances. In several cases, recommendations involve evaluating or developing new approaches or strategies, such as development of a seabird colony monitoring strategy, identifying appropriate strategies for pelagic seabird monitoring, or developing improved approaches for monitoring shorebirds on migration. Any such strategies should be brought to the Avian Monitoring Committee for review and endorsement prior to implementation.

DEVELOPING A SCHEDULE FOR SURVEY REVIEWS

The Committee should develop a schedule to ensure that all surveys are reviewed regularly and at appropriate intervals, taking into account available resources for staff or contractors to carry out reviews. Surveys that are critical for decision making, surveys involving major investments, and surveys presenting significant challenges or uncertainties should be reviewed most frequently, but all surveys should be reviewed at least every 5-10 years to ensure they remain relevant, efficient and effective. Table 5.1 provides a suggested priority for further review of surveys examined through the Avian Monitoring Review, but this may need to be updated to reflect evolving priorities or concerns.

Whenever possible, and appropriate, related surveys should be considered together when developing a review schedule. Surveys may be grouped based on the type of survey or the suite of species being surveyed. For example, a review of the potential value of checklist surveys for population monitoring should consider all checklist programs at the same time (including eBird, ÉPOQ, and the Northwest Territories and Nunavut checklist program). Similarly, a review of the value of nest record schemes should consider all regional and national programs at the same time. For specialized species-specific surveys, such as scoter surveys, it may be appropriate to consider all scoter surveys together, regardless of sampling method.

One group of surveys that should be reviewed collectively in the near future are the specialized surveys for individual species at risk. This should be done in collaboration with biologists from the Species at Risk and Migratory Bird programs in EC. A set of criteria should be developed for prioritizing among different species at risk and among potential recovery actions, science actions activities or monitoring programs. Criteria to consider in setting priorities include the status of the species (e.g., Special Concern, Threatened or Endangered), whether or not the causes of decline or appropriate recovery actions are known, and the extent to which new monitoring data will inform decision-making. If causes of decline are not known, research to identify them may be a higher priority than developing new monitoring. Monitoring may be required to evaluate recovery actions if there is high uncertainty about their effectiveness, but may be less important if the recovery actions are known to be helpful. The fact that a species is listed does not necessarily mean that more precise monitoring data are required for that species.

DEVELOPING STANDARDS FOR ASSESSING SURVEYS

The Avian Monitoring Committee should develop a set of standard information required for assessing surveys. These should include at least the following:

Objectives. It is essential to have clearly articulated survey objectives that identify the specific conservation, management, regulatory or policy program needs that the survey results would support in sufficient detail to help guide the design of the survey itself. These must clearly indicate how monitoring data will influence decision making.

Data requirements. It is necessary to understand the specific characteristics of the information required to make appropriate management decisions and to inform conservation actions, such as geographic and jurisdictional scale, frequency, duration, accuracy and precision. Not all decision-making, and therefore not all surveys, require the same statistical precision and power to detect change. The proposed analysis methods usually need to be known to determine the required sample sizes to achieve a particular level of precision.

Survey design. Survey protocols and analytical techniques should be consistent for similar surveys across Canada to enable cross comparison and linkage of results, and should reflect cutting-edge Research and Development to ensure the most effective use of available technology.

Alternatives considered. In many cases, alternative solutions may be available to answer a particular information need. Generally, there is a trade-off between statistical precision and cost. In some cases, information needs can likely be met through a combination of methods. For example, these might include a combination of

statistically-rigorous monitoring, repeated periodic inventories (e.g., atlases) and *ad hoc* checklist programs. Some of these may require involvement of highly trained professionals, while others may be largely undertaken by volunteers. Many amateurs are highly skilled at bird identification (often more skilled than professionals) and with appropriate guidance and support can make important contributions to many bird monitoring programs, although difficulties of access or safety considerations may limit volunteer participation in some surveys. Often, compromises may be required between a desired level of precision and available resources to implement the program. If different levels of investment are possible, the review should highlight the risks associated with each alternative; how, and how much, will risks be reduced with increased levels of investment?

Focal parameters. What parameters will the survey measure, and why? Currently most surveys are designed to provide an estimate of change in population size over time, either by estimating actual total population size, or indices of population size. However, some surveys estimate demographic parameters such as survival and productivity which can be useful in understanding potential causes of population change. The majority of the latter are for waterfowl. What are the potential advantages of each, relative to their costs, and how will they contribute to reducing risk in decision making?

ENHANCING METADATA ON MONITORING PROGRAMS AND OTHER SURVEYS

Metadata on surveys include information on survey objectives, dates, time spans, geographic coverage, data holdings, survey protocols, data applications, data access, and budgetary information. Such data help to ensure that people are aware of surveys and data holdings, that they understand their values and limitations, and that they know how the data were collected to enable appropriate analytical methods. They are also valuable for planning, for example to understand resource allocations among surveys, and to help design future programs.

Through the Avian Monitoring Review, extensive metadata were gathered through a series of questionnaires and spreadsheets, but effective metadata management systems need to be developed to ensure these can be maintained and updated over time. Ideally such a system would allow the tracking of changes over time; for example, tracking how the resources associated with each program, or even the design of the program, have changed over time.

The Avian Monitoring Committee should work with the newly formed Information Management and Information Technology (IM-IT) Working Group as well as other partners who manage monitoring data, to ensure that an appropriate metadata system is deployed as soon as possible. The Avian Monitoring Committee should be supported by a secretariat than can be responsible for populating the metadata and for working with project leaders to ensure that the metadata remain up-to-date.

IMPROVING DATA MANAGEMENT, ANALYSIS AND REPORTING

Several areas were noted for improvement of data management, analysis and reporting during this review process; many surveys and monitoring programs did not meet basic standards. The Avian Monitoring Committee should work with the EC IM-IT Working Group, program staff and data management experts to encourage and promote the following activities:

Improving data and information management. The utility of the results of many long-running surveys are impeded by cumbersome and often inappropriate procedures used for managing data. The highest priority is to ensure that all data are integrated into a secure and accessible national data management system that is operated to modern standards and quality control to protect the integrity and longevity of the data, to aid appropriate quality assurance and quality control and to increase access to, and use of, the data. The Avian Monitoring Committee should work closely with the IM-IT Working Group to determine the most appropriate system for each survey, and to ensure that these systems are rolled out as soon as possible and then used by program staff for management of their data. Priority should be given to datasets that are not currently adequately managed (e.g., those currently in spreadsheets or other systems on the desktop of individual biologists). Some surveys, such as those managed by Bird Studies Canada, are already in web-accessible databases and archived in the Avian Knowledge Network. A secondary priority would be developing links to ensure that these external data can be effectively queried in combination with other EC databases. Similarly, EC migratory bird monitoring databases should be easily accessible throughout the department, and most should be directly accessible by external agencies and experts.

Data analysis. A community of practice should be developed among biostatisticians and biologists with strong analytic skills within the migratory bird program to share experiences and expertise with respect to data analysis. This will serve to share knowledge of new analysis methods as they become available, to enhance consistency in

choice of analysis methods for similar programs, and to increase efficiency by sharing statistical models, etc. This should be led by the biostatistician in the CWS Species Abundance and Distribution group. This group need not be limited to EC employees, and could benefit from drawing in expertise from outside the department.

Reporting and decision making. Monitoring results should be regularly and systematically reported within EC, to its partners and other wildlife management agencies, and to the general public in as transparent and accessible a manner as possible. Web-based data reporting tools should be developed for all surveys, providing users with the results of data analyses (e.g., long-term or short-term trends, annual indices, etc.). Within EC, such web reporting is currently available for the Breeding Bird Survey, the National Harvest Survey and the Population Status of Migratory Game Birds in Canada report (although all need to be upgraded), but for few other surveys. Bird Studies Canada has developed a flexible reporting system for results of their surveys through their NatureCounts website, which may provide a useful model for future reporting of other surveys. Additional decision making support tools may be required for other purposes, such as web-based mapping tools to bring together distributional information from surveys. Many such tools have been developed already by other programs and could be adopted by EC. The new Status of Birds in Canada website provides one example of synthetic reporting and dissemination of information that will enhance the value of data collected through monitoring programs.

ADDRESSING GAPS AND RISKS

As noted above, the improvements to methodologies and analytical approaches recommended in this review will not yield sufficient financial savings to fill many of the high risk gaps identified. Many required improvements are logistically challenging to design and implement, and will be very costly to deliver – the surveys that are relatively easy to implement are generally those that already exist. As a consequence, new resources will be required to fill most gaps.

The Avian Monitoring Committee should promote development of strategies to fill each of the priority gaps associated with high to moderate risks. Such strategies will generally need to be considered separately for each bird group or geographic area, although in some cases synergies may be possible across bird groups (e.g., surveys developed to sample boreal landbirds may be able to provide useful data on some shorebirds and inland waterbirds at the same time). Strategies should generally consider a variety of different scenarios or options and, particularly if significant new investment is required, a business case should be developed that clearly indicates the level of investment required for each scenario, the reduction in risk associated with that alternative, and any residual risk remaining. Development of such strategies should generally be led by biologists within each bird group, under the guidance of the relevant regional manager(s). A biostatistician should also be involved.

Implementation of strategies that require substantial new resources will clearly be dependent upon successful marketing of the business case to the relevant levels of management (starting with the Canadian Wildlife Service Executive). Decisions will likely depend on the costs in relation to the reduction in risks. In many cases, cost-sharing opportunities may be possible and should be pursued; for example, monitoring strategies being developed for the oil sands of Alberta may provide useful planning information that can be applied to other parts of the boreal. Similarly, development pressures in areas such as northern Quebec (“Plan Nord”) may provide funding opportunities to support new monitoring or inventory programs in the region.

HABITAT MONITORING

The current review did not address monitoring of the habitats on which bird populations depend. However, as many population trends may be driven by changes in habitat quantity and quality, insight into habitat change is essential for understanding potential causes of population change, as well as for developing appropriate management and conservation programs. Effective habitat monitoring also complements bird population monitoring and, in some cases, may reduce the requirements for population monitoring.

An initial inventory indicated that, within EC, about $400,000 (O&M) is dedicated annually to habitat surveys related to migratory birds. However, habitat monitoring efforts in EC generally lack clearly-articulated objectives and coordinated application of results. Important opportunities for more efficient and integrated habitat monitoring will continue to arise with ongoing technological improvements in remote sensing. Through effective inter-agency linkages and federal-provincial collaborations, opportunities are likely to arise for fuller integration of habitat monitoring with other aspects of avian population monitoring in the future.

An overall review of habitat monitoring programs in EC, involving a joint team of bird program managers and habitat program managers, is a high priority.

WORKING WITH PARTNERS

Many of the bird monitoring programs in Canada rely on partners for funding and/or delivery. These partners may include provincial and territorial governments, other federal departments, various agencies in the United States including the US Fish and Wildlife Service, US Geological Survey, States and Flyway Councils, and non-government organizations such as Bird Studies Canada, Nature Canada and Ducks Unlimited. Many additional partners may be involved in international surveys for Canadian birds in Latin America or the Caribbean.

The Avian Monitoring Review emphasized the information needs of EC when assessing programs, but those of partners must also be considered to maintain partnerships. Many of these information needs will be similar to those of EC, and hence many of the general conclusions drawn from this review will also be relevant to partners. The recommendations derived from this review may be particularly valuable to continental-scale collaborative networks such as the North American Bird Conservation Initiative and the North American Waterfowl Management Plan. In other cases, partners may have different information needs, depending upon their particular mandates. For example, some partners are primarily concerned with harvest management, while others may have a primary mandate to work with members of the public including volunteer citizen scientists, both for data collection as well as for educational objectives. While EC must ensure that its investment is commensurate with meeting its own information needs, the overall program design and development must consider the needs of all partners who are investing in and supporting a program.

One of the most effective means of building and maintaining partnerships is to ensure effective communication at all stages of the review and implementation process. Partners should be consulted early in any review process to identify and clarify their objectives as well as those of EC. An added benefit of early consultation is that partners may also be able to contribute expertise and/or resources to the review process. Partners should also be consulted on the conclusions of any review, and should be given an opportunity for input prior to finalizing or implementing recommendations.

ENHANCING MONITORING OUTSIDE OF CANADA

The incorporation of monitoring data from the Caribbean and Latin America is becoming increasingly important for understanding hemispheric conservation needs and filling information needs for EC. In some cases, such as for some shorebirds, monitoring on the wintering grounds may provide the most effective time of year or location for monitoring the overall population trends of a species. In other cases, monitoring at migration stopovers or on the wintering grounds may provide critical additional information to help understand causes of population change. Monitoring changes in the distribution and relative abundance of birds on their wintering grounds can help to determine whether changes in winter habitats or changes in breeding habitats are limiting a species population. This information can have major consequences for conservation actions within Canada – for example, if a species is declining due to loss of habitat on the wintering grounds, then breeding habitats may not be a limiting factor, and management to enhance or restore new breeding habitats would not be an effective use of conservation resources.

EC should continue to develop and maintain selective and strategic collaborative partnerships in Latin America and the Caribbean, focused on those bird groups or species for which monitoring data from another country would fill an identified gap and risk. A number of collaborative efforts already exist and could be enhanced with Canadian participation. The Southern Wings program of the US Association of Fish and Wildlife Agencies is one example of such a program, as is the Western Hemisphere Bird Banding Network. One valuable role of Environment Canada in promoting the effective collection of bird monitoring data in Latin America and the Caribbean would be assisting with survey design and training of non-government organizations and government biologists in other countries to develop and implement appropriate monitoring programs.

BUILDING A VOLUNTEER BASE FOR FUTURE SURVEYS

Many of the current survey programs, particularly for landbirds, are critically dependent on participation by volunteer ‘Citizen Scientists’ for data collection. For example, the Breeding Bird Survey and Christmas Bird Counts are currently the primary source of trend information for many landbirds as well as some other species, and both are largely reliant on volunteers. Volunteers also provide the majority of data for other surveys such as the Coastal Waterbirds Survey, breeding bird atlases, nocturnal owl surveys, Project FeederWatch, several marsh monitoring programs and many beached bird surveys.

Increased participation by volunteers has helped to expand geographic coverage and resolution of survey data. While the design of some surveys such as checklists is less rigorous than for professionally-run surveys, the large quantities of data available may allow addressing additional information needs. Across all programs, the total amount of data being contributed by volunteers has greatly increased over the past few decades, with over 1 million new records currently being contributed each year.

Ongoing efforts are needed to maintain and build this volunteer base for future surveys. Appropriate educational and training materials are required to ensure that young people continue to become interested in birds and develop the skills to participate in surveys. New surveys, during their initial design phase, should consider the potential for volunteer involvement. This includes factoring in the costs for managing, coordinating and training volunteers. This does not necessarily mean that the protocols need to be simplified – many volunteers are able to collect data of comparable complexity and quality to professionals. Effective analysis methods also need to be developed to take advantage of data collected through the less formal surveys (e.g., checklists). In some cases, a mixture of volunteers and professionals may be appropriate. For example, in the largely volunteer-driven breeding bird atlases, some seasonal staff are hired to fill gaps in volunteer coverage such as remote areas that are difficult to access. Adoption of new technologies such as acoustic recorders may increase the potential to involve volunteers in formal surveys, through assisting with deploying recorders or with analysis of recordings.

Effective feedback is also required to encourage the ongoing participation of volunteers. This should include the prompt and timely reporting of results to the volunteers and to the public through web pages and other modern communication tools, and ample and explicit recognition of volunteer contributions. Building a strong and dedicated volunteer base will not only help to build monitoring programs, but also to build a community of people with a strong interest in birds who can help to promote and implement activities to protect and conserve birds.

ADDRESSING FUTURE NEEDS

Efforts are required to ensure that the information needs and risks used to assess surveys not only remain up-to-date and relevant over time, but also anticipate future information needs. The Avian Monitoring Review based its assessment of surveys on EC's information needs as determined from the current results-based management structure. Risks associated with gaps were assessed based on current understanding of threats to migratory birds and their habitats, as well as economic, legal and credibility risks anticipated with current regulations and development plans. Both the information needs and the associated risks are likely to evolve over time. For example, climate change is an ongoing pressure affecting all aspects of the environment, including birds and their habitats, both directly from changing phenology and temperature, but also indirectly through changing human activities (e.g., increased ship traffic in the Arctic). Currently, most analyses of climate change impacts on birds have been based on data from monitoring programs originally developed with other objectives. As climate change impacts become stronger, it may become necessary to modify many programs both to accommodate impacts (e.g., changes in nesting dates may require changes in survey protocols) and to better understand the consequences of climate change to birds and potential mitigation measures.

The information needs and objectives of avian monitoring programs in Canada should be reviewed in detail every few years, as part of a regular review process for individual survey programs, to ensure that monitoring programs supported by EC continue to remain relevant and effective.

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GLOSSARY & ABBREVIATIONS

Some of the terms commonly used to describe avian monitoring programs have multiple definitions, or variable interpretations in different contexts. The definitions in this glossary are those that have been used throughout the report and review process, and may not correspond with other definitions of these terms.

Adaptive resource management is an iterative approach that incorporates sound science, departmental policies and societal factors as the basis for management and conservation. This cycle involves six key activities which are undertaken in an iterative sequence: population status monitoring, status assessment, modeling, research, conservation planning, conservation actions, and evaluation studies. The process is usually triggered by population changes detected through population status monitoring, or sometimes by indications of possible conservation concern identified by tracking other information sources. The process is truly cyclic in that the sequence of steps may be repeated with the incorporation of new information, or in response to changes in the status of bird populations or in the effectiveness of conservation action. Each iteration of the cycle improves the knowledge base on which conservation decisions are undertaken, and as a consequence, normally increases the effectiveness of the management activities.

Critical habitat: "The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species" [from Canada's Species at Risk Act, 2002]

Demographic monitoring: The measurement of population-specific demographic parameters or vital rates, their main drivers, and their changes over time. These parameters may include survival and mortality rates, age at first breeding, immigration, emigration, productivity measures, or harvest rates.

Incidental take: The inadvertent destruction of migratory birds, their nests or eggs, through the undertaking of human activities such as mining, forestry and agriculture, electrical generation and transmission, commercial fishing, management of infrastructure, and urban development.

Inland Waterbirds: Bird species primarily using inland waters (lakes, rivers, wetlands) during their life cycle (e.g., feeding, breeding), including 'marshbirds' and some colonial-breeding species, e.g., herons, grebes, loons, but excluding passerines that nest near water.

Inventories are one-time or infrequent collections of data in a defined area, that document the presence of bird species and their absolute or relative numbers, and may include measurements of associated attributes such as sex ratios, breeding status, age proportions, etc. Inventories provide basic data on occurrence, and repeated inventories may serve as a baseline for longer-term monitoring.

Landbirds: Bird species primarily using terrestrial habitats during their life cycle for feeding and breeding etc., and which are not included in the other four bird groups, including species belonging to the order Passeriformes (e.g., warblers, thrushes, sparrows), and various other families (e.g., birds of prey, hummingbirds, woodpeckers).

Migratory Birds Convention Act: Canadian federal legislation signed in 1917 to meet the terms of the Convention for the Protection of Migratory Birds (signed in 1916 with the USA), and most recently updated in 1994. Its objectives are "to enable effective actions to be taken to improve migratory birds conservation, and to cooperatively manage populations, regulate take, protect lands and waters and share research and survey information".

Migratory birds: Birds that make repeated seasonal movements between breeding and non-breeding locations. This review covers those Families of migratory birds that spend at least part of each year in Canadian territory (land or waters) and which are specifically identified in the Migratory Birds Convention Act.

Monitoring, for the purposes of this review, is defined as the long-term, repeated collection of population-related information in a scientifically-rigorous way, to detect and quantify changes in abundance, distribution or key vital rates (e.g., survival, reproductive rates) of birds. ***Status or surveillance monitoring*** is a wide-spread activity conducted at regular intervals, often annually, to determine population status and to detect changes in population components, generally at the regional or national level (i.e., monitoring the status of the overall population). This may involve monitoring population size, or an index of population size, distribution, or demographic parameters such as productivity or survival. ***Effectiveness or evaluation monitoring*** is intended to evaluate the effectiveness of a conservation intervention, often involving repeated counts at regular intervals, in specified

areas, using standardized techniques. This often takes place at a smaller scale than status monitoring (i.e., at the scale of the management activity). ***Research monitoring*** is the targeted tracking of population or demographic information aimed at evaluating or understanding causes of population changes

Population describes those individuals of a species occurring in a specific area; often, entire populations are composed of smaller sub-populations that interact to varying degrees via exchange of individuals.

Population modeling involves the application of simple or statistical models to better understand how complex interactions and processes work and affect bird populations. Descriptive modeling provides an objective and manageable way to understand how bird numbers change in relation to factors such as habitat, climate, interactions with other species, and human-related stressors. Once a descriptive model is validated so that it describes the natural system in a realistic and useful way, it can be used in a predictive role to consider how changes in certain model parameters (such as decreasing predation or increasing availability of suitable habitat) might affect other parameters (such as population size).

Research is the focused investigation of specific questions of function, impact or interactions that provides information about the species of interest and environmental and human factors that affect its well-being and ecological functions. ***Targeted research*** is undertaken in response to the identification of a specific conservation need, which stems from the results of an assessment or modeling exercise. It is designed to provide key information necessary to understand and model the sensitivities of populations to the impacts of specific stressors, and the mechanisms and timing within the annual cycle where these impacts are likely occurring. This information can then be used to design effective focused mitigative actions to reverse these negative effects. ***Anticipatory research*** is often undertaken in advance of and frequently in anticipation of specific conservation-oriented information needs, in keeping with the concept of due diligence and the need to understand sensitivities of bird populations. As it may take several years to complete and interpret effective research, this anticipatory investigation of key factors relating to the viability and health of bird populations is essential to enable the timely response to the identification of population concerns.

Seabirds: Bird species spending much of their life in marine habitats and often breeding near the sea, including some Charadriiformes (Alciidae, Stercorariidae [though inland when they breed], Lariidae [except when they are breeding inland]), Procellariformes, Suliformes [except when they are inland], e.g., gulls, auks, shearwaters.

Shorebirds: Bird species belonging to the families Charadriidae, Haematopodidae, Recurvirostridae, Scolopacidae within the order Charadriiformes, i.e., those primarily using coastal freshwater or marine habitats during their life cycle (feeding, breeding), such as plovers, sandpipers, and phalaropes.

Species at Risk Act: Federal legislation passed in 2002 (Bill C-5), the purpose of which is “to prevent Canadian in digenous species, subspecies, and distinct populations from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and encourage the management of other species to prevent them from becoming at risk” [www.sararegistry.gc.ca]

Species at Risk: Species listed in the List of Wildlife Species at Risk set out in Schedule 1 of the federal Species at Risk Act, as Special Concern, Threatened, Endangered, or Extirpated.

Surveys are broadly defined as any project designed to collect information on the status of bird populations. Any type of survey that involves repeatedly collecting data over time to identify change can be considered a monitoring program.

Waterfowl: Bird species belonging to the family Anatidae, i.e., ducks, geese and swans, and including the majority of harvested species or ‘game-birds’.

TABLE G.1. Abbreviations and acronyms for terms commonly used throughout this report.

Abbreviation/Acronym	Meaning
ACSS	Atlantic Canada Shorebird Survey
BAM	Boreal Avian Monitoring Project
BBS	North American Breeding Bird Survey
BCR	Bird Conservation Region
BCR-3	Arctic Plains and Mountains
BCR-4	Northwestern Interior Forest
BCR-5	Northern Pacific Rainforest
BCR-6	Boreal Taiga Plains
BCR-7	Taiga Shield and Hudson Plains
BCR-8	Boreal Softwood Shield
BCR-9	Great Basin
BCR-10	Northern Rockies
BCR-11	Prairie Potholes
BCR-12	Boreal Hardwood Transition
BCR-13	Lower Great Lakes/St Lawrence Plain
BCR-14	Atlantic Northern Forest
BOAS	Birds Oiled at Sea
CBC	Christmas Bird Count
CMMN	Canadian Migration Monitoring Network
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
CWS-GSGO	Canadian Wildlife Service – Greater Snow Goose surveys
EA	Environmental assessment
EC	Environment Canada
ÉPOQ	Études des populations d'oiseaux du Québec
FWS	US Fish and Wildlife Service
GBM	Grassland Bird Monitoring
GL-CWS	Great Lakes Colonial Waterbird Survey
HELP	High Elevation Landbird Project
IBA	Important Bird Area
JV	Joint Venture (e.g., Eastern Habitat Joint Venture)
MAPS	Monitoring Avian Productivity and Survival
MBCA	Migratory Birds Convention Act
MBS	Migratory Birds Sanctuary
MMP	Marsh Monitoring Program
MWS	Mid-winter Waterfowl Survey
NABCI	North American Bird Conservation Initiative
NAWMP	North American Waterfowl Management Plan
NCC	Nature Conservancy of Canada
NGO	Non-governmental organization
NHS	National Harvest Survey
NWA	National Wildlife Area
OSS	Ontario Shorebird Survey
PFW	Project FeederWatch
PRISM	Program for Regional and International Shorebird Monitoring
REET	Regional Environmental Emergencies Team
RMAF/RBAF	Results-based Management and Accountability Framework and Risk-Based Audit Framework
SAR	Species at Risk
SARA	Species at Risk Act
UN-FAO	United Nations Food and Agriculture Organization
WBPHS	Waterfowl Breeding Population and Habitat Survey
WLSD	Wildlife and Landscape Science Directorate

APPENDIX A – Detailed Program Evaluations

FOREST BIRD MONITORING PROGRAM – ONTARIO (LB-34)

SUMMARY RECOMMENDATIONS

1. Continue survey LB-34, the Ontario Forest Bird Monitoring Program, at a minimal level of investment sufficient to maintain the data base and current volunteer base, pending the outcomes of recommendations 2 and 3 that critically evaluate the value of the survey.
2. Analyse results of the survey by 2012, in time to inform planning for the 2013 field season, to determine whether the survey can help to understand the causes of population change among Ontario forest birds.
3. Consider in 2013, whether to expand the current survey beyond Ontario, or else discontinue the survey, depending on the results of the analysis.

SUMMARY OF RATIONALE

The Ontario FBMP was developed in 1987 with the following objectives (from Welsh 1995):

- to describe changes in numbers over time of all forest songbirds;
- to develop a habitat-specific baseline inventory of forest birds (species composition and relative abundance); and
- to develop regionally accurate habitat association profiles for all common forest birds.

The survey takes place within forested regions of central and southern Ontario, and was intended to complement, build on and augment the broad regional base of the Breeding Bird Survey (BBS).

An internal review of the FBMP by a subcommittee of the EC landbird committee concluded that the FBMP has provided useful data for the 2nd and 3rd of these objectives, although there is still need for further analyses and reporting, including publication of more scientific peer-reviewed reports on the data. These objectives do not require long-term continuation of the project.

For the 1st objective, in the strict sense of estimating trends, the review suggested the FBMP was largely redundant to other surveys such as the Breeding Bird Survey or the Ontario Breeding Bird Atlases; as a result it has only been used as a secondary source of information for status assessment. Nevertheless, the review concluded that the survey has potential to provide significant added value by helping to understand causes of population change in forest birds. Because this survey provides long-term data on population trends within suitable habitat, it can be contrasted with surveys such as the BBS that provide trends across all habitats.

Differences in trends can help to understand potential causes. For example, if a species is declining on the BBS, but stable or increasing in suitable habitat on FBMP, this would imply that loss or degradation of breeding habitat in Ontario may be a cause of declines. Conversely, if the species is also declining in suitable breeding habitat, this would implicate other factors, such as threats on migration or wintering grounds.

The next step in the process is to carry out a scientific analysis of the data to determine whether the survey data actually have sufficient precision to realize this potential. Several of the more frequently encountered species on the FBMP have been found to be declining on the Breeding Bird Survey (e.g., selected aerial insectivores), so these could be examined and contrasted with species that are not declining on BBS. The required analysis would estimate trends from the FBMP within specific habitats for various species, both increasing and decreasing, and compare them with data from other sources, including any available data on habitat trends, to determine whether the results provide useful insight for understanding causes of population change.

Cost Summary

The following table outlines costs related to the current Ontario Forest Bird Monitoring program.

	Forest Bird Monitoring Program - Ontario
EC Operating costs/y	<$1 000
EC Personnel costs/y	(0.1 PY) $8 000
EC Annual costs	***$9 000***
Non-EC funds/y	Volunteer / In-kind
Non-EC personnel costs/y (including volunteers)	(~0.9PY - volunteer)
Non-EC Annual costs	***Volunteer***

DETAILED RATIONALE

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Great Lakes – St. Lawrence (BCR 13) + parts of S. Boreal (BCR 12): The FBMP has already provided useful data on habitat associations of birds in this region which can help with landscape planning. As noted above, it has the potential to help understand causes of population change for birds breeding in this region, and hence to help inform appropriate management actions for species in this region. The proposed recommendations would help to address whether this potential can be realized and determine whether ongoing investment in the survey is warranted.

2) Incidental take is minimized and long-term conservation is supported
Substantial development is occurring in the region covered by this survey. FBMP data could be used to estimate potential impacts of various activities, but most likely existing data would be sufficient for this purpose.

3) Threats to migrants in other countries are reduced
The FBMP has the potential to help understand causes of population change for birds breeding in Ontario, and hence to help determine whether population change is due to factors on the breeding grounds in Canada or elsewhere. Clear evidence that change is due to factors elsewhere could help to inform investment in conservation actions elsewhere.

4) Migratory Bird harvests are maintained at sustainable levels
Survey does not contribute to this need.

5) Priority sites for Migratory Birds are protected and improved
Because many FBMP survey sites were selected within protected forested areas, the survey provides data that are potentially relevant to many protected areas. However, it is unclear whether the precision of the data is sufficient to inform management actions at any given site.

6) Population-level effects of toxic substances are reduced
Survey does not contribute significantly to this need.

7) Populations of Migratory Birds under particular threat are conserved
Survey does not contribute significantly to this need.

8) Migratory Birds in land claim areas are conserved
Survey does not contribute significantly to this need.

9) Threats due to Migratory Birds to public and economy are reduced
Survey does not contribute significantly to this need.

10) Avian Species at Risk are assessed, identified and listed
Data from the survey are potentially useful for assessing the status of birds in Ontario, but analyses by the working group suggest they do not add significantly to other existing surveys.

11) Populations of avian Species at Risk are recovered
Survey does not contribute to this need.

Other Risks to Take Into Account

Legal risk
No known legal risks associated with either maintaining or terminating this survey.

Maintenance of external funding
Survey does not currently receive external cash funding, although has substantial volunteer and in-kind support from other agencies, and would need to manage any change to avoid alienating volunteers who may also contribute to other surveys.

Public support for management actions
Survey is not relevant to this risk.

Partner Expectations

The Ontario Ministry of Natural Resources has adopted the FBMP protocol for many of their forest bird surveys, as have some other agencies / groups (e.g., Parks Canada, Ontario Parks). In many cases, data from those surveys are contributed to the FBMP database. If EC support for running the survey were discontinued, a mechanism should be developed to ensure partners can continue to use the database.

PROGRAM FOR REGIONAL AND INTERNATIONAL SHOREBIRD MONITORING (PRISM) ARCTIC MONITORING PROGRAMS (SB-7)

SUMMARY RECOMMENDATIONS

1. Complete SB-7 Arctic PRISM first round of surveys in Canada as quickly as possible with available funds, and no later than 2018, to estimate current population sizes, breeding distribution, breeding habitat and densities throughout the Arctic
2. Encourage US partners to complete their PRISM first round ground surveys in Alaska no later than 2018, to ensure that reliable range-wide information is available for Arctic nesting shorebirds.
3. Assess, by 2012, data collected on non-shorebird species (landbirds, waterbirds and waterfowl) during PRISM ground surveys and associated surveys (e.g., helicopter transects between PRISM plots) to determine their usefulness and cost-effectiveness and to decide whether reducing or expanding this aspect of the program is required.
4. Review, by the end of 2013, Arctic PRISM methodology to determine whether it can be modified to allow more efficient collection of population information, and whether ongoing surveys in the Arctic are still the most efficient and effective method for estimating trends in shorebird population size and/or distribution.

SUMMARY OF RATIONALE

Canada (and Alaska) have high responsibility for many species of arctic-nesting shorebirds, but there is high uncertainty in the conservation status of most species. All species are long-distance migrants, requiring suitable wetland habitats on migration stopover sites at various locations in Canada and the U.S., as well as on their wintering grounds in Latin America. Many species are considered vulnerable and potentially of concern due to loss or degradation of wetlands required at various stages of their life cycle, as well as anticipated threats in the Arctic due to climate change and development pressure. Migration count data and wintering surveys suggest that many species have been declining dramatically, but there is high uncertainty in those results due to potentially very large bias – for example, the current design of those surveys cannot distinguish changes in stopover or wintering habitat or changes in stopover behaviour from changes in population size. Several populations of one species (Red Knot) have recently been listed under SARA, and other species may also be candidates for listing. However, without reliable status information, there is a risk that incorrect decisions could be made on listing. Reliable information on current status is also necessary to prioritize conservation actions among species.

To reduce our risks associated with managing shorebirds, we recommend completing the first round of arctic shorebird surveys, as recommended by PRISM, which are about half-way complete. The Arctic breeding ground surveys are expensive, but are the only reliable way to obtain estimates of population size to determine the current status of each species. They will also provide information on densities and distribution of shorebirds throughout the Arctic; information necessary to model and predict potential impacts of Climate Change and future arctic development, such as resource extraction activities, on shorebird populations. They will provide baseline information that could be used to assess future population change through repeat surveys. Finally, information on population sizes can be used to help calibrate and evaluate monitoring programs at other times of year (e.g., to determine what percentage of the population is being detected on winter or migration surveys).

Any decision as to whether the Arctic surveys are the most effective long-term monitoring program can be postponed until after the first round of surveys is completed for several reasons. As noted above, a complete Arctic survey will provide valuable information for management decisions even if it is not continued as a long-term monitoring program. The cost-effectiveness of using Arctic surveys for long-term monitoring can be evaluated more effectively after completion of the first-round of surveys. Population size data from the first round of Arctic surveys will also provide a basis for calibrating migration surveys, and re-evaluating their potential role in long-term monitoring. Similarly, reliable population estimates would allow for better calibration of wintering ground surveys, and an evaluation of their feasibility for long-term monitoring.

To date a total of 683 rapid plots and 50 intensive plots have been surveyed in 8 of the 12 Canadian Arctic PRISM regions involving dozens of principal investigators, hundreds of cooperators, and thousands of hours of field and analysis time.. Round one of surveys is considered 33% complete which covers 10% of the Canadian Arctic owing to the different sizes of the regions being sampled. Preliminary results from surveys conducted during the development phase of the program and details of the methodology are currently in press for publication as a monograph. Interim species population size estimates (i.e. the estimated population size for only the regions surveyed to date) indicates that the currently used estimates, derived from *ad hoc* analysis of many different sources of survey data may strongly underestimate the true population size of many species.

Cost Summary

The following table summarizes actual past and proposed future costs of the Arctic PRISM surveys, separated by EC and non-EC Operations and Maintenance costs. Actual values are shown for 2001-11, and estimated values for 2011-18. Note that the schedule post-2010 cannot be done without addition of a full time FTE (EG-05) in Yellowknife. PCSP represents the Polar Continental Shelf Project; IPY is the International Polar Year funding; INAC is Indian and Northern Affairs Canada. “A base” refers to core EC funding; “B base” is special EC funding; MGP is Mackenzie Gas Pipeline environmental assessment funding. A crew typically involves 3 biologists .

Year	# Crews (rapid / intensive)	EC – O&M	Non-EC O&M	EC Staff	Volunteers	Total Cost
2001/02	0.5 / 0.5	10K (A base) 29K (B base, Gwich’n)	66K (PCSP)	3	1	105K
2002/03	0.5 / 0.5	10K (A base) 29K (B base, Gwich’n)	80K (PCSP)	3	1	119K
2003/04	1.5 / 0.5	20K (B base, Nunavut) 39K (B base, Gwich’n)	80K (PCSP)	2	2	139K
2004/05	1 / 3	15K (A base) 45K (B base, Gwich’n) 20K (B base, MGP)	80K (PCSP)	3	9	160K
2005/06	2 / 3	15K (A base) 45K (B base, Gwich’n) 123K (B base, MGP)	2K (Trent Univ.) 100K (PCSP)	10	11	285K
2006/07	2 / 3	18K (A base) 41K (B base, Gwich’n) 172K (B base, MGP)	2K (Trent Univ.) 130K (PCSP)	7	9	363K
2007/08	3 / 3	48K (A base) 42K (B base, Gwich’n) 203K (B base, MGP)	131K (IPY) 111K (PCSP)	8	9+3	535K
2008/09	2 / 2	48K (A base) 122K (B base, MGP)	212K (IPY) 108K (PCSP)	6	6+3	490K
2009/10	1 / 1	80K (A base) 94K (B base, MGP)	37K (IPY) 84K (PCSP)	4	3	295K
2010/11	2 / 3	265+48 (A base)	30K (CIMP, INAC) 10K (Manomet) 13K (ARIF, INAC) 34K (PCSP)	8	9	400K
2011/12	2 / 4	380K (A base)	50K (PCSP)* 30K (INAC)*	8	12	460K
2012/13	3 / 5	605K (A base)	50K (PCSP)*	15	12	655K
2013/14	3 / 6	560K (A base)	50K (PCSP)*	16	14	610K
2014/15	3 / 6	480K (A base)	50K (PCSP)*	16	14	530K
2015/16	2 / 5	430K (A base)	50K (PCSP)*	10	10	480K
2016/17	2 / 2	280K (A base)	50K (PCSP)*	6	8	330K
2017/18	0 / 0	100K (A base)	-	2	0	100K

DETAILED RATIONALE

Given the numerous indicators that shorebird species are in decline and therefore are a considerable conservation concern, there is a need for sound scientifically-based information from which species of concern can be identified and appropriate actions taken. To date, accurate estimates of population size have proven difficult to obtain for many shorebird species. Some species disperse widely during migration, and varying lengths of stay makes enumeration difficult even for species that aggregate at stop-over sites. Estimates provided in the most recent description of shorebird population numbers represent the best information currently available, and although the authors have devoted substantial effort to refining the estimates, the inherent difficulties in estimating population size at stop-over locations and wintering areas mean that 63% of the taxa described have population estimates that are only considered "correct" within an order of magnitude or worse.

Between 1998 and 2000, Canada and the United States jointly developed separate national shorebird conservation plans with the intent that the implementation of recommendations for actions (conservation, research and monitoring) be done through programs that incorporate partners from throughout the ranges of shorebird species – effectively the Western Hemisphere. In response to the need to coordinate and cooperate in the delivery of shorebird monitoring, the Program for Regional and International Shorebird Monitoring (PRISM) was developed to package existing efforts and indicate those that were needed into a single framework. The broad goals for PRISM are to describe shorebird populations (distribution, size and trend) at all stages of their annual cycle through the delivery of appropriate surveys during the breeding season (divided into three components: Arctic, Boreal and Temperate), during migration, and during the non-breeding period. PRISM is overseen by the PRISM Committee, jointly chaired by Canada and the United States. This Committee determined early on that the component with the greatest need for development and implementation was the Arctic surveys given the high proportion of species thought to be in decline that breed there.

The Arctic PRISM program is designed to focus on 26 species of shorebirds that breed primarily in the Arctic. The primary goals of the arctic surveys are to estimate and monitor population size, determine range and habitat associations and help determine the location and cause of declines. Trend is assessed by estimating population size during two periods, each lasting several years, and comparing estimates as appropriate. Arctic PRISM's accuracy target for estimating trend is as follows: 80% power to detect a 50% decline occurring over 20 years, with a two-tailed test and a significance value of 0.15.

Surveys are proposed for throughout the North American Arctic which has been divided into 19 regions, 7 in Alaska and the remaining 12 in Canada. Data are being collected using a double sampling protocol, whereby a large number of plots are surveyed using a rapid method to provide extensive geographic coverage, and a smaller number of plots are surveyed intensively to estimate detection probabilities on the rapid plots, which can be used to estimate total population size. Based on knowledge of habitat availability, population estimates are calculated within each region and a continental population estimate is derived once all regions have been surveyed.

Agencies in Canada and the United States initially agreed to conduct surveys in each of the regions occurring in each nation such that data can be combined once all regions have been surveyed to create pan-arctic estimates for each species. Now that a target date for completion of the surveys of 2018 is being proposed, it would be prudent to seek an indication from the United States that they will be able to meet this date as well.

The costs of any survey in the Arctic are significantly more than comparable surveys in the south given the high costs of fuel and transportation. Completion of the Arctic surveys requires placing field camps in remote locations which can add to the overall cost. The need for the continued use of helicopters to move from camp to survey plots and associated fuel costs, all of which must be cached on the landscape in advance of the surveys means that the overall cost of the survey will be high. A fully operational Arctic PRISM crew will require approximately $235K per season in a highly isolated area. Multiple crews per season are required to complete surveys within the time frame. These costs present the program with a challenge and must be considered in balance with the need for population information and the possibility that it may be the only methodology that can deliver these results without significant sources of bias.

The length of time required to generate trend information is dependant on available funding (more funds will allow larger numbers of crews to operate each year reducing the amount of time required to complete the pan-Arctic survey). Initially, it was hoped that ten years would be sufficient to complete one round, in which case the first comprehensive estimate of population change would not be available until the end of the second round, 20 years after the beginning of the program. Subsequent data points would be added every 10 years after that. In practice, the first round is currently projected to take substantially longer than 10 years (14-16 years), due to limited budgets as well as the need to carry out pilot surveys in many areas which had not previously been surveyed.

This is a very long time and, in fact, there is a significant risk of population change during this period that would not be detected.

PRISM Committee members recognized that, in the case of species declining very rapidly, alternate survey methods might be required to detect the change, as was the case with some populations of the Red Knot. For many species, migration surveys provide an alternative survey method, despite the potential bias from incomplete sampling frames, changes in stopover behaviour, and the need to address variable effort through the season. The idea is that changes in migration counts can provide indicators that a problem may be occurring at which point the Arctic data could be reviewed to determine if a similar signal is present and conservation action warranted. Indeed, a review of migration monitoring methodology is required to determine if it can be refined to reduce bias and become the main indicator of shorebird population trends.

It is important to note that during Arctic PRISM surveys, data are collected on all bird species encountered therefore they also generate valuable data for numerous other landbirds, waterbirds, and waterfowl in regions that are not generally surveyed for these taxa. On each PRISM survey plot, any bird species encountered is recorded regardless if it is a shorebird or not. In addition, observations are made from the helicopter along transects that connect PRISM survey plots that allow the collection of information on larger species such as waterbirds and waterfowl. At the very least, presence data on non-target species can be of some use; however, a more detailed assessment of the data collected is required to determine if the information is actually usable and if there are opportunities to adjust the approach to non-shorebird species to increase the value of the data collected.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Arctic PRISM surveys are designed to be implemented in landscapes located above the treeline. For Canada, this is represented by the Bird Conservation Region (BCR) 3 while in the United States, surveys are carried out in BCRs 1,2, and 3. Information on shorebird densities and distributions in the Arctic has implications for landscape planning, especially where areas that were previously unknown are identified as important for shorebirds. Given the large number of Arctic-breeding species believed to be declining, this information is important for ensuring that breeding success is not a limiting factor. For those species that become listed under SARA, ensuring healthy landscapes (and having the ability to identify them) will be critical for their recovery.

It is important to note that the methodology employed in this survey cannot be carried out in Boreal habitats but the breeding ranges of some species span the tundra-forest border. Further works is required to develop survey methods that can be implemented in these areas. Survey results for these species must be interpreted carefully, to take into account these gaps, when estimating population sizes.

The recommended actions for this survey will enhance this value, as they will enable completion of coverage of the remaining areas of the arctic potentially important for shorebirds. The need for this information is very high, not only because many species of shorebirds are declining, but also because there are increased threats within the arctic, due to activities such as mineral, oil and gas exploration and mining, as well as projected changes to the ecosystems due to Climate Change.

2) Incidental take is minimized and long-term conservation is supported
Arctic PRISM surveys do not contribute directly to measuring incidental take, but completion of these surveys will provide necessary information on population sizes to estimate any impacts of any incidental take due to collisions or other factors.

3) Migratory Bird harvests are maintained at sustainable levels
Arctic surveys do not contribute to maintaining sustainable harvests in Canada, as the only shorebird species harvested in Canada, the Woodcock, is a temperate breeder and covered by a species-specific survey. However, shorebirds from Canada are harvested in a number of Caribbean countries including Barbados, Guadeloupe, Martinique and Suriname. In Barbados, information suggests that the species most impacted include boreal and arctic breeders such as Greater and Lesser yellowlegs, Pectoral Sandpiper, Stilt Sandpiper, Short-billed Dowitcher and American Golden Plover. An analysis of data from hunting clubs in Barbados is currently underway, using best available current population estimates, to determine if population level effects are likely from this hunt.

Information from Arctic breeding ground surveys, once they are completed, will allow for much more reliable estimates of total population size of many species, which can be used to determine whether current levels of harvest are likely to be sustainable.

4) Species harvested for Aboriginal subsistence use
There is believed to be minimal aboriginal use of shorebirds from the Arctic within Canada, and this survey is unlikely to be particularly relevant to this need.

5) Priority sites for Migratory Birds are protected and improved
Surveys conducted so far during the first round of Arctic PRISM have identified a number of previously unknown areas that are important for breeding shorebirds. Distributions of shorebirds in the Arctic have not been systematically described prior to the implantation of the PRISM surveys; therefore, completion of this survey will be important for identifying additional sites within the arctic that are important for future protection.

Many broad-scale habitat conservation programs such as those under the Ramsar Convention, the Important Bird Areas Program and the Western Hemisphere Shorebird Reserve Network use designations based on the percentage of total population using a site. Better information on population size and trend, derived from Arctic surveys, will facilitate identification of important sites, and better enable these programs to implement conservation measures for shorebirds in Canada and in other countries.

6) Population-level effects of toxic substances are reduced
Not currently believed to be a serious concern Canada, but the level of shorebird exposure to agrichemicals on migration and on non-breeding grounds, particularly in rice fields, is poorly understood. Estimates of total population size from Arctic surveys, as well as more reliable estimates of population change, would be valuable to determine whether species that use agricultural habitats in winter or on migration may be adversely affected by toxic substances such as pesticides.

7) Populations of Migratory Birds under particular threat are conserved
Sound information on population size and trend is needed to identify species requiring management for their conservation. Many species of shorebirds are believed to be declining, suggesting a need for conservation action. Information from the Arctic PRISM surveys will help to identify potential causes of population change, particularly through providing reliable estimates of population size that can be used to evaluate changes in numbers at key migration stopover and wintering areas.

8) Migratory Birds in land claim areas are conserved
Shorebirds are not generally a focus for land claims, and the arctic PRISM surveys are unlikely to contribute much to this need. There is some potential for economic development (tourism) for Cree communities on James Bay centred on the site of hemispheric importance under the Western Hemisphere Shorebird Reserve Network (WHSRN), and it is possible that completion of PRISM surveys may identify additional areas of international importance for shorebirds within land claim areas.

9) Threats due to Migratory Birds to public and economy are reduced
Compared to other incidences of damage by migratory birds, damage by shorebirds is much smaller and isolated compared to other species groups such as waterfowl. A few instances have been reported of shorebirds such as Upland Sandpipers and Whimbrel in berry crops, but arctic breeding surveys are unlikely to have a significant contribution to management of these issues. Similarly, any threats from shorebirds related to aircraft collisions generally relate to migration concentrations and are unlikely to be influenced by PRISM surveys.

10-11) Species at Risk
A high proportion of shorebird species (50-80%) are currently thought to be in decline in Canada, based mainly on analysis of migration counts, including many species that breed in the Arctic. The estimated declines in many species are sufficiently large to meet listing criteria used by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), but there are many potential biases to migration counts, and the reliability of the trend estimates is low. There is thus a substantial risk that, with present information, species may not be listed, even though they are actually declining, thus losing an opportunity to enhance protection, or conversely, species may be listed based on trends on migration counts which later prove unreliable, thus leading to wasted resources conserving a species that was not in trouble. Several shorebird species currently being considered by COSEWIC, including Semipalmated Sandpiper, Red-necked Phalarope and Buff-breasted Sandpiper, nest in the Arctic. Completing the Arctic PRISM surveys will substantially reduce the risks of incorrect listing and, in the case of species that become listed, provided valuable information to inform appropriate recovery strategies.

Other Risks to Take Into Account

Legal risk
With increased industrial activity in the Arctic, and evidence that many shorebird species are declining and some are now listed by COSEWIC, information on the distribution and abundance of species across the arctic, to provide context for and inform environmental assessments, would reduce the risk that EC will be sued by environmental groups for failing to take adequate measures to protect shorebirds at risk in the arctic.

Maintenance of external funding
Early implementation of the Arctic surveys was completed largely using one-time opportunistic funding from the oil and gas sector and some ongoing support from Natural Resources Canada – Polar Continental Shelf Program. Currently, the search for additional support for these surveys is ongoing, as Environment Canada and the Polar Continental Shelf Program are the only current funders. The recommended target date assumes an annual O&M expenditure of about $350,000 (with commensurate human resource effort), and continued Polar Continental Shelf Program expenditures at current levels. The level of survey effort possible at this funding level would provide for the completion of surveys in all PRISM sampling regions by 2018. Surveys can be conducted at reduced funding levels; however, the time required tocomplete the full component of surveys required to calculate population estimates would increase in response to this, and the reliability of the population estimate would decline in parallel. For example, funding at $250,000 would require an additional eight years to complete the surveys by 2026.

Public support for management actions
As habitat joint ventures become increasingly engaged in the delivery of management for all bird species, they will require information on the status of species occurring in their region to assist them in the development of implementation plans. Key to the survival of Arctic-breeding shorebirds is the availability of healthy staging habitats where birds can rest and re-fuel on their way to and from northern breeding areas. As a result, management by partners in southern habitats may become a critical factor in the survival of shorebird species in decline. Reliable information on population change is critical to persuading international partners of the need to take conservation actions.

Partner Expectations
Completion of the first round of Arctic surveys, as recommended, would help to fulfill the international PRISM committee expectations of a unified continental program.

Summary of Implications of Recommended Changes

While there is a clear need for the information generated by the Arctic PRISM surveys, there are significant challenges in terms of cost and human resources to complete, at the very least, the first round by 2018 covering the Canadian Arctic.

It is acknowledged that the Arctic PRISM surveys as currently designed are a robust design to estimate population size, as well as collecting presence/absence information on other bird species in the Arctic. However, the high cost to conduct these surveys and the time required to generate estimates of population size remain a concern. Further examination should occur to see if the same information needs can be met by altering the current methodology or putting more reliance on migration and/or non-breeding surveys.
The proposed recommendations, once implemented, will contribute significantly to our ability to describe shorebird populations and will represent an important contribution to the international shorebird community such that the information collected will inform decisions made throughout the hemispheric-wide ranges of these species.

PROGRAM FOR REGIONAL AND INTERNATIONAL SHOREBIRD MONITORING (PRISM) MIGRATION MONITORING (SB-9, 10)

SUMMARY RECOMMENDATIONS

1. Maintain Atlantic Canada SB-9 and Ontario SB-10 migration count programs at current levels pending development of a strategy to reduce potential bias and improve reliability of the counts.
2. Improve the efficiency of SB-9 and SB-10 through improved data management systems, including web-based data entry for volunteers, preferably using an e-Bird protocol the same as, or similar to, that adopted by the International Shorebird Survey (ISS) in the U.S., with any necessary modifications to meet Canadian needs.
3. Analyse, by 2012 all available eastern North America migration count data (including SB-9, SB-10 and American surveys), using modern analysis methods (e.g., hierarchical Bayes models) to obtain best available estimates on recent trends, and to quantify the likely magnitude of bias from changes in turnover rates and stopover sites.
4. Assess, by 2012, the feasibility of enhancing shorebird migration monitoring to obtain more reliable population trend estimates, considering improved and expanded site selection, any necessary changes in sampling protocols, incorporation of methods to estimate stopover duration, if required, etc. The survey design should be developed at a scale that considers both Canadian and U.S. stopover locations within a single sampling frame. If economically feasible, start to implement changes by 2013.

SUMMARY OF RATIONALE

Shorebirds are characterized by lengthy annual migrations and, for many species, their use of remote habitats during breeding and non-breeding periods. As a result, most species remain poorly described in terms of their population size, trend and distribution at various times of year. Because so many species breed in remote Boreal and Arctic habitats, and winter in Latin America, most of the indicators of shorebird status have come from migration counts in Canada and the United States. Available information on trends for shorebirds, largely based on migration surveys, suggest that between 50 and 80% of 72 shorebird species and populations are in decline.

Migration monitoring in Canada was established with the goal of identifying important shorebird staging habitats with the objective of supporting their management and conservation. The data have been used to support the management of landscapes for shorebird species through programs such as Environment Canada protected areas programs, the Ramsar Convention, the Important Bird Areas program and the Western Hemisphere Shorebird Reserve Network. As shorebird numbers and the availability of habitats changes through time, continued migration counts are useful for maintaining actions at established sites and, if sampling sites are added or re-distributed, identifying new sites for consideration.

Migration monitoring data have been used to estimate trends, but there are many potential biases to the trend estimates, including the fact that study areas were not randomly selected and only cover a subset of potential stopover areas, the stopover duration for shorebirds may change over time, and the numbers of counts through the season varies among sites. The latter component creates some challenges in selecting appropriate analysis methods. Theoretical approaches have been developed to address these concerns, but a practical approach for implementing them has not yet been developed.

We recommend continuing the current migration surveys because of their importance for managing stopover areas, and because they currently provide the only available information, despite potential biases, on population trends for many species. Even if the Arctic PRISM surveys are fully implemented, they will not cover all species that are covered by migration counts (especially species that breed in the boreal and the boreal / taiga transition zone), and even for Arctic species, will only provide trend estimates at intervals of 10 or more years.

Much of the current cost of the surveys, which are largely carried out by volunteers, relates to the administration of the surveys, especially the Atlantic Canada Shorebird Survey (ACSS, formerly Maritimes Shorebird Survey; see table). These costs could be reduced, and the data made more readily accessible to analysis, if a web-based data management system is adopted that would allow volunteers to enter and manage their own data. A potentially suitable system has recently been developed by the International Shorebird Survey using e-Bird, which should largely meet EC needs, though some up-front investment may be required to ensure that it meets all of the current data management needs of the Canadian systems, including an ability to manage associated habitat data. Costs of any modifications can potentially be shared with the ISS.

We also recommend a thorough analysis of the existing data, using modern analysis techniques (e.g., hierarchical Bayes models) including an acknowledgement of the potential effects of bias, to ensure that the data are being used to their full potential for conservation and management purposes. We also recommend that measures be adopted to improve the reliability of the surveys for future trend analysis, including an expansion of the current sampling frame and implementation of any necessary auxiliary studies (e.g., to look at stopover duration or detectability), but only after completion of a detailed analysis that identifies the predicted gains in reliability with different levels of investment, and development of an implementation plan based on the investment level that optimizes the balance between costs, benefits and risks. Such an analysis should be carried out at a continental scale (considering both U.S. and Canadian sites) as it is appropriate, in a migration analysis, to combine data from both countries.

The coverage and average annual costs of the Atlantic Canada Shorebird Survey and the Ontario Shorebird Survey, since 1974, are outlined below:

	Atlantic Canada Shorebird Survey	Ontario Shorebird Survey
Sites surveyed annually	40-50	11
Surveys per site	1-10	13
Species captured regularly	16	14
Field Time (person-days -- largely volunteer)	650	150
Operating Funds	$500	$1000
EC Staff time (BI-03)*	$78,750	$1050

* estimating the maximum salary and benefits of a BI-03 to be $105K

DETAILED RATIONALE

Between 1998 and 2000, Canada and the United States jointly developed separate national shorebird conservation plans with the intent that the implementation of recommendations for actions (conservation, research and monitoring) be done through programs that incorporate partners from throughout the ranges of shorebird species – effectively the Western Hemisphere.

In response to the need to coordinate and cooperate in the delivery of shorebird monitoring, the Program for Regional and International Shorebird Monitoring (PRISM) was developed to package existing efforts and identify those that were needed into a single framework. The broad goals for PRISM are to describe shorebird populations (distribution, size and trend) at all stages of their annual cycle through the delivery of appropriate surveys during the breeding season (divided into three components: Arctic, Boreal and Temperate), during migration, and during the non-breeding period. PRISM is overseen by the PRISM Committee, jointly chaired by Canada and the United States, and determined early on that the component with the greatest need for development and implementation was the Arctic surveys given the high proportion of species thought to be in decline that breed there. However, due to the high costs of Arctic surveys, and the large number of years required to complete one round of surveys, it was recognized that migration counts would continue to be an important part of any strategy.

Migration monitoring in Canada is largely based in Atlantic Canada and Ontario with a smaller program in the Lower Mainland of British Columbia. The Atlantic Canada Shorebird Survey has operated since 1974 and in 2009 included surveys at 151 sites involving 89 volunteers. Given the varied interest and availability of volunteers to conduct the surveys from year to year, the overall totals for the program between 1974 and 2009 includes data for 705 sites collected by over 500 volunteers. The Ontario Shorebird Survey has similarly operated since 1974 and in 2009, operated at 120 sites but has collected information on 258 sites since the survey began. A complementary program operates in the U.S., largely in the east, called the International Shorebird Survey, and using similar methods. The U.S. program is managed out of Manomet Observatory, but the data management has recently migrated to e-Bird, a web-based data management system operated out of the Cornell Laboratory of Ornithology. In Canada, Bird Studies Canada coordinates E-Bird, using the same web-based software.

At present, surveys are conducted in a restricted set of non-randomly selected areas. Changes in local abundance could reflect changes in shorebird distribution, as opposed to population decline. Achieving rigorous and defensible estimates of shorebird trends with migration monitoring is possible if improvements are made in three categories: delineation of an appropriate study area, a sampling plan to allocate effort within that study area, and more accurate counts.

Potential bias from shifting distributions would be greatly reduced if an area is identified within which all habitats where shorebirds might stopover on migration, and then a rigorous, stratified random sampling plan is adopted to select locations within that area. This sampling frame would necessarily be very large, including areas along much of the flyway. Sites chosen using a randomized procedure could potentially be supplemented by additional volunteer-chosen sites to allow for some level of continuity. This large sampling frame and rigorous sampling plan has two benefits: a shift in distribution of shorebirds would not cause any bias in the estimates of numbers present, and changes to turn-over rates would cause minimal bias because most birds would be present at all times somewhere within the sampling frame.

The current relatively low cost of migration monitoring would necessarily increase somewhat with the adoption of more a more rigorous approach, but would likely still remain cheaper than Arctic surveys. Additional paid staff might be required to support and conduct additional surveys in areas where there are insufficient volunteers to meet the requirements of a more rigorous sampling frame. For example, the benefits of increasing sample effort five-fold is indicated in the table below; however, the logistical considerations and the added costs of increasing the survey are not accounted for.

The table below shows standard error (SE) of the slope parameter for trends in mean counts of shorebirds, 1974-2006. Current scheme refers to real results from the ACSS, while Nationwide Scheme refers to a hypothetical network of surveys 5 times larger than the Current Scheme. This comparison assumes that variance in counts among and within sites is approximately equal for the two schemes, and change in SE reflects the effects of an increasing sample size only. The fraction of species for which a significant decline of 1.7 – 4.5%/year could be identified is also displayed. The 16 species best captured by the current ACSS surveys are considered.

		Species for which a 20 year decline of X would be identified at α = 0.15, ignoring bias…			
	Average SE of Slope	30% total (1.7%/yr)	40% total (2.5%/yr)	50% total (3.4%/yr)	60% total (4.5%/yr)
Current Scheme	0.048	1/16	3/16	6/16	10/16
Nationwide Scheme	0.021	7/16	10/16	12/16	14/16

Increasing sampling intensity and the area over which surveys are conducted will result in a larger number of species for which trends can be calculated. While current sampling effort in Canada will provide information for 16 species, a broader analysis of data from the United States and Canada suggest that upwards of 30 species out of the 47 that occur in Canada might be assessed although it is unclear how large a sample is required to obtain a reliable estimate for each species. It was also indicated that despite a more rigorous analysis, the author could not rule out that detected trends were not partly explained by birds moving to different sites.

Support for the inclusion of more sites (e.g. a 10 fold increase from current) may require the hiring of additional staff to coordinate surveys and manage data ($210K for two coordinators), as well as hired staff to survey areas where volunteers are unavailable or reluctant to go, such as wetlands with low concentrations of birds (e.g., $100K / year in contract work). To address concerns about bias, special studies to estimate detection rates ($30K / year), and to estimate length of stay (up to $200K / year to cover multiple sites) could substantially increase the overall annual cost of the survey to over $500K, although not all studies would necessarily be required every year.

Of the 16 species detected in reasonable numbers by the current migration surveys, 6 are species that straddle the Arctic/sub-Arctic boundary, and an additional 3 are not captured at all in the arctic surveys. Thus migration monitoring could contribute to shorebird monitoring in Canada even if the arctic surveys were implemented. A possible path forward would be a survey approach that used combination of migration monitoring and arctic surveys. Under this scenario it may be unnecessary to address all sources of bias in the migration surveys; these could serve as an “early warning system”. If a specific monitoring standard (i.e., time frame and precision) is identified, it would be possible to design a monitoring program that balances the strengths and weaknesses of both the migration surveys and the Arctic PRISM surveys.

Implications of survey modifications to ability of suite of surveys to address EC monitoring needs

1) Landscape conditions accommodate Migratory Bird requirements
Migration monitoring offers a snapshot of habitats used by shorebirds during spring and fall migration. While there are inherent biases in the information as it is currently being collected, these counts have played a significant role in identifying key staging habitats for shorebirds in eastern Canada and similarly for more localized counts in the prairies and on the Pacific coast. This information is critical for informing land use planning exercises, the implementation of recommendations from Bird Conservation Region plans and SARA Recovery plans. The proposed changes would maintain or increase the value for these purposes.

2) Incidental take is minimized and long-term conservation is supported
Migration Monitoring surveys do not contribute directly to measuring or managing incidental take, but information on migration concentration areas would be valuable for assessing potential risks of new development activities such as wind turbines or other structures in stopover areas.

3) Threats to migrants in other countries are reduced
Not applicable.

4) Migratory Bird harvests are maintained at sustainable levels
Migration monitoring for shorebirds does not contribute to maintaining sustainable harvests. The only shorebird species harvested regularly in Canada, Woodcock, is generally found in upland habitats which are not visited during general shorebird surveys. Instead, it is monitored by a specialized breeding survey.

The largest harvest of shorebirds occurs in a number of Caribbean countries including Barbados, Guadeloupe, Martinique and Suriname. The indication of population trend from migration monitoring has been important in identifying species of conservation concern. While these harvests do not take place in Canada, information from migration counts is being communicated to hunters and governments in the Caribbean to inform them of which species are at greatest risk so that harvests might be adapted to focus on species where sustainable hunts may be possible.

This value would be maintained or enhanced with the proposed changes, as we anticipate obtaining better and more reliable trend information.

Species harvested for Aboriginal subsistence use :Shorebirds are not harvested in significant numbers in Canada, so this survey is not relevant to that need..

5) Priority sites for Migratory Birds are protected and improved
Many broad-scale habitat conservation programs such as those overseen by the Ramsar Convention, the Important Bird Areas Program and the Western Hemisphere Shorebird Reserve Network require information on numbers of individuals on site in order to qualify for the conservation benefits of these programs. Because of the tendency of shorebirds to congregate at staging areas on migration and because major staging areas tend to be a focus for volunteer based surveys, migration monitoring has been key for the identification and on-going surveillance of bird use at these sites.

The proposed changes to the survey would maintain or enhance these values, especially if improved estimates of stopover duration allow more reliable estimates of the total number of individuals using each site, and not simply the maximum number at any one time. Any changes to the sampling frame for migration counts would need to be made in such a way that the most important known concentration areas would continue to be part of the sampling frame, if necessary through stratification based on numbers of birds estimated to use an area, with total sampling of all sites estimated to support >1% of the known population of any species. It is possible that an expanded program, surveying additional sites could identify new priority sites.

6) Population-level effects of toxic substances are reduced
To date, there have been very few indications that exposure to environmental contaminants is generating negative population level effects with the exception of a possible correlation between shorebird use of rice field habitats and the decline of some species (e.g. Greater and Lesser Yellowlegs). Spring migration of many Arctic and Boreal breeding shorebirds takes them on a path through the center of the continent. For many, migration through areas where they might encounter tailings ponds generated by oil sands activities is probable. Shorebird use of these ponds and the potential for exposure to lethal and sub-lethal levels of contaminants remains to be investigated.

Expansion of migration monitoring activities into western Canada would enhance the value of the survey to meet this need, by providing baseline information on numbers of birds stopping in the region, and could be combined with site-specific surveys in industrial locations to estimate impacts of contaminants.

7) Populations of Migratory Birds under particular threat are conserved
Indications of population status from existing data have alerted governments and non-government agencies of numerous shorebird species in decline. While the information from these indicators is potentially biased, they are nevertheless the best available information for many species. In some cases, the estimates have been corroborated by surveys in wintering areas (e.g., Red Knot). The cause(s) of declines, and locations of areas where mitigation measures would be effective, are poorly known in most cases, but in some cases changes in stopover habitat have been implicated (e.g., for Red Knots). Especially in these cases, migration monitoring can provide an indication of the effectiveness of any management actions that are undertaken.

8) Migratory Birds in land claim areas are conserved
Shorebirds are not generally a focus for land claims, and migration counts generally are not taking place in land claim areas.

9) Threats due to Migratory Birds to public and economy are reduced
Compared to other incidences of damage by migratory birds, damage by shorebirds is much smaller and isolated compared to other species groups such as waterfowl. An example of damage by shorebirds would be the occurrence of Upland Sandpipers and Whimbrel in berry crops. Migration monitoring is unlikely to have a significant effect on the reduction of these isolated occurrences which might be better reduced by through development of best management practices so that operators might make their crops unattractive to all bird species that use them.

10-11) Species at Risk
Except for a few species where there have been long-standing specialized species surveys (e.g. Piping Plover and Red Knot), the best available information on shorebird trends in support of status comes from migration counts. Although the trend information from migration counts is potentially biased, it remains the best available data. The proposed recommendations will maintain or enhance the value of these counts for status assessment by COSEWIC, and will also enhance their value for monitoring the effectiveness of any recovery measures. Combining migration count information with estimates of population size from Arctic PRISM, as recommended in our assessment of that survey, would further enhance the reliability of status assessments under COSEWIC.

Other risks to take into account

Legal risk
Environment Canada has responsibilities for the conservation of shorebirds under the MBCA and, increasingly, the recovery of shorebirds under SARA. The continued and widespread decline of species is well known by non-governmental organizations largely due to data collected during migration counts. The recommendations to maintain and eventually improve these surveys will minimize risk that EC will be considered to be neglecting this responsibility.

Maintenance of external funding
Migration monitoring is not currently supported by external funds

Public support for management actions
Declining shorebird populations and the lack of reasons for these declines is well known by NGOs who are aware of the need for increased monitoring efficiency and the need to act to reverse declines.

Partner Expectations
Integrating migration monitoring across the continent would require close coordination with the U.S. Informal discussions with staff at Manomet Observatory, who run the International Shorebird Survey, suggest that they would be supportive of using the same data management platform for all the surveys. Moving to a better designed continental survey, with a different sampling frame, would require extensive consultation and discussion prior to implementation.

Summary of implications of recommended changes

Migration counts for shorebirds have been effective in identifying key staging habitats and have provided indication of declining populations. The changes recommended are intended to assess sampling methodology to

determine if biases that limit the application of migration data can be minimized. In doing so, it would be then possible to determine if the improvement in the quality of data would allow for quicker and potentially more cost effective determination of shorebird population trend than is currently possible through the Arctic PRISM program. It is important to note that completion of population estimates from the first round of Arctic surveys will be important for enhancing the credibility of the migration counts, because it will provide a context for understanding the numbers of birds stopping at sites currently being monitored, and hence for estimating the proportion of the population of each Arctic nesting species that is using stopover sites outside of the current sampling frame.

RED KNOT MONITORING PROGRAM (SB-8)

SUMMARY RECOMMENDATIONS

1. Maintain support for the Red Knot (*rufa*) wintering population survey in South America, to provide near-annual indices of population trends for southern portion of the *rufa* population. By 2014 the EC Shorebird Committee should review and confirm the appropriate frequency for these surveys (annual or some longer period).
2. Implement consistent improvements to the Tierra del Fuego survey protocol to enable more effective estimation of bias, including use of consistent surveyors, ground-truthing, mark-recapture estimates etc., with analysis, archiving and reporting of survey results in accessible EC databases, annual reports and published literature.
3. Continue training and mentoring of South American survey biologists. Survey tasks to be shared with EC staff in the short term, with the objective of transferring the operational delivery of the Tierra del Fuego surveys to Chilean/Argentinean experts by 2014 but retaining close links and funding support from EC.
4. Determine the sub-specific identity (*rufa* or *rosalaari*) of Red Knot populations wintering in Brazil by 2013 in cooperation with the international Red Knot Working Group,
5. Work with Brazil and the Guyanas to establish regular coastal surveys for Red Knot and other species such that data can be combined with those from other regions to provide population-wide estimates and trends.
6. Assess by 2013 the possibility of using spring aerial counts in Delaware Bay to reduce the need for annual overwintering counts in Tierra del Fuego, Brazil and Florida.
7. EC Shorebird Committee to determine the most effective approach for obtaining population estimates and trends for *islandica* and *rosalaari* populations by 2013, considering opportunities in breeding, migration and overwintering areas.

SUMMARY OF RATIONALE

Three subspecies of Red Knot (*Calidris canutus)* breed in Canada, including *islandica* which breeds in High Arctic Canada and Greenland and winters in Europe*, roselaari* which breeds further west, extending into Alaska, and *rufa* which breeds in the central Canadian Arctic. In 2007, *roselaari, islandica*, and *rufa* were proposed by COSEWIC for classification as *Threatened, Special Concern* and *Endangered*, respectively. In 2011, a one-year 40% drop was detected in the southern population of *rufa* knots. This drastic annual change combined with an already steep rate of decline indicates the need for continued regular surveys for this subspecies. Because of the challenges in counting Red Knot, and the importance of obtaining consistent annual population indices, multi-species shorebird surveys are supplemented by key targeted surveys focused primarily on specific populations of Red Knot.

Because knots are dispersed breeders rarely occurring at high density during the nesting season, surveys are generally conducted at migration concentrations or on the wintering grounds. Wintering grounds surveys in Tierra del Fuego and adjacent parts of Chile and Argentina, which are the primary monitoring tool for the *rufa* population of Red Knots, have indicated that this population has declined precipitously since the 1990's. Knots which winter in Tierra del Fuego and migrate through Delaware Bay are the primary focus of EC's monitoring South American efforts. Adult survival of this population has declined markedly, as adults had insufficient access to horseshoe crab eggs during northbound migration through Delaware Bay. This in turn resulted in the drastic reductions in population size by these surveys, which led to the recommendation for *Endangered* status. Winter surveys completed in January 2011 indicated a continuing major decrease in that wintering population – by 35% compared to January 2010, and over 80% since 2000.

The present surveys are conducted annually, to provide a yearly index of the size of the *rufa* population, to support the following three objectives:

- *Monitoring and Evaluation*: This survey monitors the bulk of the *rufa* population, and thus indicates the magnitude and direction of population change. Annual changes are used to assess the effectiveness of conservation actions on the population trajectory and in achieving recovery objectives. Given the significant declines detected since 2000, and the corresponding urgency for effective population management, Red Knot conservation specialists argue that annual tracking is important.
- *Research*: Annual changes in the population index are linked to events in the annual cycle, such as good or poor breeding seasons, high or low availability of horseshoe crab eggs, or significant weather events such as hurricanes, to better understand their influence in directly effecting productivity or survival, and thus, population size.

- *Management*: Population numbers and trends detected in the Tierra del Fuego surveys and other programs are built into decision-making protocols for closure of the Delaware Bay horseshoe crab fishery in those years when knot numbers are low, as ensuring the availability of horseshoe crab eggs as food for knots on northbound migration is a high priority.

Aerial surveys of Red Knots in Tierra del Fuego are subject to sources of bias and imprecision, but remain the best index of population trend. Close correspondence with independent mark-recapture estimates from a staging site in Argentina suggests that the surveys are tracking trends effectively. However, to ensure that these surveys can effectively address these three objectives, actions are required to further assess and to the extent possible, minimize the sources of bias and imprecision identified in the Avian Monitoring review of this survey (Smith, 2010). The primary aerial surveyor is Dr. R.I.G. Morrison, a research scientist from EC's Wildlife Research Directorate, whose acknowledged skills and experience over many years have provided importance consistency and reliability throughout the survey period. However, with Dr. Morrison's anticipated retirement, plans should be made to transfer survey oversight to the Canadian Wildlife Service, which has operational responsibility for monitoring programs under MBCA and SARA within EC. It will be the responsibility of CWS to determine the best path forward for the continuation of these surveys, be it through continued Canadian participation or through support for in-country surveyors to carry out the work.

A second index of trend is available from aerial surveys conducted each year in Delaware Bay. This survey is advantageous in that it includes birds from each of the main overwintering areas and can be conducted using local biologists, making it less expensive to EC than surveys currently run in South America. Because of bias introduced by variable turnover rates, errors associated with counting birds moving through an area over several weeks (Delaware Bay) make these estimates less reliable compared to counts taken when birds are stationary for several months (Tierra del Fuego, Brazil and Florida). However, data from the two surveys can be used strategically to reduce the need for annual counts in South America if Delaware Bay counts are employed to give an indication of trend in between less frequent counts in South America (e.g. every 5 years). As a result, it may be possible to reduce the frequency of more expensive surveys without significantly impacting the overall indication of trend over a long period.

EC has traditionally provided the survey protocol, rented aircraft, and skilled survey staff to monitor the Tierra del Fuego wintering population, and EC's leadership in these aerial surveys is widely recognised as an important contribution to international Red Knot conservation efforts. However, recent changes have been initiated to develop monitoring capacity amongst agencies and experts from Argentina and Chile, and to reduce overall costs to EC (currently $18,000 O&M plus approximately $33,000 salary). Surveys in 2009-11 were flown with a Chilean survey biologist, using a helicopter on loan from the Chilean national petroleum company. Given the availability of scientific expertise in South America, but not of local agency funding, there is the potential to eventually transfer the responsibility to deliver this winter monitoring to these countries, as long as funding support from sources such as EC continues to be available.

There is increasing recent evidence based on resightings of banded birds that those Red Knots overwintering in Brazil are also of the *rufa* population and not *rosalaari* as was earlier thought. Given the size of the Brazilian overwintering population, estimated to be 3700 individuals, these birds could represent a significant proportion of either population, and their status could significantly influence the direction of conservation measures taken to recover either population. For example, if these wintering birds are *rufa*, conservation considerations should be linked to actions taken for the other birds found in southern South America and Florida, but if they are *rosalaari*, they need to be tied to actions undertaken for those knots found in coastal North and Central America.

The *islandica* population of Red Knots links breeding areas in Canada to migration through Greenland on their way to Europe. Overwintering populations are monitored primarily in the Netherlands and Great Britain. A more complete understanding of the status and conservation needs of this population may require improved linkages to monitoring programs in those countries.

Cost Summary

The follow table outlines approximate costs of current surveys of *rufa* Red Knot in Tierra del Fuego, and other shorebird surveys in South America (Brazil and the Guyanas) that document wintering Red Knot, based on 2010-12 estimates.

	EC Funds	Partner Funds	Partner (in-kind)
Tierra del Fuego Surveys			
S&T a-base	$2,000		
EC International Affairs	$12,500		
S&T salaries	$6,000		
South American Academics/NGOs			$5,000
ENAP (Chilean Petroleum Company)			$20,000
Total	**$20,500**		**$25,000**
Other South American Surveys			
S&T a-base			
S&T salaries	$2,500		
US agencies/NGOs	$6,000		
South American Academics/Agencies		$30,000	$5,000
Total	**$8,500**	**$30,000**	**$5,000**

DETAILED RATIONALE

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Red Knot breed in BCR-3 (Canadian Arctic) where they are a priority species, and stop at several locations in Canada on migration, notably along the coast of James Bay and at the Mingan and Magdalen islands. Tracking population trends of this listed species relies on South American surveys to monitor population changes as their low-density breeding distribution in Arctic Canada precludes effective monitoring in the Arctic. This species is included in the Arctic PRISM monitoring initiative currently under review, but PRISM will not provide population trends for at least a decade.

2) Incidental Take is minimized and long-term conservation is supported
Not applicable.

3) Threats to migrants in other countries are reduced
Although climate change effects in breeding areas may affect populations of Canada's Red Knot, all recently-identified risks are related to human activity (especially competition for food sources and disturbance), and occur at migration stopovers and wintering areas in other countries (USA and South America). In the USA, the Atlantic States Marine Fisheries Commission purports to use the results of the aerial surveys in Tierra del Fuego on an annual basis, as one component of its complex modelling approach to determine whether the population of *rufa* knots is sufficiently large to allow a harvest of female horseshoe crabs in Delaware Bay. However, annual take of horseshoe crabs has not changed significantly in the past ten years, as a reduction in harvest on the New Jersey side of Delaware Bay was compensated for by increases elsewhere. Survey results have also been used to support requests by USFWS and NGOs to reduce horseshoe crabs harvest to allow crab populations to recover. This survey, and the initial EC South American shorebird survey from which it was derived, were used to identify key areas for protection from disturbance in South America. Expansion of surveys into Brazil and the Guyanas can be used to ensure that threats to knots and other shorebirds such as hunting and management of coastal areas are not contributing significantly to population declines.

4) Migratory Bird harvests are maintained at sustainable levels
Red Knot monitoring provides information that enables EC and partners in the Caribbean and northern South America to influence harvest of shorebirds in these regions. While the number of knots taken each year may be small, the current status of their populations warrants actions to ensure that there is no tolerance for the take of any birds.

5) Priority sites for Migratory Birds are protected and improved
Surveys are conducted annually at the same location, and thus provide information on the role that these areas play in supporting wintering birds. Protection of these key sites is important to ensure that Red Knot can continue to pass the winter periods undisturbed, through focused conservation, protection and stewardship initiatives in Chile and Argentina. Periodic surveys undertaken over more extensive lengths of coastline will identify other areas of importance and changes in the numbers of birds they support, and will facilitate protection and stewardship decisions. In Canada, there are three migration sites known to be important for Red Knots (Mingan/Magdalen Islands, coastal James Bay and the Nelson River estuary). The need for undisturbed foraging and roosting sites at migration stop-overs dictate that these sites warrant either formal protection, such as the

inclusion of the Mingan Islands within a National Park, or stewardship through opportunities provided by the Western Hemisphere Shorebird Reserve Network and Important Bird Areas programs.

6) Population-level effects of toxic substances are reduced
As Red Knot populations do not currently seem to be affected by impacts of toxic substances, changes to these surveys will not affect population-level effects of toxics.

7) Populations of Migratory Birds under particular threat are conserved
The *rufa* sub-species of Red Knot is expected to be confirmed under SARA as *Endangered* in 2012. These birds are under particular threat as a consequence of impacts of horseshoe crab harvesting in Delaware Bay on foraging effectiveness and survival, which is considered the primary cause of population declines. The *rosalaari* population is also expected to be listed under SARA as *Threatened* in 2012, and a clearer picture is required of population trends and potential threats, thought mainly to be disturbance and coastal development. The *islandica* sub-population is already SARA-listed as *Special Concern,* and will require input from partners in Greenland and Europe to determine trends and actions needed to address its status.

8) Migratory Birds in land claim areas are conserved
Southbound migration of *rufa* knots depends on healthy stopover habitats along the cost of James Bay on lands that are part of one or more Cree land claims. Currently, the Moose Cree First Nation is involved in the potential designation of James Bay as a WHSRN site of hemispheric importance.

9) Threats due to Migratory Birds to public and economy are reduced
Red Knot and other shorebirds do not generally present significant risks to public or the Canadian economy, although the migration of knots through Delaware Bay is thought to contribute millions of dollars to local economies via the ecotourism industry.

10) Avian Species at Risk are assessed, identified and listed
Results of Tierra del Fuego surveys were important in identifying significant declines in *rufa* Red Knot since the mid-1990s, which met COSEWIC criteria for rapid and significant declines, enabling appropriate population assessment and leading to the recommendation for listing the three subspecies under SARA.

11) Populations of avian Species at Risk are recovered
As the Tierra del Fuego counts give an annual index of population change for the bulk of the *rufa* population of Red Knot, this survey has an important role in interpreting the causes of annual changes in population estimates, and in tracking the continuing decline and future population increases against which to assess the success of recovery efforts. These components will be built into the developing Red Knot recovery strategy, which will require an effective population tracking survey to track numbers and success in moving towards a recovery goal.

Other Risks to Take into Account

Legal risk
In addition to MBCA obligations, Environment Canada has increasing responsibilities for the conservation of Red Knot, as COSEWIC recommendations for listing under SARA are confirmed in 2012. Information from the Tierra del Fuego surveys was instrumental in identifying declines that triggered COSEWIC status, and will be integral to developing an effective recovery plan and evaluating progress towards population recovery. This formal EC interest is recognised by our partners and reflected in support for this program as a Canadian contribution to cooperative international Red Knot recovery efforts.

Maintenance of external funding
External resources support several key aspects of these surveys, including provision of the helicopter survey platform by ENAP, the Chilean National Petroleum Company, contributions of time from Chilean observers, and in-kind support. Ongoing annual EC contributions (in order of $10K) are anticipated from EC-International Affairs, under the Canada-Chile Environmental Agreement.

Public support for management actions
The new COSEWIC status of Red Knot, and its role as a focus for shorebird conservation, is well-recognised among Canadian NGOs, and Canadian, US and South American conservation partners. They are aware of Canada's role in collecting consistent population data through these surveys, and despite some shortcomings, these surveys are considered to be the gold standard of shorebird monitoring.

Partner Expectations
Canada and its US and South American partners participate together in research, monitoring, management and stewardship activities linked to Red Knot conservation, and meet annually through the Red Knot working group to evaluate progress and coordinate conservation actions. EC's role in providing the key observer for South American surveys since their inception is considered an essential contribution by our international partners.

Summary of Implications of Recommended Changes

These recommendations are intended to confirm that the approach taken for these surveys is optimal by reducing sources of bias and imprecision, and ensuring appropriate responsibility of South American partners in undertaking this work. They will also ensure that *roselaari* and *islandica* populations are monitored appropriately by EC or its partners, within the resources available. They are intended to ensure that Canada's commitment to international objectives and internal obligations under the MBCA and SARA are met, in providing appropriate survey results for populations of all three subspecies, as required to meet conservation objectives for Red Knot in support of monitoring and evaluation, research and management needs.

SEABIRD COLONY MONITORING PROGRAMS (SE-2, 3, 4, 13, 25, 30)

SUMMARY RECOMMENDATIONS

1. Prepare, by end of 2011-12, an up-to-date national list of all seabird colonies being monitored, and a proposed sampling frequency for monitoring them over the next 20 years (i.e., 2012-2032) under various funding scenarios, assuming that all major colonies should be surveyed at least every 5-10 years.
2. Ensure that colony surveys are coordinated and prioritized within and among regions, recognizing differences in importance (colony size), threats and survey costs associated with different colonies.
3. Implement starting in 2012 schedule of surveys for highest priority colonies using current resources, while seeking sufficient additional funds internally or externally, to fill the gaps.
4. Evaluate the feasibility, by 2012, of expanding current aerial surveys for terns in Atlantic (e.g., SE-3) to cover all species of dispersed seabirds (e.g., gulls and terns) in Atlantic and Quebec.
5. Develop a plan to incorporate Leach's Storm-petrel into Atlantic Region Seabird Colony Ground Surveys (SE-4).
6. Continue to seek opportunities, funds and/or partners to assist in surveying seabirds in accessible colonies (e.g., using existing staff in protected areas), and evaluate the feasibility and cost-effectiveness of using volunteers to survey relatively accessible sites with low risk to surveyors or birds.
7. Coordinate surveys of species that nest both at sea and inland (e.g., gulls and terns), with any inland colonial waterbird monitoring and other relevant survey programs.
8. By 2012, develop a strategy to ensure seabird colony databases are easily integrated across regions for national and international assessments of population status and trends.
9. By 2013, develop plans to monitor priority species in the north with little existing coverage (Sabine's, Ross' and Iceland Gull, Arctic Tern). These will be challenging species, and integration across survey programs and bird groups will be needed.
10. Evaluate approaches for using technologies (e.g., automated photo counts, automated sensors) to improve survey methods, enhance worker safety and/or reduce costs.

SUMMARY OF RATIONALE

Seabird Colony Monitoring in Canada is relatively well developed compared to many other non-game bird monitoring programs in EC, with virtually all major colonies having been surveyed at least once, and plans developed for ongoing monitoring. Nevertheless, visiting most colonies is expensive, especially in the arctic, and much of the funding to visit these colonies has been opportunistic and dependent on external funding sources, such as special Northern Research Funds. Although most southern colonies in the Pacific, Atlantic and Quebec regions are visited on a fairly regular schedule, some of the largest and most important colonies are in the arctic and have been visited at less than half the desired frequency (10-30 year intervals rather than 5-10 intervals). The result is that range-wide population trends for many species are often imprecise, dated or only available at irregular intervals. Furthermore, some of the arctic monitoring is being undertaken in conjunction with long-term research programs, and alternative arrangements will be required if those research projects are completed or discontinued.

To address these concerns, existing colony monitoring plans should be reviewed and updated, and synthesized across regions to ensure that the highest priority colonies at a national level are identified, taking into account the importance (size) of the colony, potential threats facing the colony and the costs associated with surveying the colony. An appropriate colony survey plan should be developed, assuming that most colonies will be visited at 5-10 year intervals, with the specific interval determined by their priority. The value of annual or biennial visits to selected colonies for monitoring annual variation in colony attendance, size or demography, should also be considered, especially if any of the long-term research programs currently providing this information are discontinued. The plan should consider various budget scenarios such as (a) current EC investment levels, only; (b) current EC investment plus typical annual external investment; (c) funding levels required to ensure coverage of all colonies at least once a decade. If individual colonies are prioritized, then monitoring decisions can be made if intermediate levels of funding become available.

Approaches are also needed to address species of seabirds which are not currently well monitored, or for which only part of the population is monitored. In some cases, it may be appropriate to build on existing survey methods, such as expanding current aerial surveys of terns to cover additional species of gulls and additional areas, or adjusting colony survey methods to address burrowing species such as storm-petrels. Other species may continue to be a challenge such as some of the arctic species of gulls and terns which nest both in small colonies and in isolation.

Innovative ways of monitoring colonies also need more consideration. In some circumstances it may be appropriate to engage partners from other agencies or levels of government (e.g., provincial or federal park staff working in protected areas with significant colonies). For colonies which are relatively easily and safely accessed, it may be possible to engage volunteers to assist with surveys. New technologies should also be evaluated and, if appropriate, adopted. These include approaches such as automated analyses of high resolution photographs, which may be taken from the air, the ground or the water. The latter approach could potentially be integrated with volunteers or other collaborators such as tour operators who may be approaching colonies within a sufficient distance to take photographs.

Cost Summary

The following table outlines costs related to the current suite of seabird colony surveys.

	SE-2 Eastern Arctic Seabird Monitoring Program	SE-3[a] Atlantic Canada Tern Surveys	SE-4 Atlantic Region Seabird Colony Ground Surveys	SE-13 Pacific Colonial Seabird Monitoring Program	SE-25 Monitoring Northern Gannets[b]	SE-30 Quebec Seabird Colonies	Total
Fiscal Year	***2010-11***	***2010-11***	***2010-11***	***2010-11***	***2009-10***	***2010-11***	
EC Operating costs/y							
Mig Birds		$20,000	$5,000	$25,000	$4,000[b]	$30,000	$84,000
SARA		$32,000	$6,000				$38,000
Northern Contaminants	$40,000						$40,000
G&C			$10,000	$10,000			$20,000
EC PY							
CWS	0.4	0.2	0.5	0.5	0.04[b]	0.7	2.34
S&T	0.3		0.04	0.2	0.03[b]		0.57
PY converted into $	$63,000	$18,000	$48,600	$63,000	$6,300[b]	$63,000	$261,900
EC annual costs*	***$103,000***	***$70,000***	***$69,600***	***$98,000***	***$10,300***	***$93,000***	***$443,900***
Non-EC funds/y	$27,000	$5,000	$5,000	$4,000		$1,000	$42,000
Non-EC PY (including volunteers)	0.78	0.02	0.04	0.14		0.11	1.09
PY converted into $	$70,200	$1,800	$3,600	$12,600		$9,900	$98,100
Non-EC annual costs	***$97,200***	***$6,800***	***$8,600***	***$16,600***		***$10,900***	***$140,100***

[a] This survey is evolving into the Atlantic Region Seabird Colony Aerial surveys since the initial questionnaires were sent, with a general focus on all dispersed nesting coastal species (gulls and terns). High costs in 2010-2011 reflect surveys conducted in Labrador to support the Nunatsiavut Land Claim.

[b] Survey only conducted once every five years, annualized costs shown (full costs = $20,000 O&M, 0.35 PY)

Note: 1 PY = 90K

DETAILED RATIONALE

Background

The Seabird Colony Monitoring program is one of the longer-standing non-game migratory bird monitoring programs in Canada, with the first surveys being conducted on the Quebec North Shore in the 1920s. Programs in the Arctic, Atlantic and the Pacific were initiated in the 1960s and 1970s. Unlike many other migratory bird species, for many colonial seabirds, it is often possible to estimate the total size of the breeding population, or at least that of a substantial portion of the population, with a limited number of surveys. The challenges with monitoring seabird colonies are often related both to their remoteness and relative inaccessibility, as well as the massive density of breeding birds; effective methodologies that minimize the disturbance to breeding birds are required. Because of the technical challenges in monitoring seabird colonies, volunteer opportunities, especially from the general public, are limited, and colonies usually need to be monitored by experienced professionals (traditionally mainly EC employees or affiliated academic researchers). In fact, access to most of the major colonies in Canada is restricted without an appropriate permit issued by EC.

Both aerial and ground/boat surveys are used depending on the species. Aerial surveys are used for the more dispersed nesting species like terns and gulls, and for highly visible birds such as gannets (and murres) on flat colonies. Ground and/or boat surveys are used more at the large colonies, and a wide-variety of methods are employed depending on the species. Methods for most species are well-developed (Nettleship 1980), although it is recognized some species will always be problematic to survey accurately (Razorbills, guillemots). Modern technologies are being used more and more (e.g. digital photography, GIS systems, 'burrow-scopes') and there may be potential to expand their use, but much of the work still involves highly-trained seabird biologists using traditional and labour-intensive techniques.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Bird Conservation Regions – all with coastal areas. Seabird colonies are a major factor when considering land use planning along coastal areas. Colony monitoring programs provide the needed information on the distribution and abundance of colonies. Generally this need is well met in southern areas of the country. Data on dispersed nesting species (like gulls and terns) is not well known in northern areas, and some estimates of total numbers for major northern colonies are out of date.
Bird Conservation Region - Marine coasts. Although data from pelagic surveys are the main information source for truly marine areas, seabird colony data is also useful for more inshore areas. Certainly abundances of marine birds are vastly increased by orders of magnitude around major seabird colonies in the breeding season, making areas around seabird colonies very important areas for any bird conservation planning.
Proposed changes would maintain or enhance the data available for this need.

2) Incidental Take is minimized and long-term conservation is supported
Data collected have direct applications for informing incidental take from industries such as fisheries, wind farms and oil and gas exploration, development and production. Because colony monitoring programs have the potential to estimate total population size with precision, assessing the impacts of industrial activities and other forms of take are actually possible for some species when data on the take from the various sectors are known. Regionally specific impacts can also be detected, if incidental take occurs at significant levels in local areas. Ascribing population change to incidental take would only be possible for a few closely monitored species that are easily surveyed (i.e. gannets); however, gross changes in population trajectories would be detected for most species in the colony monitoring program. There are still some risks in the current program for northern species, especially dispersed nesters, as their status and trends are not well known, and population estimates are often dated. Proposed changes would improve our ability to meet this need, ensuring that the highest priority colonies are monitored with sufficient frequency.

3) Threats to migrants in other countries are reduced
Many colonial seabirds breeding in Canada spend some or all of their non-breeding season in other countries or the High Seas. The US and Greenland are key non-breeding countries for Canadian breeding seabirds. Data from Canada are used heavily in both countries for migratory bird conservation planning. For other species that winter beyond North America, the breeding colonies provide the only reasonable opportunity to census the species (terns, Sabine's Gulls, storm-petrels) and provide input to conservation planning processes in other countries and international venues (i.e. UN – FAO and IMO as it relates to fisheries bycatch and oil pollution).

For many species, the available surveys are adequate to inform decision making in other countries and international bodies, with the exception of dispersed nesting species in the north (i.e. jaegars, some gulls and terns). Proposed changes would maintain or enhance this value.

4) Migratory Bird harvests are maintained at sustainable levels
The seabird colony monitoring program is the primary means of assessing the population status and trends of common and thick-billed murres, species which are hunted legally in both Canada (Newfoundland and Labrador) and Greenland. Smaller numbers of a variety of other seabirds and their eggs are taken by Inuit and other First Nations in Canada (and the US and Greenland).
Data collected from the seabird colony monitoring programs are probably sufficient for a large-scale assessment of population trends of the two species, but would be improved with better monitoring of murres at some of the very large Arctic colonies (i.e. Akpatok Island, Cape Hay) and smaller colonies that appear to sustain higher hunting pressure (Labrador). These concerns will be highlighted and/or addressed through the proposed recommendations. Current monitoring is probably sufficient to monitor population status and trend of other species taken in low numbers by First Nations.

5) Priority sites for Migratory Birds are protected and improved
This need was a large driver in the establishment of seabird colony monitoring programs, and most major colonies in Canada are protected. The current seabird monitoring program now monitors colonies in these protected areas, and has the potential to identify other priority sites; and is sufficient for these purposes.

6) Population-level effects of toxic substances are reduced
Seabird colony monitoring programs have identified population-level impacts of a variety of toxins (e.g. DDT and gannets) and have been used as key pieces of information to support arguments to reduce these compounds in the environment. Colony monitoring programs have also been used to understand the impact of marine oil pollution on seabird populations. The current survey program is probably sufficient to detect population level impacts for most important species and to provide baseline data and a foundation for enhanced monitoring if a particular substance such as an oil spill becomes a concern. However, even with proposed recommendations, impacts may remain difficult to detect on some semi-dispersed nesters (e.g., guillemots).

7) Populations of Migratory Birds under particular threat are conserved
Seabird colony monitoring programs are essential for meeting this need; because seabirds are so concentrated in colonies, they are particularly vulnerable to localized threats such as invasive species or oil spills. Population trend data have been used to instigate a variety of extensive and directed conservation measures at different colonies in Canada (rat eradication in BC colonies, avian predator control). Seabird colony surveys are also very important information sources in managing an oil spill response. The current survey program is probably sufficient to detect population level impacts for most important species. Nevertheless, there are currently some significant gaps. At some colonies, surveys have been sufficiently irregular that the arrival of a new threat, such as an introduced predator, may go undetected for many years, leading to delays in implementation of conservation actions. For dispersed nesting species and poorly covered species (storm-petrels and guillemots) impacts may not be readily detected; this may be a particular concern for storm-petrels, which are highly vulnerable to predators (introduced and native). Improved survey frequencies at large colonies, and incorporation of specialized survey methods for storm-petrels as proposed in the recommendations would reduce this risk.

8) Migratory Birds in land claim areas are conserved
Used in the context of identifying migratory bird resources in coastal portions of claim areas. Existing survey data are generally sufficient to meet this need, as the location and approximate number of most or all major colonies are fairly well known.

9) Threats due to Migratory Birds to public and economy are reduced
This need is generally considered in the context of human-gull interactions. Seabird colony surveys provide information on the distribution of gull colonies, which can inform siting decisions of various activities (new airports, water reservoirs, waste management, etc…). Trend information can inform whether mitigation measures (e.g. improved landfill management practices) can circumvent the increase of gull populations near reliable food sources. The current programs generally provide the information needed to meet this need, although there are some gaps, particular in northern areas. Proposed recommendations would only address some of those gaps.

10) Avian Species at Risk are assessed, identified and listed
Seabird colony surveys are the primary means of assessing trends in many seabird species, and have been used to support listing under SARA of a number of seabirds (e.g. ANMU, CAAU in fall 2011). The ability of the current program to address this need was addressed by the seabird technical committee (Table A-1). Coupled with

information on Canadian responsibility for these species (Table A-2), and assessment of the current ability to meet this need, EC's risk in not meeting this need is presented in Table A-3. In general, the current program is adequate for most highly colonial species. The largest gap and risk exists for Leach's Storm-petrel, which is not adequately monitored by the current program and for which Canada hosts the majority of the global population. Guillemots (black and pigeon) are also not well monitored. Of the more dispersed nesting birds, the current program runs high risks for Arctic Tern, Iceland and Sabine's Gulls, (with moderate risks for other gulls like Ross', Glaucous-winged, Glaucous and Mew). Proposed recommendations would only partially address those gaps.

11) Populations of avian Species at Risk are recovered
Seabird colony monitoring programs are the main tool in assessing the recovery of listed species. Programs to monitor listed species are either part of general seabird monitoring programs (i.e. ANMU in BC), or form extensions of existing programs (e.g. IVGU and ROTE). In general the monitoring of listed species is adequate to assess their recovery.

OTHER RISKS TO TAKE INTO ACCOUNT

Partner risk and implications for seabird colony conservation

Many of the major seabird colonies in Canada are protected under legislative tools not under EC's jurisdiction. For example, all major seabird colonies in Newfoundland and Labrador and British Columbia (and some in Québec) are protected under provincial legislation, while a number of colonies in the Arctic are in National Parks. Therefore, EC does not always bear the effort and costs of protecting and managing many important seabird colonies. In these cases, the management agencies look to EC to provide the relevant biological information, including the key data on status and trends, of the seabirds nesting in these reserves. Without this information, there is the risk of the managing agencies making poor decisions to protect seabird colonies, and the risk of the perception of EC not filling its responsibility for management of migratory birds. Nevertheless, there may be opportunities for working more closely with partners to deliver monitoring programs.

SUMMARY OF IMPLICATIONS OF RECOMMENDED CHANGES

In general, the seabird colony monitoring program is poorly leveraged when compared to many other bird monitoring programs. This is partly due to the need for highly qualified and experienced personnel, as many OHS risks are involved when accessing a seabird colony (e.g. difficult boating, rock climbing, polar bears, travelling in small aircraft, living in rough environments, etc.) and the work itself is often physically demanding and/or highly repetitive. Additionally, the seabird monitoring program is often seen as EC's major contribution in the overall management of the seabird colonies which EC does not manage directly. However, partnering opportunities should still be considered where they make sense, especially with other agencies and groups that have an interest in seabird resources (e.g. Parks, provincial agencies, ENGOs, universities). Some species can be surveyed with relatively little OHS risk and only minor technical skill (e.g. kittiwakes). This may be particularly useful in southern parts of the country, as other agencies/groups may be in a better position to access and survey colonies. In addition, for colonies that can be monitored from a distance using techniques such as digital photography, there may be opportunities for others to take photographs with appropriate instructions.

The seabird monitoring programs across the country were developed in some isolation from each other based on the regional delivery of CWS. The relative independence of the Pacific program is not a major concern, as many of the species in BC are unique to the Pacific, and integration with US and on Pacific Rim countries is of more importance. On the Atlantic side, the programs in the eastern Arctic, in Atlantic Canada and in Québec are essentially delivered in isolation. In this part of Canada, however, many of the species are shared amongst the three regions. From Table A-3, it is apparent that relatively few species are distributed equally among multiple regions, and hence requiring truly integrated programs to produce national trends (NOGA, HERG, GBBG, BLKI, RAZO and BLGU). Northern Gannets are already well integrated by the survey that is conducted jointly by Atlantic and Quebec (SE-25). Better integration / coordination may be helpful for the other species to facilitate analysis (e.g., by synchronizing surveys), although modern statistical methods may allow combining data from multiple survey approaches.

Of potentially more importance is assessing the current level and focus of monitoring devoted to species in regions that do not have significant populations (e.g. Atlantic Puffin, Leach's Storm-Petrel and Common Murre in Quebec, or Arctic Terns in Quebec and Atlantic), and ensuring that adequate effort is placed on surveying the highest priority colonies. It is recognized that the incremental costs of monitoring other species when already present at a colony may often be low. However, there may be situations where reducing survey frequency or survey effort in some regions may be appropriate to allow enhanced resources to be directed to high priority

colonies in other regions. These include consideration of reducing effort in southern Quebec to enhance survey effort in northern Quebec, for example. A national monitoring plan, integrated across regions, would help to assess this need.

As mentioned above, most highly colonial species for which Canada has a significant responsibility are currently being monitored, though not always at the desired frequency. The notable exception is Leach's Storm-Petrel, which is monitored to an extent, but a thorough plan to monitor the species in Atlantic Canada, which includes the all-important colony on Baccalieu Island, has not been fully implemented. The more dispersed nesting Black Guillemots is also not well monitored in any region. Existing monitoring protocols should be reviewed to determine whether they can be modified to fill these important gaps.

For gulls and terns, monitoring is adequate for some species, and not for others. The partially dispersed nesting species are particularly challenging to monitor, but Canada has a major responsibility for a number of them. Further, local and regional management issues are often influenced by changes in populations of terns and gulls. Working closely with the emerging inland colonial waterbird monitoring plans, a plan to address gaps for priority and heavily managed species (e.g. HERG, GBBG, GWGU and the terns), should be developed for consideration by the AMC. Additionally, approaches to address the gap for northern gulls and terns for which Canada has international responsibility (Sabine's Gull, Ross' Gull, Iceland Gull, Arctic Tern) needs to be evaluated, and integration with other survey programs is almost certainly necessary (inland colonials, PRISM and others).

Of the all the monitoring programs, the northern program is most at risk of program non-delivery due to its reliance on funds outside of EC's wildlife program. There are currently no core Mig Bird or SAR funds dedicated to seabird monitoring in the Arctic, yet that region supports a wide-range of priority species, and the only heavily harvested species (TBMU). Plans to address the gap and risks in the Arctic are needed, especially with emerging development and other pressures in region (e.g. increased shipping, mining, exploding human population). Diverting funds, and possibly more importantly personnel, to monitor key Arctic colonies on a 5-10 year plan should be developed and made available for consideration by the Avian Monitoring Committee. The current Québec program does not include any northern areas, so although technically in PNR, from a national perspective and with effective delivery in mind, there may be some merit in having the seabird colonies along the Ungava Peninsula considered partially or wholly within Quebec's seabird colony monitoring program. There is a precedent within CWS for Quebec and Atlantic regions to assist with seabird colony surveys in the Arctic.

Data management by the seabird monitoring program is generally adequate, with most regions storing their data in database programs. However, there is no national database for seabird colony data, making accessing data for national and increasingly international assessments of species status and trends difficult. Consideration on how to best streamline data access for national and international assessments and ensure national quality control needs to be done.

Newer technologies, specifically devices that can remotely log visual, infrared or auditory information are emerging that have the potential to greatly assist in collecting data. Digital imaging (i.e. digital photography)is used by a number of survey programs to capture images of colonies to assess total numbers and/or plots numbers, but it is not being used in a wide-spread way to monitor colonies in Canada. Remote digital imaging (and other technologies like digital recorders) should be considered as a means to improve data collection and reduce the number of people-days needed on colonies. Putting workers on seabird colonies is expensive, involves OHS risk and poses some disturbance risk to the seabirds; any cost-effective means to reduce worker presence on colonies should be evaluated.

Table A-1. Overview of information currently collected and quality of existing information for 34 species monitored under Environment Canada's existing colonial seabird monitoring programs.

Species	*Region(s) in which species occurs (1% or more of NA population)*	*EC seabird program(s) currently monitoring this species*	*Type of information collected*	*Quality of existing trend information 1 = adequate 2 = poor 3 = species not monitored*	*Other EC monitoring programs that could complement information need*	*Current/potential partners available to complement information need*
Northern Fulmar	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size, breeding success	**2 (need to survey >1 colony)**		
Manx Shearwater	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys	Population size	**1**		University (MUN), Province of Newfoundland
Leach's Storm-Petrel	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys	Population size, occupancy rates	**2 (need to increase frequency of ground surveys)**		Universities (MUN, Acadia)
	Pacific & Yukon Region			**3**		
Fork-tailed Storm-Petrel	Pacific & Yukon Region			**3**		
Northern Gannet	Quebec and Atlantic Regions	Monitoring Northern Gannets	Population size and trends, distribution, breeding success	**1**		Province of Newfoundland
Ivory Gull	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size	**1 for trend 2 for causality**		
Mew Gull	Pacific & Yukon Region			**3**	Surveys of geese and swans in the Inuvialuit Settlement Region [WF-39]; **overlaps with Inland Colonial Waterbird Monitoring Program**	Cooperative Roadside Waterfowl Breeding Population Survey (Yukon) Coastal Waterbird Survey (BC-BSC)
Ring-billed Gull	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**	Survey of Ring-Billed Gull in Quebec; **overlaps with Inland Colonial Waterbird Monitoring Program**	University (UQAM) Parks Canada (Mingan)
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys; Atlantic Canada Tern Surveys	Population size (breeding pairs and/or index) and distribution	**1**		
Herring Gull	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**	Breeding waterfowl survey of Northern Québec [WF-12];	Black Duck Joint Venture Parks Canada (Mingan, Magdalen Is., Forillon)

Species	Region(s) in which species occurs (1% or more of NA population)	EC seabird program(s) currently monitoring this species	Type of information collected	Quality of existing trend information 1 = adequate 2 = poor 3 = species not monitored	Other EC monitoring programs that could complement information need	Current/potential partners available to complement information need
					Overlaps with survey of Ring-Billed Gull in Quebec	
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys; Atlantic Canada Tern Surveys	Population size (breeding pairs and/or index) and distribution	**1**		
	Prairie & Northern Region	S&T NWRC	Population size, breeding success	**2 (need to survey more colonies)**		
Thayer's Gull	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size	**1**		
Iceland Gull	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size	**2 (need to survey more colonies)**		
Glaucous Gull	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size; demographics, breeding success	**2 (need more colonies and more dedicated monitoring)**		
Glaucous-winged Gull	Pacific & Yukon Region	Opportunistic surveys at colonies	Nest counts, and contents	**2**		
Great Black-backed Gull	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**	Breeding waterfowl survey of Northern Québec [WF-12]; Overlaps with survey of Ring-Billed Gull in Quebec	Black Duck Joint Venture Parks Canada (Mingan, Magdalen Is.,)
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys; Atlantic Canada Tern Surveys	Population size (breeding pairs and/or index) and distribution	**1**		Parks Canada (Torngat National Park)
Ross's Gull	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Distribution, reproductive success	**2 (need regional surveys)**	PRISM?	
Sabine's Gull	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Distribution, reproductive success	**2 (need work at additional sites for regional tracking)**	PRISM; Helicopter breeding population surveys for birds in the Canadian central Arctic	Migratory Bird Survey in Canadian Arctic

Species	*Region(s) in which species occurs (1% or more of NA population)*	*EC seabird program(s) currently monitoring this species*	*Type of information collected*	*Quality of existing trend information 1 = adequate 2 = poor 3 = species not monitored*	*Other EC monitoring programs that could complement information need*	*Current/potential partners available to complement information need*
					[WF-30]; **overlaps with Inland Colonial Waterbird Monitoring Program**	
Black-legged Kittiwake	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size, reproductive success	**1**	PRISM	
	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**	Some overlap with the Monitoring Northern Gannets (3 colonies)	Parks Canada (Mingan, Magdalen Is., Forillon)
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys; Atlantic Canada Tern Surveys	Population size (breeding pairs and/or index), distribution, reproductive success	**1**		Parks Canada (Torngat National Park)
Common Tern	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**	**Overlaps with Inland Colonial Waterbird Monitoring Program**	Parks Canada (Mingan, Magdalen Is., Forillon)
	Atlantic Region	Atlantic Canada Tern Surveys	Population size (breeding pairs and/or index) and distribution	**1**		Province of Nova Scotia; Parks Canada; Universities (UNB)
Arctic Tern	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Reproductive success	**2 (need additional coverage at other colonies)**	PRISM; **overlaps with Inland Colonial Waterbird Monitoring Program**	
	Atlantic Region	Atlantic Canada Tern Surveys	Population size and distribution (breeding pairs and/or index)	**1**		Province of Nova Scotia; Parks Canada; Universities (UNB); Nunatsiavut Government
Roseate Tern	Atlantic Region	Atlantic Canada Tern Surveys	Population size, distribution, reproductive success	**1**	Roseate Tern Recovery Program (population size and reproductive success)	
Common Murre	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**		Parks Canada (Magdalen Is., Forillon)

Species	*Region(s) in which species occurs (1% or more of NA population)*	*EC seabird program(s) currently monitoring this species*	*Type of information collected*	*Quality of existing trend information 1 = adequate 2 = poor 3 = species not monitored*	*Other EC monitoring programs that could complement information need*	*Current/potential partners available to complement information need*
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys; Monitoring Northern Gannets	Population size, reproductive success	**1**		Universities (MUN, UNB), Province of Newfoundland
	Pacific and Yukon Region	Opportunistic surveys at colonies	Opportunistic counts of individuals	**2**		
Thick-billed Murre	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size, index, reproductive success	**1**		
Razorbill	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**		Parks Canada (Mingan, Magdalen Is., Forillon)
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys	Population size or index	**1**		Universities (MUN, UNB)
	Prairie & Northern Region			**3**		Very few in Northern Conservation Division; <1% NA population
Dovekie	Prairie & Northern Region			**3**		
Pigeon Guillemot	Pacific & Yukon Region			**3**		
Black Guillemot	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys; Atlantic Canada Tern Surveys		**2-3 (monitor index plots at key sites from ground surveys; aerial surveys in Labrador)**	Eastern Waterfowl Surveys	
	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1-2 (assessment of adult counts variability needed to confirm trends)**		Parks Canada (Magdalen Is., Forillon)
	Prairie & Northern Region	Eastern Arctic Seabird Monitoring Program	Population size	**2 (more colonies, better methods needed)**		
Ancient Murrelet	Pacific & Yukon Region	Focal species of the PYR Colonial Seabird	Burrow counts in permanent plots	**1**		Laskeek Bay Conservation Society

Species	*Region(s) in which species occurs (1% or more of NA population)*	*EC seabird program(s) currently monitoring this species*	*Type of information collected*	*Quality of existing trend information 1 = adequate 2 = poor 3 = species not monitored*	*Other EC monitoring programs that could complement information need*	*Current/potential partners available to complement information need*
		Monitoring Program				
Cassin's Auklet	Pacific & Yukon Region	PY Region Colonial Seabird Monitoring Program	Burrow counts in permanent plots	**1**		
Rhinoceros Auklet	Pacific & Yukon Region	PY Region Colonial Seabird Monitoring Program	Burrow counts in permanent plots	**1**		
Tufted Puffin	Pacific & Yukon Region	PY Region Colonial Seabird Monitoring Program	Burrow counts in permanent plots	**1**		
Atlantic Puffin	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**		Parks Canada (Mingan, Magdalen Is.)
	Atlantic Region	Atlantic Region Seabird Colony Ground Surveys	Population size, occupancy rates	**1**		Universities (MUN, UNB)
Great Cormorant	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**		Parks Canada (Magdalen Is.)
	Atlantic Region	Atlantic Canada Tern Surveys	Population index and distribution	**2 (need ground surveys)**		Province of Newfoundland
Double-crested Cormorant	Quebec Region	Quebec Seabird Colonies	Population size and trends, distribution	**1**		Parks Canada (Mingan, Magdalen Is., Forillon), Province of Québec (MRNF)
	Atlantic Region	Atlantic Canada Tern Surveys	Population index and distribution	**2 (need ground surveys)**		Province of Newfoundland
Pelagic Cormorant	Pacific & Yukon Region	Nothing formal in PYR (species is not a federal responsibility) opportunistic surveys	Nest counts	**3**		Province of British Columbia
Brandt's Cormorant	Pacific & Yukon Region			**3**		

Table A-2. Proportion of seabirds breeding by region in relation to North American population estimates. Percentages derived from Wings Over Water, regional conservation plans, Birds of North America, and BCR assessments

Species	% of global population in Canada	% of North American population in Canada	% of North American population in Pacific & Yukon Region	% of North American population in Prairie & Northern Region	% of North American population in Québec Region (excluding BCR 3*)	% of North American population in Atlantic Region	WOW priority
Fulmars							
Northern Fulmar	10-30%	30%	<0.001%	30%	0%	<0.001%	3
Shearwaters							
Manx Shearwater	<10%	100%	0%	0%	0%	100%	2
Storm-Petrels							
Leach's Storm-Petrel	50-70%	50-70%	5-10%	0%	<0.01%	60%	1
Fork-tailed Storm-Petrel	<10%	10%	10%	0%	0%	0%	3
Gannets							
Northern Gannet	10-30%	100%	0%	0%	75%	25%	3
Gulls							
Ivory Gull	10-30%	100%	0%	100%	0%	0%	1
Mew Gull	10-30%	30-50%	30-50%	0%	0%	0%	3
Ring-billed Gull	50-70%	50-70%	0%	0%	15%	2%	3
Herring Gull	10-30%	>70%	Low in marine areas	<20%	40%	40%	2
Thayer's Gull	>70%	>70%	0%	100%	0%	0%	1
Iceland Gull	30-50%	>70%	0%	>70%	0%	0%	3
Glaucous Gull	10-30%	>70%	<0.1%	>65%	0%	4%	3
Glaucous-winged Gull	10-30%	10-30%	10-30%	0%	0%	0%	3
Great Black-backed Gull	10-30%	50-70%	0%	0%	15-20%	30-40%	3
Ross's Gull	<10%	100%	0%	100%	0%	0%	2
Sabine's Gull	50-70%	>70%	0%	>70%	0%	0%	3
Black-legged Kittiwake	10-30%	10-30%	<0.001%	6%	5%	5%	3
Terns							
Caspian Tern	<10%	30-50%	0%	0%	<0.1%	<0.1%	3
Common Tern	10-30%	50-70%	0%	0%	10%	24%	2
Arctic Tern	30-50%	>70%	?	?	?	1%	2
Roseate Tern	<10%	<10%	0%	0%	0.05%	3%	2
Alcids							
Common Murre	<10%	10-30%	<0.001%	0%	2.5%	5%	3
Thick-billed Murre	10-30%	30-50%	<0.001%	50%	0%	<1%	2
Razorbill	<10%	>70%	0%	<0.01%	55%	44%	3
Dovekie	<10%	>70%	0%	100%	0%	0%	3
Pigeon Guillemot	10-30%	30-50%	30-50%	0%	0%	0%	2
Black Guillemot	30-50%	>70%	<0.1%	>30%	10%	30%	3

Species	% of global population in Canada	% of North American population in Canada	% of North American population in Pacific & Yukon Region	% of North American population in Prairie & Northern Region	% of North American population in Québec Region (excluding BCR 3*)	% of North American population in Atlantic Region	WOW priority
Ancient Murrelet	30-50%	30-50%	30-50%	0%	0%	0%	1
Marbled Murrelet	10-30%	10-30%	10-30%	0%	0%	0%	1
Cassin's Auklet	>70%	>70%	>70%	0%	0%	0%	1
Rhinoceros Auklet	30-50%	30-50%	30-50%	0%	0%	0%	3
Tufted Puffin	<10%	<10%	<10%	0%	0%	0%	3
Horned Puffin	<10%	<10%	<10%	0%	0%	0%	2
Atlantic Puffin	<10%	>70%	0%	0%	4%	96%	3
Cormorants							
Great Cormorant	<10%	>70%	0%	0%	22%	>70%	3
Double-crested Cormorant	30-50%	30-50%	0.05%	0%	8%	8%	3
Pelagic Cormorant	<10%	<10%	<10%	0%	0%	0%	2
Brandt's Cormorant	<10%	<10%	<10%	0%	0%	0%	2

*Québec's BCR 3 area is included under the Prairie & Northern Region

Table A-3. Species-specific assessment of Canadian responsibility and quality of monitoring for the colonial seabird monitoring program. Responsibility was assigned as "Global" if > 30% of the world population is in Canada, and "Continental" if > 10% of the North American population is in Canada.

Species	Responsibility	Primary region	Quality of monitoring	Risk
Northern Fulmar	Continental	PNR	Poor	Some
Manx Shearwater	Continental	ATL	Adequate	Low
Leach's Storm Petrel	Global	ATL	Poor	High
Northern Gannet	Continental	QUE/ATL	Good	None
Ivory Gull	Continental	PNR	Adequate	Low
Mew Gull	Continental	PYR	Poor	Some
Ring-billed Gull	Global	QUE	Good	Low (Inland program also covers)
Herring Gull	Continental	PNR/ATL/QUE	Good in south, poor in north	Low
Thayer's Gull	Global	PNR	Adequate	Low
Iceland Gull	Global	PNR	Poor	High
Glaucous Gull	Continental	PNR	Poor	Some
Glaucous-winged Gull	Continental	PYR	Poor	Some
Great Black-backed Gull	Continental	ATL/QUE	Adequate	Low
Ross's Gull	Continental	PNR	Poor	Some
Sabine's Gull	Global	PNR	Poor	High (Inland program could also cover)
Black-legged Kittiwake	Continental	PNR/ATL/QUE	Adequate	Low
Caspian Tern	None			
Common Tern	Continental	ATL	Adequate	Low
Arctic Tern	Global	PNR	Poor	High
Roseate Tern	None	ATL	Good	None
Common Murre	None (Continental for Atlantic)	ATL	Adequate	Low (Atlantic)
Thick-billed Murre	Continental	PNR	Adequate	Low
Razorbill	Continental	QUE/ATL	Adequate	Low
Dovekie	None	PNR	Poor	None
Pigeon Guillemot	Continental	PYR	Poor	Some
Black Guillemot	Global	PNR/ATL	Poor	High
Ancient Murrelet	Global	PYR	Adequate	Low
Marbled Murrelet	Continental	PYR		
Cassin's Auklet	Global	PYR	Adequate	Low
Rhinoceros Auklet	Global	PYR	Adequate	Low
Tufted Puffin	None	PYR	Adequate	None
Horned Puffin	None	PYR	Poor	None
Atlantic Puffin	Continental	ATL	Adequate	Low
Great Cormorant	Continental	ATL	Poor	None (not MB)
Double-crested Cormorant	Global	ATL	Poor	None (not MB)
Pelagic Cormorant	None	PYR	None	None (not MB)
Brandt's Cormorant	None	PYR	None	None (not MB)

PELAGIC MONITORING PROGRAMS (SE-14, 26, 37)

SUMMARY RECOMMENDATIONS

1. Maintain SE-26 Pelagic Surveys - N. Pacific and Arctic at current investment levels, focusing the survey pending the results of recommendation number 4.
2. Maintain SE-37 Québec Seabirds at Sea at current levels, focusing the survey pending the results of recommendation number 4.
3. Maintain SE-14 Eastern Canada Seabirds at Sea at current levels, focusing the survey pending the results of recommendation number 4.
4. Immediately assess the relative merit and feasibility of seeking out more ships of opportunity operating in poorly covered priority areas versus surveying routes that are currently repeated regularly (i.e. Line P, Arctic Ocean Cruise and the AZMP).
5. Continue to seek opportunities, funds and/or partners to survey high priority areas with emerging threats and poor coverage.
6. In 2011, develop a strategy to conduct predictive modeling work to enable extrapolation to areas with no or poor coverage.
7. In regions where they are not currently available, produce stock maps and/or atlases to reduce work load stemming from data requests to staff in 2011, and make processed (corrected) data publically available in 2012.

SUMMARY OF RATIONALE

Due to the sheer vastness of Canada's ocean EEZ, no amount of surveying will be able to cover all areas in all seasons. However, it is recognized that this program fulfils a number of important needs that cannot be met in any other way. Therefore a strategic approach is needed on where to invest survey effort. The national framework proposes an increase in core funding from 66K to 150K, and 2 PYs to 5.

Maintaining the core funding and PYs assigned to this program is recommended, while the increased investment proposed by the technical committee is not supported until a broader examination of other monitoring gaps across all bird groups is conducted.

Within the existing funding levels, the pelagic program should evaluate the relative effort placed on "repeated" transects (recognizing that these surveys do not always follow the exact same routing and/or timing), and on seeking other opportunities to survey in different priority areas. This evaluation will also need to consider the possibility of developing predictive models to possibly reduce the survey effort required and still provide the information needed.

Cost Summary

The following table outlines costs related to current suite of pelagic bird surveys. Note that non-EC contributions not-included, as they amount in the millions in terms of vessel time.

	SE-14 Atlantic[a,b]	SE-26 Pacific[a]	SE-37 Quebec	Annual TOTAL
EC Operating costs/y	$23 000	$28 000	$15 000	**$66 000**
EC Personnel costs/y	$90 000	$45 000	$45 000	**$180 000**
	(1 PY)	(0.5 PY)	(0.4 PY)	**(2 PY)**
EC Annual costs	***$113 000***	***$73 000***	***$60 000***	***$246 000***

[a] Arctic program (1 cruise), including in Pacific and Atlantic costs, as the vessel transits these oceans to and from the Arctic.
[b] Atlantic program (SE-14) was subsidized with an additional 140K/annually for 3.5 years (1 BI-02 and 70K O&M) from the ESRF (Environmental Studies Research Funds).

DETAILED RATIONALE

Background

The pelagic survey program is effectively an all-bird monitoring program for all Canadian waters extending beyond the immediate coast. Unlike many other bird surveys, this is a year-round program. The distribution of birds using Canadian waters varies dramatically across seasons and in some areas, birds may be abundant in all seasons (except the solid (10+) ice-covered waters of the Arctic [partially ice-covered waters can support large concentrations of some species]).

Due to the inherently patchy nature of ocean resources, marine birds are similarly patchily distributed and densities often have high variances. As such, pelagic surveys are best suited to monitor distribution of marine birds on the oceans. In some cases they can be used to detect changes in densities of marine birds, but in general only gross changes can be detected and cautious interpretation is necessarily. Since these surveys provide the only information on bird densities at sea (although recent telemetry and geolocation devices are now providing further information), these data are heavily used for planning and assessment purposes.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Bird Conservation Region - Marine coasts. Information from pelagic surveys is often the key and only data available to describe migratory bird distribution and abundance in marine areas. Colony surveys can also provide some information, but only in the breeding season and close to shore. Information on bird distribution and abundance allows planners to make informed recommendations on identifying risks to pelagic birds and to suggest appropriate mitigation measures. The current survey suite adequately addressed this need in areas with reasonable coverage. There are risks in the current program for areas that have not yet, or are poorly, covered.

2) Incidental Take is minimized and long-term conservation is supported
Data collected have direct applications for informing incidental take from industries such as fisheries, wind farms and oil and gas exploration, development and production. At local scales, pelagic surveys have the capacity to assess gross impacts of small-scale industrial development (best done at more coastal sites). However the most important contribution of pelagic surveys is to provide data on the timing and density of sensitive species in proposed project areas. With this information, incidental take could be reduced and/or mitigated if alternate siting could be arranged, or high-risk activities could be conducted outside of sensitive time periods. The current survey suite adequately addressed this need in areas with reasonable coverage. There are risks in the current program for areas that have not yet, or are poorly, covered.

3) Threats to migrants in other countries are reduced
For highly pelagic species, at-sea surveys are one of few monitoring tools available. This is especially true in cases where species at not monitored at their breeding colonies outside Canada (the case for some austral breeding species). The current survey program likely adequately addresses this need, at least in terms to be able to detect gross changes.

4) Migratory Bird harvests are maintained at sustainable levels:
Data on murre abundance and distribution is obtained in Atlantic Canada, but not used directly in harvest management. Data could potentially be used to detect large scale changes in density or distribution.

5) Priority sites for Migratory Birds are protected and improved
Pelagic survey data are often key data input for a proposing, defining and managing the variety of marine protected areas in Canada. Most of these proposed areas are not under EC jurisdiction; DFO is the main developer of marine protected areas. The current survey suite adequately addresses this need in areas with reasonable coverage. There are risks in the current program for areas that have not yet, or are poorly, covered. However, there are unlikely to be areas that are critically important for marine birds that have not been identified in some way.

6) Population-level effects of toxic substances are reduced
The main use of pelagic survey data for this need is in risk mapping, overlaying sensitive seabird distributions with shipping routes or known oil spill locations. The current survey suite adequately addresses this need in areas with reasonable coverage, which includes most heavily traveled shipping lanes. There may be future risks in the current program for areas that may see heavier traffic in the future (e.g. the Arctic).
7) Populations of Migratory Birds under particular threat are conserved

Pelagic surveys have been used during emergency response to determine the densities of species at risk from the emergency. Subsequent damage assessments can also use pelagic survey data to estimate the numbers of birds potentially impacted from the incident. The current survey suite adequately addresses this need in areas with reasonable coverage, which includes most heavily traveled shipping lanes and industrial areas (i.e. oil and gas production areas in Newfoundland and Nova Scotia). There may be future risks in the current program for areas that may see heavier traffic or development in the future (e.g. the Arctic).

8) Migratory Birds in land claim areas are conserved
Only used in the context of identifying migratory bird resources in marine portions of claim areas. Not a major need.

9) Threats due to Migratory Birds to public and economy are reduced
Not used to address this need, could be used in the future with greater development in pelagic areas (aircraft routing and bird strike risks of offshore installations).

10) Avian Species at Risk are assessed, identified and listed
Pelagic surveys are one of two ways to identify the presence of globally threatened pelagic seabirds in Canadian waters (the other one being satellite tracking). These data were used as the basis as whether to pursue listing in Canada. Pelagic survey data were used to list Short-tailed and Black-footed Albatross and Pink-footed Shearwater in Canada.

11) Populations of avian Species at Risk are recovered
As pelagic surveys are one of only two ways to identify the presence of globally threatened pelagic seabirds in Canadian waters, these data are used to monitor their continued presence in Canada. Little can be probably be done with pelagic surveys to further monitor these species in Canadian waters without prohibitively large investments.

Summary of Implications of Recommended Changes

Survey framework

- In general, the framework proposed by the seabird technical committee has merit, and will meet many EC monitoring needs that cannot currently be met in any other way.
- To ensure that program needs are being met as best as possible within the current funding envelope, by the end of 2011 the relative investment in 'repeated' transects versus seeking other opportunities in different priority areas needs to be evaluated.
- The importance of staff dedicated to oversee regional pelagic programs is recognized. Training and managing observers, maintaining key contacts with vessel operators (who provide millions of $$ of vessel time, most notably CCGS/DFO) and maintaining the data bases are all time-consuming and specialized activities.
- Many local data gaps are identified. To rectify these gaps, funds or opportunities will need to be found to address the top priority gaps. These gaps will often be defined by immediate development pressure. EC funds should be flexible and be allowed to move across regions as priorities emerge and decline.
- Where outside partners and funds can be accessed, they should be used; especially to survey emerging priority areas, which generally are of great interest to industry.
- Efforts should me made to have data collected by non-EC managed staff to be of sufficient quality to be comparable to EC data. This will likely require considerable up-front time investments to train and work with consultants, but could greatly increase the amount of data available to the larger community. Data-sharing agreements with industry should also be considered where possible.

Data collection

- The data management of this program is good to excellent; other programs in Canada could use this program as a model. Continued work to update the Pacific data capture system, as done in the Atlantic and Quebec, should continue.
- The importance of having a pool of trained observers is recognized, and efforts and resources will be needed to maintain this pool.
- Efforts in Quebec to explore the use of aerial surveys for pelagic birds should continue, with findings reported back to all regions.

Data use

- The initiative to produce stock maps to supply to end-users, instead of producing maps with every request, is an excellent time-saving recommendation and should be pursued immediately.
- By the end of 2011, an analysis of the repeated survey transects should be conducted, to determine the magnitude of changes that could be detected. This will inform whether continued heavy investment in the repeated transects is warranted, or whether effort should be focused on surveying high priority areas.
- The specific recommendation in the national framework (*5.2.4*) to develop predictive models for marine bird abundance in Canadian waters should be pursued starting in 2011. If successful these models will ultimately allow for extrapolation to areas with no or poor survey coverage. This analysis will also inform on the optimal survey framework for building the most robust models. This, along with the above recommendation will require further staff time investment from a statistically savvy worker, but need not be a long-time requirement. If framed appropriately, this work could be conducted by an academic partner with G&C funds (Ph.D. student – 20-25K/year, post-doc 50-60K/year for 2-4 years). A post-doctoral fellow would be more expensive, but likely require shorter period of time to complete the work (2 years), PhD students are cheaper, but less skilled and will have other commitments; a 4 year commitment is probably needed.

BEACHED BIRD SURVEY MONITORING PROGRAMS (SE-6, 20, 35, 36)

SUMMARY RECOMMENDATIONS

1. Maintain the Newfoundland Beached Bird Survey (SE-35); by 2012 add data from St. Pierre et Miquelon if costs are minimal. Continue to recruit volunteers to deliver this survey.
2. Maintain pilot Beached Bird Surveys in Québec (SE-36), and implement strategically-planned and cost-effective long-term survey once pilot data are collected in 2012-13.
3. Maintain botulism surveys in Ontario as needed (SE-20), with the understanding that this work is outside of a beached bird survey program.
4. Maintain beached birds surveys in British Columbia (part of SE-6).
5. Ensure that all surveys clearly differentiate between long-term monitoring sites, and beaches surveyed for specific purposes, including start and end dates.
6. Discontinue support for a Maritimes-wide Beached Bird Survey (part of SE-6).
7. Consider developing a beached bird survey in Northumberland Strait by 2012, if other means of tracking fisheries by-catch are not available/possible.
8. Develop a mechanism to access data collected on Sable Island by 2011.

SUMMARY OF RATIONALE

In general, the national beached bird survey program appears to be proceeding at appropriate investment levels. Regional differences are apparent, but reflect the stage of development of each program and are expected. Like all survey programs, there is an inherent tendency for the program to grow as time passes. This is apparent in British Columbia, where they are tackling the issue of scoping out the geographic extent of oil pollution in BC waters. Similarly the program in Newfoundland expanded to the Maritimes through a volunteer-based program, which ultimately failed simply due to too few birds being recorded by the program. Newfoundland is also wrestling with the problem a having fewer and fewer birds being found, so needing more frequent surveys to have the power to detect trends. Quebec's strategic plan (Bolduc 2007) for their Birds Oiled at Sea program is a good example of how to develop a beached bird survey program, and obviously takes in the lesson learned from other jurisdictions. This tendency to grow needs to be countered by returning to the stated objectives of the program, which are now highlighted in the current proposed national framework (but still some work and further prioritizing are needed). All programs should be very clear on which beaches constitute the core of the long-term monitoring program, and which others form part of specific projects to address a focused question or issue. Good collector beaches are infrequent, therefore an effort should be made to ensure the extensive data from Sable Island is accessible.

What needs to be made clear in all beached bird survey programs is that it is a rather crude way of assessing waterbird mortality. But it's also often the only tool available and has a demonstrated track record of being a successful program to inform conservation decision-making.

Cost Summary

The following table outlines the costs related to the current suite of beached bird surveys. No significant change in the budget is recommended, so the existing budget will remain. Note that the Non-EC personnel costs for SE-6 assume that the EC cost would be $250/day to conduct work internally.

	SE-6 BSC – British Columbia	SE-35 Newfoundland	SE-36 Quebec	SE-20 Ontario Botulism surveys	Annual TOTAL
EC Operating costs/y	$45 000	$2 000	$22 500	$3 000	$72 500
EC Personnel costs/y	0	$10 000	$5 000	$18 000	$33 000
EC Total annual costs	$45 000	$12 000	$27 500	$21 000	$105 500
Non-EC funds/y	$10 000	$25 000		$0	$25 000
Non-EC personnel costs/y (including volunteers)	$100 000	0	TBD	$0	$100 000
Non-EC Total annual costs	$110 000	$25 000	TBD	$0	$125 000

DETAILED RATIONALE

Unlike the majority of surveys and monitoring programs with migratory birds program, the beached bird surveys monitor dead birds found, as an index of mortality from various sources. In this way they are most similar to the harvest survey. Unlike the harvest survey however, by themselves beached bird surveys can only provide an index of mortality from non-specific causes, as a wide range of factors independent of bird mortality can influence the number of birds being found on a beach. In spite of the fact that only relative indices of mortality sources can be obtained from beached bird surveys, it is often the only tool available to assess and assign mortality to a source other than hunting; and is a tool simply not available to other bird groups. Ultimately beached bird surveys are conducted to assess trends in a mortality source. When coupled with a specific set of research programs, absolute numbers of birds dying from a mortality source may be obtained, as done in Newfoundland in 1998-2001 to assess how many murres and dovekies were being oiled from chronic sources.

There are also instances when it is desirable to conduct a set of beached bird surveys for other purposes than long-term monitoring. One is obviously an emergency response, such as an oil spill. Another is to scope out the geographic extent of a known or suspected mortality source. A third would to assess the possible impacts of known or suspected point source, ideally before and after completion of the project.

It is apparent that beached bird surveys conducted across the country are in different phases of development, and this development is a natural progression of implementing beached bird surveys. The youngest program is in Quebec region, where the feasibility of these surveys is just now being determined with pilot studies using volunteer surveyors. British Columbia has an extensive volunteer-based network, and it seeking to expand the program to determine the scope of potential mortalities. In the Atlantic, the oldest program is in Newfoundland which has essentially contracted to monitoring a set of core beaches in southeastern part of the island known to be good deposit beaches for oiled birds. In Maritime Canada, a 5-year program was conducted by Birds Studies Canada in the early 2000s, and very few carcasses were retrieved. There is no program in the Arctic, and although beached bird surveys are conducted during incidents in the Great Lakes, they are done solely on a response basis or for retrieving carcasses related to botulism outbreaks.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Bird Conservation Region: Marine coasts – Beached Birds Surveys are a highly effective tool to monitor the health of marine ecosystems, and specifically for stressors that directly impact migratory birds. In this way beached bird surveys can provide a tool to monitor progress of activities to maintain and improve marine landscape conditions for migratory birds. A specific example is the information provided by beached bird surveys as justification to move forward on reducing ship source oil pollution in the Atlantic.

2) Incidental Take is minimized and long-term conservation is supported
Beached bird surveys provide one tool to monitor levels of fisheries bycatch, and have been used in British Columbia to assess impacts of fisheries over background levels. Beached bird surveys only provide decent indices of bycatch in certain conditions, and are generally not as useful as ship-board observer programs. But where observer programs are not possible (e.g. small boat fisheries), beached bird surveys may prove useful in indexing fisheries bycatch.

3) Threats to migrants in other countries are reduced
Not used for this purpose.

4) Migratory Bird harvests are maintained at sustainable levels
Newfoundland beached bird surveys do index the level of murre harvest based on previous analyses. However, other programs, such as colony monitoring and harvest surveys provide superior data to monitor murre populations and its harvest.

5) Priority sites for Migratory Birds are protected and improved
Not used for this purpose.

6) Population-level effects of toxic substances are reduced
This is probably the most important monitoring need filled by beached bird surveys, and often the original reason these surveys were implemented. Beached birds surveys have proven their ability to monitor toxic substances in the environment, as they directly impact birds, and to monitor changes in the impact of these substances on migratory birds.

7) Populations of Migratory Birds under particular threat are conserved
Beached bird surveys are able to provide baseline data to help interpret beached bird survey during emergency response. Without these background data, assigning beached carcasses to a specific event, rather than to other background sources, is not possible.

8) Migratory Birds in land claim areas are conserved
Not used for this purpose.

9) Threats due to Migratory Birds to public and economy are reduced
Not used for this purpose.

10) Avian Species at Risk are assessed, identified and listed
Not a major purpose of this survey, but could be used to identify significant and increasing mortality of a declining species.

11) Populations of avian Species at Risk are recovered
Not a major purpose of this survey, but could be used to set recovery goals of reducing or eliminating the number of birds found in beached bird surveys.

Other Risks to Take Into Account

Legal risk
Beached bird surveys have been used in various legal proceedings (charges, sentencing and damages) related to oil spills. Beached bird surveys have the ability to set the context of background levels of oil pollution, and help to assign which carcasses were likely attributable to the specific incident, each of which could be a charge under the MBCA.

Maintenance of external funding
Over half of the funds needed to deliver these surveys are provided by volunteers and other funders (oil and gas industry, Birds Studies Canada). This funding will be lost if EC reduces its effort on beached bird surveys. Even a temporary reduction will run risks, as the volunteer network will be disrupted and time will be required to renew the network.

Public support for management actions
Many of these surveys rely on data collected from volunteers, this garners public interest and ownership in the issues that kill marine migratory birds. For EC to reduce its beached bird surveys, it runs the risk of the public perceiving that EC is no longer interested in marine migratory birds and the sources of mortality that kill these birds.

Usefulness to other EC priorities
Beached bird surveys are used by the department and OGDs as one index of the health of the marine environment, especially as an index of the extent of chronic oil pollution. TC, CCG, DFO and others in EC (EPOD, enforcement) rely on these data to assess the progress of programs designed to reduce ship source oil pollution (e.g. MART, ISTOP, NASP).

Summary of Implications of Recommended Changes

Maritimes (SE6 and possibly new)

- Terminate and do not renew the Maritimes beached bird survey program (given the lack of carcasses found on the 2001-2006 BSC volunteer survey).
  - No financial implications, as project was completed in 2006.
- By 2012, assess potential for alternative monitoring methods, specifically, fishery observer programs, to collect data needed to assess the impact of bycatch on northern gannet and other species. If these methods prove ineffective, develop a specific Gulf of St. Lawrence survey to assess mortality from fisheries by-catch.
  - If developing this survey is deemed appropriate to assist in monitoring fisheries by-catch, costs for the new survey, in terms funds and PYs, will need to be done and approved before any new survey is conducted.

- Seek to obtain data from Sable Island by 2011 and establish a mechanism to ensure the data is collected and accessible in the long-term from this key site. Once the data is obtained, analyse the data for long-term trends in oiling rates (by 2012).

Newfoundland (SE-35)

- Maintain beached bird surveys in the southwestern Avalon. By 2011, develop a plan to ensure data continuity in the case that partner funding (specifically Husky Oil) is withdrawn. Develop a withdrawal or reduction plan in the event that insufficient carcasses are being collected for meaningful analysis. Determine a survey frequency that allows the detection of a substantial increase in carcass deposition once carcass deposition rates become very low; weekly surveys to detect increases from very low to low rates are likely not needed.
  - No O&M and or PY change expected, and possibly less PY needed as volunteer network grows.
- Evaluate cost effectiveness (including time investment), and if appropriate, work cooperatively with St. Pierre et Miquelon in developing a beached bird program on the French Islands by 2012. This site is a known collector of carcasses and could serve as a site to corroborate trends on the southwest Avalon.

Quebec (SE-36)

- Maintain pilot survey through volunteer NGO networks until 2011-2012.
- Once complete, implement a long-term monitoring program in areas with a) high deposition rates and b) suspected or known sources of mortality by 2012-2013.

British Columba (SE-6)

- Evaluate alternate options for monitoring low deposition beaches in 2011. Consider small-scale targeted beached bird surveys in areas where mortality sources are expected to increase, with clear start and end dates.
- Explicitly define beaches that will be used for long-term monitoring, from other beaches that are not a priority but covered due to the vagaries of using volunteers and non-assigned site selection. Develop a plan to monitor these beaches in the case of the volunteer network failing by 2012.
- Once the geographic scope of the issue is determined, contract the beached bird survey program to key sites for long-term monitoring. This does not preclude the development of site-specific surveys in areas of expected increases in mortality, but these surveys will need start and end dates, and need not be included in a long-term monitoring program.

Arctic (no survey to date)

- In anticipation of increased shipping and other activity through Arctic waters, develop programs to monitor offshore mortality in the Arctic by 2012. Evaluate potential for beached bird surveys within this process. Consider utility of setting one or more small-scale surveys in areas where activity is, or will be, greatly increasing.
  - If surveys are deemed necessary and feasible then develop a cost (O&M and PY) estimate for assessment.

General guidance:

- Before initiating a beached bird survey program, carcass trajectory modeling in conjunction with bird distribution, should be considered to pre-select areas with higher chances of collecting carcasses.
- The termination of a beached bird survey program should always be considered an option, as there is a chance that a mortality source may be mitigated or resolved; or better ways to assess the mortality source may become available. The time-frame of the program should reflect the time-scale of the suspected mortality source.
- The objective of using beached bird surveys to detect mortality events should be a minor one. Generally significant mortality events are detected by the public (or reported by the source) long before a regular beached bird survey would be conducted. Where beached bird surveys excel is detecting chronic, lower-level morality and differentiating that from background natural mortality. Surveys should be designed with that objective at the forefront.
- There is considerable value in responding to acute mortality events, and much can be learned from beached bird surveys conducted during events. These responses should be treated as a special case of beached bird surveys and not necessarily part of the long-term monitoring program.
- Studies to relate beached bird numbers to absolute numbers killed should be considered when there is a policy or conservation need to estimate absolute numbers. However, as these studies do require considerable effort, they should only be conducted when really needed to inform conservation decision-making.

- Continue to find ways to partner with the pathology community to find ways to assess cause of death. An assignment of cause of death can greatly increase the value of a carcass count obtained from beached bird surveys.
- Further consideration is needed on using beached bird surveys to assess non-oiling related mortality. The ability of beached bird surveys to index fisheries bycatch needs further exploration, BUT given the relatively crude signal given by beached bird surveys, should only be considered when the data cannot be collected another way.
- Usefulness of beached bird surveys to monitor inland freshwater fishery bycatch of waterbirds should be evaluated. Right now there is no other obvious way to assess this mortality source.

INLAND WATERBIRD MONITORING PROGRAMS (WB-7, 8, 10, 16, 17, 23, 27, 29)

SUMMARY RECOMMENDATIONS

The following recommendations build on existing monitoring efforts for inland waterbirds in Canada and identify actions needed to build a national waterbird monitoring program

A) Continue to develop and refine methods for large scale waterbird monitoring in Canada with a focus on:

1. In 2012, complete the pilot program in Boreal Ontario and determine if there is a need for expansion into other regions in the future.
2. By 2014, carry out inventory and identify the priority of keeping a long-term survey similar to Great Lakes on Great Slave to provide similar data from the only area in the Boreal forest with baseline. Survey methodology should allow for comparison wit data from early 1990s and incorporate any improvements stemming from the Boreal Ontario pilot.
3. By 2014, complete design of and evaluate the costs of developing large-scale programs in the prairies (WB-33) and develop a schedule for repeatable surveys that capture as many species as is practical.
4. By 2014 develop inland waterbird monitoring programs during the nesting season in PYR linked to WB-33. Inland areas of Ontario, Quebec and Atlantic regions should be considered for future expansion.

B) Explore the benefits of using existing surveys to deliver key information for inland waterbirds specifically:

5. Assess by 2013 the ability of monitoring programs designed for other species to deliver data for inland waterbirds (e.g. coastal surveys, waterfowl aerial surveys, PRISM).
6. Determine by 2013, species that may be more cost-effective to monitor outside of the nesting season in collaboration with partners outside of Canada if necessary. Determine also species that would be better surveyed in Canada during the winter.
7. Ensure by 2014, that accurate population information for the western population of Horned Grebe is available either through existing surveys if possible. Consider doing the same for Western Grebes
8. Evaluate by 2012, the use of existing waterfowl and waterbird surveys to monitor loon populations.

SUMMARY OF RATIONALE

While waterbirds as a group tend to be broad in their definition, the surveys considered in this report do not include species considered to be marshbirds or seabirds and therefore only includes loons, cranes, gulls, terns, grebes, and at inland sites. Our understanding of waterbird populations can be generalized to be either very good for colonial species found on the Great Lakes and St. Lawrence River or very poor for species found outside of this region across the rest of Canada. As a result, the bulk of recommendations are geared towards strengthening our knowledge base of waterbirds outside of the Great Lakes/St. Lawrence. Many efficiencies can be gained by tapping into existing surveys that may or may not be primarily designed to collect information on waterbirds.

Cost Summary

The following table outlines current and proposed costs of inland waterbird surveys. Current program costs vary annually depending largely on the three years out of every ten when the Great Lakes Decadal Waterbird Survey is conducted; the table describes a scenario when all surveys are active. The total O&M costs of $162,000 would be reduced to $126,000 if the Great Lakes survey and the Quebec Ring-billed Gull survey are not conducted. Proposed costs depend on research and recommendations by the Inland Waterbird Technical Committee and largely center on expansion of Boreal pilot work to regions outside of Ontario and continuation of one-time census work carried out in the prairies. PY indicates person-years.

	Current costs									***Proposed costs***				
	WB-07[a] PNR	**WB-08 Quebec**	**WB-10[a] PNR**	**WB-16 Ontario**	**WB-17 Ontario[b]**	**WB-23 PYR[c]**	**WB-27 Quebec**	**WB-29 Quebec[d]**	**Current Annual TOTAL**	**WB-33 PNR[e]**	**new various regions**	**new various regions**	**new PNR**	**Total New**
Specific survey	Red-throated Loons Beaufort	Bonaparte's Migration Survey	Waterbirds Delta Marsh	Great Lakes Coastal Wetlands	Great Lakes Colonial Waterbirds	Mono Lake Eared Grebe	Quebec Black Terns	Quebec Ring-billed Gulls		Prairie Parkland Waterbirds	WB-33 expanded to other regions	Extended Boreal Pilot	Great Slave Lake Survey	
EC Operating costs/y	$80 400	$2 000	$500	$30 600	$31 500	$500	$12 000	$5 000	**$192 500**	$50 000	50,000	$35,000	80,000	**$215,000**
EC Personnel costs/y	(0.2 PY) $18 000	(0.2 PY) $18 000	(0.1 PY) $9 000	(0.8 PY) $72 000	(1.3 PY) $117 000	(.07 PY) $6 300	(.26 PY) $23 400	(0.2 PY) $18 000	**(5.13 PY) $461 700**	(2 PY) $180 000	(2PY) $180,000	(0.5 PY) $45,000	(1PY) $90,000	**$495,000**
EC Annual costs	***$98 400***	***$20 000***	***$20 000***	***$102 600***	***$148 500***	***$6 800***	***$35 400***	***$23 000***	***$654 200***	***$230 000***	***$230,000***	***$80,000***	***$170,000***	***$710,000***

[a] survey currently not implemented
[b] survey conducted 3 out of every 10 years
[c] survey conducted in California
[d] survey conducted every 3 years
[e] survey was completed once with no intention to repeat in the future. It was conducted over several years for a single species only; recommendation is to consider repeating with an expanded focus to all waterbirds.

DETAILED RATIONALE

Background

There are approximately 600 species of birds that occur in Canada, approximately 29 of which are considered inland waterbirds. The group of birds discussed in this document includes: loons, cranes, gulls, terns, grebes, and herons at inland sites.

Inland waterbird monitoring in Canada varies greatly by area. In certain areas such as the Great Lakes, (ON), St. Lawrence River (QC), most of the Maritimes and insular Newfoundland and Labrador there are comprehensive long-term monitoring programs for gulls, terns, cormorants and herons. In other areas, such as the prairies, species by species censuses are being considered. Recently Franklin's Gulls were censused and currently a census of Western Grebes is ongoing. In PYR, most monitoring of inland waterbirds is done through coastal surveys of wintering birds and in the Yukon, roadside monitoring provides long-term information for a small area. In Yellowknife, surveys have been periodically conducted on Great Slave Lake or portions thereof (late 1980s/early 90s, 2000-2002 and 2010) providing a baseline from which trend information for Boreal waterbirds can be obtained if surveys were to be repeated at regular intervals in the future. In the Arctic, a limited number of surveys have been done, as part of other monitoring programs such as the helicopter transect surveys conducted between shorebird survey plots done as part of the PRISM program. Some species of inland waterbirds are surveyed outside of the nesting season as part of the Coastal Waterbird Survey, a volunteer-based, year-round survey conducted in the Straight of Georgia and coordinated by Bird Studies Canada and the Aerial Survey of Wintering Waterbirds on the BC Coast survey. Other species such as Eared Grebes and Bonaparte's Gulls have been monitored through programs at fall migration and staging areas. Common Loons are surveyed extensively in southern Canada as part of the Canadian Lakes Loon Survey coordinated by BSC and in the eastern portion of their range through Acid Deposition Biomonitoring programs. Other species such as Green Herons are not systematically surveyed due to difficulties associated with their elusive nesting habits.

Areas where waterbird monitoring is lacking (very limited or no consistent monitoring) include inland and boreal areas in eastern Canada, boreal areas in PNR, inland areas of PYR and the Arctic. However, there are several initiatives currently underway to tackle this shortcoming. For example Ontario region is currently conducting a pilot program on monitoring colonial waterbirds in the Boreal, which is expected to inform the development of a long term program in Ontario and other regions. In the Arctic, waterfowl biologists have proposed the continuation and institutionalization of a monitoring program for waterfowl and waterbirds. Last but not least, CWS has recently hired additional biologists in PNR and PYR whose duties include waterbirds, therefore it is hoped that new staff can undertake inland waterbird programs in these areas, as one of the key gaps that has been identified by the waterbird technical committee is lack of staffing in some regions.

Implications of survey modifications to ability of suite of surveys to address EC monitoring needs

1) Landscape conditions accommodate Migratory Bird requirements
For most species, habitat requirements are well known and can be described to land mangers and developers to minimize the effects of human activity on waterbirds. However, with the exception of the Great Lakes/St. Lawrence, our knowledge of the distribution of most species is poor such that we cannot indicate what species can be expected to occupy habitats.

2) Incidental Take is minimized and long-term conservation is supported
Waterbirds can be affected by improper placement of wind generating facilities and other industrial activities that alter breeding habitat such as the expansion of infrastructure into areas rich in wetlands. Our ability to predict the location of breeding habitat outside of the Great Lakes St. Lawrence is for the most part insufficient to inform management decisions that could lead to incidental take.

3) Threats to migrants in other countries are reduced
Threats to migrants in other countries is poorly understood. A general understanding of conditions is maintained through the operations of the Waterbird Conservation Council of the Waterbird Conservation for the Americas plan. Continued involvement with this group can alert Environment Canada representative to issues that might affect waterbirds from Canada when they are in other countries. Once issues are identified, this same body can facilitate actions in other countries in a cost effective way by involving in-country expertise.

4) Migratory Bird harvests are maintained at sustainable levels
Hunting is permitted in Canada and the USA for one species of inland waterbird (Sandhill Cranes*)*. Continued monitoring is required to ensure that hunting pressure does not affect populations either as a stand-alone threat or

in combination with other threats. Current monitoring efforts are considered appropriate to inform setting of bag and possession limits.

5) Priority sites for Migratory Birds are protected and improved
Current knowledge of important sites for waterbirds is largely restricted to well sampled areas on the Great Lakes and along the St. Lawrence River. An improved inland waterbird monitoring program would improve determination of the distribution of species and identify key areas for protection.

6) Population-level effects of toxic substances are reduced
There are good programs for the monitoring of the effects of human-made toxic substances such as organochlorines and brominated flame retardants on the Great Lakes, in Quebec, the Arctic and PYR. However for other toxics issues where likelihood of occurrence is high, such as the ability to assess the impacts of the Botulism Type-E on the Great Lakes, out ability to detect and react to their effects is hampered by a lack of monitoring capacity. The sampling of levels and population effects of toxic substances is very variable. Inability to detect population declines associated with toxins; Lack of action and appropriate management actions taken in time could mean that population effects could go un-noticed. Increased coordination with S&T for research and monitoring on levels of toxins and associated effects is required. Contingency planning in order to address unforeseen or new issues when they arise should be considered (e.g. monitoring of Botulism Type-E outbreaks on the Great Lakes).

7) Populations of Migratory Birds under particular threat are conserved
Threats to birds in the Great Lakes/St. Lawrence have a solid history in the identification of threats to populations and the subsequent recovery of species once the problem has been removed as illustrated by the widely publicised effects of industrial pollutants on waterbirds in the 1970s. Monitoring of these birds is ongoing such that population level effects of new threats should be readily detected. Our reduced knowledge of waterbirds elsewhere in the country would not permit us to detect population changes and the causes of those changes to the same level of detail in most cases.

8) Migratory Birds in land claim areas are conserved
Waterbirds are not thought to have a significant presence on land claim areas.

9) Threats due to Migratory Birds to public and economy are reduced
Expanding populations of Ring-billed Gulls in urban areas has become problematic and a concern to the public for health and safety reasons. Human health concerns arise from the potential degradation of water quality to the transmission of diseases such as Newcastle Disease. Public safety is of greatest concern in areas where gulls congregate at or near airports. The solution to these concerns is effective habitat management to dissuade gulls from congregating in areas where they can cause health or safety concerns. Waterbirds can also negatively impact agricultural operations largely through the trampling of young plants when they are foraging for worms and other prey on empty fields. They can also impact aquaculture operations by preying on whatever stock is in production. Effective monitoring can act as an early warning system to alert managers that gull numbers are approaching nuisance levels.

10) Avian Species at Risk are assessed, identified and listed
Currently only Horned Grebe (western and Magdalen Island populations) and Whooping Crane are listed on Schedule 1 of SARA. Whooping Crane populations are well monitored and their recovery is guided by an international MOU with the US. Information on western populations of Horned Grebe (Special Concern) come from Christmas Bird Count data while the Magdalen Islands population is counted in a special survey. For many of the other species, especially those who's range does not include the Great Lakes/St. Lawrence, the basic information to support assessment from COSEWIC is not available.

11) Populations of avian Species at Risk are recovered
Causes of decline for either population of listed Horned Grebe are not well understood but are generally thought to be driven by wetland loss or degradation such as eutrophication resulting from agricultural runoff. Expansion of predator populations and Type E Botulism may also be key factors. For the very small Magdalen Islands population, demographic, environmental and genetic factors may be implicated. The current approach to monitoring the western population cannot provide the level of information to direct recovery actions and may require a new approach.

Other risks to take into account

Legal risk
With the exception of Sandhill Crane, waterbirds are not hunted so the risk mismanaging the regulation of a hunt. Lack of information may become problematic should additional species be listed under SARA if insufficient information is available to describe critical habitat.

Political Risk
Waterbirds generally have low political risk as they are not hunted and generally occur away from human populations. Expanding Ring-billed Gull populations are increasingly becoming a nuisance in urban areas especially on or beside recreational waterways and at airports. Sound monitoring is in place for regions where this is most widespread and data arising from this work can be used to direct management decisions. Habitat modifications can have a significant impact on gull use of urban areas. Municipalities and other major land managers may benefit from guidelines based on knowledge of gull biology and distribution information from existing surveys.

Detailed Recommendations and Considerations

- In general, a comprehensive inland waterbird survey program has yet to be developed. The best path forward in developing such a program is to first determine priorities based on species with the greatest need for information as well regions where conservation pressures warrant expansion of monitoring efforts. In some cases, existing surveys might provide results directly or could be made effective for waterbirds with a small added investment (e.g. to pay for additional observers on aerial surveys for waterfowl). This analysis of what information we have or can get relatively easily will inform decisions on what new surveys will be required to meet key program needs.
- Monitoring programs that provide information for a suite of species and/or at a national or landscape level are preferable to efforts with a focus on a single species and/or in a single region. Taking this into consideration, there may be much to be gained by completing the Boreal Ontario pilot survey and, if the pilot produces favourable results, consider applying it in other regions. Similarly, the current single species approach to waterbirds has produced good results in determining the location of breeding sites and population size of Franklin's Gull and will soon have information on Western Grebes. Given the cost of assembling field crews and transporting them across the Prairie and Parkland region, it would be more cost effective to explore the efficiencies of adopting a multispecies approach to conducting waterbird surveys in this region. Results of that analysis might inform a discussion of expanding a general survey approach into other regions of Canada that are not currently covered. Included in that expansion should be a survey that is conducted on Great Slave Lake.
- In some cases, species might be better monitored during the non-breeding season if they can be more easily counted in areas where they congregate or if they occupy areas that are more easily accessible than on their summer breeding range. These areas might be within Canada but may also be on other countries and may require developing new partnerships to implement winter surveys. These should only be considered if the species cannot be surveyed accurately during the breeding season.
- Species listed on Schedule 1 of SARA require special attention to be able to report on their changing status which may or may not be the result of specific recovery actions. Of the species on, or about to be on, Schedule 1, only the western population of Eared Grebe is potentially in need of additional monitoring to be able to meet the reporting need of SARA. As a result, this should be the first species to undergo an analysis of our current ability to provide population information based on existing surveys be they for grebes, waterbirds in general or other species. Should this analysis indicate a need for better information, an approach that first looks at implementing broad scale surveys and then considers a single species survey should be adopted.
- Loons are easily picked up on waterfowl aerial surveys and for the sake of monitoring, should be considered waterfowl and consideration should be given to relying on these monitoring programs to provide population information. Alternatively, the Canadian Lakes Loon Survey provides some population information but also provides information on productivity and other useful demographic parameters. An analysis of the utility of data provided by the CLLS should direct considerations of expanding the survey into a greater proportion of the Common Loon's range or if it is still worth Environment Canada support.

MARSH BIRD MONITORING PROGRAMS (WB-18, 19, 22, 28, 34)

SUMMARY RECOMMENDATIONS

1. Maintain support for WB-18 Great Lakes, WB-28 Québec and Prairie Pothole Marsh Monitoring Programs at current investment levels pending results of recommendations 4-6.
2. Maintain support for WB-19 King Rail, WB-22 Least Bittern and WB-34 Yellow Rail Monitoring Programs as required for SAR programs pending results of recommendations 4-6.
3. Continue to seek opportunities, funds and/or partners to survey high priority areas with emerging threats and poor coverage.
4. In 2012, re-evaluate WB-18 and WB-28 current sampling scheme and statistical power in order to maximize value of the data collected.
5. In 2012, complete a BCR-based gap/risk assessment where marsh bird monitoring is not currently done.
6. In 2012, complete a National framework for marsh bird monitoring in Canada.

SUMMARY OF RATIONALE

Due their elusive nature, some species of wetland-obligate birds require intensive sampling techniques in order to be adequately monitored. There are currently three regional programs conducted by Bird Studies Canada (BSC) that deliver marsh bird monitoring in the Great Lakes, southern Quebec and Prairie landscapes. Environment Canada supports these programs primarily through a G&C and relies on the information obtained through these programs. However, there are elements of scale and sampling design for those programs which require assessment and possibly modification in order to improve the value of information obtained. Species specific monitoring protocols are also utilized to monitor SARA listed secretive marsh bird species. There are large areas of Canada that currently do not have marsh bird monitoring programs, potentially limiting the ability of EC to meet some of its obligations in relation to the Migratory Birds program.

Maintaining current levels of support for ongoing regional programs is recommended. The increased investment proposed by the technical committee report is not supported until the current monitoring programs are re-evaluated, a BCR-based gap/risk assessment for marsh birds in completed and a broader examination of monitoring needs across all bird groups is conducted.

Cost Summary

The following table outlines costs related to current programs.

	WB-18 Ontario[a]	WB-28 Quebec[a]	WB-19,22,34 SAR[b]	Annual TOTAL
EC Operating costs/y	$65 000	$5 000	$60 000	**$130 000**
EC Personnel costs/y	$36 000	$0	$135 000	**$181 000**
	(0.4 PY)	(0 PY)	(1.5 PY)	**(1.9 PY)**
EC Annual costs	***$113 000***	***$73 000***	***$60 000***	***$246 000***

[a] Programs are delivered by Birds Studies Canada, annual EC G&C contribution to support BSC marsh bird monitoring program in QC, ON, Prairies is approximately $73K
[b] King Rail, Least Bittern and Yellow Rail surveys not completed on an annual basis. O&M and personal costs vary. Typically completed when and where required to inform SAR programs.

DETAILED RATIONALE

Implications of survey modifications to ability of suite of surveys to address EC monitoring needs

Information from Pekarik et al. 2010 has been has been incorporated into the following.

1) Landscape conditions accommodate Migratory Bird requirements
Information on marsh bird populations and their habitat associations can contribute to the development of BCR plans, including providing advice on habitat management at the landscape level and determining whether population objectives described in the plans are being met.

2) Incidental Take is minimized and long-term conservation is supported
The survey does not contribute directly to measuring incidental take, but completion of these surveys will provide necessary information on population sizes to estimate any impacts of any incidental take due to development activities.

3) Threats to migrants in other countries are reduced
The survey provides information on population trends of marsh bird species that could be used to identify any population declines that may be related to threats outside of Canada.

4) Migratory Bird harvests are maintained at sustainable levels
Hunting is permitted for some species of marsh birds, including American Coots, Soras and in some provinces, Common Moorhen, Virginia Rails and Sandhill Cranes. Moreover, many species of marsh birds are hunted in the United States to a greater extent than they are in Canada. Monitoring information provides a scientific basis for setting harvest limits and determining if hunting is having a detrimental effect on populations.

5) Priority sites for Migratory Birds are protected and improved
Delivery of habitat conservation for the protection of Migratory Birds is delivered through several tools, including the establishment of National Wildlife Areas (NWA) and Migratory Bird Sanctuaries (MBS), stewardship, enhancement and other activities. A marsh bird monitoring program that is spatially comprehensive can help determine the distribution of species and identify key areas for protection which can guide associated habitat-conservation programs to help ensure long-term protection of migratory birds. In addition, a marsh bird monitoring program could be used to assess the effects of habitat recovery or change, and gauge the effectiveness of targeted management activities at various scales.

6) Population-level effects of toxic substances are reduced
Not applicable.

7) Populations of Migratory Birds under particular threat are conserved
The survey results where available provide the best available information on the population trends and contributes to species assessment by Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

8) Migratory Birds in land claim areas are conserved:
Only used in the context of identifying migratory bird resources in claim areas. Not a major need.

9) Threats due to Migratory Birds to public and economy are reduced
Not used to address this need, could be used in the future with greater development in pelagic areas (aircraft routing and bird strike risks of offshore installations).
10) Avian Species at Risk are assessed, identified and listed
Currently, three species of marsh birds have been assessed and listed under SARA; the King Rail has been listed as Endangered, the Least Bittern is listed as Threatened and Yellow Rail is listed as Special Concern. For Horned Grebe (Podiceps auritus) the Magdalene Islands population has been designated as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the western population is designated as Special Concern, both populations are waiting to be added to Schedule 1 of SARA.

11) Populations of avian Species at Risk are recovered
General marsh bird and species specific monitoring is used to evaluate status and trend of species listed under SARA.

Detailed Recommendations and Considerations related to the Recommendations Document

- Continue to seek opportunities, funds and/or partners to survey high priority areas with emerging threats and poor coverage.
- In 2012, re-evaluate WB-18 Great Lakes Marsh Monitoring Program and WB-28 Québec Marsh Monitoring Program current sampling scheme and statistical power in order to maximize value of the data collected. Re-evaluation should consider the following:
    - Randomized and/or stratified distribution of sample sites only within specific regions (e.g. Great Lakes Areas of Concern (AOCs)
    - Changes to protocol (e.g. increasing sampling from 2 to 3 times a year, possibly in combination with a corresponding reduction in the total number of routes surveyed to account for additional sampling
    - Improved consistency in the sampling of routes over several years

  - Spatial Sampling Framework
  - Assessment of the effects of detection probability
- In 2012, complete a BCR-based gap/risk assessment where marsh bird monitoring is not currently done
  - Compile and summarize regional BCR information for marsh birds
  - Rank information gaps and risks using a national standard
- In 2012, complete a National framework for marsh bird monitoring in Canada.
  - Develop appropriate sampling designs and cost estimates to implement marsh bird monitoring program.
  - Include incorporation of SAR needs within a multi-species monitoring framework.
  - Provide spatial prioritization and recommendations for a phased implementation
  - Work with partners in the United States to develop, to the extent possible, methodology that will allow for continental assessments of species.

PRAIRIE WATERFOWL BREEDING POPULATION SURVEY (WF-24)

SUMMARY RECOMMENDATIONS

1. Maintain WF-24 (Prairie Waterfowl Breeding and Population Survey), but work towards improving the efficiency and reducing costs by 2012, including reducing ground survey effort by 25-50%.
2. Collaborate with key partners such as the United States Fish and Wildlife Service to identify and implement changes to improve the efficiency and reduce costs, starting as soon as possible to ensure that changes can be implemented no later than 2012. Options to consider include:
    - Update analytical approaches to make better use of existing data (i.e., by using Bayesian hierarchical models) to increase or maintain precision of population estimates, while allowing a reduction in field data collection.
    - Identify ways to reduce the number of ground surveys by 25-50% starting by 2012 (with, if possible, some reductions in 2011), while meeting precision targets.
    - Complete a review, by mid-2012, of management objectives and data needs for the entire survey, considering precision and survey coverage requirements to meet current and future management objectives.
3. Analyze and Review habitat data collected in association with the ground survey by the end of 2011, to assess their value in meeting monitoring needs and to identify ways that protocol could be improved or made more efficient (e.g., changing data collection protocol or reducing frequency of data collection), starting in 2012.
4. Evaluate the potential of the ground survey to collect reliable information on other wetland-associated bird species, with a view to implementing any options that can be accommodated within current survey protocols starting in 2011.

SUMMARY OF RATIONALE

The Prairie waterfowl surveys are widely recognized as one of the most reliable large-scale surveys of bird populations in the world. The surveys provide the best available information on the population status of many waterfowl species, and provide essential information for managing the harvest of several of these species, especially mid-continental Mallard ducks. Data are also used routinely to plan on-the-ground conservation activities such as habitat protection and restoration and other land management practices. The data also have the potential to contribute to evaluation of these conservation activities.

However, our review suggests that current analysis methods do not make the most efficient use of survey data, particularly for estimating detectability. Implementing powerful new methods like hierarchical Bayesian approaches would allow information gathered in previous years, especially with respect to visibility correction factors, to help inform estimates in a current year. This makes intuitive sense because many of the factors that affect the air-ground visibility corrections do not change every year. Incorporating this information into the derivation of abundance estimates could allow for similar or greater precision in the population estimates with reduced effort, particularly for the ground portion of the survey.

Changes to the surveys must be adopted gradually because survey results are directly incorporated into harvest management decisions in the United States, and also inform harvest and land management programs in Canada. As such, we recommend working closely with the U.S. to develop and implement new analysis approaches based on hierarchical Bayes methods. Based on preliminary analyses, a minimum reduction in ground effort of 25% and potentially up to 50% could be made while still meeting precision targets for priority species with improved analysis methods. These changes should be made no later than 2012 to allow for redirection of resources to other priority areas.

Program managers have been challenged to address monitoring deficiencies with respect to landscape (habitat) changes and species of high conservation concern. Ground survey crews have been recording various features and impacts to wetlands and surrounding upland habitat since 1985; this data set represents one of only a few long-term assessments of status and trends in wetland habitat for the Canadian prairie-parkland region. However, a thorough evaluation of the quality and utility of these habitat data has not been performed. An assessment is needed to determine the utility of these data, whether the survey could be improved to meet needs more efficiently; whether the frequency of data collection could be reduced (especially if this would reduce overall survey costs) or whether the survey is no longer required and could be dropped.

EC is currently lacking reliable monitoring information for most other wetland-dependent species in the region of this survey. An assessment should be made to determine whether the sampling frame for the ground component

of this survey would be appropriate for collecting data on other waterbird species and, if so, what data could be collected in conjunction with the current survey. If any data can be collected by the same crews, with minimal extra costs (e.g., information on some grebe species or other readily detected species) then changes to the protocols should be implemented, at least on a pilot basis, in 2011. Potential changes which might require substantial additional costs (such as deploying and retrieving recording equipment for secretive marsh birds) should be identified, but implementation postponed pending further development of those methods and a review of alternative options for monitoring those species.

Cost Summary

The following table outlines the annual salary and Operations/Maintenance costs of surveys of breeding duck populations on the Canadian prairies between 2005-09, as well as the costs and savings related to proposed reductions in ground survey effort in 2011 or 2012 and onwards. The 5 year average assumes a ratio of 60% salary : 40 % O&M. Note that survey costs vary among years due to weather conditions, duck numbers and volunteer availability which influence the total cost of ground counts.

	2005	2006	2007	2008	2009	5-YEAR AVG	2010-2011	2011-2012 (Revised protocol)
Actual costs (2005-09)								
EC Operating costs/y	$94,850	$94,350	$108,600	$101,850	$99,950	$82,450		
EC Personnel costs/y	$91,825	$91,825	$83,425	$120,925	$108,900	$116,850		
EC Annual costs	***$186,675***	***$186,175***	***$192,025***	***$222,775***	***$208,850***	***$199,300***		
Number of Non-EC personnel (including volunteers)*	13	15	15	8	9	12		
Proposed costs								
Proposed budget							~$200 K**	$100K-$150K
EC Annual savings relative to 2010-2011 (Operating & Personnel)							n/a	**$50K-$100K*** **

* Note. Non-EC personnel participated in surveys for periods ranging from, e.g., 2-20 days.
** Estimated based on mean of 2005-2009 survey costs. Actual costs vary with weather and other factors.
*** Assumes a 25-50% reduction in ground surveys will result in 25-50% reduction in costs; however, costs may not be strictly linear, and the actual savings may be less.

DETAILED RATIONALE

Cooperative annual surveys of Prairie breeding duck populations and wetland habitats.

The Waterfowl Breeding Population and Habitat Survey is a cooperative effort by the United States Fish and Wildlife Service, the Canadian Wildlife Service (Environment Canada), and other state, provincial, private and tribal agencies to monitor the continental-level status of breeding waterfowl. The survey is conducted annually in May-June, covers more than 3.6 million km^2 of northern United States and Canada, and includes much of the primary duck nesting areas in mid-continent North America. This report considers only the prairie portions of this survey; the Eastern Waterfowl Surveys are being evaluated separately. The survey consists of extensive aerial transects, with ducks and ponds being counted from fixed wing aircraft. These are combined with intensive ground surveys on a subset of segments to estimate the proportion of waterfowl and ponds that are detected from the air.

The annual surveys of Prairie duck populations and associated wetland habitats provide information on status and trends of ducks and wetlands. In combination with other information, results of these surveys are used to predict sizes of fall flights and to recommend annual harvest regulations in consultation with Canadian and U.S. partners. Duck population estimates are also used by the Prairie Habitat Joint Venture and the North American Waterfowl Management Plan community to measure progress towards achieving population goals and to adjust conservation priorities, as required, on a regular basis. Population estimates and trends are also incorporated into ongoing Bird Conservation Region planning. The wetland habitat assessment component of the ground survey provides data that could be used to monitor the status of wetland bird habitats in the region. Data from this survey have been used in scores of published studies to investigate questions about population dynamics of harvested species, as well as climate and land-use impacts on duck populations.

Dr. Mark Drever's report "An Evaluation of Ground Survey Effort Necessary to Estimate Duck Population Sizes and Meet Information Needs For Management of Duck Harvests in Canada" (Dec 2009; unpublished report to EC) evaluated the implications of changing the analysis methods and reducing the number of ground segments on the precision of population estimates of selected waterfowl species on this survey. He found that use of more sophisticated analysis methods (e.g., hierarchical Bayes approaches) would make better use of existing data and yield more precise population estimates even with reductions of up to 50% in ground survey effort. This saving occurs because information on detectability from other years is used to inform estimates of detectability in any given year. As a consequence, the amount of effort spent on ground counts could be reduced while still maintaining target levels of precision for estimates of duck population sizes and wetland abundance in the Prairie Pothole region of Canada and the U.S.

The following sections consider the value of the survey for meeting EC monitoring needs, and how these values might be affected by changes in analysis methods or reductions in ground survey effort.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

Management Unit: The survey area considered in this review consists of the Canadian prairie-parkland regions of Manitoba, Saskatchewan and Alberta (including the Peace-Parkland). The survey covers all breeding waterfowl species, as well as American Coots, many of which are subject to intense harvest pressure in both Canada and the U.S.A..

1) Landscape conditions accommodate migratory bird requirements
The survey occurs primarily in BCR-11-Prairie Pothole, with small areas of BCR-6–Boreal Taiga Plains in Alberta.

Advancing and assessing Canadian and American waterfowl management agency and partner goals depend critically on monitoring program success and so monitoring needs are deemed to be "High" for ducks generally and for waterfowl species of concern (e.g., scaup and pintails) in particular, as well as for habitats (ponds). As noted above, population estimates of all species would still meet stated precision targets, even with reductions in ground survey effort. Ground survey data have the potential to provide additional information on detailed bird-habitat information that could be valuable to enhance the efficiency of landscape planning. A thorough assessment of these data has not been carried out, but it seems unlikely that bird-habitat relations change dramatically among years, and hence a reduced intensity of ground counts would likely result in little increase in risk. The surveys also may have some potential to monitor a variety of wetland-associated bird species other than waterfowl. However, at present, only grebes and coots are normally recorded (and not all survey crews necessarily record all species consistently), so it is difficult to assess the potential value of the survey for monitoring species other than waterfowl. In the past, there have been challenges in finding staff with the bird identification skills to survey non-waterfowl species. An evaluation would be required to determine whether this would increase the time required to complete surveys (and hence the total costs of the surveys). Reductions in numbers of ground transects could reduce the precision of monitoring data for other species, but, if an evaluation suggests those data are actually useful, then strategies such as a rotating design (whereby some transects are surveyed in alternate years) would likely result in minimal loss of power for long-term trend analysis.

2) Incidental Take is minimized and long-term conservation is supported
The survey provides information on overall population size of prairie breeding waterfowl species that can be used to provide a denominator to evaluate the impacts of incidental take; this value will not be changed by proposed reductions in the survey.

3) Threats to migrants in other countries are reduced
The survey provides information on population size and trends of waterfowl species that could be used to identify any population declines that may be related to threats outside of Canada. It would need to be supplemented by other sources of information to identify actual threats. These values would not be changed with proposed changes to the survey.

4) Migratory bird harvests are maintained at sustainable levels.
This survey is the most reliable and most important source of information on population size for many waterfowl species which are harvested intensively under regulations set by Environment Canada in Canada, and the USFWS in the U.S. Principal breeding habitat, ponds, are also counted and assigned to a pond type and condition status (e.g., dry, full) because renesting effort, brood-rearing success and, hence, annual fall flight estimates can be predicted based on information on pond abundance and condition. The monitoring need is High. The data are needed annually with moderate precision, due to the need to set hunting regulations on an annual basis, to evaluate the impacts of those regulations on duck populations and to minimize biological risks associated with

overhunting, or legal risks associated with challenges of the regulations. Dr. Mark Drever's report indicates that, with the use of improved analysis methods, the precision of population estimates (selected duck species and ponds) can be maintained or increased even if the number of ground surveys is reduced by 25-50%, thus enabling improved cost-efficiency while still meeting this need.

5) Priority sites for Migratory Birds are protected and improved
Not applicable.

6) Population-level effects of toxic substances are reduced
The survey provides information on population size and trends of waterfowl species that could be used to identify any population declines that may be related to impacts of toxic substances. Additional studies / research would need to be undertaken to identify any actual threats. The value of the survey for this purpose would not be changed with proposed changes to the survey.

7) Populations of migratory birds under particular threat are conserved.
Some species of waterfowl (e.g., lesser scaup and northern pintails) are well below conservation goals, and hence have an enhanced need for monitoring to ensure that harvest does not jeopardize their populations. As noted above, improved analysis techniques would ensure that precision of population estimates for these species would not be compromised by a moderate reduction in the number of ground surveys.

8) Migratory Birds in land claim areas are conserved
The survey provides information on population size and distribution over a large geographical area. The precision of the survey in any given geographic area, including any area that may be impacted by land claims, will depend on the size of the area. It may or may not be sufficient for any given land area depending on the actual locations of the aerial transects and their overlap with land claim areas. This value of the survey will not be impacted by any proposed changes, as the value is we are not currently proposing any reductions in the number or distribution of aerial transects which determine geographic coverage.

9) Threats due to Migratory Birds to public and economy are reduced
The survey provides information on population size and trends of waterfowl species that could be used to identify any population declines that may be related to impacts of toxic substances. Additional studies / research would need to be undertaken to identify any actual threats. The value of the survey for this purpose would not be changed with proposed changes to the survey.

10) Avian Species at Risk are assessed, identified and listed
The survey provides the best available information on the population size and trends of waterfowl and coots in this region, which contributes to species assessment under SARA. This value will not be compromised by proposed changes. Currently, none of the target species are listed under SARA. The potential value of this survey to collect data on other waterbird species that are under consideration for listing (such as some grebe species) remains to be determined.

11) Populations of avian Species at Risk are recovered
Not applicable.

Other Risks Taken into Account

Legal Risk
Responsible population management, including obtaining reliable estimates of duck population sizes, reduces risks of legal challenges associated with hunting regulations, notably for species of special concern. Proposed changes to this survey pose little change in risk because the survey is expected to continue to meet the precision targets and management needs.

External Funding
With proper consultations, involvement of United States Fish and Wildlife Service and Canadian partners in this survey is expected to continue at similar levels of investment, despite any reduced investment in the ground surveys by EC.

North American Waterfowl Management Plan Revision
The Plan revision will be completed in 2012 and objectives for population and landscape monitoring will be reviewed and endorsed during that process and related reviews. Recommendations for modifications to the ground surveys identified here seem unlikely to adversely affect any aspects of this plan.

SOUTHERN QUEBEC LOWLANDS AND ST. LAWRENCE RIVER WATERFOWL SURVEY PROGRAMS (WF-60, 69)

SUMMARY RECOMMENDATIONS

1. Reduce intensity and/or frequency of Southern Quebec Lowlands (WF-60) and St. Lawrence River (WF-69) Waterfowl surveys. Implement reductions in 2012.
2. Evaluate the feasibility of integrating the surveys with the Eastern Waterfowl surveys, in coordination with the USFWS, to implement changes, if any, in 2012
3. Evaluate the potential of each survey for population size and trend estimation of non-game species, particularly waterbirds by Fall 2011 and if appropriate incorporate into the survey design and implementation in 2012.

SUMMARY OF RATIONALE

The Southern Quebec Lowlands and St. Lawrence River Waterfowl Survey Programs are aerial surveys targeted towards the estimation of waterfowl population size and trends in specific areas of Quebec region. They are run on an annual basis using a rotating sampling scheme (i.e. a subset of plots are sampled every year and the full rotation over all plots is completed over a four-year period). Two complete rotation cycles will have been completed after the 2011 survey. Although both surveys use methodology that is similar and comparable to the Eastern Waterfowl Survey (WF-33), they are not currently integrated with other surveys used in the estimation of the continental eastern waterfowl population size and trend.

The Southern Quebec Lowlands and St. Lawrence River Waterfowl Survey Programs cover some of the more densely human-populated areas in Canada. Anthropogenic pressures on habitats are important as is harvest pressure on local waterfowl. As a result, this area receives the bulk of the habitat management / recovery effort in the province of Quebec. The lowlands and river habitats covered by these programs are also some of the most productive in eastern Canada and the detailed evaluation undertaken by the Avian Monitoring Review Steering Committee indicates that no other survey could adequately replace these surveys. Furthermore, there appears to be good potential for these surveys to provide information on several non-game species, particularly waterbirds. Given the potential of these surveys to be useful in Eastern Habitat Joint Venture planning and program assessment and other Federal-Provincial joint Ecosystem initiatives such as the St. Lawrence Action Plan, funding partnerships could be sought.

Main uses of the data are for harvest management , Environmental Assessment, and influencing landscape management in BCRs 7, 8, 12, 13, 14. This requires *annual information with medium accuracy and precision at the regional level.* Currently, both surveys operate *very high* accuracy and precision statistical targets, exceeding the needs identified. They aim to detect changes of 10% in the number of Black ducks (and the 4 other most abundant species), with 90% confidence interval over a 10 year period, or 80% confidence in a 6 to 7-year period. More precisely: (1) To provide annual breeding population indices for the American Black duck and for other waterfowl species in agricultural lowlands so as to track population trends over time. Population indices for Black ducks will have a CV of 12%. (2) To describe the distributions of abundance within the Southern Quebec agricultural lowlands and to provide statistically reliable population estimates of American Black duck and other waterfowl and nongame species (as appropriate).

Several options for reducing sampling intensity should be evaluated, including reducing the total number of plots in the sample or increasing the number of years required to complete the rotation. The evaluation should also consider the potential benefits of integrating these surveys within the existing Eastern Waterfowl Survey framework (WF-33).

Cost Summary

The following table outlines costs related to the current surveys.

	Southern Quebec Lowlands Survey	St. Lawrence River Survey
EC Operating costs/y	30 000$	60 000$
EC Personnel costs/y	15 000$	30 000$
EC Annual costs	***45 000$****	***90 000$****
Non-EC funds/y		
Non-EC personnel costs/y (incl. volunteers)		
Non-EC Annual costs	***0$***	***0$***

* Surveys were initiated and funded under the St. Lawrence Action Plan and not under A-base (i.e. core EC funding).

DETAILED RATIONALE

Management unit: *Southern Quebec waterfowl populations*
Migratory bird harvest regulations are developed for each province and territories. Most provinces are further sub-divided into hunting zones, and regulations can vary among these zones depending on local waterfowl population levels and trends. Access to reliable regional information on waterfowl populations is thus important in determining appropriate harvest regulations at that level. The area covered by the Southern Quebec Lowlands and St. Lawrence River Waterfowl Survey Programs is among the most densely human-populated areas in Canada. Anthropogenic pressures on habitats are important as is harvest pressure on local waterfowl. As a result, this area receives the bulk of the habitat management / recovery effort in the province of Quebec. The lowlands and river habitats covered by these programs are also some of the most productive in eastern Canada and the evaluation commissioned by the Avian Monitoring Review Steering Committee indicates that no other survey could adequately replace these surveys. Furthermore, there appears to be good potential for these surveys to provide information on several non-game species, particularly waterbirds. Given the potential of these surveys to be useful in Eastern Habitat Joint Venture planning, St. Lawrence Action Plan and the migratory bird and species at risk program assessments, funding partnerships could be sought

Implications of survey modifications to ability of suite of surveys to address EC monitoring needs

1) Landscape conditions accommodate Migratory Bird requirements
Boreal / Northern Forests (BCRs 7, 8 and 12): The St. Lawrence River survey covers a small geographic area of BCR 7, 8 and 12. Because the survey covers key shoreline habitats, it provides important information on waterfowl (and potentially other taxa) for BCR planning, as well as planning and evaluating habitat management programs of the Eastern Habitat Joint Venture.
Great Lakes – St. Lawrence (BCR 13): The two surveys cover the bulk of BCR 13 in Quebec and as such provide critical information for waterfowl (and potentially other taxa) for BCR planning, as well as planning and evaluating habitat management programs of the Eastern Habitat Joint Venture.
Maritimes (BCR 14): The St. Lawrence River survey covers key shoreline habitats in the Quebec portion of BCR 14. Because the survey covers key shoreline habitats not covered by any other surveys (fixed-wing and BBS for instance), it provides important information on waterfowl (and potentially other taxa) for BCR planning, as well as planning and evaluating habitat management programs of the Eastern Habitat Joint Venture.
As noted earlier, the precision of these surveys exceeds the requirements for this need, and hence the needs could still be met with scaled back surveys.

2) Incidental Take is minimized and long-term conservation is supported
Industrial activity is heavy in the region covered by the two surveys. Agriculture, forestry, wind power and tall structures, linear structures (e.g. roads and power lines), point sources, and fisheries are all important activities in the area. The two surveys can provide good baseline information on species distribution and densities of waterfowl (and potentially other taxa), but again this need can still be met with reduced intensity.

3) Threats to migrants in other countries are reduced
Not applicable.

4) Migratory Bird harvests are maintained at sustainable levels
Species covered by the survey fit in all categories of harvest except overabundant species. The survey provides unique information on the rapid growth of temperate-nesting Canada geese in the area and provides the basis for evaluating the impact of current or future management approaches to address the issue. The survey is optimized for Black duck and Mallard, the two most heavily harvested duck species in the east. Black ducks breeding in the area covered by the surveys are heavily harvested locally and restrictions were put in place to reduce the impact to this segment of the population. Survey data have been used in the context of stakeholder consultations for the development of waterfowl hunting regulations in Quebec. Scaling back the survey would still provide sufficient information for this purpose, particularly if it is integrated with the broader eastern surveys.

5) Priority sites for Migratory Birds are protected and improved
Both surveys could potentially provide information that would help identify important bird areas in southern Quebec. The information from the survey also provides baseline information for Environmental Assessment, especially in light of the proposed petroleum developments in the St. Lawrence Valley as well as many other on-going important threats (industrialization, intensification of agriculture, human disturbance, etc.). This need does not require annual data, and could still be met by a scaled back survey.

6) Population-level effects of toxic substances are reduced
The Lowlands survey covers areas that are farmed extensively and therefore provides information on waterfowl distribution and abundance in areas where pesticides or other toxic substances could be present; however, it is not clear that data have been used to meet this need.

7) Populations of Migratory Birds under particular threat are conserved
The St. Lawrence River survey provides information on the distribution and density of breeding waterfowl (and possibly other taxa) along St. Lawrence Seaway. Data could be valuable for planning of any emergency response along the St. Lawrence, and for assessing potential impacts. This need could still be met with reduced intensity.

8) Migratory Birds in land claim areas are conserved
Both surveys occur within several First Nations' unsettled land claim areas and many Reserves are found there (Mohawks in the Montreal sector for instance). Waterfowl are an important wildlife resource in this area, but in the absence of specific issues or concerns, a survey with reduced intensity should still meet the need.

9) Threats due to Migratory Birds to public and economy are reduced
Both surveys occur in areas of high human population density and large-scale agriculture. Issues currently exist with crop depredation, airplane strikes and bird-borne diseases and these could become more prevalent. Data from the survey could help with planning responses to these threats, but unless a specific threat is defined and management action identified, a reduced intensity could still meet this need.

10) Avian Species at Risk are assessed, identified and listed
Data from both surveys can contribute towards determining waterfowl species status at the Provincial level, but only if integrated with other surveys to provide the provincial status. This need would be met more effectively if the data are integrated into the eastern waterfowl surveys.

11) Populations of avian Species at Risk are recovered
Not applicable.

Other risks to take into account

Legal risk
Maintaining both surveys at an appropriate level (to be determined) allows the determination of sustainable harvest levels (sport hunt, conservation hunt, Eider down collection, etc.) and reduces the risk of undue court challenges with respect to hunting in this area

SOUTHERN ONTARIO WATERFOWL PLOT SURVEY (WF–58)

SUMMARY RECOMMENDATIONS

1. Maintain Southern Ontario Waterfowl Plot Survey at current (2010) levels until a decision is made on designating temperate-nesting Canada geese overabundant, which is expected within two or three years.
2. Evaluate the efficiency of the current survey and implement changes in survey protocols, if needed, by 2013.
3. Evaluate the potential of the survey for population size and trend estimation of non-game species, particularly waterbirds by Fall 2011 and if appropriate incorporate into the survey design no later than in 2013.

SUMMARY OF RATIONALE

The Southern Ontario Waterfowl Plot Survey (WF-58) was originally designed to monitor breeding waterfowl in this region. It was optimized for black ducks and mallards, but over time has proven useful for monitoring the growth of the southern Ontario breeding population of Canada geese. The timing of the survey and its geographical scope is good for monitoring southern Ontario Canada geese. The main limitation of the Southern Ontario Waterfowl Plot Survey for monitoring geese is that urban areas are not sampled. This likely does not affect other species covered by the survey as much as it does geese.

A Canada Goose Management Framework is currently being developed by Canadian Wildlife Service to address issues related to nuisance geese in temperate regions of Canada. Within that framework, numerical population objectives are to be determined on a provincial basis. The efficacy of different potential management actions are also being evaluated based on population models developed for the Southern Ontario temperate-nesting Canada goose population. Finally, an evaluation of the status of temperate-nesting geese in Canada will be undertaken, to determine whether they should be legally classified as overabundant. All of these require accurate information on breeding population size and trends, with a particular focus on breeding pairs. The Ontario temperate-nesting population of Canada geese has historically been monitored by the Southern Ontario Waterfowl Plot Survey (WF-58). Although other surveys overlap the area covered by WF-58 (e.g. Breeding Bird Survey, Eastern Waterfowl Survey fixed-wing transects), our detailed evaluation showed that these could not provide the level of detail required for the development and initial implementation of the Canada Goose Management Framework, nor the overabundant status evaluation. Thus, we recommend that WF-58 be maintained at current (2010) levels until a decision is made on the designation of temperate-nesting Canada geese as overabundant. This will insure that the decision on designation be based on a time series of population data that is consistent and comparable across years. A decision on designation is expected by 2012 or 2013. In the interim, we recommend that an assessment of the efficiency of the current survey be completed to evaluate the potential to implement a more cost-effective survey once status designation is completed. The potential of the survey to collect information on other species, particularly waterbirds, should also be evaluated.

Information collected through the Southern Ontario Waterfowl Plot Survey also meets Environment Canada needs for harvest management of other waterfowl species and influencing landscape management in BCR 13 (Great Lakes – St. Lawrence), The Ontario portion of the eastern Habitat Joint Venture.

Cost Summary

Annual costs to EC (cash and personnel) and potential savings related to AMR steering committee recommendations.

	Southern Ontario Waterfowl Survey	EC Annual SAVINGS (Operating and Personnel)
EC Operating costs/y	$10 000	0$[1]
EC Personnel costs/y	$36 000	0$[1]
EC Annual costs	***$46 000***	0$[1]
Non-EC funds/y	-	0$[1]
Non-EC personnel costs/y (including volunteers)	$4 000	0$[1]
Non-EC Annual costs	***$4 000***	0$[1]

[1]Some savings could be made if cost-effective changes in survey protocols are developed by 2013.

DETAILED RATIONALE

The Southern Ontario Waterfowl Plot Survey is a mix of ground and aerial surveys targeted towards the estimation of waterfowl population size and trends in southern Ontario. It covers an area that is not sampled by

Eastern Waterfowl Survey (WF-33) EC-delivered helicopter plots but overlaps to some degree with USFWS-delivered fixed-wing transects. It was originally focused on monitoring black duck and mallard populations but over time has evolved as the monitoring program for the Southern Ontario Canada goose breeding population.

General considerations

Although there is good geographical overlap between the Southern Ontario Waterfowl Plot Survey, the Breeding Bird Survey (LB-31) and the fixed-wing component of the Eastern Waterfowl Survey (WF-33), none of these other surveys provide the information that could entirely replace that collected under the Southern Ontario Waterfowl Plot Survey. The Southern Ontario Waterfowl Plot Survey evaluation undertaken by the Avian Monitoring Review identified that the time series for the fixed-wing component of the Eastern Waterfowl Survey was probably too short and did not provide trends that were comparable to the Southern Ontario Waterfowl Plot Survey nor the Breeding Bird Survey. Breeding Bird Survey trends were well correlated with Southern Ontario Waterfowl Plot Survey for most priority species but it does not collect information on pairs, which are an important consideration when dealing with nuisance goose issues.

Ontario temperate-nesting geese are currently used as a case study for assessing impacts of regulatory measures (harvest, lethal control) and developing a national strategy for dealing with nuisance geese which is currently an issue across the country. . It appears important that the goose survey be continued at least until a proper assessment of the status (overabundant or not) be completed. This is expected to take 2-3 years to complete.

The Southern Ontario Waterfowl Plot Survey covers some of the more densely populated areas in Canada. Anthropogenic pressures on habitats are important as is harvest pressure on local waterfowl. As a result, this area receives the bulk of the habitat management / recovery effort in the province of Ontario. Southern Ontario Waterfowl Plot Survey thus should be important for land use planning and Joint Venture program evaluation.

Implications of survey modifications to ability of survey to address EC monitoring needs

1) Landscape conditions accommodate Migratory Bird requirements
Great Lakes – St. Lawrence (BCR 13) – The survey covers a large portion of BCR 13 in Ontario and as such provides critical information for waterfowl for BCR planning, as well as planning and evaluating habitat management programs of the Eastern Habitat Joint Venture.

2) Incidental Take is minimized and long-term conservation is supported
Industrial activity is heavy in the region covered by the two surveys. Agriculture, forestry, wind power and tall structures, linear structures (e.g. roads and power lines), point sources, and fisheries are all important activities in the area. This survey can provide good baseline information on species distribution and densities of waterfowl.

3) Threats to migrants in other countries are reduced
Not applicable.

4) Migratory Bird harvests are maintained at sustainable levels
Species covered by the survey fit in all categories of harvest except overabundant species. The survey is currently optimized for Black Duck and Mallard, the two most heavily harvested duck species in the east. The survey has been shown to be effective in monitoring expanding the temperate-nesting Canada goose population of southern Ontario. This species fits the ‘heavily hunted species’ category and may become an ‘overabundant’ species soon. Blue-wing teal are also monitored through this survey and the Ontario population have been declining such that harvest restrictions may be warranted in the near future.

5) Priority sites for Migratory Birds are protected and improved
Southern Ontario Waterfowl Plot Survey has contributed to National Wildlife Area (NWA) Management Plans, specifically St. Clair, Bear Creek, and Prince Edward Point NWA Management Plans. Data include species use of the NWA and surrounding area as well as habitat change within the NWA in relation to waterfowl importance. It is expected that Long Point and Big Creek NWA Management Plans will be revised in 2012/13.

6) Population-level effects of toxic substances are reduced
The survey covers areas that are farmed extensively and therefore provides information on waterfowl distribution and abundance in areas where pesticides or other toxic substances could be prevalent.

7) Populations of Migratory Birds under particular threat are conserved
Not applicable.

8) Migratory Birds in land claim areas are conserved
Not applicable.

9) Threats due to Migratory Birds to public and economy are reduced
The survey occurs in areas of high human density and large-scale agriculture. Issues associated with nuisance by Canada geese, crop depredation, airplane strikes and bird-borne diseases are prevalent. The Minister receives several letters from the public each year regarding these issues

10) Avian Species at Risk are assessed, identified and listed
Data from both surveys are used in determine waterfowl species status at the Provincial level.

11) Populations of avian Species at Risk are recovered
Not applicable.

Other risks to take into account

Legal risk
Maintaining the survey reduces the risk of a court challenge on the Department for improper management of waterfowl populations. Canada geese may come to be categorized as overabundant in the near future and survey information will be a critical piece of information in the categorization and subsequent possible court challenges. EC issues permits for the management of including the lethal removal of geese from the area which could expose the Department to legal challenges.

Political Risk
The management of temperate-nesting geese in southern Ontario is high profile and often subject of media interest. The Minister receives numerous letters of complaints each year regarding the issue. Nuisance complaints are particularly acute in the Greater Toronto Area. Permitted lethal removal of eggs or adult geese is also controversial. Maintaining a survey that provides reliable trend information on temperate-nesting geese in southern Ontario would be viewed by the public as good management.

PRINCE EDWARD ISLAND BREEDING GROUND PLOT SURVEY (WF-55)

SUMMARY RECOMMENDATIONS

1. Re-design survey, in consultation with Prince Edward Island, such that it adequately addresses habitat and harvest management needs and allows detection of changes in breeding waterfowl and other non-game migratory bird species population trends at an appropriate level of precision. Target 2012 for implementation of re-designed survey.
2. In the interim, continue Environment Canada's involvement in current breeding pair survey but not the brood survey, which the Department stopped supporting in 2010.
3. Improve management of historical database, with a thorough validation and correction of errors, and standardization with other EC datasets, and consider an analysis of the dataset to look at impacts on landscape change in relation to waterfowl productivity in PEI.

SUMMARY OF RATIONALE

The current Prince Edward Island Breeding Ground Plot Survey (WF-55) was designed to monitor waterfowl populations on selected wetlands of the province. Because the sampling units are defined as wetlands, as opposed to some clearly defined plot area, and because the current sample of wetlands cannot be considered to be random, the data have severe limitations for estimating population size, tracking trends or changes in density or habitat. The evaluation of needs for this survey (see below) indicates that breeding pair information from the survey is important for landscape planning and setting local harvest regulations. Productivity information from the brood survey may contribute to landscape planning, but is not regularly used for setting harvest regulations. Given these, we suggest that a breeding pair survey, especially if it also considers non-game wetland species, would link better with Eastern Habitat Joint Venture program areas and allow for better planning and assessment of habitat programs. Given that productivity information does not appear to be heavily used in decision making, Environment Canada did not support the brood surveys on Prince Edward Island in 2010. A re-designed survey should have a breeding pair focus and examine the addition of a productivity component only if shown to be necessary for decision making.

Information needs for this survey are moderate so the re-design should determine whether a reduction in frequency (e.g., biennial) would be appropriate. The re-designed survey's objectives should be to provide medium levels of precision and accuracy. The potential of the re-designed survey to collect information on other non-game species should also be evaluated.

Cost Summary

The following table outlines costs related to the current survey.

	PEI Ground plot survey
EC Operating costs/y	$4 000
EC Personnel costs/y	(0.15 PY) $13 000
EC Annual costs	***$17 000***
Non-EC funds/y	Unknown
Non-EC personnel costs/y (including volunteers)	(0.55PY) $49 500
Non-EC Annual costs	***unknown***

DETAILED RATIONALE

Management unit: *Provincial breeding waterfowl populations (Prince Edward Island)*
Migratory bird harvest regulations are developed separately for all provinces and territories. Access to reliable regional information on waterfowl populations is thus important in determining appropriate harvest regulations at that level. There are few sampling units from national/international monitoring programs on Prince Edward Island (hereafter PEI): 4 Breeding Bird Survey (LB-31) routes and small portions of 6 fixed-wing survey segments from the Eastern Waterfowl Survey (WF-33). These surveys are not sufficient to provide province-specific information on waterfowl populations but can be useful at a larger scale (i.e. Maritimes).

The PEI Breeding Ground Plot Survey was designed to track breeding waterfowl populations and productivity on selected wetlands of the Province. It has two main components: a waterfowl breeding pair survey carried out during the early-nesting period, and a productivity survey later in the nesting period on which waterfowl broods are recorded and used as an index of productivity. Both components are from the ground with experienced observers from Environment Canada and the Prince Edward Island Department of Environment, Energy and Forestry. Because the sampling units are defined as wetlands, as opposed to some clearly defined plot area, and because the current sample of wetlands cannot be considered to be random, the data have severe limitations for estimating population size, tracking trends or changes in density or habitat.

Implications of survey modifications to ability of suite of surveys to address EC monitoring needs

1) Landscape conditions accommodate Migratory Bird requirements:
Maritimes (BCR 14): The PEI breeding ground plot survey covers wetland habitats in the PEI portion of BCR 14. Because the survey covers a pre-determined set of wetlands, it is uncertain whether all key habitats are captured. Historical information should be very useful for BCR planning in this region but does not require annual updating. Less frequent but more targeted surveys could prove to be more efficient for BCR planning, as well as planning and evaluating habitat management programs of the Eastern Habitat Joint Venture. The productivity information from the brood counts could provide useful information on habitat quality but it has not been used consistently for this purpose. A redesigned survey should address this need in a more efficient manner. Foregoing the brood-count component in the interim is not expected to lead to an increase in risk associated with this outcome.

2) Incidental take is minimized and long-term conservation is supported
Industrial activity is important in the region covered by the survey. Agriculture, wind power and tall structures, linear structures (e.g. roads and power lines), are important activities in the area. The survey can provide good baseline information on species distribution and densities of waterfowl within the sampled wetlands but sampling frame prevents extrapolating outside of sampled areas. A re-designed survey should address the issue associated with sampling areas.

3) Threats to migrants in other countries are reduced
Survey does not contribute to this need.

4) Migratory Bird harvests are maintained at sustainable levels
Species covered by the survey fit in all categories of harvest except overabundant species. Survey data has been used to inform the development of waterfowl hunting regulations in PEI (e.g. specific bag limits for Black ducks, no early Canada goose seasons). Current survey allows for relatively robust long-term trend estimation but not on the short-term often required in harvest management. There is a small risk that basing PEI harvest regulations on regional estimates (e.g. Maritime-wide) would result in unsustainable harvest of PEI breeding waterfowl. Periodic provincial surveys would reduce this risk.

5) Priority sites for Migratory Birds are protected and improved
Because the survey occurs on pre-determined wetlands, its potential to provide information that would help identify important bird areas in PEI is limited. It is unsure how a re-designed survey would address this issue.

6) Population-level effects of toxic substances are reduced
The survey covers areas that are farmed extensively and therefore provides information on waterfowl distribution and abundance in areas where pesticides or other toxic substances could be prevalent.

7) Populations of Migratory Birds under particular threat are conserved
Survey does not contribute to this need.

8) Migratory Birds in land claim areas are conserved
Survey does not contribute to this need.

9) Threats due to Migratory Birds to public and economy are reduced
The survey occurs in areas of high human density and large-scale agriculture. Issues associated with crop depredation, airplane strikes and bird-borne diseases could be important. Risk of replacing current survey with a less frequent one appears low in regards to this need.

10) Avian Species at Risk are assessed, identified and listed
Data from the survey are used to determine waterfowl species status at the Provincial level. However, because of statistical issues (sampling frame, low power to detect trend), the current survey may have limited value in this respect. A re-designed survey should address some of those issues, especially those associated with the sampling frame.

11) Populations of avian Species at Risk are recovered
Survey does not contribute to this need.

Other risks to take into account

Legal risk
Potential risk of court action if PEI migratory bird regulations are set in the absence of province-specific population data. Risk is likely low and would be further reduced by implementing a less frequent survey.

Maintenance of external funding
The Prince Edward Island Department of Environment, Energy and Forestry provides the bulk of personnel and time to conduct the survey. Their support would be essential for any new survey design as it is unlikely Environment Canada would increase its investment in a re-designed survey.

Public support for management actions
Public support for management actions (e.g. hunting regulations) is usually greater when local information is available to support actions. Developing a new survey would not increase risks in this regard.

Partner Expectations
The survey is delivered jointly by Environment Canada and Prince Edward Island Department of Environment, Energy and Forestry and is important for public support of wildlife management activities in the Province of Prince Edward Island. PEI would expect locally based waterfowl surveys to continue in the future.

GREATER SNOW GOOSE MONITORING PROGRAMS (WF-1, 9, 28, 67, 79, 81)

SUMMARY RECOMMENDATIONS

1. Terminate WF-1 Arctic breeding ground survey
2. Terminate WF-9 Ellesmere Is. Component - Arctic productivity, banding and habitat monitoring
3. Terminate WF-28 Fall body condition survey
4. Delay WF-67 decision on reducing spring aerial survey frequency to fiscal year 2012-13; decision will be based on a re-evaluation of the impact of running survey every second year.
5. Maintain WF-9 Bylot Island component - Arctic productivity, banding and habitat monitoring at current level
6. Maintain WF-79 fall productivity survey at current level
7. Maintain WF-81 satellite-telemetry study at current level for fiscal year 2010-11, then terminate in 2011-12.

SUMMARY OF RATIONALE

The Greater Snow Goose is considered Overabundant, which means there is a High need for reliable monitoring information to support the implementation and evaluation of special regulations to manage the population. The required monitoring parameters include population size, survival rates, and productivity, to evaluate and predict impacts of management actions on the population.

Detailed analysis indicates the current suite of surveys provides redundant information, and some surveys can be dropped or reduced without loss of information. For population size, the spring aerial survey (WF-67) provides the best and most reliable information. The Arctic breeding ground survey (WF-1) is a count of selected breeding colonies. It has provided useful information on the distribution of colonies, but is not necessary or useful for monitoring changes in population size, and can be discontinued. The spring survey could potentially be reduced in frequency to be run every other year, because analysis of past surveys indicates this would have led to little loss of precision. However, any decision on changing the frequency should be postponed at least 2 years for 3 reasons: annual surveys are required for 2 years to support an intensive evaluation of the survey using satellite telemetry; the count has become much more variable and less predictable in the past 2 years, and half the funding comes from partners who would have to agree with any change to yield any cost savings
.
For demographic information, the long-term Bylot island survey provides the most reliable information on survival and breeding ground changes. The relatively low cost fall productivity survey complements this, and provides information on the population as a whole. The Ellesmere Island productivity and banding survey has yielded similar information to the Bylot Island survey and is no longer needed. The information from fall body condition survey has not been used for management purposes and can also be dropped.

Cost Summary

The following table outlines current and projected annual costs to EC (cash and personnel) and potential savings related to the AMR steering committee recommendations. Note that WF-1 takes place only once every 5 years, so costs for survey year are divided by 5 to estimate annual costs.

	WF-1 Breeding ground aerial survey	**WF-9 Bylot Is. Productivity, banding and habitat surveys**	**WF-9 Ellesmere Productivity, banding and habitat surveys**	**WF-28 Fall body condition survey**	**WF-67 Spring aerial survey**	**WF-79 Fall productivit y survey**	**WF-81 Satellite-telemetry study**	**EC Annual TOTAL (Operating and Personnel)**	**EC Annual SAVINGS (Operating and Personnel)**
Current costs (to 2009-10)									
EC Operating costs/y	$4 000	$50 000	$20 000	$3 000	$14 500	$3 000	$0		
EC Personnel costs/y	$2 000	14 500$	$38 000	$3 600	$7 200	$3 600	$3 600		
EC Annual costs	***$6 000***	***$64 500***	***$58 000***	***$6 600***	***$21 700***	***$6 600***	***$3 600***	***$167 000***	
Non-EC funds/y	$7 900	$288 000	$149 500	$0	$15 000	$0	$124 000		
Non-EC personnel costs/y (including volunteers)	$9 000	$140 000	$7 200	$0	$0	$3 600	$0		
Non-EC Annual costs	*$16 900*	*$428 000*	*$156 700*	*$0*	*$15 000*	*$3 600*	*$124 000*		
Projected costs									
2010 and 2011		$64 500			$21 700	$6 600	$3 600	**$96 400**	**$70 600**
2012 (& following even years)		$64 500			**	$6 600		**$71 100****	**$95 900****
2013 (& following odd years)		$64 500			$21 700** ($36 700 if non-EC funding is lost)	$6 600		**$92 800 ($107 800 if non-EC funding is lost)**	**$74 200 ($59 200 if non-EC funding is lost)**

* For surveys that are not run every year, the costs during years when the survey is run, are averaged with zeros in years when the survey is not run (e.g., WF-1 costs $30K every 5 years, for an average annual cost of $6K) ** Savings of $21,700 in even years would only occur if decision is made to reduce survey frequency to biennial; however, these could be largely offset if reduction in survey frequency leads to loss of partner funding (see discussion, in detailed rationale, on this risk).

DETAILED RATIONALE

***Management unit**: Greater snow goose monitoring must differ from Lesser snow goose monitoring*
Subspecies level (*Anser caerulescens atlantica*). This subspecies's range does not significantly overlap that of the other subspecies, the lesser snow goose (*Anser caerulescens caerulescens*). Greater snow geese are confined to the eastern high Arctic and Greenland during the breeding season, and the Atlantic Flyway States during the winter. Most greater snow geese stage along the St. Lawrence River estuary and main tributaries in both fall and spring. The historical population trends and status also differ markedly from the lesser snow goose, with greater snow geese recovering from a low of a few thousand birds in the early 1900's to a population that is now exceeding 1 million. Thus, threats and management issues are quite different between the 2 snow goose subspecies, which warrants specific monitoring programs.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Bird Conservation Region (BCR) 3 Arctic Plains and Mountains – Greater snow goose is a possible focal species for this region. The monitoring needs for this outcome are mainly delivered through the spring survey (WF-67) for general trend and abundance status, as well as the Bylot Island and Ellesmere Island productivity, banding and habitat surveys (WF-9). The breeding ground survey (WF-1) contributes to an understanding of trends at one colony (Bylot Island) but this is only a portion of the total breeding population. There are still some gaps in terms of detailed spatial distribution and abundance information in the Arctic, because existing surveys only occur at some colonies. However, the lack of this information is not presently viewed as a significant risk, as no management actions are happening on the breeding grounds. Targeted and punctual breeding ground surveys could be carried out in the future if the need arises. In other respects, the current suite of surveys exceeds the needs for this outcome, because they were developed for other specific outcomes (e.g., special regulations for harvest management) that require greater information. The proposed reductions in survey effort would not impair Environment Canada's ability to deliver key information about habitat management.

BCR 13- Great Lakes – St. Lawrence, BCR 14 Atlantic Maritime, and the lowlands of BCR 12 (Lac St-Jean) are the major stopover areas during spring and fall migration. WF-67 (spring survey) fills the monitoring need for spring, while WF-79 (fall productivity) allows an assessment of fall distribution and abundance (although the survey is not intended for that purpose). Satellite telemetry (WF-81) should provide important information for both seasons on migration chronology and regional bird distribution patterns, as well as being useful as population correction factor for WF-67. Reducing the frequency of WF-67 would not significantly increase risk in decision making.

2) Incidental Take is minimized and long-term conservation is supported
Not applicable.

3) Threats to migrants in other countries are reduced
Not applicable.

4) Migratory Bird harvests are maintained at sustainable levels
Overabundant waterfowl - Monitoring requirements to support management of overabundant waterfowl are considered very high because of the need to justify special control measures and to evaluate their effectiveness. The suite of surveys recommended are those that are required to meet these needs. The spring survey (WF-67) provides information on population size, the Bylot Island breeding survey (WF-9) provides information on productivity and survival at one site, while the fall productivity survey (WF-79) provides information on range-wide productivity. The satellite telemetry survey (WF-81) is a short-term research project that has been developed to evaluate the accuracy and precision of the spring survey.

Anna Calvert's report indicates that the spring survey frequency could be reduced to biennial without substantial loss of information, based on historical data. However, we recommend delaying any decision on reducing survey frequency until at least FY 2012 for several reasons. First, this would allow a better evaluation of the impacts of the implementation in spring 2009 of a special conservation order in the U.S., and allow the use of special approaches to increase harvest, such as the implementation of spring seasons. Given that impacts due to changes in regulations usually are strongest in the first few years of implementation, it appears important to collect information on an annual basis through to at least spring 2012. Second, the spring survey is needed on an annual basis for the next 2 years to allow completion of the satellite telemetry study which is designed to estimate the proportion of birds in the total population being counted on the spring surveys. The results of this study will enhance the reliability of the count data, and allow for improved modelling and decision making, especially with

respect to the effectiveness of special measures. It requires having spring count data for each year of the telemetry study. The satellite telemetry survey has the bulk of its funding secured for the next 2 years. Third, the most recent few years of data indicate substantially increased variance in the counts – if this variation continues, the conclusion that the survey frequency could be reduced may need to be revisited.

The Bylot Island productivity, banding and habitat surveys (WF-9) provide the demographic information required for this outcome and even though the quality of the information may exceed needs in certain areas, the science-based evaluation has shown that savings would be negligible from scaling back effort at this colony. Furthermore, the study is heavily leveraged with outside funds that are supporting a larger research program, and the additional data are an important part of that research program. However, the data from the Ellesmere Island survey do not substantially add to this information, and the risk of managing this population with data from only the main colony (Bylot Island) is low. Therefore, Environment Canada participation in the Ellesmere Island survey should be terminated.

Species harvested for Aboriginal subsistence use – The recommended suite of surveys meets or exceed the needs for this outcome in all areas except for the estimation of subsistence harvest. This does not appear to be a high risk at the moment, given the large size of the population. A targeted harvest survey could be initiated in the future if the need arises (e.g. if spring survey shows an important reduction in population size).

5) Priority sites for Migratory Birds are protected and improved
Most priority sites for this species are known on the breeding, staging and wintering areas. Spring population counts (WF-67) provide sufficient information to meet monitoring needs for decision making for this outcome with this species.

6) Population-level effects of toxic substances are reduced
No current need. Lead ingestion could have been an issue in the past. Pesticides could potentially become an issue both for bird condition and human health in the future given Greater snow goose reliance on crops for feeding.

7) Populations of Migratory Birds under particular threat are conserved
Emergency response along St. Lawrence River. Current understanding of distribution from WF-67 and most recently for WF-81 plus another existing database (EPOQ checklist) for at different times of year is sufficient in the short-term.

8) Migratory Birds in land claim areas are conserved
This is an important species for Inuit subsistence harvest) in Nunavut Territory in particular. Small gaps exist in knowledge of breeding (Arctic) distribution. Range-wide population trend information (from spring survey – WF-67), combined with intensive data from the main colony (WF-9) appears to be sufficient to meet information needs at present. Important Greater snow goose staging areas are found in northern Quebec (Nunavik land claim area) but little information is available on aboriginal harvest in this area covered by the James Bay and Northern Quebec Agreement. Satellite-telemetry (WF-81) may provide sufficient information on use of areas in Nunavut and Nunavik during staging but results from this study will need to be analyzed to ensure that is the case. Risk related to this outcome is potentially low as long as WF-9 is maintained in Nunavut (Bylot Island). Monitoring needs for Nunavik should be evaluated at the end of satellite telemetry study (WF-81). As noted earlier, unless population shows major declines, risk in this area is likely low.

9) Threats due to Migratory Birds to public and economy are reduced
Mainly related to crop damage in spring, and recently in the fall in new areas used by staging birds (Lac St-Jean). Knowledge of distribution and abundance in spring is adequately covered by WF-81, but no other survey is in place to monitor regional use in relation to crop damage after WF-81 terminates (FY 2012), however this is considered to be a minor risk. Airport hazards are currently low or nil.

10/11) Species at Risk
Not applicable.

Other Risks to Take Into Account

Legal risk
Greater snow geese are legally designated as Overabundant. The current monitoring programs were crucial in a judge's decision to reject a court challenge and, hence, enable Environment Canada to invoke special conservation measures to manage the growing population. Given recent uncertainty in population trends following

the implementation of special conservation measures, the impact of reducing spring population survey frequency to every other year should be carefully re-evaluated before instituting a change. Maintaining the spring survey at current levels for FY 2011-12 coupled with ongoing technical work to address sources of bias are expected to reduce uncertainty in population size and trends and therefore minimize legal risk associated with a change in frequency.

Maintenance of external funding
Most of the current monitoring programs are supported by external funding. Major partners include the United States Fish and Wildlife Service, Atlantic Flyway Council, National Science and Engineering Research Council and the Polar Continental Shelf program of Natural Resources Canada. Negotiations would be required with partners to either build a biennial funding structure or find an agreed-to replacement program in the non-survey year. The latter would have the benefit of maintaining annual program-specific funds within partner budgets. The replacement program would likely need to be targeted at migratory game birds to address partner needs.

Public support for management actions
Special conservation measures (e.g., spring harvest, use of electronic calls) implemented to curb the growth of this overabundant population have been controversial among some of the public and stakeholders. The high quality of the monitoring data for greater snow geese has allowed Environment Canada to build a very strong case for their "Overabundant" designation, and has been critical in establishing public support for the management actions. We stress the importance to phase-in any changes in the frequency of the spring survey, to allow sufficient dialogue with the stakeholders, and particularly with the wildlife conservation and farming communities, to ensure that changes are not misinterpreted as a reduction of interest on the part of Environment Canada towards the issues of crop depredation and recreational hunting. We believe the recommended modifications to the monitoring program would not undermine public support in a significant way. However, more drastic reductions (e.g., terminating the Bylot Island Productivity, banding and habitat surveys) could lead to an erosion of public and partner support and trust in the short-term.

Summary of Implications of Recommended Changes

WF-1 (Arctic breeding ground survey):

- Survey was last run in 2008 and was next scheduled to be run in 2013.
- No immediate implications in either O&M or staff time.
- Estimated savings in FY 2013-14:
    - $20 000 in O&M
    - $10 000 staff time (20 field days by EC goose biologist (QR), 0.1 py for survey administration)
- Implications for partner funding
    - $40 000 NRCAN (Polar Continental Shelf Program) not required
    - (this could potentially enhance funding for other EC projects in Arctic, but at discretion of NRCAN)
- Risk associated with termination:
    - EC's responsibility in land claim areas (Nunavut Territory) is not fulfilled (low risk if WF-9 Bylot Island survey is maintained; high risk if all Arctic work is terminated)
    - Any risks are further reduced because targeted breeding ground surveys could be carried out in the future at any time if the need arises.

WF-9 (Arctic productivity, banding, habitat monitoring) - Ellesmere component

- Conducted over the past 3 years
- Partly funded by funds no longer available, so survey could not be continued without increased EC funding
- Not evaluated by Anna Calvert due to short time series and resulting lack of data (mainly banding operations), but the WF-9 Bylot Island component appears sufficient for Arctic monitoring of habitat, productivity and other demographic parameters
- Estimated annual savings from terminating survey:
    - $20 000 O&M
    - $38 000 staff time (4 weeks of field work for EC goose biologist + EC technician + survey administration)
- Implications for partner funding
    - $20 000 NRCAN (PCSP) not required

    - (this could potentially enhance funding for other EC projects in Arctic, but at discretion of NRCAN)
- Risk associated with termination:
    - Low, as long as the Bylot Island component is maintained. Data from Ellesmere are not being used in harvest decision making at present. Data from Bylot Island appear to be sufficiently representative of the overall population for management purposes.
    - Fall productivity survey provides an index of conditions elsewhere in breeding grounds that complements Bylot Island survey

WF-28 (Fall body condition survey)

- Originally a research program
- Data have not been used recently
- Estimated annual savings:
    - $3 000 O&M
    - $3 600 staff time (approx. 10 days for EC goose biologist)
- Implications for partner funding: none
- Risk associated with termination: None. Program does not align with current EC monitoring needs

WF-67 (Spring aerial survey)

- Spring survey is the main source of data from which management decisions are made
- A conservation order (including spring seasons) on Greater snow geese was implemented in 2008-09 in the U.S. Atlantic Flyway States. The spring survey is the main source of data for evaluating impacts of this management action
    - Impacts of management actions are usually strongest in the first few years following implementation, thus more efficient from management evaluation perspective to keep annual survey during this critical phase
- Studies are underway to increase efficiency of survey (develop automated photo-counting method, changes in sampling frame for photo counts)
- Telemetry study will allow quantification of any bias in spring survey bias (detection)
- Maximize efficiency of bias study by having annual surveys during telemetry study
    - Telemetry study (WF-81) funded for next 2 years, EC contributes staff time only
- Re-evaluate spring survey frequency in light of findings in 2 years, FY 2012-13
- Estimated savings if frequency is reduced to biennial and if no partner funding is lost:
    - $14 500 O&M in non-survey years (average savings $7,250 per year)
    - $7 200 staff time in non-survey years (average savings $3,600 per year)
- Implications for partner funding
    - $15 000 USFWS and Arctic Goose Joint Venture- U.S in non-survey years not required
    - Risk that funds could be lost in survey years as well, if partners are unable or unwilling to manage funds on a biennial basis.
    - If EC needs to make up these funds, this would largely offset any savings accrued.
- Risk associated with reduction in survey frequency: medium to high
- Decreased ability to track effectiveness of special conservation measures
- Variance in annual population estimates higher since implementation of special measures, so predictability is lower
- Potential that would lose partner funding (approx. 40% of overall survey cost), which EC would need to make up
- Erosion of public and stakeholder support (esp. farming community) for management actions

TUNDRA SWAN MONITORING SURVEYS (WF-39, 48, 74)

SUMMARY RECOMMENDATIONS

Western Population

1. Terminate WF-74 triennial winter surveys in British Columbia effective immediately and instead rely on Christmas Bird Count (CBC) data to monitor changes in swan abundance and distribution in British Columbia during winter.

Eastern Population

2. Discontinue WF-39-Inuvialuit Geese and Swan Surveys (helicopter-based), and do not resume unless there are needs related to cumulative effects from development and/or land claims that cannot be met by other surveys.
3. Evaluate with USFWS by autumn 2011, the costs and benefits of potential expansion of continental Waterfowl Breeding Population and Habitat Surveys (WBPHS) into the Inuvialuit Settlement Region to allow decisions regarding potential implementation in 2012.
4. Do not resume WF-48 survey, which was set up to establish Tundra Swan population baselines in the Mackenzie Delta, unless new development proceeds and a comparison is required.
5. Ensure that all data from WF-48 and WF-39, including detailed locations of all survey plots, transects, bird observations, etc. are properly managed in a nationally accessible database.
5. Consider conducting an aboriginal subsistence harvest survey of Tundra Swan harvest in Canada only if there is a need with respect to harvest allocation issues, aboriginal management issues or treaty negotiations

SUMMARY OF RATIONALE

Tundra Swans are considered secure in Canada, with no assessment by COSEWIC or designation status under SARA. At the provincial level, the species is largely designated as secure, but is listed as “May be at Risk” in the Yukon, and Sensitive in British Columbia, Ontario and Quebec. Tundra Swans suffered heavy market hunting in the 19th Century, and populations were reduced drastically by the time the species was afforded protection through the Migratory Birds Convention Act of 1918. Surveys of the wintering grounds were coordinated and standardised by the 1950’s, and have documented a significant recovery of populations in both eastern and western North America. Both populations continue to exceed their management targets. Limited sport-hunting of the species has been reintroduced in the USA. There is some subsistence harvest in Canada, which is not well monitored, but is believed to be less than 5,000 swans per year.

Given the sustained growth and expansion of Tundra Swan populations in range and numbers, and the very limited harvest, the current precision of monitoring programs is in excess of management and conservation needs. Furthermore, surveys at different stages of the life-cycle currently provide redundant information on population size and trend.

Mid-winter aerial surveys of selected areas in British Columbia have been conducted approximately every 3 years since 1968 (WF-74). Although the survey was primarily designed to monitor Trumpeter Swans, some Western Tundra Swans (300 to 500) are counted. This represents <0.5% of the Western Population and is of little importance in the continental monitoring of the Western Population. Although the survey provided some distributional information, the Christmas Bird Count also records Tundra Swans and provides coarse distributional information.

Helicopter-based surveys of geese and swans in the Inuvialuit Settlement Region (WF-39) were carried out for several years, but not in 2009 or 2010. The existing surveys have provided sufficient information for current planning and land claim concerns, and are not cost-effective for long-term population monitoring, so they should not be resumed unless new issues arise that cannot be addressed with other surveys.

Discussions have been initiated about expanding the USFWS Waterfowl Breeding Population and Habitat Surveys (WBPHS) farther north into areas that would include the Inuvialuit Settlement Region as well as the Queen Maud Gulf and Rasmussen Lowlands. This survey would cover swans as well as other waterfowl species. The costs and benefits of this survey are still being evaluated.

The WF-48 surveys were designed to generate baseline data on the distribution, abundance, and breeding success of Tundra Swans in the area of the proposed Mackenzie Valley Oil and Gas Project. With the baseline data collected, and the objectives therefore achieved, the surveys were discontinued. There are no plans to

repeat these surveys; however, if development goes forward, repeating them to assess the effects of development may be desirable.

Cost Summary

The following table outlines annual costs to EC (cash and personnel) and potential savings related to AMR steering committee recommendations.

	WF-74 BC (every 3 years)	WF-39 NT (~annual)*	USFWS WBPHS Survey Expansion *(anticipated)*	WF-48 NT	EC Annual TOTAL	EC Annual SAVINGS
EC Operating costs/y	$10 000	$100 000	-	Discontinued		
EC Personnel costs/y	$20 000 (0.2 PY)	$30 000 (0.3 PY)	-	Discontinued		
Current total costs in survey years	*$30 000*	*$130 000*	-	-	*$160 000 (incl. 0.5 PY)*	
Current EC Annual Equivalent	*$10 000*	*$130 000*	-	-	*$140 000*	
*Proposed Annual Surveys***	-	-	*$10 000 (incl 0.05PY)*	-	*$10 000*	$130 000

* Survey was last run in 2008
** Costs assume that aircraft and associated flight costs would be supplied by USFWS, but actual costs may prove higher. Note that this survey would cover a larger area than WF-39, and would be designed to monitor all waterfowl species.

DETAILED RATIONALE

Management units

Management of the Tundra Swan occurs separately for two populations, Western and Eastern, with distinct breeding, migration and wintering ranges.

The Western Population nests in Alaska from Kotzebue Sound southwest to the Alaska Peninsula. During migration, birds follow both coastal and inland routes to winter primarily in the western United States. Approximately 75% of the population winters in California. A small number of Tundra Swans (300-500 or <0.5% of the population) winter along the southern coast of British Columbia. Mid-winter surveys in 2008-2009 placed the Western Population at 105,200 individuals, or 69% above the management target of a three-year average of 60,000 individuals.

The Eastern Population nests from the Seward Peninsula of Alaska to the northeast shore of Hudson Bay and western Baffin Island, with a concentration of birds in the area of the Mackenzie Delta. These birds migrate across the interior of the continent to winter on the Atlantic Coast. Historically, birds of the Eastern population congregated primarily in Chesapeake Bay but their winter distribution has shifted primarily to North Carolina, where many individuals forage in agricultural fields. The shift in behavior may in part underlie the rapid population growth. During 2002-2006, 67% of wintering Eastern Population Tundra Swans were found in North Carolina, 15% in Maryland, 7% in Virginia and smaller numbers elsewhere, including in the vicinity of the Great Lakes in Ontario. The broad distribution of the Eastern Population, spanning all four flyways, has necessitated a collaborative approach to management. The first management plan for this population was prepared in 1982, by a committee including representation from the four Flyway Councils, the CWS and the USFWS. The current version of the plan (2007) provides a population objective of 80,000 swans, based on the 3-year average mid-winter count. The population has exceeded this objective since 1983, and was estimated to exceed it by 30% in 2009.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Western Population (BCR's 4, 5, 6, 9, 10, 11): The recommendation to terminate triennial winter surveys in British Columbia would only marginally reduce EC's ability to meet this program component for this species in BCR 5, but the risk is Low because few individuals winter in this area and information from the Christmas Bird Count is likely sufficient. Tundra Swans use the other listed BCRs either during migration, with very small numbers breeding, but the risk of not having monitoring data for these areas is very low.

Eastern Population (BCR's 3, 6, 7, 8, 11, 12, 13): Discontinuing the helicopter-based surveys of geese and swans in the Inuvialuit Settlement Region (WF-39) will limit EC's ability to meet this program component in BCR 3 and 6. However, the expansion of the USFWS WBPHS could fill this gap if properly implemented. If a new survey (e.g. USFWS WBPHS) is implemented, the risk is Low. If not, there would be some enhanced risk in BCR 3 and 6, but unless specific threats or management issues arise, the risk of dropping the surveys would likely remain relatively Low. Other BCRs are used at low densities for breeding (e.g. BCR 7) or during migration and the risk associated with not having monitoring data for this part of the life-cycle is very Low.

2) Incidental Take is minimized and long-term conservation is supported
Swan collisions with electric wires occur in south-western British Columbia. Deaths from this factor are tracked from publicly reported deaths, but current levels of mortality do not compromise population sustainability. The current recommendation on survey programs would not impact the ability to track these impacts.

3) Threats to migrants in other countries are reduced
Not applicable.

4) Migratory Bird harvests are maintained at sustainable levels
Currently, both the Western and Eastern populations of Tundra Swans are *lightly harvested* in the United States only, although public interest in the hunt is significant. Also, they are a s*pecies harvested for Aboriginal subsistence use* on their breeding grounds.

Subsistence harvest levels are currently unknown and the lack of an appropriate subsistence harvest survey is a gap. Implementing a "consistent and reliable subsistence harvest survey in all key areas of Eastern Population swan harvest in Canada" is an important recommendation in the 2007 USFWS / CWS Tundra Swan management plan. However, unless concerns arise about harvest allocation (e.g., due to pressure to increase the recreational harvest, indications of population declines or concerns from aboriginal communities), the risk of not implementing the plan is currently fairly Low.

5) Priority sites for Migratory Birds are protected and improved
Not applicable

6) Population-level effects of toxic substances are reduced
Lead poisoning from pellet ingestion for all species of swans is a chronic problem in southwestern British Columbia. Tracking deaths from lead poisoning is ongoing, based on public-reported mortalities, and is not affected by any of these surveys. The use of Christmas Bird Count data for British Columbia would be adequate to assess trends in numbers of birds using areas impacted by lead poisoning.

7) Populations of Migratory Birds under particular threat are conserved
Not applicable.

8) Migratory Birds in land claim areas are conserved
None of the recommended surveys cover all land claim / treaty areas where Tundra Swans occur. Past surveys in the Inuvialuit land claim area provide a good baseline and could be re-instated in the future if a need arises. The risk of not having ongoing swan information for all land claim areas is relatively small and the possible expansion of the USFWS WBPHS could fill some of the gaps.

9) Threats due to Migratory Birds to public and economy are reduced
At current population levels, Tundra Swans do not generally present significant risks to public or the economy.

10) Avian Species at Risk are assessed, identified and listed - Status of all wild species
General status assessment requires periodic information on population status and trend at the provincial/territorial level at low levels of precision and accuracy. The recommended approach would be sufficient for general status assessment in all provinces/territories if an expanded USFWS WBPHS or alternative survey is implemented, with the exception of Manitoba, Ontario and Quebec where small populations do not justify the costs associated with monitoring. Without such a survey, current winter monitoring programs in the U.S. are sufficient to provide an overall continental status assessment which is sufficient as a surrogate, especially as long as the population is increasing.

11) Populations of avian Species at Risk are recovered
Not applicable

Other risks to take into account

Legal risk
None anticipated

Maintenance of External Funding
Current surveys are largely supported by EC. Replacement surveys are dependent on external funding, but even if these external surveys are not developed, the risks of lost information are Low. No adverse impacts on external funding anticipated by dropping any surveys.

Public support for management actions
None anticipated

Partner Expectations:
If it is determined that an expanded USFWS WBPHS is an efficient way to monitor Tundra Swans and other species in the Canadian Arctic, then partners will expect some investment of resources from Environment Canada. This investment is nevertheless expected to be much less than the cost of a survey in the breeding areas that would be delivered by Environment Canada alone.

Summary of implications of recommended changes

Western Population
- British Columbia winter surveys are redundant to surveys in Alaska for assessing population status and trends at the population level.
- British Columbia winter surveys are somewhat redundant to and more costly to run than CBC data from British Columbia for assessing regional trends and distribution; furthermore, aerial surveys are less reliable for differentiating species than the ground-based CBC.
- No increase in risk is anticipated from the termination of the British Columbia winter surveys (WF-74).

Eastern Population:
- The termination of the helicopter-based surveys of geese and swans in the Inuvialuit Settlement Region (WF-39) and possible expansion of the USFWS WBPHS into the area would result in a reduction of sampling intensity and associated costs and a more statistically robust framework. However, this latter survey needs to be further evaluated before a recommendation can be finalized.
- Termination of the aerial survey (WF-49) Mackenzie Delta has no detrimental impact on EC's ability to track the continental trends of the Eastern Population.

TRUMPETER SWAN MONITORING SURVEYS (WF-71, 72 & 74)

SUMMARY RECOMMENDATIONS

Pacific Coast Population

1. Terminate triennial winter surveys (WF-74) effective immediately and instead rely on Christmas Bird Count (CBC) data to monitor changes in Trumpeter swan abundance and distribution in British Columbia during winter.
2. Terminate portions of the 5-year post-breeding survey (WF-72) covering the Canadian Pacific Coast Population areas in British Columbia.

Rocky Mountain Population

3. Modify the 5-year post-breeding surveys (WF-72) within Alberta, North West Territories, northern British Columbia and the Yukon to use a stratified random sampling approach as implemented in 2010, instead of attempting a complete census.
4. Consider conducting an aboriginal subsistence harvest survey in British Columbia only if there is a need with respect to harvest allocation issues, aboriginal management issues or treaty negotiations.

Interior Population

5. Maintain WF-71 the volunteer-based survey of Trumpeter Swans in Ontario at 5-year intervals.
6. Terminate portions of the WF-72 survey in Saskatchewan and Manitoba effective in 2010.

SUMMARY OF RATIONALE

Trumpeter swans were once assessed as species of special concern under COSEWIC. The current monitoring programs were put in place at that time. The species was no longer considered to be at risk by COSEWIC (at the national level) in 1996 but surveys were not scaled down. Instead, the extent of the surveys increased as they attempted to census a growing and more widely distributed population. Breeding and winter surveys were also developed in B.C. and the USA. Given the sustained growth and expansion of Trumpeter Swan populations in both range and numbers, the current precision of monitoring programs is in excess of management and conservation needs. Surveys at different times in the annual life-cycle stages provide largely redundant information on population size and trend. An analysis of EC's needs relative to the monitoring of Trumpeter Swans, determined that post-breeding surveys based on a stratified sampling scheme run at 5-year intervals is the most efficient for providing the information needed for the management and conservation of Trumpeter Swans in Canada. Surveys in north-western BC can be dropped with minimal loss of information, as the majority of the Pacific Coast population breeds in Alaska where it is adequately monitored. Similarly, surveys in Saskatchewan and Manitoba can be dropped as they contribute only a small proportion of overall birds to population estimates. The volunteer survey in Ontario should be maintained as it is relatively low cost and provides information on a population that has been subject to some management measure (re-introduction) that is not otherwise monitored. Any needs for information on wintering swans in BC can be adequately met by the Christmas Bird Count (CBC), as evidenced by good correlations between numbers on the CBC and previous aerial surveys in winter.

The post-breeding survey carried out during the summer of 2010 has not yet been analysed, but is expected to confirm the sustained growth of the population and may result in down-listing Trumpeter swan status in Alberta, where it is currently 'at risk'. Down-listing the species would likely result in significant reduction in monitoring needs at the provincial level.

Cost Summary

The following table outlines current annual costs to EC (both in cash and in personnel), and potential savings related to recommended changes. Note that for WF-72, the original cost is based on a complete census flown in 2005 (not stratified 2010 survey); the next date in the cycle is 2015. In 2005, also, approximately $100,000 of additional in-kind and external financial support was required to complete the survey. Actual cost of proposed survey will depend on partners (e.g. USFWS aircraft availability, provincial involvement)

	WF-74 BC Winter Survey	WF-72 BC, YT, NT, AB, SK, MB	WF-71 Ontario	EC TOTAL	EC savings per year (Operating and Personnel)
EC Operating costs in Survey Year	$10 000	$95 000	$1 500		-
EC Personnel costs in Survey Year	$20 000 (0.2 PY)	$70 000 (0.7 PY)	$10 000 (0.1 PY)		-
Current Total costs in Survey years	$30 000 (every 3 years)	$165 000 (every 5 years)	$11 500 (every 5 years)	$206 500 (if all same yr)	-
Current EC Annual Equivalent	$10 000	$33 000	$1 300	$44 300	-
Proposed Totals in Survey Years (every 5 years)	*$0*	*$60 000 (incl. 0.2 PY)*	*$11 500 (incl. 0.1 PY)*	*$71 500*	$135 000 (but usually surveys not in same year)
Proposed Annual Equivalent	*$0*	*$12 000*	*$1 300*	*$13 300*	$31 000

DETAILED RATIONALE

Management unit

Three populations of Trumpeter Swans have been defined on the basis of their nesting areas, but no subspecies are formally recognized. Given their discrete winter ranges and different associated threats, these 3 populations are managed independently. The *Pacific Coast Population* breeds mainly in Alaska, with a small proportion in northern British Columbia and southern Yukon and winters along the Pacific coast of North America, including southwestern British Columbia. The *Rocky Mountain Population* breeds mainly in British Columbia, Yukon, Alberta and NWT with smaller more isolated population in the United States. Finally the *Interior Population* breeds in Saskatchewan, Manitoba, Ontario and in the United States (see Fig. 1 of Smith, P.A. Trumpeter swan surveys in Canada).

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

1) Landscape conditions accommodate Migratory Bird requirements
Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12): Trumpeter swan is a possible focal species for BCR 4, 6, and12. Monitoring needs for this outcome can be met by a periodic survey of the breeding grounds at a medium level of precision. The recommendation to move from a 5-year census of the population to a 5-year stratified survey design for BCR 4 and 6 would be sufficient to meet the need for this program component; in contrast, the census approach not only exceeded requirements for precision, but also risked some bias due to expansion of the population outside traditionally surveyed areas. This component would also be adequately addressed in BCR 12 by the proposed continuation of the Ontario 5-year volunteer survey.
Western mountains (BCRs 5, 9, 10): Trumpeter swan is a possible focal species for BCR 5. Monitoring needs for this outcome would be met by a periodic survey of the wintering grounds. It is believed that Christmas Bird Count (CBC) data would be sufficient to meet this need and therefore terminating WF-74 (winter BC surveys) would not significantly increase risk in conservation decision-making.
Prairies (BCR 11): Trumpeter swans of the Interior Population breed in small numbers in this BCR. The recommendation to terminate post-breeding surveys in Saskatchewan and Manitoba would limit EC's ability to meet this program component for this species. The risk is considered to be Low, as the numbers are small relative to other populations.

2) Incidental Take is minimized and long-term conservation is supported
Swan collisions with electric wires as well as ongoing mortality from ingestion of spent lead shot are both potential concerns in southwestern British Columbia. None of these surveys provides information on levels of mortality from these causes, though an index of mortality is available from carcasses reported by the public. The proposed changes to the surveys would still provide sufficient information on overall population size and population trends to estimate impacts of this mortality, and to detect if they started to cause declines in the populations.

3) Threats to migrants in other countries are reduced
Threats in the USA are similar to those in Canada (other than harvest which is addressed below), and similar answers apply.

4) Migratory Bird harvests are maintained at sustainable levels
Trumpeter swans are a *lightly harvested species* in the United States (Rocky Mountain Population) and a s*pecies harvested for Aboriginal subsistence use* on their breeding grounds. Maintenance of the 5-year survey on the breeding grounds at the proposed level would be adequate to monitor regional, Flyway, and continental population trends to detect if there is any indication the harvest is unsustainable. Aboriginal harvest levels are currently unknown and the lack of an appropriate subsistence harvest survey is a gap, although the risk of not filling this gap is probably low, as long as the population is increasing.

5) Priority sites for Migratory Birds are protected and improved
Not applicable.

6) Population-level effects of toxic substances are reduced
Lead poisoning from pellet ingestion is a recurrent problem in southwestern British Columbia. Tracking deaths from lead poisoning is ongoing based on other surveys (carcass reporting). The recommended population survey and use of Christmas Bird Count data for British Columbia would be adequate to assess trends in populations in areas impacted by lead poisoning.

7) Populations of Migratory Birds under particular threat are conserved
Not applicable.

8) Migratory Birds in land claim areas are conserved
The recommended post-breeding survey approach would insure that population survey data is collected in the several land claim / treaty areas in which Trumpeter swans are found and used for subsistence purposes. Currently, a need for highly precise data on population numbers within each land claim area has not been identified.

9) Threats due to Migratory Birds to public and economy are reduced
At current population levels, Trumpeter Swans do not generally present significant risks to public or the economy, but the current surveys would be adequate to detect major changes in numbers that could lead to risks.

10) Avian Species at Risk are assessed, identified and listed - Status of all wild species
General status assessment requires periodic information on population status and trend at the provincial/territorial level at low levels of precision and accuracy and more precise levels at a national level. As long as populations do not start to decline dramatically, the recommended approach would be sufficient for status assessment in all provinces/territories, with the exception of Saskatchewan and Manitoba, where small populations do not justify the costs associated with monitoring.

11) Populations of avian Species at Risk are recovered
Not applicable

Other Risks to Take Into Account

Legal risk
No concerns anticipated; the proposed changes will still provide adequate information for management purposes.

Maintenance of external funding
The 5-year breeding surveys depend on funding from a variety of sources including the U.S. and some provinces. Partners need to be convinced that the revised surveys will meet their needs in order to continue to provide their share of funding. Given that the survey will still provide reliable information on population status, this is not anticipated to be a problem.

Public support for management actions
No concerns anticipated.

Partner Expectations
Alberta has relied on these surveys to evaluate the status of the Trumpeter Swan to determine whether it should still be designated as “At Risk”. The proposed changes to the surveys should continue to provide sufficient information for that evaluation. In addition, they have relied on the survey to identify individual wetlands used by the species, which can therefore be protected from development under provincial legislation. The revised surveys will reduce the value for this purpose, because they will only identify a sample of wetlands. However, with an

increasing population, the status of the species is likely to change in the near future, which will potentially reduce the argument for protecting all wetlands used by the species.

Summary of Implications of Recommended Changes

Pacific Coast Population:

- British Columbia winter surveys are redundant to post-breeding surveys in Alaska for assessing status and trends at the population level
- British Columbia winter surveys are somewhat redundant to and more costly to run than Christmas Bird Count data from British Columbia for assessing regional trends and distribution.
- No increase in risk is anticipated from the termination of the British Columbia winter surveys (WF-74).

Rocky Mountain Population:

- Maintenance of the current 5-year post-breeding survey in 2010 helped appease partner concerns over a quick transition, as well as contributing sufficient data to assist with reassessment of the status of Trumpeter Swans in Alberta (potential down-listing).
- The re-design of the survey using a stratified sampling design will result in a reduction of sampling intensity and associated costs while also yielding a statistically more robust framework.

Interior Population:

- Aerial surveys in Saskatchewan and Manitoba detect only about 2% of the estimated Interior Population (113 birds were counted in this region in 2005).
- This survey provides a minimal contribution to the estimate for this population, so termination of the aerial survey in this region would have no detrimental impact on EC's ability to track the continental trends of the Interior population.
- The volunteer-based survey of breeding Trumpeter Swans in Ontario at 5-year intervals has minimal cost to EC, and is sufficient to monitor that segment of the population.
- This will result in no breeding ground information for Saskatchewan and Manitoba, but this is believed to pose Minimal risk.

EIDER DUCK MONITORING (WF-4, 7, 15, 19, 20, 23, 29, 52, 73; SE-30, 31)

SUMMARY RECOMMENDATIONS

1. Solidify EC core funding for Eiders at levels comparable to average investment over recent years to implement as many as possible of the proposed suite of monitoring programs, described below, for each of the 6 populations of Common and King eiders, recognizing that complete implementation will depend on partner funding. From the perspective of harvest management, the highest priorities are American, Northern, and Pacific common eiders, though consideration of King Eiders by COSEWIC may change their priority.
2. Seek collaborative partnerships for implementation and funding from both traditional and non-traditional sources with an interest in eiders, to help implement the proposed suite of monitoring programs.

SUMMARY OF RATIONALE

In August 2010, an EC Working Group produced a report that evaluated current and proposed monitoring strategies for common (*Somateria mollissima*) and king (*Somateria spectabilis*) eiders. The report provided an overarching recommendation that all 6 groups of eiders (i.e., 2 king eider populations; 4 common eider subspecies) should be managed and monitored independently (i.e., "in a distinct manner"). This report was updated in spring 2011 and a prioritization was completed among the 6 distinct management units under consideration. This prioritization was meant to ensure that, if insufficient resources were available to implement the monitoring plan in its entirety, key priority components could be supported. The report suggested that, from the perspective of harvest management, the highest priorities are American, Northern, and Pacific common eiders, though consideration of King Eiders by COSEWIC may change their priority.

Serious information deficiencies were identified for each of the six eider subpopulations; foremost among these gaps were uncertainties over population status and trends and, in some cases, unknown impacts of harvest (subsistence, recreational, and Greenland commercial) and disease, especially avian cholera. Improved monitoring of populations, harvest levels and key demographic rates would reduce uncertainty, inform conservation actions and reduce management risks (e.g., harvest allocation). Canada has a core responsibility for eider management, but coordination and cooperation are needed with northern Wildlife Management Boards, Russia, Greenland, France and the U.S.A for implementation of the monitoring plan. This required level of cooperation enhances the need for good monitoring data, but also creates the possibility for joint funding of monitoring programs – currently 70-80% of the operating funds for the eider monitoring in Canada come from sources external to EC.

The AMR Steering Committee has reviewed these recommendations and has selected the highest priority surveys that would provide a significant improvement over the current suite of monitoring programs, described below, but recognizes that current EC resources are not sufficient to implement all of them. As such, the overall recommendations target two areas – solidifying EC core funding for eider programs and shifting the allocations towards the recommended suite of programs; and seeking collaborative partnerships and funding to implement the recommendations. We also acknowledge the need for better understanding of the impact of disease on eider populations but conclude that this would be better addressed through directed research programs, rather than monitoring programs per se, and hence are outside of the scope of these recommendations.

Recommendations for suite of highest priority monitoring programs for eiders

Multi-population recommendations

1. Evaluate, by 2012, the feasibility of modifying the National Harvest Survey (WF-52) to improve the sample for eider hunters, including consideration of a hunter outreach program to increase hunter participation in the survey, and supporting development of techniques to discriminate among the Hudson's Bay/northern/American subspecies complex from the Species Composition Survey.
2. Encourage and support the northern Wildlife Management Boards to carry out decadal aboriginal harvest surveys (including Nunavut and Inuvialuit) to understand the impact of aboriginal harvests on eiders in Canada.

Individual Populations

American common eider (Somateria mollissima dresseri)

1. Complete breeding distribution surveys in 2012, using a survey design that allows for assessment of repeatability and potential bias in spring counts of breeding males. Priority areas to be surveyed are

Nova Scotia and the north shore of the Gulf of St. Lawrence in Quebec. If sufficient funds are secured (particularly from Sea Duck Joint Venture and Provinces) include the south coast of Labrador in the survey.

2. Develop a stratified random sampling approach based on the results of recommendation 1, for implementation in 2013**.** Sampling effort and frequency should be based on an evaluation of existing data. This survey would replace the Atlantic Spring Eider Survey (WF-15). Partnerships with Provincial governments should be sought.
3. Continue existing sentinel monitoring programs (WB-30 Quebec seabird colonies and St. Lawrence estuary colony counts conducted by a NGO)
4. Develop a regionally-coordinated banding strategy that will produce data on demographic parameters (particularly survival and harvest rates) of sufficient quality to develop demographic models for this population for implementation in 2013. Seek partnerships with provincial governments, NGOs (DUC, Duvetnord), universities (UQAM), Sea Duck Joint Venture and USFWS for implementation.

Northern common eider (Somateria mollissima borealis)

1. Develop a stratified random sampling approach for breeding aerial survey by summer 2012. The sampling plan will be developed based on the results of previous distributional surveys conducted in the area. Sampling effort and frequency should be based on an evaluation of existing data.
2. Implement a spring aerial survey in the Canadian portion of the northern eider range in 2013**.** The survey could use a rotational design (e.g. 3-year cycle to complete survey). Partnerships with Canadian aboriginal and Greenland governments should be sought.
3. If resources are insufficient to deliver recommendation #2; then implement a community-based monitoring program at selected colonies in 2013. Partnerships with Canadian aboriginal governments and communities should be sought.
4. Continue triennial Atlantic Winter Eider Aerial Survey in Atlantic Canada (WF-73). Next survey is planned for winter 2011-12. Seek partnership with France (St-Pierre et Miquelon) government.
5. Evaluate, the need for long-term demographic monitoring (banding and productivity) data for this population by 2012, and determine how long to continue the existing program at East Bay, NU (WF-7), and whether to establish a second demographic monitoring site in western Ungava Bay.

Pacific common eider (Somateria mollissima v-nigra)

1. Implement aerial surveys (3 consecutive years on a 6-year basis) of males early during nest initiation over a portion of the breeding range (Bathurst Inlet-Queen Maud Gulf region) staring in 2012; expand the past survey program (Bathurst Inlet Eider Breeding Pair Survey WF-19) to ensure complete coverage of the population. Partnerships with Canadian aboriginal governments and communities, USFWS (Alaska) and Russia should be sought.
2. Evaluate whether the Alaska Point Barrow Eider Spring Migration Count (WF-4; delivered once every 6 years) provides sufficiently reliable data to support management measures, especially if resources are insufficient to implement breeding surveys. Partners would be North Slope Borough and USFWS.

Hudson Bay common eider (Somateria mollissima sedentaria)

1. Continue Belcher Islands Aerial Seaduck Winter Survey (WF-20) every five years. The next survey should be conducted in 2013.
2. Encourage northern communities / wildlife management boards to implement an annual summer community-based monitoring at selected colonies in 2012.

Western population king eider (Somateria mollissima spectabilis)

1. Support the USFWS's Central and Western Arctic Waterfowl Survey (WF-29). The survey is not yet operational but could be implemented in **2012**. Levels of monetary and/or staff support provided would have to be negotiated with USFWS. This survey would cover several other species (waterfowl and waterbirds).

Eastern population king eider (Somateria mollissima spectabilis)

1. Evaluate and compare potential for the USFWS's Central and Western Arctic Waterfowl Survey (WF-29) and an alternative 5-year aerial survey of wintering king eiders (Greenland, Hudson's Strait and southern Davis Strait in Canada) for monitoring this population. Complete evaluation by spring 2012.
2. Develop and implement an efficient monitoring program based on the results of recommendation #1 by 2013.

DETAILED RATIONALE

As noted above, distinct monitoring recommendations were presented for the four sub-species of common eiders and two populations of king eiders. This decision was based on the fact that these units are for the most part distinct on the breeding grounds and to some extent on the wintering grounds and that they are subject to different harvest pressures; as a result the monitoring needs differ among them. By splitting recommendations into these units, it is possible to direct the appropriate amount of effort required based on an analysis of needs, resulting in a more efficient use of monitoring resources.

Common and king eiders are among the most important migratory birds to northern Canadian aboriginal communities. The northern and American sub-species of the common eider are also heavily harvested by recreational hunters in Canada and the USA (American) as well as commercially in Greenland (northern). Current harvest levels appear to be near maximum levels for long-term sustainability and lead to allocation issues between the countries involved. Pacific and Hudson Bay common eiders as well as king eiders are mostly harvested for aboriginal subsistence uses in Canada, USA, Russia while Greenland extracts a commercial and a subsistence harvest on king eiders.

The cost estimates associated with the current recommendations are high and represent the cost of monitoring species in remote northern regions of Canada. It is clear that partnerships will need to be developed to implement parts or all of the above recommendations. Non-traditional partners (e.g. Greenland and Russian governments, Northern governments/management boards/communities) will need to be approached along with our more traditional partners. The group of experts that was tasked to develop a monitoring plan was also asked to rank species and sub-species in order of priority to determine which programs should be funded if available resources were insufficient. They concluded that monitoring for northern, American and Pacific common eiders was of equally very high priority, while Hudson Bay common eider and king eider monitoring was high priority. Monitoring needs for northern and American common eiders are among the highest among waterfowl.

Cost Summary

The following table outlines the annual minimum costs to EC (cash and personnel) of both current surveys and the proposed suite of “preferred” surveys.

	Recent investment in common and king eider surveys [a]	Proposed investment in eider surveys
EC Operating costs/y [a]	$110 867	$111 000
EC Personnel costs/y	10 PY [b]	3.5 [c]
EC Annual costs	***$910 870***	***$391 000***
Non-EC funds/y [a]	$416 250	$413 000 [d]
Non-EC personnel costs/y (including volunteers)	81.7 PY [b]	5.0 [d]
Non-EC Annual costs		

[a] Sum of costs averaged over the number of years between surveys (i.e., 1, 2, 3, 5, 10 [intermittent] years); see EXCEL spreadsheet for additional details.
[b] Includes investments from 2 major research programs where effort is dedicated to other scientific activities in addition to monitoring
[c] Only includes investments in monitoring
[d] Investment required to fulfill recommendations. Negotiations still required with partners to determine future investment

Prioritization of Eider Monitoring Programs

We rank Northern, American and Pacific Common Eiders as the highest priorities for monitoring. All three subspecies have harvest allocation issues. Northern eiders are heavily harvested for recreational purposes in Newfoundland, and recreational and commercial and subsistence harvests in Greenland. This population also supports locally important subsistence harvests of birds eggs and eiderdown in Inuit communities in Nunavik (Western Ungava Bay and Hudson’s Strait) and Nunavut (Hudson’s Strait and Frobisher Bay). The American eider supports heavy recreational harvests in eastern Canada and the eastern U.S.A., and a large commercial harvest of eiderdown in the St. Lawrence Estuary. The Pacific eider is harvested for subsistence purposes in Canada, Alaska and Russia, but is poorly understood. Climate change is also predicted to have the most profound effects on Northern and Pacific eiders, and projected increases in shipping activity increase the potential for disturbances and oiling to affect these populations.

We rank the Hudson's Bay Common Eider as the second highest monitoring priority. There are no concerns about harvest allocation for this population, however, subsistence harvests of birds, eggs and eiderdown are important to many Inuit communities in Nunavut and Nunivak, and Cree communities in eastern James and Hudson's Bays. Although there has been past attempts to commercially harvest eiderdown from this population, we are not aware of current operations. This population may be vulnerable to changes in sea ice dynamics that may result from climate change and changes in hydrology resulting from the large hydro-electric developments in north eastern Quebec. We also speculate that avian cholera may become an issue for this population as cholera now occurs in adjacent breeding areas for Northern Eiders.

We ranked the monitoring needs for Eastern and Western populations of King Eider lowest priority of the group, although this priority should be revisited if COSEWIC lists the species. The low ranking in part reflects the significant challenges that must be met to deliver a monitoring program that could detect trends in these populations. Both populations winter outside Canada, and there are limited opportunities to develop winter monitoring programs. There are options for monitoring these populations across their breeding areas; however, the vast remote nature of their breeding ranges, and their breeding low densities, make such surveys logistically and financially challenging.

Implications of Survey Modifications to Ability of Survey to Address EC Monitoring Needs

Refer to Table A-4 for an overall summary of these requirements.

1) Landscape conditions accommodate Migratory Bird requirements (BCRs)
Arctic – (BCR 3); Great Lakes – St. Lawrence (BCR 13); Maritimes (BCR 14); Pacific Coast (BCR 4, 5)

2) Incidental take is minimized and long-term conservation is supported
For most groups considered herein, incidental take by industrial sectors involves mainly fisheries by-catch, shipping, and aquaculture, and wind power and tall structures. Northern eiders are known to be killed when they strike ships at sea (particularly at night in winter when they are attracted to the lights), and perhaps tall structures along coasts as well. In addition, eiders are drowned in the nets of fisheries particularly related to the lump-sucker fishery in Greenland and Newfoundland, which sets nets along coastlines where eiders forage in shallow water. Monitoring surveys of ship crews and placing observers on ships could help assess these population losses. Hydro-electric power generation in Quebec has the growing potential to alter sea ice conditions in winter, and these possible effects on wintering eider populations should be monitored.

3) Threats to migrants in other countries are reduced
Aspects of over-harvest of northern common eiders in Greenland are discussed below.

4) Migratory Bird harvests are maintained at sustainable levels
This is an overriding information need for eiders. We believe that developing a strategy that addresses monitoring requirements for harvest management would fill the needs for most other need categories, with the possible exception of Incidental Take and effects of toxics. Below is a description of needs by management units.

American common eider (Somateria mollissima dresseri)

The current American eider population estimate is around 300 000 birds and is among the most commonly harvested waterfowl in several coastal regions of eastern Canada and U.S.A. The sustainable harvest rate was estimated around 10% and current harvest estimate is about 32 000 birds which exceeds the estimate of sustainable harvest for this subspecies. Considerable uncertainty surrounds these estimates. Recent trends suggest that U.S.A. has typically taken about 70% of the American eider harvest. This situation leads us to categorize American common eiders as a subspecies that is heavily-hunted, with concerns about harvest allocation with U.S.A. In addition to the recreational harvest, American Common Eiders are harvested for Aboriginal subsistence use, and are locally important for some Aboriginal communities in Québec and Atlantic Canada.

The above harvest program components require estimates of population abundance, survival, productivity, habitat index, and/or harvest rate. The recommended frequency of monitoring is annual with very high level of accuracy and precision. In addition, estimates of Aboriginal subsistence use are required periodically at medium accuracy and precision levels.

Recent American eider survey programs have generally lacked coordination and common goals, leading to high levels of uncertainty in population and demographic estimates. Past surveys provided information for segments of the population: Québec (Gulf of St. Lawrence and St. Lawrence Estuary) and Newfoundland

surveys were at the colony level while the south-western New Brunswick survey provided information at the provincial level. These surveys did not provide the information required to estimate population abundance and trend required to support harvest management for a heavily-hunted population. Furthermore, the Newfoundland survey was discontinued in 2001. The Québec-Newfoundland Triennial Winter Survey, the Maritimes survey and the New England States survey cover only portions of the American eider's wintering range and are not integrated in a way that would provide an overall evaluation of population trend and abundance.

Demography monitoring has also lacked coordination and common objectives. Productivity studies have been conducted at two local sites that are unlikely to provide population-level estimates of key demographic parameters. Regular banding has been conducted in Nova Scotia (NS-DNR), on the Labrador coast (Ducks Unlimited Canada) and in the St. Lawrence Estuary (UQAM). All three are active research programs with different goals and aiming different segments of the population (e.g. females and young in the Estuary, moulting males in NS) and there has not been a comprehensive analysis of these data. There are no estimates of the subsistence harvest of eiders in Québec or Atlantic Canada. Problems identified with the NHS for estimating eider harvest are: 1) a component of the harvest occurs after the NHS is completed, 2) eider hunters are highly clustered and are not well represented in the large geographic strata that are currently used in the NHS, and 3) the wing keys are not fully developed for the sea ducks, and further work is required on the key to provide better estimates of the age and sex composition of the harvest.

Northern common eider (Somateria mollissima borealis)

This subspecies is intensively harvested commercially in west Greenland and is subjected to both subsistence and recreational harvest in Canada. Demographic modelling recently suggested that harvest levels were unsustainable. The bulk of the harvest occurs in Greenland and insular Newfoundland, but harvest levels in Greenland were determined to be excessive, leading to a harvest allocation issue with Canada. More restrictive harvest regulations were put in place in Newfoundland in 1997 and Greenland in 2002-04 resulting in a decrease in overall harvest, but harvest levels remain high. Pressures to liberalize harvest in Greenland and Newfoundland continue, and population impacts of recent avian cholera outbreaks in the Canadian arctic continue to be a major population threat. The northern common eider subspecies should be categorized as a sub-species that is heavily-hunted, with concerns about harvest allocation with Greenland. In addition, this subspecies is harvested for Aboriginal subsistence use. The heaviest subsistence harvest in Canada occurs along the west coast of Ungava Bay and southern coast of Hudson's Strait where birds, eggs and eiderdown are harvested. No recent estimates of subsistence harvest are available.

The above harvest program components require estimates of population abundance, survival, productivity, habitat index, and/or harvest rate. The recommended frequency of monitoring is annual with very high level of accuracy and precision. In addition, estimates of Aboriginal subsistence use are required periodically at medium accuracy and precision levels.

On the breeding grounds, a few disparate colony surveys have been conducted historically. They provide local (colony-level) population indices and trends but don't provide population-level estimates of trends and abundance. Winter surveys were conducted in Canada in the 1980's and since 2003, the Quebec and Atlantic Regions have jointly delivered a triennially survey of the Canadian wintering range in Quebec and Newfoundland. This is the only population-level survey available, although it covers only a small fraction of the population (most winter in Greenland). Some colony-level information is available from Greenland.

There is currently a demographic study of the Northern eider at East Bay, NT. The ongoing program monitors several demographic parameters including population size at the nesting colony, survival rates of females, nest success, harvest rate, and mortality rates from emerging diseases such as avian cholera. It is the only program to generate the information that is required to assess the sustainability of harvest levels in Canada and Greenland.

The Canadian recreational harvest is monitored annually through the National Harvest Survey, although it is recognized that the National Harvest Survey is poorly designed to quantify harvest of sea ducks (see American eider above). Recent estimates of subsistence harvest in Nunavut are available and the harvest information from Greenland is considered to be robust.

Pacific common eider (Somateria mollissima v-nigra)

Pacific common eiders are subject to recreational harvest as well as Aboriginal subsistence harvest in Canada, U.S.A and Russia. There is some concern that local harvest at communities such as Holman,

Canada and Wainwright, Alaska are high and may impact populations. However, harvest data for Canada and Alaska lack the accuracy and precision needed to assess the impact of the harvest on this subspecies. Subsistence harvest information for Alaska and Canada from mid 1970's to mid 1990's suggest <5% of the population was taken annually. However, this study is based on data more than a decade old. We categorize the Pacific Common Eider as harvested but with little information on impact, as well as a subspecies that is harvested for Aboriginal subsistence use.

The above harvest program components require estimates of population abundance or trend and harvest level at periodic intervals and with a medium level of accuracy and precision. In addition, estimates of Aboriginal subsistence use are required periodically at medium accuracy and precision levels.

Current population-level estimates of abundance and trends are based on the Alaska Point Barrow migration count. This survey is known to suffer from important sources of bias, although it is not known whether trend estimates are biased. Breeding ground surveys have been conducted in Canada recently but only covered a small proportion of the range and were generally costly. A demographic study, part of a larger research program, occurs at one colony. Information from Alaska is also available. There have been subsistence harvest surveys conducted in the past (1980's and 1990,s) and more recently (2002-2008).

Hudson Bay common eider (Somateria mollissima sedentaria)

Hudson Bay eiders are culturally important to the Inuit of the Belcher Islands where they provide important sources of food throughout the year, and eider skins were once the primary material used in the construction of winter clothing. More recently, eiders have supported the local economy as eiderdown has replaced eider skins as the insulation of choice for Inuit hunting parkas, and has been sold into Canadian and European markets (McDonald and Fleming 1990). They can be categorized as a subspecies that is harvested for Aboriginal subsistence use and is not subject to recreational harvest. The impact of this subsistence harvest is not known so it can also be categorized as harvested but with little information on impact.

The above harvest program components require estimates of population abundance or trend and harvest level at periodic intervals and with a medium level of accuracy and precision. In addition, estimates of Aboriginal subsistence use are required periodically at medium accuracy and precision levels.

Colony-based surveys provide a good foundation for monitoring, but they have been conducted too infrequently to follow population trends at time scales of relevance to harvest levels. Surveys also have only covered a small geographic portion of the range of the eiders within Hudson Bay. Aerial surveys of the Belcher Islands have been conducted recently. These winter surveys provide detailed information on wintering distributions and habitat use, and also show promise to monitor population trend at course levels. Aboriginal subsistence harvest survey information is crude and dated.

Western king eider (Somateria spectabilis)

Western king eiders are harvested for subsistence use around a few Canadian communities as well as in Russia and Alaska. They can be categorized as a subspecies that is harvested for Aboriginal subsistence use. The impact of this subsistence harvest is not known so it can also be categorized as harvested but with little information on impact.

The above harvest program components require estimates of population abundance or trend and harvest level at periodic intervals and with a medium level of accuracy and precision. In addition, estimates of Aboriginal subsistence use are required periodically at medium accuracy and precision levels.

They have historically been monitored by the Point Barrow Alaska migration count, which is known to suffer from important sources of bias. It is not known to what extent trend estimates are also biased. More recently, an expanded WBPHS survey has provided information from the western king eider range. A continuation of this survey is what is being recommended. Western king eiders winter off Russia and there are no plans for surveys in this area. There is recent information available on subsistence harvest.

Eastern king eider (Somateria spectabilis)

The Eastern King Eider is harvested for recreational and Aboriginal subsistence use in Canada and is also harvested commercially and for subsistence use in Greenland. It should be categorized as a subspecies that is harvested but with little information on impact and harvested for Aboriginal subsistence use.

The above harvest program components require estimates of population abundance or trend and harvest level at periodic intervals and with a medium level of accuracy and precision. In addition, estimates of Aboriginal subsistence use are required periodically at medium accuracy and precision levels.

There is no population abundance or trend information available for eastern king eiders. There are estimates of commercial and subsistence harvest from Greenland. There are no subsistence or recreational harvest estimates available for Canada.

5) Priority sites for Migratory Birds are protected and improved
Enhanced monitoring of the distributions and abundances of breeding, moulting and wintering eiders would provide reliable information needed to identify and justify protection for priority sites.

6) Population-level effects of toxic substances (diseases) are reduced
Levels and distribution of toxins (especially oiling) are uncertain for most groups. Northern common eiders may also be vulnerable to mercury in the environment although the population-level effects of toxic substances such as this are not quantified. Eider contaminant levels are occasionally monitored as part of an ongoing contaminants monitoring program lead by Environment Canada. A separate issue considers that eiders are occasionally killed by oil discharge at sea, and this has been documented along coasts in Newfoundland and Quebec. The occurrence and numbers of eiders killed due to oil should be monitored when these incidents occur. Increased shipping traffic resulting from the enhanced port in Churchill and extended shipping season may increase risk of oil events. A potentially serious and immediate threat for the Pacific Common Eider is the industrial development that is occurring on both the breeding range and migration corridor. Two key spring staging areas, east Chukchi Sea and southeast Beaufort Sea, are areas of prime interest to oil companies for offshore oil and gas extraction. With the opening of the Northwest Passage in Eastern Canada, shipping will increase and the risk for oiling events too. Disturbance of moulting and wintering eiders in the Hudson Strait is also expected with this increased traffic. Highly localized concentrations of moulting and wintering King Eiders are particularly vulnerable to oiling in Greenland, where transport vessels and offshore exploration are increasing.

Avian cholera has recently emerged as an important factor affecting the survival and reproduction of Northern common eiders since its first appearance in the eastern Canadian Arctic in 2005. It remains unknown what proportion of the population is killed annually and to what extent that disease has spread geographically into other areas within Nunavut, Nunavik and west Greenland. This disease is often fatal and has recently emerged among Northern common eiders since 2005 as a threat to populations.

Hydro-electric power generation in Quebec has the growing potential to alter sea ice conditions in winter, and these possible effects on wintering Hudson Bay common eider populations should be monitored.

7) Populations of Migratory Birds under particular threat are conserved
No specific issues and actions are identified at this time.

8) Migratory Birds in land claim areas are conserved
Waterfowl are an important wildlife resource in many areas (i.e., food, eider down). Subsistence harvests of Pacific common eiders and king eiders occur in Canada, Russia and Alaska.

9) Threats due to Migratory Birds to public and economy are reduced
No specific threats have been identified.

10) Avian Species at Risk are assessed, identified and listed
King eider is a low priority species for status assessment according to COSEWIC (http://www.cosewic.gc.ca/eng/sct3/index_e.cfm#2).

11) Populations of Avian Species at Risk are recovered
See above.

Other risks to take into account

Legal risk
Poor quality of harvest data generates the risk that potentially unsustainable harvest rates are not detected. This information deficiency could create difficulties if there is a challenge to harvest regulations for these species.

Maintenance of external funding
Directed studies of eiders are undertaken as part of the Sea Duck JV activities.

Public support for management actions
No issues were identified.

Partner Expectations
Continued cooperation is anticipated by USFWS, Denmark (Greenland) and Sea Duck Joint Venture and associated partners.

Table A-4. Monitoring needs as determined according to EC RMAF Logic Model intermediate outcomes and associated program components.

	Common Eider				King Eider	
	Pacific	**Hudson Bay**	**Northern**	**American**	**Western**	**Eastern**
Landscape conditions accommodate Migratory Bird requirements						
For priority or focal species (identified in EC conservation plans,…)	√	√	√	√	√	√
Marine coasts (marine BCRs) --- Wintering	√	√	√	√	√	√
Arctic (BCR 3)	√	√	√		√	√
Boreal/Northern Forest (BCR 4, 6, 7, 8, 12)				√		
Great Lakes-St. Lawrence and Maritimes (BCR 13, 14)				√		
Incidental Take is minimized and long-term conservation is supported						
Fisheries	√		√	√	√	√
Wind Power, Towers, Tall Buildings, Vessel Strikes	√		√	√	√	√
Threats to migrants in other countries are reduced						
General, across all species with international migratory bird links to Canada	√		√	√	√	√
For identified priority or focal species (in international conservation plans, EC international strategy, or equivalent)	√		√	√	√	√
Migratory Bird harvests are maintained at sustainable levels						
Heavily-hunted species, and those with concerns about harvest allocation			√	√		
Species with substantial harvest but no allocation concerns						
Species that are harvested but with little information on impact	√	√			√	√
Species harvested for Aboriginal subsistence use	√	√	√	√	√	√
Priority sites for Migratory Birds are protected and improved						
Sites including EC-established National Wildlife Areas (land-based and marine) and Migratory Bird Sanctuaries; and other priority habitats for birds (e.g., IBAs) and protected areas (parks, etc.)	√	√	√	√	√	√
Population-level effects of toxic substances are reduced						
Impacts such as Chronic oiling, Pesticides, Lead shot, other toxic substances	√	√	√	√	√	√
Populations of Migratory Birds under particular threat are conserved						
Actions such as Predator control, Emergency response, other short-term interventions			√	√		
Migratory Birds in land claim areas are conserved						
Land claim agreements	√	√	√	√	√	√
Avian Species at Risk are assessed, identified and listed						
Status of all wild species	√	√	√	√	√	√
COSEWIC status reports - assessments and re-assessments					√	√

CONTINENTAL CANVASBACK SURVEY (WF-31)

SUMMARY RECOMMENDATIONS

- Terminate WF-31 Continental Canvasback Survey

SUMMARY OF RATIONALE

The Continental Canvasback Survey was established in 1974 in response to concerns about declining numbers of Canvasbacks. It has provided an annual snapshot of numbers of Canvasbacks at major concentration areas in 6 areas in Ontario (especially Lake St. Claire, Rondeau Point and Long Point) during fall migration. Complementary surveys in the U.S. covered an additional 65 staging areas, but several have since been discontinued or integrated with other surveys. Although the survey has provided useful information on the locations and relative importance of staging areas, the information is not used in setting harvest regulations nor is it required for population monitoring on a national or continental scale. The multi-species Waterfowl Breeding Population and Habitat Survey (WF-24) provides that information in a more reliable form. Data from the survey may be useful for environmental assessments (e.g., for assessing potential wind power development in and around Lake St. Claire and Lake Erie), but this use does not require annual surveys nor long-term trend information. Furthermore, the same information needs for EA are being met adequately by the multi-species decadal waterfowl surveys undertaken on the lower Great Lakes by Ontario Region (WF-47 Lower Great Lakes Migrant Survey).
Given that the survey is now largely redundant to other surveys, and new information from the survey is not currently required for management, we recommend terminating it.

Cost Summary

The following table outlines the annual costs to EC (cash and personnel) and potential savings related to AMR steering committee recommendations.

	EC Annual TOTAL - CURRENT (Operating and Personnel)	EC Annual TOTAL – RECOMMENDED (FY 2011 and beyond) (Operating and Personnel)	EC Annual SAVINGS (Operating and Personnel)
O&M	4 500$	0$	4 500$
Staff Time	10 800$ (0.12 PY)	0$	10 800$ (0.12 PY)
Total	15 300$	0$	15 300$

DETAILED RATIONALE

Management unit

Canvasbacks are generally managed as a single continental population. The Canadian portion of the Continental Canvasback Survey was targeted towards a segment of that population that passes through the Canadian portion of the Great Lakes during fall migration, although surveys elsewhere in the U.S. covered many other staging areas.

Survey Management

Ongoing management of this survey had been undertaken by the Ontario region program. The survey biologist running the program had been considering discontinuing the survey in a few areas in the eastern study area (e.g., around Wolfe Island) due to low numbers of birds.

Implications of survey modifications to ability of suite of surveys to address EC monitoring needs

1) Landscape conditions accommodate Migratory Bird requirements
Bird Conservation Region (BCR) 13. Great Lakes – St. Lawrence. Important staging areas for Canvasback are located in this area and the species is a potential focal species in the BCR. However, historical information is more than sufficient for current planning purposes, and further information, incorporating many other species, is available from the decadal multi-species migrant survey. Terminating this survey would not preclude the assessment of future trends, as the survey could always be repeated in the future if a new need arose for the information.

2) Incidental Take is minimized and long-term conservation is supported
Wind Power is the main possible source of incidental take in this region. Existing data from this survey and the decadal survey on distribution and population size are sufficient to provide the general information required to assess the potential impacts of future projects, and to provide context for individual environmental assessments. Separate surveys specific to a site or a project would be required to quantify the magnitude of incident take or impact of any given project, and would more likely be designed to incorporate many species..

3) Threats to migrants in other countries are reduced
Canvasback is a focal species under the North American Waterfowl Plan (NAWMP). However, this staging survey did not contribute significantly to this Plan, and is not required for future planning.

4) Migratory Bird harvests are maintained at sustainable levels
This survey is not used in determining the status of the species nor is it formally used for setting annual harvest regulations in Canada and the U.S.

5) Priority sites for Migratory Birds are protected and improved
The survey covered known priority sites (e.g., Long Point). It was not designed to identify new priority sites and its frequency (annual) was more than is needed for this outcome. Other existing surveys such as the Lower Great Lakes Waterfowl survey (WF-47) provide more than sufficient information to maintain this outcome.

6) Population-level effects of toxic substances are reduced
Not applicable. Other surveys provide sufficient information on waterfowl in the area.

7) Populations of Migratory Birds under particular threat are conserved
Not applicable.

8) Migratory Birds in land claim areas are conserved
Not applicable.

9) Threats due to Migratory Birds to public and economy are reduced
Not applicable.

10) Avian Species at Risk are assessed, identified and listed - Status of all wild species
This survey, even when combined with complementary surveys from the U.S., does not have a sufficiently rigorous statistical design to provide reliable population status information, and in any case, it would be redundant to the Waterfowl Breeding Population and Habitat Survey (WF-24) which provides the necessary data for this program component.

11) Populations of avian Species at Risk are recovered
Not applicable

Other risks to take into account

Legal risk
None anticipated.

Maintenance of External Funding
Not applicable; many complementary surveys in the U.S. have already been discontinued and the survey data are not used internationally.

Public support for management actions
None anticipated.

Partner Expectations
None anticipated.

APPENDIX B – Detailed Gaps and Risks Rationale.

For each of the gap and risk scores summarized in Tables 7.3 and 7.4, the following table outlines the rationale behind the scores, briefly outlines mitigation options, and lists the specific risk categories identified (e.g. biological (B), legal (L), economic (E), credibility (C); see Table 7.1). Note that gaps and risks were scored from 0 (very few/low) to 3 (high), and were current as of April 2011. See Chapter Seven for full details of the gaps and risks assessment process.

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Arctic (BCR 3)	Landbirds - Arctic	2	Monitoring largely based on checklists with limited geographic scope, and also Christmas Bird Count in winter.	1	Most species are widespread, indirect data (e.g., Christmas Bird Counts) do not currently suggest declines; development threats in arctic relatively limited, unlikely to have major impacts on landbirds; planning more likely to be based on other bird groups	Completion of Arctic PRISM and associated landbird monitoring will reduce the gap.		
1. Landscape Management - Arctic (BCR 3)	Seabirds - Pelagic	2	Some distribution information for most species, but much is old, and little or no trend information	1	Currently limited planning in offshore region, and bird data likely to have a limited impact on decision making; information from older surveys provide some basic information on distribution and potential risk areas.			
1. Landscape Management - Arctic (BCR 3)	Seabirds - colonial	1	Good information on the distribution and trends in colonies	1	Current information is probably sufficient, but any reduction could lead to substantially increased risk			
1. Landscape Management - Arctic (BCR 3)	Seabirds - Other (e.g., jaegers)	2	No information on trends, only limited information on distribution from checklists, etc.	1	Only limited number of species, which are generally widespread and sparsely distributed; thought to be unlikely to be impacted by development activities or threatened by habitat loss in region.	Promoting use of checklists by arctic researchers and developers will reduce gap.		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Arctic (BCR 3)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Limited information on abundance or distribution in most parts of arctic, quantitative data from some regions, and some information on trends of some species from non-breeding surveys	1	Risk considered low overall because many species also found in boreal, and not thought to be currently declining. However, information on these species could be relevant for assessing changes in inland waterbodies (e.g., due to climate change), especially in aquatic food, and there is some risk that development activities could have adverse impacts. If any indirect evidence (e.g., winter surveys) suggests decline, risk would increase substantially.	Promoting use of checklists by arctic researchers and developers will reduce gap. For large waterbirds, promote use of existing surveys for waterfowl species. May be able to improve surveys outside breeding grounds for some species.		
1. Landscape Management - Arctic (BCR 3)	Shorebirds - Arctic	3	Limited information on which are key habitats in many areas to help with planning and prioritization of effort. Lack data on basic distribution and abundance for most of arctic. Current trend information for many species considered unreliable (migration monitoring) so uncertain about priorities.	2	Because main information need is for management within the arctic, overall risk is moderate rather than high. We lack data for strategic planning, and unaware which areas may be most important; nevertheless, precautionary approach will likely require extensive survey work for any major project involving wetland areas, even without background data. Risk would increase if development pressure increased.	Completing first round of Arctic PRISM surveys would provide basic distribution and habitat modelling data which would further reduce risk. For some species, monitoring elsewhere than on the breeding grounds may be more effective for monitoring trends but still need distribution information in arctic.	B-d 2,B-c 2,E-b 1,E-c 2,C-d 2,	B-d 2-may fail to identify key areas for appropriate management or protection, leading to loss of key breeding areas, B-c 2-may fail to identify key areas for appropriate management or protection, leading to loss of key breeding areas, E-b 1-some risk of placing an inappropriate burden on developers, but this risk may be low, as detailed surveys in any proposed development would probably be required even if we had very good broad-scale information, E-c 2-risk of focusing conservation dollars and efforts on lower priority areas if not all areas properly identified, C-d 2-risk that EC efforts to manage development on the basis of risks to birds may be challenged.
1. Landscape Management - Arctic (BCR 3)	Waterfowl - Seaducks	2	No reliable surveys in most parts of Arctic, but quantitative data from some regions, and also information from surveys for other species and from checklists	1	For most species (mainly non-colonial), threats unlikely to be in nesting areas, threats more likely act at moulting and/or winter congregations outside arctic, so coarse scale nesting distributional information sufficient for planning purposes.			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Arctic (BCR 3)	Waterfowl - geese and swans	1	Distribution of all major colonies well known; reasonably precise trend information on all species and populations.	0	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Landbirds - Boreal	3	Only limited information from southern edge and a few other parts of boreal; over most of boreal, no monitoring of landbirds; many areas lack even basic distribution information	3	Overall risk is high, because of extensive development pressure in many parts of boreal (energy, mining and forestry) and lack of data for overall prioritization and strategic planning. Lack data for contextual analysis of environmental assessment from individual projects, to do any strategic planning, or to evaluate potential cumulative impacts. Also lack data to assess impacts of management activities, to determine when mitigation might be required, and to design appropriate mitigation if required.	A combination of habitat and distributional modelling with extensive distributional surveys in key areas that have not been surveyed (many of which are remote and difficult to access) could reduce risk somewhat even without extensive large-scale monitoring programs.	B-d 3,B-c 3,E-b 2,E-c 2,C-n 2,C-d 2,	B-d 3-Unaware which species are declining until too late, B-c 3-Uncertainty about priority species could lead to inappropriate or inadequate management of development activities; limited ability to influence others because of lack of data. ,E-b 2-risk of inappropriate burden on industry if species listed as at risk when should not have been, based on inadequate data. ,E-c 2-Some risk of inefficient use of conservation dollars, if focus on regions that are not highest priority - somewhat lower risk to EC, because limited spending on conservation actions in region ,C-n 2-NGO objections that Environmental Assessment, etc. not based on sufficient information ,C-d 2-Risk that developers will argue that no need to restrict / limit development, because inadequate data to prove it will adversely impact bird populations.,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Waterbirds - Marsh	3	Know nothing about their distribution or abundance in boreal	2	Although gap is high, risk is considered moderate because only a limited number of species in region, and wetlands tend to receive some level of protection in development; nevertheless, a few species may be largely dependent on region (e.g., Yellow Rail, especially in Hudson Bay lowlands), and some development activities do affect watersheds (e.g., mining). We lack information to prioritize regions, to determine which areas are most important for waterbirds, and to estimate any potential development impacts		B-d 2,E-c 2,	B-d 2-inaccurate prioritization could lead to declines, E-c 2-incorrect priorities could lead to inefficient conservation efforts,
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Waterbirds - Inland Colonial	2	Some distribution information for most species, especially in southern boreal, little or no trend information within region except for a few species.	1	Most species not dependent on boreal; those that are (e.g. pelicans) are fairly well known.			
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Limited distribution info; little or no trend information	1	Only a few species in region, mostly believed to be widely distributed and not currently thought to be declining; better trend information unlikely to have a major impact on planning and priority setting.	Possible information on some species can be picked up on aerial-based waterfowl surveys		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Shorebirds - Boreal	3	Very little information on distribution or trends; unknown whether there are concentration areas; but unknown about basic distribution; also concerns in taiga / arctic transitions zones including Hudson Bay.	2	Although gap is high, considered moderate risk because true boreal species thought to be widely distributed (although this is inferred based on limited data, and may not be valid), and wetlands do receive some level of protection. Nevertheless, some species are thought to be declining, and unknown whether any threats are in boreal, and what actions are required to mitigate those threats.	Possible that information on some species can be picked up on waterfowl surveys; other species could potentially be detected on boreal landbird surveys (if they are developed); most challenging area with be taiga / arctic transition zones which are very difficult to access even with helicopters.	B-d 2,E-c 1,C-n 2,	B-d 2-Insufficient information to determine what actions are required to prevent declines or to know what is declining, E-c 1-Risk of inefficient conservation actions (but currently limited efforts underway),C-n 2-Risk that EC may be challenged by NGOs or others if allow development in region without adequate monitoring to evaluate risks or potential impacts.
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Waterfowl - Seaducks	1	Some information gaps on distribution (e.g., some parts of N Quebec), but generally fairly well known	1	Adequate information for BCR planning and landscape management purposes			
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Waterfowl - geese and swans	1	Populations and distribution fairly well known	0	Species doing well; minimal risk			
1. Landscape Management - Boreal/Northern Forest (BCRs 4, 6, 7, 8, 12)	Waterfowl - other	1	Some gaps in knowledge in BCR 7 on distribution and abundance	1	General adequate information for planning and management purposes			
1. Landscape Management - Marine coasts (west and east coasts).	Seabirds - Pelagic	2	Geographic gaps, some areas not recently visited; limited information on temporal changes in distribution (among years and among seasons)	1	Low risk, because data on pelagic seabird distributions only likely to have limited impact on planning in region; current levels of at-sea surveys sufficient to provide broad patterns.	Maintain periodic at-sea surveys		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Marine coasts (west and east coasts).	Seabirds - colonial	1	Adequate information on the distribution and general trends in most colonies	1	Current information is sufficient, but any reduction could substantially increase risk			
1. Landscape Management - Marine coasts (west and east coasts).	Seabirds - Other (e.g., jaegers)	2	Geographic gaps, some areas not recently visited; limited information on temporal changes in distribution (among years and among seasons)	1	Low risk, because data on these species only likely to have limited impact on planning in region.	Maintain periodic at-sea surveys		
1. Landscape Management - Marine coasts (west and east coasts).	Shorebirds - Arctic	2	Geographic gaps, some areas not recently visited; limited information on temporal changes in distribution (among years and among seasons)	1	Includes phalaropes, some species of which may have been declining; however, risk considered low because data on these species only likely to have limited impact on planning in region.	maintain periodic at-sea surveys		
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Landbirds - Prairie	1	Adequate information for planning purposes (Okanagan), though limited precision on some rarer species	1	Probably sufficient for planning purposes			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Landbirds - other	2	Good information in some areas, but little or no information in many areas; BC atlas, if able to access remote areas, should improve information	2	Best information in areas of highest development and threats; nevertheless, substantial development (e.g., resource extraction) in more remote areas, with very little bird information. Risk of inappropriate prioritization, failure to protect key areas.	Ensure good coverage of remote areas in B.C. atlas to understand current status and distribution of species; Develop monitoring strategies to understand change over time, particularly in areas subject to development	B-d 2,B-c 2,C-n 2,	B-d 2-inappropriate development could lead to declines in species that would not be detected, B-c 2-lack of data limits ability to influence developers to plan appropriately to protect species, C-n 2-unable to defend against challenges from NGOs or others that permission to develop in region is leading to declines of landbird populations,
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Seabirds - colonial	1	Good information on the distribution and trends in colonies, but some species not well covered (PIGU, storm petrels)	1	Current information is probably sufficient, but any reduction could substantially increase risk			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Seabirds - Other (e.g., jaegers)	1	Marbled Murrelet a lot of information already, though not all well compiled and still some gaps	1	Current information is probably sufficient for planning and management			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Waterbirds - Marsh	2	Very little information on most species, either breeding or non-breeding. Some information on distribution. BC atlas should improve information.	1	Some levels of protection already in place for wetlands; better data on these species could affect their priority ranking, but unlikely to have a major influence on planning.			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Waterbirds - Inland Colonial	1	Probably sufficient information from coastal waterbird survey and GBHE inventories and atlas	1	Likely sufficient information, if maintain current surveys			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Probably sufficient information from coastal waterbird survey for non-breeding season; uncertain about breeding season distribution and trends.	1	Likely sufficient information, depending on level of breeding season surveys and threats.			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Shorebirds - Arctic	2	Important wintering area for many species, but only limited data on trends; some information on spatial distribution and (Coastal Waterbird Survey, Christmas Bird Count, shorebird migration counts), but trend information from these surveys is of limited reliability.	2	Important wintering area for many species, with high risks associated with development, finer scale and more precise information required than currently available		B-d 2,B-c 2,E-b 1,E-c 1,	B-d 2-unable to determine appropriate mitigation and guidance for development, which may lead to declines, B-c 2-lack strong data to influence development patterns, E-b 1-some risk of unnecessarily delaying development that will have little influence on birds (but could be mitigated with basic surveys and studies that may be required anyway),E-c 1-Some risk of inefficient use of conservation dollars, if focus on regions that are not highest priority, but possibly sufficient basic distribution information to mitigate this risk,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Shorebirds - Boreal	1	Probably sufficient information from coastal waterbird survey for non-breeding season planning, though not very good trends.	1	Likely sufficient information for this purpose			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Shorebirds - other	2	Very little information on trends for Black Oystercatcher or Long-billed Curlew, though some information on distribution from coastal waterbirds; specialized surveys and Atlas	1	Only a few species; better trend information unlikely to have a major influence on land use planning			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Waterfowl - Seaducks	1	Fairly good monitoring information for breeding season, though not well integrated with other surveys. Non-breeding information from coastal waterbirds, sporadic aerial surveys, etc.	1	Wintering area is very important for many species, with high development pressures and threats; any reduction in current efforts could increase risks			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Waterfowl - geese and swans	1	Very comprehensive monitoring for most species, possibly some gaps in breeding distribution of CAGO	0	Currently no risks, but could increase substantially if monitoring reduced due to importance of species			
1. Landscape Management - Western mountains (BCRs 5, 9, 10)	Waterfowl - other	1	Fairly good monitoring information for breeding season, though not well integrated with other surveys. Non-breeding information from mid-winter survey, Christmas Bird Counts, etc.	1	Monitoring information largely adequate for planning purposes			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Prairies (BCR 11)	Landbirds - Prairie	1	Grassland bird survey with BBS provides adequate information for most species for planning purposes, including those in wooded areas, especially combined with atlas and other distribution info	1	Fairly high pressures; more intensive information might help with evaluating effectiveness of land management options			
1. Landscape Management - Prairies (BCR 11)	Landbirds - Boreal	1	Probably sufficient distributional information from Christmas Bird Count for wintering birds for planning purposes.	1	Not currently a major concern for wintering landbirds			
1. Landscape Management - Prairies (BCR 11)	Waterbirds - Marsh	2	Only coots well monitored (from waterfowl survey). Marshbird program only recently developed on a pilot basis; not yet established with no information on trends, though starting to provide some information on distribution.	2	Wetlands on prairies heavily managed for waterfowl, but uncertainty about effectiveness for other waterbirds coupled with insufficient knowledge for prioritization means marsh birds little considered in planning. Risk management may not be appropriate for some species	Risk could be mitigated with shorter-term surveys / research to develop habitat models for marsh birds, combined with existing wetland monitoring data (good monitoring of ponds from air; better data potentially available from ground surveys but little used)	B-d 2,E-c 1,	B-d 2-Risk that species may decline due to inappropriate wetland management / prioritization, E-c 1-Risk that conservation efforts are not effective for these species (though probably still beneficial for other species),
1. Landscape Management - Prairies (BCR 11)	Waterbirds - Inland Colonial	2	Periodic inventories of some species, but no consistent monitoring programs; hence moderate distributional info, but not trends	2	Wetlands on prairies heavily managed for waterfowl, but uncertainty about effectiveness for other waterbirds coupled with insufficient knowledge for prioritization means they are excluded from influencing planning.	Distributional surveys could mitigate risk	B-d 2,E-c 1,	B-d 2-Risk that species may be declining due to inappropriate management, or focus on lower priority areas, E-c 1-Risk that conservation efforts are not effective for these species (though probably still beneficial for other species),

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Prairies (BCR 11)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Most species not adequately monitored, though could potentially get adequate data from other programs (e.g., ground component of waterfowl surveys, nascent Marsh bird program	1	Wetlands on prairies heavily managed for waterfowl, but uncertainty about effectiveness for other waterbirds; most likely, requirements for these species being met anyway, but there is some uncertainty and risk.	Collecting better data on these species through ground surveys	B-d 1,E-c 1,	B-d 1-Some risk that species may decline due to inadequate management of habitat, E-c 1-Risk that conservation efforts could be more effective if monitoring allowed better direction.,
1. Landscape Management - Prairies (BCR 11)	Shorebirds - Arctic	2	Little information on staging areas. May be important for some species	2	Wetlands on prairies heavily managed for waterfowl, but uncertainty about effectiveness for staging shorebirds on migration; possibly less critical than for staging areas on coasts, because diffuse use of many small areas, but nevertheless, large numbers migrate through prairies and very little is known about their requirements and whether staging habitat could be a limiting factor		B-d 2,	B-d 2-Risk that species may decline due to inappropriate management (loss of habitat) on staging areas. ,
1. Landscape Management - Prairies (BCR 11)	Shorebirds - Boreal	2	Little information on staging areas. May be important for some species	2	Wetlands on prairies heavily managed for waterfowl, but uncertainty about effectiveness for staging shorebirds on migration; possibly less critical than for staging areas on coasts, because diffuse use of many small areas, but nevertheless, large numbers migrate through prairies and very little is known about their requirements and whether staging habitat could be a limiting factor		B-d 2,	B-d 2-Risk that species may decline due to inappropriate management (loss of habitat) on staging areas. ,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Prairies (BCR 11)	Shorebirds - other	2	Some species (e.g., Piping Plovers) very intensively monitored, but others such as Long-billed Curlew, Avocet, Marbled Godwit, only periodically surveyed	2	Wetlands on prairies heavily managed for waterfowl, but uncertainty about effectiveness for staging shorebirds on migration; possibly less critical than for staging areas on coasts, because diffuse use of many small areas, but nevertheless, large numbers migrate through prairies and very little is known about their requirements and whether staging habitat could be a limiting factor		B-d 2,E-c 2,	B-d 2-Risk that species may be declining due to lack of information to guide appropriate landscape level management, E-c 2-Risk that conservation efforts could be spent more effectively with better prioritization and information on key requirements for these species. ,
1. Landscape Management - Prairies (BCR 11)	Waterfowl - Seaducks	1	Good data on species that breed in region (White-winged Scoter), even if not quite as good as for other waterfowl in region	0	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Prairies (BCR 11)	Waterfowl - geese and swans	1	Fairly good information on distribution and relative abundance in breeding season; major concentration areas well known; overall trends well known	0	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Prairies (BCR 11)	Waterfowl - other	0	Good, well-designed surveys cover most species, though some of the rarer species may have low precision.	0	Information sufficient for planning, including habitat management (e.g., NAWMP) though any reductions could increase risk of ineffective management			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Landbirds - Arctic	1	Probably sufficient information from Christmas BC for most purposes on wintering species	1	not currently major concerns			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Landbirds - other	1	Most species well monitored by multiple surveys including BBS, atlas, and specialized SAR surveys.	1	Sufficient information for most planning, though because development is so intense in this area, the information needs are very high and some species (e.g., Chimney Swifts) may benefit from more data for planning. Improved habitat monitoring would help.			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Waterbirds - Marsh	1	Generally covered by Marsh Monitoring Program, but some problems with MMP survey design, in that do not get the smaller wetlands adequately, so may be biased in trends; however, atlas should fill some gaps in coverage	1	Limited information on importance of small wetlands, as well as rate of loss - could be met by better monitoring of wetlands themselves		B-d 2,E-c 1,	B-d 2-Risk that species may be declining without adequate management, E-c 1-Conservation efforts could be more cost-effective, with better information to direct planning. ,
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Waterbirds - Inland Colonial	0	All major colonies well monitored at regular intervals (decadal). Possibly some gaps in small colonies, but very minor (and atlases fill many of those gaps)	0	Adequate information for planning (but could be substantial risks if monitoring reduced)			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Most species adequately captured by other surveys	0	Not an important area for most of these species, other than on migration / winter, though possible issues on Great Lakes			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Shorebirds - Arctic	1	Ontario Shorebird Survey captures many important shorebird stopping areas; uncertain about gaps	1	Information probably adequate; not sure how important the BCR-13 wetlands are for shorebirds at national level, but some areas may be important for some species			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Shorebirds - Boreal	1	Ontario Shorebird Survey captures many important shorebird stopping areas; uncertain about gaps	1	Information probably adequate; not sure how important the BCR-13 wetlands are for shorebirds at national level, but some areas may be important for some species			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Shorebirds - other	0	Well monitored by BBS and other surveys (including specialized for woodcock)	0	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Waterfowl - Seaducks	1	Good information on coastal migrating birds; somewhat weaker for offshore in Great Lakes	1	Sufficient for most purposes, although some information needs for offshore wind development not quite met, due to limited offshore surveys			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Waterfowl - geese and swans	0	Counted by many different surveys	0	Lots of information for planning			
1. Landscape Management - Great Lakes - St Lawrence (BCR 13)	Waterfowl - other	1	Most species well monitored by both specialized surveys and general surveys such as atlas and BBS	1	Information needs are high due to high development pressures, especially on wetlands			
1. Landscape Management - Maritimes (BCR 14)	Landbirds - Arctic	1	Probably sufficient information from Christmas BC for most purposes on wintering species	1	not currently major concerns			
1. Landscape Management - Maritimes (BCR 14)	Landbirds - other	1	Between BBS and atlases and HELP, quite good information on current distribution, relative abundance and general trends	1	Sufficient information for most planning, though because resource extraction and development affects whole area so intensely, the information needs are very high. Improved habitat monitoring would help.			
1. Landscape Management - Maritimes (BCR 14)	Seabirds - colonial	1	Colonies in this region are well monitored at regular intervals	0	Sufficient information for planning and landscape management purposes			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Maritimes (BCR 14)	Waterbirds - Marsh	2	Some information on distribution from atlases; no regular monitoring captures secretive species	2	Lack information on trends in marsh birds (for prioritization); limited information on importance of small wetlands; in many cases wetland management assumed to meet needs of Waterbirds - Marsh, but lack data to verify this.	Better wetland monitoring would partially mitigate bird monitoring, if decent habitat models can be developed	B-d 2,E-c 1,	B-d 2-Risk that species may be declining without adequate management, E-c 1-Conservation efforts could be more cost-effective, with better information to direct planning. ,
1. Landscape Management - Maritimes (BCR 14)	Waterbirds - Inland Colonial	1	Between BBS and atlases probably sufficient information for most species (i.e., herons - other species in region are classified as "seabirds"	1	Sufficient information for most planning, though because resource extraction and development affects whole area so intensely, the information needs are high			
1. Landscape Management - Maritimes (BCR 14)	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Information on breeding from BBS and atlases. Relatively little information on wintering loons / grebes.	1	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Maritimes (BCR 14)	Shorebirds - Arctic	1	Maritimes shorebird survey probably provides sufficient information for most BCR planning purposes on distribution and trends within sites	1	Due to importance of area for many species, risks could increase substantially if survey were reduced			
1. Landscape Management - Maritimes (BCR 14)	Shorebirds - Boreal	1	Maritimes shorebird survey probably provides sufficient information for most BCR planning purposes on distribution and trends within sites	1	Due to importance of area for many species, risks could increase substantially if survey were reduced			
1. Landscape Management - Maritimes (BCR 14)	Shorebirds - other	1	BBS covers some species, Woodcock survey fairly good coverage.	0	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Maritimes (BCR 14)	Waterfowl - Seaducks	1	Sufficient surveys for most species (eiders, mergansers, harlequins) both breeding and wintering	1	High information needs to plan locally; currently met fairly well, but any reduction could enhance risk			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
1. Landscape Management - Maritimes (BCR 14)	Waterfowl - geese and swans	0	Sufficient information on distribution, timing of arrival of passage and wintering birds for planning purposes	0	Sufficient information for planning and landscape management purposes			
1. Landscape Management - Maritimes (BCR 14)	Waterfowl - other	0	Eastern Waterfowl survey and supplementary surveys provide sufficient info	0	Sufficient information for planning and landscape management purposes			
2. Incidental Take is minimized (forestry)	Landbirds - Boreal	2	Moderate information from some parts of boreal and from some forest companies; much distributional information can feed into habitat models (e.g., BAM) but lacking from some large geographic areas; information on habitat monitoring held by many companies but not always easily accessed and not centrally collated. Remote sensing not yet sufficiently precise or large scale to measure changes at required scale.	2	Forest companies spend substantial resources managing forests to accommodate bird needs, especially through management plans designed to accommodate predicted habitat relations, but limited data to test those and to monitor their effectiveness, thus risk that some may be inappropriate.	Research on bird - habitat - forestry practice relationships and better access to large scale forest habitat maps will reduce requirement for monitoring for this need.	B-d 2,E-b 2,E-c 2,	B-d 2-Risk that species may be declining due to inappropriate forest management due to lack of monitoring to evaluate management effectiveness, E-b 2-Risk of imposing unnecessary burden on industry to manage for species that may not require special management. ,E-c 2-Risk that some conservation efforts to protect species may be ineffectively used for species not requiring management,
2. Incidental Take is minimized (forestry)	Landbirds - other	2	Good information from some forested areas (e.g., Great Lakes, Maritimes), but gaps in others (e.g., BC)	2	Forest companies spend substantial resources managing forests to accommodate bird needs, especially through management plans designed to accommodate predicted habitat relations, but limited data to test those and to monitor their effectiveness, thus risk that some may be inappropriate.		B-d 2,E-b 1,E-c 2,	B-d 2-Risk that species may be declining due to inappropriate forest management due to lack of monitoring to evaluate management effectiveness, E-b 1-Risk of imposing unnecessary burden on industry to manage for species that may not require special management. ,E-c 2-Risk that some conservation efforts to protect species may be ineffectively used for species not requiring management,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (forestry)	Waterbirds - Marsh	2	Very little information on marsh birds in forested areas	1	Relatively few species dependent on forested areas; probably management for other wetland attributes may largely meet needs.	Research on the effectiveness of various riparian buffer zones on maintaining wetland quality and waterbird densities		
2. Incidental Take is minimized (forestry)	Waterbirds - Inland Colonial	1	Moderately good information on distribution of colonies and how to avoid incidental take	1	Relatively few species dependent on forested areas; current management plans probably sufficient, though some uncertainty about meeting habitat requirements beyond simply nesting sites.			
2. Incidental Take is minimized (forestry)	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Moderately good information on distribution and how to avoid incidental take	1	Current data probably sufficient for management to avoid incidental take, though population effects must consider water quality impacts.			
2. Incidental Take is minimized (forestry)	Shorebirds - Boreal	2	Relatively little information on distribution and specific habitat requirements	1	Only a few species; management for other wetland attributes likely to contribute to species habitat needs, thus reducing risk	Research on the effectiveness of various riparian buffer zones on maintaining wetland quality and shorebird densities would further reduce risk		
2. Incidental Take is minimized (forestry)	Shorebirds - other	1	Woodcock moderately well monitored, though mortality due to forestry not measured	1	Current forestry practices likely to benefit woodcock, as prefer early successional habitats, but uncertainty about impacts of configuration (e.g. size of clearcuts, etc.)			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (forestry)	Waterfowl - Seaducks	1	Moderately good information on distribution and how to avoid negative impacts (e.g., goldeneye, buffleheads, mergansers, scoters, harlequin). Limited monitoring on retention of adequate nesting trees for cavity nesters	1	Current management plans probably sufficient, as long as consider water quality impacts, but some risks if not monitoring cavity availability.			
2. Incidental Take is minimized (forestry)	Waterfowl - geese and swans	0	Well known distributions and habitat requirements	0	Populations doing well, negative impacts unlikely, although limited data on how the wetland habitats are impacted by forestry			
2. Incidental Take is minimized (forestry)	Waterfowl - other	0	Well known distributions and habitat requirements	0	Have current research on impacts of forestry on populations; better known than many other groups (prompted by declines in some species such as ABDU)			
2. Incidental Take is minimized (agriculture)	Landbirds - Prairie	2	Have basic information on grassland bird population trends (through BBS and grassland bird survey), but limited information on impacts of different agricultural practices on birds; have some information on timing of nesting for best management practices, but additional information to address changes over time would be valuable as well as some demographic monitoring. Land use data appear to be available.	2	Have enough information to make some decisions now, but outcome of changes hard to predict. Given current declines more monitoring to evaluate impacts of changes required; for example, uncertain about importance of breeding vs wintering threats. Possibly could reduce risk with research instead of monitoring	Targeted research to understand the impacts of these activities would reduce risk	B-d 2,	B-d 2-Risk that species could decline due to inappropriate management / conservation actions to reduce incidental take and other losses,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (agriculture)	Landbirds - Other	1	(Birds in agriculture outside prairies, e.g. bobolinks in ON, QC, Maritimes. Probably similar in S BC) basic information on bird population trends available (BBS), moderate information on impacts of different land use practices on birds; given many species are declining, may need some more demographic monitoring (e.g. nest records for phenology), but fairly good information to make decisions now. Land use data appear to be available.	1	Enough information to make some decisions now; still some uncertainty about outcome of changes, and also striking balance between changes in agriculture (which impacts costs and productivity) and retention of birds.			
2. Incidental Take is minimized (agriculture)	Waterbirds - Marsh	2	Poor information on impacts of loss and alteration of wetlands for agriculture and whether this is causing incidental take	1	Risk of incidental take for waterbirds (killing of adults or nests) probably low, apart from some filling or destruction of wetlands in breeding season; however, impacts on populations from loss of wetlands could be significant (currently captured under land use planning component).			
2. Incidental Take is minimized (agriculture)	Waterbirds - Inland Colonial	2	Poor information on impacts of loss and alteration of wetlands for agriculture and whether this is causing incidental take	1	Risk of incidental take for waterbirds (killing of adults or nests) probably low, apart from some filling or destruction of wetlands in breeding season; however, impacts on populations from loss of wetlands could be significant (currently captured under land use planning component).			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (agriculture)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Limited monitoring information, though ecology and impacts probably fairly well known.	1	Risk of incidental take for waterbirds (killing of adults or nests) probably low, apart from some filling or destruction of wetlands in breeding season; however, impacts on populations from loss of wetlands could be significant (currently captured under land use planning component).			
2. Incidental Take is minimized (agriculture)	Shorebirds - other	2	Basic information on population trends for some species (KILL, UPSA, WILL) but weak for others (MAGO, LBCU). Amount of IT unknown. Land use data appear to be available.	2	Could have population impacts on some species (e.g., UPSA, MAGO, LBCU), but impacts and best practices uncertain. Possible could reduce risk with research instead of monitoring	Research on the impacts of agriculture on grassland shorebirds.	B-d 2,	B-d 2-Could have population impacts on some species, but lack information to evaluate,
2. Incidental Take is minimized (agriculture)	Waterfowl - geese and swans	1	Good information on trends, probably little information on IT, but enough to know probably not a major issue	0	No risk that this is a significant threat to any populations			
2. Incidental Take is minimized (agriculture)	Waterfowl - other	1	(dabblers nesting in agricultural areas) - excellent trend information; good information on level of IT and management, especially on common species (MALL, NOPI).	1	High percentage of some populations (nests and adults) being killed by mowing and other agricultural practices. May need new monitoring to evaluate effectiveness if new practices to reduce IT are implemented. Risk higher if some species declining, but not currently limited by monitoring data.	research on specific management practices		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (fisheries)	Seabirds - Pelagic	2	Limited data on total numbers of birds killed; limited trend and/or population size data for many species	2	Overall impact of fisheries in Canada may be low and declining, due to declining fishery and reduced overall impact; however risk to some species still high at regional and local levels, and errors can decimate populations if impact is underestimated.		B-d 2,B-c 1,B-i 2,C-i 1,	B-d 2-Lack of data on numbers of birds taken by fisheries could lead to undetected declines in poorly monitored species, B-c 1-Lack of data could limit ability to influence fisheries industry to take appropriate protective measures, though many measures being taken already, B-i 2-Insufficient information could reduce ability to influence other countries to take appropriate conservation actions, C-i 1-International - risk of criticism from other international governments / agencies (e.g. UN-FAO), including international treaty partners (U.S.) though risk somewhat reduced because actions being taken anyway.
2. Incidental Take is minimized (fisheries)	Seabirds - colonial	2	Limited data on total numbers of birds killed; however, better trend and population size data for many species	1	Overall impact of fisheries in Canada may be low and declining, due to declining fishery and reduced overall impact; however risk to some species still high at regional and local levels, and errors can decimate populations if impact is underestimated.	Research on magnitude of bycatch would reduce risk	B-d 1,B-c 1,B-i 1,C-i 1,	B-d 1-Lack of data on numbers of birds taken by fisheries could lead to undetected declines in poorly monitored species, B-c 1-Lack of data could limit ability to influence fisheries industry to take appropriate protective measures, though many measures being taken already, B-i 1-Insufficient information could reduce ability to influence other countries to take appropriate conservation actions, C-i 1-International - risk of criticism from other international governments / agencies, including international treaty partners (U.S.) though risk somewhat reduced because actions being taken anyway,
2. Incidental Take is minimized (fisheries)	Waterbirds - Inland Colonial	2	Limited data on total numbers of birds killed, but appears to be very low; reasonable trend and population size data for many species	0	Take appears to be very low and most potentially affected species are thriving (e.g., gulls).			
2. Incidental Take is minimized (fisheries)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Little data on total numbers of birds killed; trend and population size data limited	2	Too little knowledge to assess risks, especially in fresh water fisheries. Potentially could affect populations, but uncertain		B-d 2,	B-d 2-Potential populations being affected but mitigation not taken because not adequately documented.,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (fisheries)	Waterfowl - Seaducks	2	Limited data on total numbers of birds killed by fisheries; however, reasonable trend and population size data for many species, relative to some other waterbirds.	1	Risks may be low in Canada, due to declining fishery and predicted low overall impact relative to other mortality sources; however possibility of local impacts in some areas.			
2. Incidental Take is minimized (fisheries)	Waterfowl - other	2	Potentially an issue for scaup; limited data on total numbers of birds killed; however, reasonable trend and population size data for most species	1	Risks may be low in Canada, due to declining fishery and predicted low overall impact; however possibility of local impacts in some areas (possible in selected inland fisheries and Atlantic coasts including U.S. waters).			
2. Incidental Take is minimized (collisions)	Landbirds - Prairie	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	2	Large kills from some structures; uncertain whether this may be causing population impacts on any species, but possible (need information on rates). Lack of information hampers management and mitigation.	Targeted research and/or monitoring of mortality rates would address concerns more than overall population monitoring, as also provides information on potential mitigation.	B-d 2,B-c 2,E-b 2,	B-d 2-Risk that collisions may be causing declines in some species, but lack data to identify appropriate mitigation actions, B-c 2-Insufficient data to influence others to take mitigation actions, even if potential actions are known, E-b 2-Potential to be imposing unreasonable burden on developers in some sectors that are having relatively lower impact than other sectors that are not well understood.,
2. Incidental Take is minimized (collisions)	Landbirds - Arctic	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Most arctic landbirds do not seem to be killed in large numbers, but limited data, so may be more kills than currently known - many species do not migrate as far south as boreal species, and hence less exposed to risk.	Targeted research and/or monitoring of mortality rates would address concerns more than overall population monitoring, as also provides information on potential mitigation.	B-d 1,B-c 1,E-b 1,	B-d 1-Risk that collisions may be causing declines in some species, but lack data to identify appropriate mitigation actions, B-c 1-Insufficient data to influence others to take mitigation actions, even if potential actions are known, E-b 1-Potential to be imposing unreasonable burden on developers in some sectors that are having relatively lower impact than other sectors that are not well understood.,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (collisions)	Landbirds - Boreal	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	2	Large kills from some structures; uncertain whether this may be causing population impacts on any species, but possible (need information on rates). Lack of information hampers management and mitigation.	targetted research may help address concerns rather than additional monitoring	B-d 2,B-c 2,E-b 2,	B-d 2-Risk that collisions may be causing declines in some species, but lack data to identify appropriate mitigation actions, B-c 2-Insufficient data to influence others to take mitigation actions, even if potential actions are known, E-b 2-Potential to be imposing unreasonable burden on developers in some sectors that are having relatively lower impact than other sectors that are not well understood.,
2. Incidental Take is minimized (collisions)	Landbirds - other	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	2	Large kills from some structures; uncertain whether this may be causing population impacts on any species, but possible (need information on rates). Lack of information hampers management and mitigation.	targetted research may help address concerns rather than additional monitoring	B-d 2,B-c 2,E-b 2,	B-d 2-Risk that collisions may be causing declines in some species, but lack data to identify appropriate mitigation actions,B-c 2-Insufficient data to influence others to take mitigation actions, even if potential actions are known, E-b 2-Potential to be imposing unreasonable burden on developers in some sectors that are having relatively lower impact than other sectors that are not well understood.,
2. Incidental Take is minimized (collisions)	Seabirds - Pelagic	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions, though some exceptions (brightly lit buildings in coastal areas). However, data limited, so this may be misleading.	targetted research may help address concerns rather than additional monitoring		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (collisions)	Seabirds - colonial	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions, though some exceptions (brightly lit buildings in coastal areas). However, data limited, so this may be misleading.	targetted research may help address concerns rather than additional monitoring		
2. Incidental Take is minimized (collisions)	Waterbirds - Marsh	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	2	Large kills from some structures; uncertain whether this may be causing population impacts on any species, but possible (need information on rates). Lack of information hampers management and mitigation.	targetted research may help address concerns rather than additional monitoring	B-d 2,B-c 2,E-b 2,	B-d 2-Risk that collisions may be causing declines in some species, but lack data to identify appropriate mitigation actions, B-c 2-Insufficient data to influence others to take mitigation actions, even if potential actions are known, E-b 2-Potential to be imposing unreasonable burden on developers in some sectors that are having relatively lower impact than other sectors that are not well understood.,
2. Incidental Take is minimized (collisions)	Waterbirds - Inland Colonial	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions, though some exceptions (e.g., brightly lit objects in coastal areas). However, data limited, so some uncertainty on impacts.			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (collisions)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions. However, data limited, so some uncertainty on impacts.			
2. Incidental Take is minimized (collisions)	Shorebirds - Arctic	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions. However, data limited, so some uncertainty on impacts.			
2. Incidental Take is minimized (collisions)	Shorebirds - Boreal	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions. However, data limited, so some uncertainty on impacts.			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (collisions)	Shorebirds - other	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions. However, data limited, so some uncertainty on impacts.			
2. Incidental Take is minimized (collisions)	Waterfowl - Seaducks	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions. However, data limited, so some uncertainty on impacts.			
2. Incidental Take is minimized (collisions)	Waterfowl - geese and swans	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks relatively low for most species, though collisions with powerlines a potential issue for swans. Doesn't necessarily need more monitoring data to address concern.			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (collisions)	Waterfowl - other	2	Good information on impacts (kills) of wind turbines; poor information on towers and tall buildings and windows other than gross categorical impacts. Good information on number of structures. Limited information on mitigation for tall buildings and windows.	1	Risks probably low, because species rarely seem to be involved in collisions, and impacts unlikely to be large enough to have population level impacts.			
2. Incidental Take is minimized (linear structures and roads)	Landbirds - Prairie	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines). Fragmentation may or may not also be an issue.	2	Could be major sources of mortality for some species, but insufficient information to decide how to deal with this.	targetted research on numbers of birds killed may help address concerns	B-d 2,B-c 2,	B-d 2-Species could be suffering declines, without sufficient information to take appropriate action, B-c 2-Lack of solid monitoring data to demonstrate impacts limits ability to influence changes in practices,
2. Incidental Take is minimized (linear structures and roads)	Landbirds - Arctic	2	Poor information on numbers of birds hit by vehicles; impacts due to other factors such as fragmentation unlikely	1	Impact uncertain, but unlikely to be population level			
2. Incidental Take is minimized (linear structures and roads)	Landbirds - Boreal	2	Poor information on numbers of birds hit by vehicles; limited information on impacts of fragmentation due to linear structures and on incidental take during construction and maintenance of roads, seismic lines, etc.	2	Could be major sources of mortality and/or habitat loss for some species, especially in western boreal, but insufficient information to decide how to deal with this.	Targetted research may help address concerns instead of general research	B-d 2,B-c 2,	B-d 2-Species could be suffering declines, without sufficient information to take appropriate action,B-c 2-Insufficient information on impacts to influence changes in practices,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (linear structures and roads)	Landbirds - other	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	2	Could be significant source of mortality for some species, but insufficient information to decide how to deal with this.	Better monitoring / research on amounts of mortality could mitigate risk	B-d 2,B-c 2,	B-d 2-Species could be suffering declines, without sufficient information to take appropriate actions, B-c 2-Insufficient information on impacts to influence changes in practices,
2. Incidental Take is minimized (linear structures and roads)	Waterbirds - Marsh	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	2	Could be significant source of mortality for some species, but insufficient information to decide how to deal with this.	Better monitoring / research on amounts of mortality could mitigate risk	B-d 2,B-c 2,	B-d 2-Species could be suffering declines, without sufficient information to take appropriate actions, B-c 2-Insufficient information on impacts to influence changes in practices,
2. Incidental Take is minimized (linear structures and roads)	Waterbirds - Inland Colonial	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	1	Unlikely to have population level impacts on any species			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (linear structures and roads)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	1	Unlikely to have population level impacts on any species			
2. Incidental Take is minimized (linear structures and roads)	Shorebirds - Boreal	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	1	Unlikely to have population level impacts on any species			
2. Incidental Take is minimized (linear structures and roads)	Shorebirds - other	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	1	Could be major source of mortality for some species (e.g., Killdeer) but unlikely that additional monitoring information would help with decision making, though research may be useful	Research on amounts of mortality and mitigation measures more effective way to reduce biological risk		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (linear structures and roads)	Waterfowl - geese and swans	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	1	Possible that significant numbers of some populations of Canada Geese being killed by roadside maintenance operations, but species is thriving, so risk of adverse population impacts is very low.			
2. Incidental Take is minimized (linear structures and roads)	Waterfowl - other	2	Poor information on numbers of birds hit by vehicles or how this might change with different practices; information from other sectors (e.g., agriculture and forestry) would be similar with respect to IT during maintenance operations (e.g., mowing and clearance of lines)	1	Possible that significant numbers of some species being killed by roadside maintenance operations, but probably not at levels that affect populations; increased monitoring may be needed if enhanced regulation regarding incidental take.			
2. Incidental Take is minimized (other sources including cats)	Landbirds - Prairie	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	2	Risk that mortality could be substantial on some species (in winter), with no information on appropriate actions or their effectiveness.	Research on amounts of mortality combined with existing population estimates would fill information gap	B-d 2,B-c 2,	B-d 2-Insufficient information to determine if cats are having population level impacts,B-c 2-Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (other sources including cats)	Landbirds - Arctic	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	2	Risk that mortality could be substantial on some species (in winter), with no information on appropriate actions or their effectiveness.	Research on amounts of mortality combined with existing population estimates would fill information gap	B-d 2,B-c 2,	B-d 2-Insufficient information to determine if cats are having population level impacts,B-c 2-Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts,
2. Incidental Take is minimized (other sources including cats)	Landbirds - Boreal	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	2	Risk that mortality could be substantial on some species (especially on migration and in winter), with no information on appropriate actions or their effectiveness.	Research on amounts of mortality combined with existing population estimates would fill information gap	B-d 2,B-c 2,	B-d 2-Insufficient information to determine if cats are having population level impacts,B-c 2-Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts,
2. Incidental Take is minimized (other sources including cats)	Landbirds - other	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	2	Risk that mortality could be substantial on some species (breeding, migration or in winter), with no information on appropriate actions or their effectiveness.	Research on amounts of mortality combined with existing population estimates would fill information gap	B-d 2,B-c 2,	B-d 2-Insufficient information to determine if cats are having population level impacts,B-c 2-Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
2. Incidental Take is minimized (other sources including cats)	Waterbirds - Marsh	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	2	Risk that mortality could be substantial on some species (breeding, migration or in winter), with no information on appropriate actions or their effectiveness.	Research on amounts of mortality combined with existing population estimates would fill information gap	B-d 2,B-c 2,	B-d 2-Insufficient information to determine if cats are having population level impacts,B-c 2-Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts,
2. Incidental Take is minimized (other sources including cats)	Shorebirds - other	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	2	Risk that mortality could be substantial on some species (especially during breeding season), with no information on appropriate actions or their effectiveness.	Research on amounts of mortality combined with existing population estimates would fill information gap	B-d 2,B-c 2,	B-d 2-Insufficient information to determine if cats are having population level impacts, B-c 2-Reduced ability to implement appropriate conservation actions (e.g., management of cats) without better documentation of impacts,
2. Incidental Take is minimized (other sources including cats)	Waterfowl - other	2	Little information on impacts of cats in Canada on birds; little information on numbers of feral cats (including barn cats); have some estimates for pet cats that spend time outdoors. Monitoring would seem most important if policies are introduced to reduce cat impacts, to monitor their effectiveness	1	Probably low risk for most adults, but likely take upland nesting ducklings			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (USA)	Landbirds - Prairie	1	Good information on distribution and relative abundance in winter in USA; uncertain about limiting factors for declining species	1	Uncertain whether limiting factors in summer or winter or both, but generally conservation actions happening in both areas anyway			
3. Threats to migrants in other countries reduced (USA)	Landbirds - Arctic	2	Limited information on population trends, but good information on distribution and relative abundance in winter in USA	1	Species doing OK right now			
3. Threats to migrants in other countries reduced (USA)	Landbirds - Boreal	1	Fairly good information on distribution and relative abundance in winter for those species that winter in USA	1	Unlikely many species limited by USA winter habitat			
3. Threats to migrants in other countries reduced (USA)	Landbirds - other	1	Fairly good information on distribution and relative abundance in winter for those species that winter in USA	1	Unlikely many species limited by USA winter habitat			
3. Threats to migrants in other countries reduced (USA)	Seabirds - Pelagic	1	Fairly good information on distribution and relative abundance in winter for those species that winter or breed in USA	1	Monitoring is not a limiting factor in decision making for these species			
3. Threats to migrants in other countries reduced (USA)	Seabirds - colonial	1	Fairly good information on distribution and relative abundance in winter for those species that winter or breed in USA	1	Monitoring is not a limiting factor in decision making for these species. Sufficient information to ID priority species.			
3. Threats to migrants in other countries reduced (USA)	Seabirds - Other (e.g., jaegers)	2	Poor information on population trends; however, otherwise fit in pelagics category	1	Unlikely to be threats in USA that are affecting them			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (USA)	Waterbirds - Marsh	1	Fairly good information on distribution and relative abundance in winter for those species that winter in USA; USA has better monitoring of wetland habitats trends than Canada.	1	Monitoring is not a limiting factor for these species. Threats due to habitat loss, overhunting, etc. probably not affected by monitoring data.			
3. Threats to migrants in other countries reduced (USA)	Waterbirds - Inland Colonial	1	Good information on distribution and relative abundance in winter for those species that winter in USA; USA has better monitoring of wetland habitats trends than Canada.	1	Not currently threatened in USA			
3. Threats to migrants in other countries reduced (USA)	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Good information on distribution and relative abundance in winter for those species that winter in USA; USA has better monitoring of wetland habitats trends than Canada.	1	Monitoring is not a limiting factor for these species. Threats due to habitat loss (e.g. water levels in California), etc. probably not affected by monitoring data.			
3. Threats to migrants in other countries reduced (USA)	Shorebirds - Arctic	2	Poor information on population status, limited understanding of limiting factors. Only a few species have targetted monitoring (e.g., Red Knot) to understand impacts of stopover site quality, but others may be declining and require management	2	U.S. monitoring at stopover sites to assess site quality helps reduce risk, but uncertainty remains whether changes in numbers at stopover sites due to deterioration at site, changes in overall population size (potentially due to factors elsewhere), or changes in migration routes. Results in reduced ability to influence management at stopover sites.	Better understanding of overall population trends, and research on causes of declines could reduce risk	B-d 2,B-i 1,	B-d 2-population declines could be exacerbated by lack of appropriate action,B-i 1-Reduced ability to influence management at stopover sites in USA because of uncertainty of magnitude and causes of declines,
3. Threats to migrants in other countries reduced (USA)	Shorebirds - Boreal	2	Poor information on population status, limited understanding of limiting factors.	1	most species do not appear to be currently threatened in US, though information a bit uncertain			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (USA)	Shorebirds - other	1	Better monitoring information than other shorebirds; reasonable data on distributions in USA.	1	Little data on limiting factors, but no evidence that major limitations in USA; additional monitoring data unlikely to affect risk.			
3. Threats to migrants in other countries reduced (USA)	Waterfowl - Seaducks	1	Good information on distribution and relative abundance in winter for those species that winter in USA	1	Monitoring is not a limiting factor for these species with respect to non-hunting threats.			
3. Threats to migrants in other countries reduced (USA)	Waterfowl - geese and swans	0	Sufficient information on abundance and distribution and demography for this purpose	0	More than sufficient information for this purpose			
3. Threats to migrants in other countries reduced (USA)	Waterfowl - other	0	Sufficient information on abundance and distribution and demography for this purpose	0	More than sufficient information for this purpose			
3. Threats to migrants in other countries reduced (Central/South America)	Landbirds - Prairie	2	Limited information on distribution and trends in wintering areas in Central/South America; little knowledge of limiting factors	2	Many Prairie landbirds in decline are short-distance migrants (grassland birds) wintering in U.S. and northern Mexico. Uncertainty about where to most effectively carry out conservation actions; may fail to take appropriate management actions in right region and/or may waste resources on management in wrong region.	Given amount of habitat that has been lost / converted in both breeding and wintering areas, may be more cost-effective to take management actions to protect habitat at all stages of life cycle, rather than to spend a lot of resources trying to identify causes of declines, which may still have considerable uncertainty; likely to benefit other species as well.	B-d 2,B-c 2,E-c 1,	B-d 2-Many species known to be in decline; some may continue to decline because of lack of appropriate actions,B-c 2-Insufficient data to persuade international partners to take appropriate actions, E-c 1-Some risk of inefficient use of conservation resources, though likely that any conservation of grasslands would benefit some species. ,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (Central/South America)	Landbirds - Arctic	2	Limited information on distribution and trends in wintering areas in Central/South America; little knowledge of limiting factors	1	Very few species winter as far south as Mexico; those that do are not known to be declining			
3. Threats to migrants in other countries reduced (Central/South America)	Landbirds - Boreal	3	Many species winter in Central/South America, but little information on distribution, connectivity; no information on trends in wintering grounds; little knowledge of limiting factors	3	Many species involved; some declining; lack of knowledge of limiting factors limits ability to manage appropriately; substantial costs to industry to manage habitat in Canada for some species if breeding habitat is not actually limiting factor; lack of knowledge limits redirecting those resources.	Research to evaluate limiting factors could substantially reduce risk of not having monitoring data, though would be limited to relatively few species and would require a long-term research investment.	B-d 3,B-i 3,E-b 3,E-c 2,	B-d 3-Declining species may continue to decline if appropriate action not taken,B-i 3-Reduced ability to influence other governments to conserve birds (although this may be only partially limited by monitoring data),E-b 3-May be imposing substantial burden on Canadian industry to conserve breeding habitat for species which are actually limited on wintering grounds, although improved breeding habitat likely to benefit some species,E-c 2-May direct resources to inappropriate areas (though any conservation actions in Central/South America likely to benefit at least some priority species).,
3. Threats to migrants in other countries reduced (Central/South America)	Landbirds - other	2	Limited information on distribution, poor information on trends in wintering grounds; little knowledge of limiting factors	2	Uncertainty about where to most effectively carry out conservation actions; may fail to take appropriate management actions in right region and/or may waste resources on management in wrong region.		B-d 2,B-i 2,E-c 2,	B-d 2-Some species may decline because of lack of appropriate actions in wintering areas,B-i 2-Weak data limited ability to persuade international partners to take appropriate actions, E-c 2-Inappropriate management actions may lead to less efficient use of conservation resources,
3. Threats to migrants in other countries reduced (Central/South America)	Seabirds - Pelagic	2	Moderate information on breeding distribution outside Canada, but limited information on non-breeding; poor information on trends.	2	Reduced ability to influence management outside of Canada (also an issue in non-jurisdictional offshore waters - drifts nets, oil, plastics, ...)		B-i 2,	B-i 2-Reduced ability to influence management outside of Canada,
3. Threats to migrants in other countries reduced (Central/South America)	Seabirds - colonial	1	Moderate information on distribution in winter; fairly good information on trends in Canada	1	Few species have much of wintering range in Central/South America, so risk believed low			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (Central/South America)	Seabirds - Other (e.g., jaegers)	2	Poor information on winter distributions	1	Not likely that main limiting factors are in Central/South America			
3. Threats to migrants in other countries reduced (Central/South America)	Waterbirds - Marsh	2	Limited information on distribution, poor information on trends in wintering grounds; little information on trends in wetland habitats	2	Only a few species, such as Sora, winter mainly in Mexico and Central America; but lack of data can greatly reduce ability to influence conservation		B-d 2,B-i 2,	B-d 2-Some species may decline because of lack of appropriate actions in wintering areas,B-i 2-Insufficient data to persuade international partners to take appropriate actions,
3. Threats to migrants in other countries reduced (Central/South America)	Waterbirds - Inland Colonial	3	Very little information on distribution in winter, poor information on trends in wintering grounds; little information on trends in wetland habitats	2	Reduced ability to influence international conservation; somewhat mitigated by recognition that wetlands need conservation anyway, but reduced ability to prioritize	Improved distributional information in wintering areas would reduce risk	B-d 2,B-i 2,	B-d 2-Some species may decline because of inappropriate prioritization of wetlands for conservation actions,B-i 2-Insufficient data to persuade international partners to take appropriate actions
3. Threats to migrants in other countries reduced (Central/South America)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Limited information on distribution, poor information on trends in wintering grounds; little information on trends in wetland habitats	2	Many species winter farther north, but some winter in Mexico and Central America; lack of knowledge reduces ability to influence and prioritize conservation efforts in Central/South America		B-d 2,B-i 2,	B-d 2-Some species may decline because of lack of appropriate actions in wintering areas,B-i 2-Insufficient data to persuade international partners to take appropriate action,
3. Threats to migrants in other countries reduced (Central/South America)	Shorebirds - Arctic	3	Moderate information on distribution in winter, poor information on overall trends, though some is from wintering grounds; no information on whether winter habitats are limiting	3	Possibility that some species, which are apparently declining strongly, may be limited on stopover or wintering areas in Central/South America, but lack data to influence, prioritize and guide conservation efforts		B-d 3,B-i 3,E-c 2,	B-d 3-Some species may continue to decline because of lack of appropriate actions in wintering / stopover areas; risk is high because many species have strong apparent declines,B-i 3-Insufficient data to identify most critical conservation actions and to persuade international partners to take appropriate action,E-c 2-Conservation actions to protect shorebirds may be taken in less appropriate areas ,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (Central/South America)	Shorebirds - Boreal	2	Moderate information on winter distribution; poor information on population status, limited understanding of limiting factors.	2	Possibility that some species may be limited on stopover or wintering areas in Central/South America, but lack data to influence, prioritize and guide conservation efforts. Risk perceived to be lower than for arctic wintering species, only because fewer species appear to be declining		B-d 2,B-i 2,	B-d 2-Some species may decline because of lack of appropriate actions in wintering areas,B-i 2-Insufficient data to persuade international partners to take appropriate action,
3. Threats to migrants in other countries reduced (Central/South America)	Shorebirds - other	2	Moderate information on winter distribution; poor information on population status, limited understanding of limiting factors.	2	Reduced ability to influence conservation actions in winter; may be limiting factor for some species such as PIPL and UPSA; Good data required to convince others to act		B-d 2,B-i 2,E-c 2,	B-d 2-Some species may decline because of lack of appropriate actions in wintering areas,B-i 2-Insufficient data to persuade international partners to take appropriate action,E-c 2-Conservation actions to protect shorebirds may be taken in less appropriate areas (e.g., efforts in breeding grounds may be misguided if limiting factors are elsewhere),
3. Threats to migrants in other countries reduced (Central/South America)	Waterfowl - geese and swans	1	Good information on distribution in Central/South America; excellent information on population trends	0	Sufficient to manage species, only a few have much distribution in area (mostly Mexico)			
3. Threats to migrants in other countries reduced (Central/South America)	Waterfowl - other	2	Little information on wintering distribution, amount of harvest, trends in abundance in wintering areas.	1	Because most species generally doing OK, risks not as high; however, if any start to decline, risk of inability to plan management could be high especially for species such as teal that winter mainly in Central/South America			
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Landbirds - Arctic	1	Better information on winter distribution than breeding for species such as Wheatear	1	Sufficient information to manage species threats			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Seabirds - Pelagic	1	Generally breeding distributions fairly well known (e.g., NZ, Antarctica). Elsewhere in CAFF information generally as good as Canada. Trend information weak on some species (as it is in Canada)	1	Management, from a Canadian perspective, generally not limited by monitoring info			
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Seabirds - colonial	1	Fairly good information on distribution in winter; good information on trends in Canada	1	Some uncertainty related to harvest in Greenland (e.g., IVGU) and threats or status elsewhere (e.g., ROGU), but management decisions / actions probably not limited by monitoring data			
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Seabirds - Other (e.g., jaegers)	2	Poor information on winter distributions	1	Currently, no evidence that Canadian populations seriously threatened outside the Americas			
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Shorebirds - Arctic	2	Moderate information on distribution in winter, poor information on overall trends, though some is from wintering grounds	1	Populations that migrate through Europe not currently thought to be declining, and monitoring data unlikely to be limiting factor in management. Relatively few Canadian birds believed to migrate through Asia (although potentially major threats on stopover sites)			
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Waterfowl - Seaducks	2	Poor information on status and distribution and threats in west (Russia) for shared species; better information in east (e.g. Greenland)	2	Lack of information blocks ability to manage shared populations with Russia; some species declining and cause unknown		B-t 2,B-d 2,B-i 2,	B-t 2-Risk that combined harvest in North America and elsewhere may be unsustainable, B-d 2-Some species may decline because of lack of appropriate actions internationally, B-i 2-Insufficient data to persuade international partners to take appropriate actions,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Waterfowl - geese and swans	1	Good information on snow geese breeding in Russia, and on populations of other species that migrate to Europe. Somewhat limited information on populations of brant in Russia.	1	Populations currently doing OK, so risk is low. If western species breeding in Russia (mainly brant) show signs of declines, information need might increase.			
3. Threats to migrants in other countries reduced (Europe/ Asia/ Africa)	Waterfowl - other	1	Fairly good monitoring info; enough data to indicate movements not a major issue.	0	Numbers of birds moving to other countries too small to be important for management, except perhaps in a disease transmission context, but that is unlikely to be affected by further data.			
4. Harvest Management (overabundant species - management)	Waterfowl - geese and swans	0	Excellent information on population size and demographic parameters. May have more data than actually needed	0	Sufficient information; however, would need to assess carefully any reductions in effort to ensure that risks are not greatly increased, especially legal risks			
4. Harvest Management (overabundant species - habitat recovery)	Waterfowl - geese and swans	1	Information available from some areas based on ground surveys and remote sensing - if adequately analysed and maintained, will be sufficient. Some uncertainty about spring staging areas and impacts on other species.	1	Monitoring should be sufficient to determine if impact has been mitigated.			
4. Harvest Management (heavily hunted species)	Waterfowl - Seaducks	2	Some information on population size, limited trend information; reasonable information on harvest (borealis eiders)	2	Canadian harvest increasing; Greenland Inuit pressure to reduce restrictions in Greenland; risk of mismanaging harvest, challenges with international negotiations and aboriginal harvest		J-r 2,L-t 2,B-t 2,C-a 2,C-i 1,	J-r 2-Risk of challenge to hunting,L-t 2-Risk of challenges in negotiating treaties,B-t 2-Risk of excessive combined take (Canadian permitted, international, aboriginal) leading to declines,C-a 2-Risk aboriginal harvest could be impacted if regulated take is unsustainable; risk of criticism for making decisions that influence aboriginal harvest with inadequate data. ,C-i 1-International - risk of criticism from other international

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
								governments / agencies for failing to manage harvest, or for requesting changes in harvest without solid data,
4. Harvest Management (heavily hunted species)	Waterfowl - geese and swans	0	Good monitoring for all affected species; some monitoring could be better, but probably still adequate for decision making. (White-fronted Goose, AP Canada Goose)	0	Adequate information now; any reduction in effort would need to be assessed to ensure does not excessively increase risk			
4. Harvest Management (heavily hunted species)	Waterfowl - other	0	Good monitoring for all affected species; some monitoring could be better, but probably still adequate for decision making (Black Duck, Mallard, Pintail)	0	Adequate information now; any reduction in effort would need to be assessed to ensure does not excessively increase risk			
4. Harvest Management (substantial harvest - no allocation concerns)	Shorebirds - other	1	Woodcock current surveys, if fully implemented, should be sufficient, but need some design improvements (both population and harvest surveys)	1	Generally information adequate, but population declining and some uncertainty about importance of harvest vs habitat change in driving population changes			
4. Harvest Management (substantial harvest - no allocation concerns)	Waterfowl - Seaducks	1	(*dresseri* Eiders). In aggregate, enough effort, but efficiency of surveys can be improved to yield better data for similar or reduced effort	1	Harvest levels not a serious concern; existing levels of survey effort sufficient to manage harvest, especially if surveys better coordinated; some concerns about local harvests.			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
4. Harvest Management (substantial harvest - no allocation concerns)	Waterfowl - geese and swans	0	Western arctic snow geese, Ross, brant, other Canada). Monitoring information adequate	0	Adequate information now; any reduction in effort would need to be assessed to ensure does not unduely increase risk			
4. Harvest Management (substantial harvest - no allocation concerns)	Waterfowl - other	0	(canvasbacks). Sufficient data from population surveys and harvest surveys to manage species	0	Adequate information now; any reduction in effort would need to be assessed to ensure does not unduely increase risk			
4. Harvest Management (lightly-harvested species)	Waterbirds - Marsh	0	(coots). Plenty of information on population trends from BPOP; adequate information on harvest	0	Enough information to manage species, at present.			
4. Harvest Management (lightly-harvested species)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	(SACR) adequate information for current western harvest; currently lack all required information for eastern populations to manage a harvest	1	Current plans to gather baseline information on eastern population should be sufficient to manage harvest			
4. Harvest Management (lightly-harvested species)	Shorebirds - Boreal	1	(snipe). BBS information on trends for southern part of range; little or no information in boreal; harvest information for Canada and U.S., but fairly high uncertainty, possible bias	1	Current information probably adequate as long as species is not declining			
4. Harvest Management (lightly-harvested species)	Waterfowl - Seaducks	1	(mergansers, goldeneyes, bufflehead, harlequin….) adequate information to manage harvest for most species because harvest is low (some species only monitored by index surveys such as Christmas Bird Count or Coastal Waterbirds -	1	Current information generally sufficient unless harvest increases or populations show major declines, though some local area concerns, where managing with very low information			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
			e.g., harlequin duck)					
4. Harvest Management (lightly-harvested species)	Waterfowl - geese and swans	0	(brant, Trumpeter and Tundra swans). Populations that are harvested are well monitored relative to need	0	Adequate unless substantial increase in harvest or populations start showing major declines			
4. Harvest Management (lightly-harvested species)	Waterfowl - other	0	(wigean, gadwall, teal, etc.). Good information on most species; needs relatively low because of low harvest	0	Adequate unless substantial increase in harvest or populations start showing major declines			
4. Harvest Management (uncertain impact)	Landbirds - other	2	Band-tailed Pigeon relatively imprecise harvest and population estimate in Canada, though overall harvest including in U.S. appears to be very low.	2	Species is currently harvested, but also listed as Special Concern due to major population declines. COSEWIC status assessment suggests that current harvest is unlikely to be a limiting factor, but data imprecise.	Stopping Canadian harvest, which is low anyway, would mitigate this risk	J-r 2,	J-r 2-Risk of legal challenge to regulations for allowing harvest with limited data to demonstrate lack of adverse impacts,
4. Harvest Management (uncertain impact)	Waterbirds - Marsh	2	(Rails) - limited information on population size or trends in many parts of Canada, though some species counted on BBS, and others have special SARA surveys; information from U.S. on overall harvest but little known about impact on Canadian populations.	1	No permitted Canadian harvest, and most harvest not currently thought to be limiting factor for most populations, though possibly some biological risk for King Rail due to U.S. harvest			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
4. Harvest Management (uncertain impact)	Waterfowl - Seaducks	2	Includes most species, and some eider subspecies. Little information on population size, trend and harvest estimates have low precision	2	Risk that current harvest is not sustainable; opens up legal risks		J-r 2,B-t 2,	J-r 2-Risk of legal challenges for allowing a hunt without sufficient information on impact, especially if any species are declining,B-t 2-Risk that excessive hunting could be leading to some declines,
4. Harvest Management (uncertain impact)	Waterfowl - geese and swans	1	(Cackling Geese) monitoring programs cannot separate from Canada Goose in many areas	1	Some legal risk because cannot demonstrate harvest is sustainable owing to confusion with CAGO; however, most likely population is thriving as are other geese, so risk is low			
4. Harvest Management (uncertain impact)	Waterfowl - other	2	(scaup - classed here because of declines and uncertain impact). Some weaknesses in current surveys -- Lesser and greater scaup hard to separate in survey. Range shifts confounded with population change; uncertain whether some recent declines due to harvest	2	Uncertain whether population declines may be related to harvest; adds legal risk of challenge of regulations; risk that could be COSEWIC listed, even if not appropriate, leading to economic risks (e.g., unnecessary restrictions on hunting)		J-r 2,B-t 2,E-b 1,	J-r 2-Risk of legal challenges that regulating a hunt without sufficient information on impact, especially if any species are declining,B-t 2-Risk that excessive hunting could be leading to some declines,E-b 1-Some risk that could end up with unnecessary restrictions on hunting industry, especially if species are inappropriately listed due to inadequate information,
4. Harvest Management (aboriginal)	Seabirds - colonial	2	Little or no information on size of aboriginal harvest; reasonable information on size of recreational harvest in Atlantic (murres) and population sizes	1	Overall risk low as long as populations stable; risks of loss of local colonies near some aboriginal communities (e.g., due to egging of terns, gulls, auks)	encourage sustainable local management		
4. Harvest Management (aboriginal)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	(loons) Little information on size of aboriginal harvest although most likely very low	1	At national level, risk low as long as population stable; possibly some risks of loss of local populations	encouraging local management of harvest		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
4. Harvest Management (aboriginal)	Waterfowl - Seaducks	2	Some information on harvest levels (e.g., Nunavut survey), but uncertain accuracy, and only covers some areas. Have other information on population size, trend information;	2	Risks of loss of local populations, aggregate overharvest (including recreational) and allocation concerns		J-r 2,L-t 2,B-t 2,E-b 2,C-a 2,	J-r 2-Risk of legal challenges that regulating a hunt without sufficient information on impact, especially if any species are declining,L-t 2-Risk that limited data could adversely influence treaty negotiations,B-t 2-Risk that excessive hunting could be leading to some declines,E-b 2-Lack of knowledge could lead to inappropriate allocations among aboriginal and recreational hunters,C-a 2-risk of criticism from aboriginal groups for making decisions without sufficient data, or lacking data for negotiations,
4. Harvest Management (aboriginal)	Waterfowl - geese and swans	2	Some information on harvest levels (e.g., Nunavut survey), but uncertain accuracy, and only covers some areas. Have other information on population size, trend information;	1	Little risk to overall populations, as most species doing fine at population level; some risks of loss of local populations or challenges in treaty negotiations (especially if scale back any current surveys)			
4. Harvest Management (aboriginal)	Waterfowl - other	2	Some information on harvest levels (e.g., Nunavut survey), but uncertain accuracy, and only covers some areas. Have other information on population size, trend information;	1	Aboriginal harvest in most areas unlikely to be sufficient to threaten populations of most species			
5. Priority Site Designation and Management	Landbirds - Prairie	1	Sufficient inventory information to designate sites and to monitor whether still important. May require more intensive monitoring only if conservation actions planned.	1	Only need more if actually undertaking conservation actions to monitor effectiveness			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
5. Priority Site Designation and Management	Landbirds - Arctic	2	Generally had sufficient inventory information to designate sites; for many sites, lack ongoing monitoring in some areas to determine if sites are still important, though others well monitored	1	Few, if any, sites designated or likely to be designated for landbirds			
5. Priority Site Designation and Management	Landbirds - Boreal	2	Generally had sufficient inventory information to designate existing sites, though those sites lack ongoing monitoring to determine if sites are still important. Lack of detailed distributional information to help guide designation of new sites	2	Moderate risk of failing to identify most important areas in selecting new protected areas during land management planning; limited risk for management of existing protected areas.		B-d 2,E-c 2,	B-d 2-Risk of declines due to failure to prioritize important areas for protection, E-c 2-Risk of directing conservation efforts to lower priority areas,
5. Priority Site Designation and Management	Landbirds - other	2	Generally had sufficient inventory information to designate existing sites; for many sites, lack ongoing monitoring to determine if sites are still important	1	Probably no immediate threats in most protected areas; risk protecting some areas that are no longer important. Although limited data in some regions of B.C. unlikely that landbird data will have big influence on site designations.			
5. Priority Site Designation and Management	Seabirds - Pelagic	1	Sufficient data to support DFO and other agencies designation of marine protected areas, though limited information on how these change over time	1	Some gaps in knowledge could lead to missing some important areas, especially small scale "hot-spots"			
5. Priority Site Designation and Management	Seabirds - colonial	1	Plenty of information on distribution of important colonies for protecting them. Most colonies monitored sufficiently regularly to support designation.	1	A few colonies not visited as regularly as perhaps they should, so threats might not get detected right away			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
5. Priority Site Designation and Management	Waterbirds - Marsh	1	Sufficient inventory information to designate sites. Designated wetlands tend to get sufficient monitoring to meet these needs; May be some gaps for designation of new sites; May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			
5. Priority Site Designation and Management	Waterbirds - Inland Colonial	1	Sufficient inventory information to designate sites. Designated wetlands tend to get sufficient monitoring to meet these needs; May be some gaps for designation of new sites; May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			
5. Priority Site Designation and Management	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Sufficient inventory information to designate sites. Designated wetlands tend to get sufficient monitoring to meet these needs; May be some gaps for designation of new sites; May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
5. Priority Site Designation and Management	Shorebirds - Arctic	1	Sufficient inventory information to designate important sites, especially staging areas. Some data gathered in context of environmental assessments. Some gaps in monitoring of northern areas. May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			
5. Priority Site Designation and Management	Shorebirds - Boreal	1	Sufficient inventory information to designate important sites on staging areas. May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			
5. Priority Site Designation and Management	Shorebirds - other	1	Sufficient inventory information to designate important sites on staging areas. May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			
5. Priority Site Designation and Management	Waterfowl - Seaducks	1	Sufficient inventory information to designate most important concentration areas. Possibly a few gaps in north, but threats may be lower. May require more intensive monitoring only if conservation actions planned.	1	Would only need more if actually undertaking conservation actions to monitor effectiveness			
5. Priority Site Designation and Management	Waterfowl - geese and swans	0	Lots of information on locations of major colonies, staging and wintering areas	0	Sufficient to manage effectively			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
5. Priority Site Designation and Management	Waterfowl - other	0	Lots of information on locations of major nesting, staging and wintering areas	0	Sufficient to designate and protect. Only require more intensive monitoring if active management, to evaluate effectiveness			
6. Impacts of Toxic substances (chronic oiling)	Seabirds - Pelagic	2	Distributions of birds reasonably well known, but little information on amount and impacts of chronic oil offshore	1	Not believed to be a major limiting factor, though some uncertainty			
6. Impacts of Toxic substances (chronic oiling)	Seabirds - colonial	1	Fairly good information on distribution; beached bird surveys allow estimates of impacts of oil and trends in oiling events	1	Still not sufficient to determine population level impacts of chronic oiling for most species other than murres, but risk of not having that information will be minimal impact on management.			
6. Impacts of Toxic substances (chronic oiling)	Seabirds - Other (e.g., jaegers)	2	Distributions of birds reasonably well known, but little information on amount and impacts of chronic oil offshore	1	Not believed to be a major limiting factor, though some uncertainty			
6. Impacts of Toxic substances (chronic oiling)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Distributions of birds reasonably well known; some information from coastal waterbirds and beached bird surveys, but still little information on impacts of chronic oil	1	Potentially a significant cause of mortality, especially near shore, but some information from coastal waterbirds and beached bird surveys helps to reduce risk; efforts being taken to minimize oil impacts anyway			
6. Impacts of Toxic substances (chronic oiling)	Shorebirds - Arctic	2	(phalaropes). Poor trend information means unknown whether phalaropes may be declining; could be affected by chronic oil or other toxics, but would not know it. Unlikely to be a risk for other species of shorebirds.	1	Probably not a limiting factor for most species; more a research than a monitoring gap; efforts being taken to minimize oil impacts anyway			
6. Impacts of Toxic substances (chronic oiling)	Waterfowl - Seaducks	1	Fairly good information on distribution; beached bird surveys allow estimates of impacts of oil and trends in oiling	1	Some information to estimate population level impacts of chronic oiling though with some uncertainty			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
6. Impacts of Toxic substances (chronic oiling)	Waterfowl - other	1	Fairly good information on distribution; may be some information from beached bird surveys	1	Some species winter on ocean, but mostly near shore, where chronic oil is less of an issue. May be some concerns in Pacific.			
6. Impacts of Toxic substances (pesticides)	Landbirds - Prairie	2	Information on population trends, but limited quantitative data on pesticide impacts, limited information on amounts of pesticides applied (or even sold); research projects have demonstrated direct mortality impacts of various compounds; many new compounds likely to affect reproduction, but insufficient monitoring.	2	Risk that acute impacts have been affecting populations - decreased use in Canada, but increase elsewhere (e.g., Central/South America); uncertain impacts of new pesticides limits ability to manage them (e.g., some may affect productivity)	Research on impacts may be greater need than monitoring	B-d 2,B-c 2,B-i 2,	B-d 2-Risk of declines due to pesticides that are not properly managed, B-c 2-Reduced ability to influence pesticide management with insufficient data on impacts, B-i 2-Reduced ability to influence pesticide management with insufficient data on impacts,
6. Impacts of Toxic substances (pesticides)	Landbirds - Arctic	2	Limited information on population trends and pesticide impacts	2	Risks on migration and in winter mainly in southern Canada and in USA. Birds can be very concentrated and lead to big impacts - biggest recorded kill >10,000 Lapland Longspurs		B-d 2,B-c 2,	B-d 2-Risk of declines due to pesticides that are not properly managed,B-c 2-Reduced ability to influence pesticide management with insufficient data on impacts,
6. Impacts of Toxic substances (pesticides)	Landbirds - Boreal	2	Limited information on population trends and pesticide impacts	2	Risks of spraying for budworm and other forest pests, though most forest use is either B.t. or growth regulator; also risks of pesticide use in winter as most species winter in Central/South America where pesticide use is still high. Possible impacts of avicide use, including on non-target species due to ID errors	Research may be able to help fill gaps	B-d 2,B-c 2,B-i 2,E-b 2,	B-d 2-Risk of declines due to pesticides that are not properly managed,B-c 2-Reduced ability to influence pesticide management with insufficient data on impacts,B-i 2-Reduced ability to influence pesticide management internationally due to insufficient solid data on impacts,E-b 2-Potential significant economic impact on forest management in Canada, with respect to regulation of insecticide use (costs of applying / not applying as well as impact on harvest),

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
6. Impacts of Toxic substances (pesticides)	Landbirds - other	2	Fairly good information on population trends, but little information on pesticide impacts	1	Some chemical insecticide use in B.C. Indirect impacts on food supply. Orchard impacts - some research studies demonstrate bird impacts not too bad, because birds mostly feeding outside orchards Avicide use - affects many species, including on rice and non-target species due to ID errors, but monitoring data probably not limiting factor	Research to evaluate impacts, especially on any declining species		
6. Impacts of Toxic substances (pesticides)	Seabirds - colonial	1	Probably sufficient information to detect trends or impacts if they occur	1	No current known pesticide issues, though may be exposed to some when feeding in agricultural areas			
6. Impacts of Toxic substances (pesticides)	Waterbirds - Marsh	3	Very little information on trends; or on impacts (e.g., pesticide run-off into wetlands)	2	Unable to determine whether pesticides could be an important impact on populations; potentially could affect waterbirds because pesticides run-off into wetlands	Research to evaluate impacts, especially on any declining species	B-d 2,B-c 2,	B-d 2-Risk that pesticides could be causing or exacerbating declines, but insufficient data to take appropriate actions,B-c 2-Insufficient information to influence others to take appropriate action to reduce impacts of toxic substances,
6. Impacts of Toxic substances (pesticides)	Waterbirds - Inland Colonial	1	Probably sufficient information to detect trends or impacts if they occur	1	Probably no major impacts of pesticides, though likely exposed to some when feeding in agricultural areas, and may be affected by run-off			
6. Impacts of Toxic substances (pesticides)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	limited information on trends; very little information on impacts (e.g., pesticide run-off into wetlands)	2	Unable to determine whether pesticides could be an important impact on populations	Research to evaluate impacts, especially on any declining species	B-d 2,B-c 2,	B-d 2-Risk that pesticides could be causing or exacerbating declines, but insufficient data to take appropriate actions,B-c 2-Insufficient information to influence others to take appropriate action to reduce impacts of toxic substances,
6. Impacts of Toxic substances (pesticides)	Shorebirds - Arctic	3	Little information on distribution or abundance; no information on pesticide impacts, especially in Central/South America where could be affecting some species.	2	Probably few impacts in Canada, though may be issues in US or Central/South America for inland wintering / migrating species; may be some kills in ricefields; possible avicide issues	Research to evaluate impacts, especially on any declining species	B-d 2,B-i 2,	B-d 2-Risk that pesticides could be causing or exacerbating declines, but insufficient data to take appropriate actions,B-i 2-Reduced ability to influence pesticide management internationally due to insufficient solid data on impacts,

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
6. Impacts of Toxic substances (pesticides)	Shorebirds - Boreal	3	Little information on distribution or abundance; no information on pesticide impacts, especially in Central/South America where could be affecting some species.	2	Probably few impacts in Canada, though may be issues in US or Central/South America for inland wintering / migrating species; may be some kills in ricefields; possible avicide issues	Research to evaluate impacts, especially on any declining species	B-d 2,B-i 2,	B-d 2-Risk that pesticides could be causing or exacerbating declines, but insufficient data to take appropriate actions,B-i 2-Reduced ability to influence pesticide management internationally due to insufficient solid data on impacts,
6. Impacts of Toxic substances (pesticides)	Shorebirds - other	2	Fairly good information on distribution and abundance; no information on pesticide impacts	2	Probably few impacts in Canada; potential large impacts in rice and inland wintering (many nasty compounds on rice), possible factor for some declining species such as Upland Sandpiper	Research to evaluate impacts, especially on any declining species	B-d 2,B-i 2,	B-d 2-Risk that pesticides could be causing or exacerbating declines, but insufficient data to take appropriate actions,B-i 2-Reduced ability to influence pesticide management internationally due to insufficient solid data on impacts,
6. Impacts of Toxic substances (pesticides)	Waterfowl - Seaducks	1	Limited data on pesticides impacts, but good population trend data	0	No known issues that are limited by monitoring data			
6. Impacts of Toxic substances (pesticides)	Waterfowl - geese and swans	1	Distribution and abundance well known; little data on impacts, but may be exposed to many compounds in fields, golf courses, etc.	0	Unlikely to be any adverse population level impacts, especially as large animals can probably tolerate moderate levels of exposure; populations thriving			
6. Impacts of Toxic substances (pesticides)	Waterfowl - other	1	Distribution and abundance well known; some data showing that some species have been killed by pesticides (especially if nesting in agricultural areas), but lack data on rates of kills.	0	Unlikely to be any major population level impacts, though some individuals likely adversely affected			
6. Impacts of Toxic substances (lead shot & sinkers)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Limited quantitative information on amount of mortality due to lead, though some mortality events documented	1	No evidence that these are currently limiting populations; sufficient information on source of lead (fishing) for management purposes, although more quantitative information might help with generating political will to change.	Adoption of legislation banning the use of lead sinkers (lead shot already in effect)		

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
6. Impacts of Toxic substances (lead shot & sinkers)	Waterfowl - geese and swans	1	Impacts of lead well documented, but some uncertainty about how to manage reductions in impacts; good data on population monitoring.	1	All populations are increasing or stable, so no evidence of impacts			
6. Impacts of Toxic substances (other)	Seabirds - Pelagic	2	Limited data on population size trends; very little information on toxic accumulations	1	Suspected not to be a limiting factor, based on data from colonial seabirds			
6. Impacts of Toxic substances (other)	Seabirds - colonial	1	Fairly good data on population trends; monitoring of toxics at selected colonies in all regions	1	Sufficient monitoring to detect toxins, though hard to evaluate population level impacts			
6. Impacts of Toxic substances (other)	Seabirds - Other (e.g., jaegers)	2	Limited data on population size trends; very little information on toxic accumulations	1	Suspected not to be a limiting factor, based on data from colonial seabirds			
6. Impacts of Toxic substances (other)	Waterbirds - Marsh	2	Limited data on population size trends; very little information on toxic accumulations	2	Unable to determine whether toxins could have an important impact on populations	Research in impacts of toxics	B-d 1,B-c 2,	B-d 1-Risk that toxic substances could have population level impact on some species without being detected,B-c 2-Insufficient information to influence others to take appropriate actions to reduce impacts of toxic substances,
6. Impacts of Toxic substances (other)	Waterbirds - Inland Colonial	1	Fairly good data on population trends; annual monitoring of toxics at selected colonies in Great Lakes, though less elsewhere	1	Sufficient monitoring to detect toxins and to determine if population level impacts in Great Lakes, but not elsewhere			
6. Impacts of Toxic substances (other)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Moderate information on concentrations of some toxins (e.g., mercury) in loons, though mortality impacts uncertain; little information on other species	2	Known to be affecting reproduction of loons, but uncertain about population impacts; as a result, limits ability to influence regulations and political will to reduce contaminant levels	Research in impacts of toxics	B-d 1,B-c 2,	B-d 1-Risk that declines may happen due to lack of appropriate action to control toxins,B-c 2-Insufficient information to influence others to take appropriate actions to reduce impacts of toxic substances,
6. Impacts of Toxic substances (other)	Waterfowl - Seaducks	1	Some monitoring of toxics in arctic; reasonable population trend data for most species	0	No known issues that are limited by monitoring data			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
6. Impacts of Toxic substances (other)	Waterfowl - geese and swans	1	Overall population trends well known; limited monitoring of toxics	0	No known issues that are limited by monitoring data; populations thriving			
6. Impacts of Toxic substances (other)	Waterfowl - other	2	Good information on population levels and trends, but uncertain about impacts (e.g., selenium) on some species that are declining (e.g., scaup)	1	Uncertain whether toxins may be related to declines of scaup	Research in impacts of toxics		
7. Threats (Predator control)	Landbirds - other	1	Predator control for protection of SAR should be accompanied by monitoring of effectiveness - uncertain whether this is currently an issue in Canada, but is happening in US (e.g., cowbird control for Kirtland's Warbler)	1	Not sure that any predator control currently undertaken in Canada			
7. Threats (Predator control)	Seabirds - colonial	1	Reasonable information on distribution and abundance of major colonies; some information on predator threats on major colonies; in cases where predator control has been undertaken, then intensive monitoring has been implemented	1	Some risk that arrival of predators on colonies might not be detected early due to infrequent visits; intensive monitoring only needed when control actions are implemented.			
7. Threats (Predator control)	Waterbirds - Inland Colonial	1	Good information on distribution and abundance of major colonies; some information on predator threats on major colonies; in cases where predator control has been undertaken, then intensive monitoring has been implemented	1	Some risk that arrival of predators on colonies might not be detected early, though most colonies with species of concern (e.g., terns) visited fairly frequently; intensive monitoring only needed if control actions are implemented.			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
7. Threats (Predator control)	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Good information on distribution of major concentrations; currently no predator control being undertaken	1	Some risk that arrival of predators on colonies might not be detected early due to infrequent visits; intensive monitoring would only be needed if control actions are implemented.			
7. Threats (Predator control)	Shorebirds - other	0	Sufficient monitoring to understand impacts of predator control for SAR protection (Piping Plover)	0	Sufficient monitoring information			
7. Threats (Predator control)	Waterfowl - Seaducks	1	Good information on distribution of important colonies; if predator control is undertaken, then intensive monitoring would be implemented	1	Some risk that arrival of predators on colonies might not be detected early due to infrequent visits; intensive monitoring only needed when control actions are implemented.			
7. Threats (Predator control)	Waterfowl - other	1	Adequate information on population trends for all species; however, may be limited monitoring on effectiveness of predator control measures undertaken in past in some areas.	1	If major efforts being spent on predator control, would be advisable to enhance effectiveness monitoring to evaluate control measures and avoid wasting resources			
7. Threats (Emergency Response)	Landbirds - Prairie	1	Sufficient inventory information to identify major concentrations of birds and to know what species likely to be in a region if any disaster does happen	1	Risk low, as species not sufficiently concentrated in most areas to have major impacts of an emergency			
7. Threats (Emergency Response)	Seabirds - Pelagic	2	Broad distributions of birds reasonably well known, though limited fine scale information on distributions	2	Limited ability to model impacts of oil spills and respond appropriately in areas outside of recently surveyed regions, although some uncertainty about how much fine-level detail is actually required -- often triggers on-site surveys anyway.	Alternative is to trigger targetted onsite surveys if any indication may be a priority area for birds and/or if lack data for area	B-d 2,B-c 1,	B-d 2-Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority,B-c 1-Some risk of spending excessive effort on mitigating a disaster that has low risk to birds (but most disasters require clean-up, etc. anyway for other values).

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
7. Threats (Emergency Response)	Seabirds - colonial	2	Major colonies and distribution in breeding season well known; outside breeding season, broad distributions of birds reasonably well known, but limited fine scale information	2	Limited ability to model impacts of oil spills and respond appropriately in areas outside of recently surveyed regions	Alternative is to trigger targetted onsite surveys if any indication may be a priority area for birds and/or if lack data for area	B-d 2,B-c 1,	B-d 2-Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority,B-c 1-Some risk of spending excessive effort on mitigating a disaster that has low risk to birds (but most disasters require clean-up, etc. anyway for other values).
7. Threats (Emergency Response)	Seabirds - Other (e.g., jaegers)	2	Very limited information on distributions of birds outside breeding season	1	Unlikely that species are sufficiently concentrated in any area to pose population level threats from any particular disaster			
7. Threats (Emergency Response)	Waterbirds - Marsh	2	Broad distributions of birds reasonably well known, but limited fine scale information to predict impacts of a local spill	2	Limited ability to understand respond needs in any particular region, or to model impacts	Prioritization could potentially be based on habitat-based modelling, considering factors such as wetland size, reducing risk of not having monitoring data?	B-d 2,B-c 1,	B-d 2-Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority,B-c 1-Some risk of spending excessive effort on mitigating a disaster that has low risk to birds (but most disasters require clean-up, etc. anyway for other values).
7. Threats (Emergency Response)	Waterbirds - Inland Colonial	2	Major colonies and distribution in breeding season well known; outside breeding season, broad distributions of birds reasonably well known, but limited fine scale information	2	Limited ability to model impacts of oil spills and respond appropriately in areas outside of breeding season	Alternative is to trigger targetted onsite surveys if any indication may be a priority area for birds and/or if lack data for area	B-d 2,B-c 1,	B-d 2-Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority,B-c 1-Some risk of spending excessive effort on mitigating a disaster that has low risk to birds (but most disasters require clean-up, etc. anyway for other values).
7. Threats (Emergency Response)	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Broad distributions of birds reasonably well known, though limited fine scale information on distributions	2	Limited ability to model impacts of oil spills and respond appropriately in areas outside of recently surveyed regions	Alternative is to trigger targetted onsite surveys if any indication may be a priority area for birds and/or if lack data for area	B-d 2,B-c 1,	B-d 2-Risk of failing to act sufficiently in an emergency to protect species, because of insufficient data to identify as a priority,B-c 1-Some risk of spending excessive effort on mitigating a disaster that has low risk to birds (but most disasters require clean-up, etc. anyway for other values).

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
7. Threats (Emergency Response)	Shorebirds - Arctic	1	Major concentration areas and timing reasonably well known	1	Sufficient monitoring information to plan emergency response in most important areas for shorebirds			
7. Threats (Emergency Response)	Shorebirds - Boreal	1	Major concentration areas and timing reasonably well known	1	Sufficient monitoring information to plan emergency response in most important areas for shorebirds			
7. Threats (Emergency Response)	Shorebirds - other	1	Major concentration areas and timing reasonably well known	1	Sufficient monitoring information to plan emergency response in most important areas for shorebirds			
7. Threats (Emergency Response)	Waterfowl - Seaducks	1	Broad distributions of birds reasonably well known, fairly good information on winter distributions, though still gaps on migration except in BC with coastal waterbird survey	1	Some gaps in ability to model and respond to impacts of oil spills, etc., but unlikely that great improvement could really be expected with much better information	Implement on-site surveys in any emergency that involves regions likely frequented by species		
7. Threats (Emergency Response)	Waterfowl - geese and swans	0	Major concentration areas and timing reasonably well known - sufficient to plan emergency responses	0	Monitoring information unlikely to be limiting factor, as long as onsite surveys implemented in case of an emergency			
7. Threats (Emergency Response)	Waterfowl - other	1	Broad distributions of birds reasonably well known; most concentration areas outside breeding season also well known	0	Monitoring information unlikely to be limiting factor, as long as onsite surveys implemented in case of an emergency			
8. Land Claim Agreements	Landbirds - Prairie	1	Sufficient distribution and relative abundance information at coarse scales	1	Generally sufficient, and unlikely to have a big influence on land claims unless Species at Risk issues arise			
8. Land Claim Agreements	Landbirds - Arctic	2	limited information on distribution and relative abundance	0	unlikely to affect land claims			
8. Land Claim Agreements	Landbirds - Boreal	2	limited information on distribution and relative abundance	1	Unlikely to affect land claims unless SAR issues arise			
8. Land Claim Agreements	Landbirds - other	1	Sufficient distribution and relative abundance information at coarse scales	1	Generally sufficient, and unlikely to have a big influence on land claims unless Species at Risk issues arise			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
8. Land Claim Agreements	Seabirds - Pelagic	2	Broad distributions of birds reasonably well known, though limited fine scale information	1	Unlikely to affect land claims except, perhaps, in context of responsibility for emergency response (e.g., to oil spills)			
8. Land Claim Agreements	Seabirds - colonial	1	Sufficient distribution and relative abundance information at coarse scales	1	Generally sufficient, but possible some risk of gaps for negotiation of harvest			
8. Land Claim Agreements	Seabirds - Other (e.g., jaegers)	2	Broad distributions of birds reasonably well known, though limited fine scale information	0	unlikely to affect land claims			
8. Land Claim Agreements	Waterbirds - Marsh	2	Broad distributions of birds reasonably well known, though limited fine scale information	0	unlikely to affect land claims			
8. Land Claim Agreements	Waterbirds - Inland Colonial	2	Broad distributions of birds reasonably well known, though limited fine scale information in some areas	1	unlikely to have much influence on land claims except, perhaps, in context of negotiation over harvest (e.g., tern eggs) at which point estimates of population size and likely impacts would help			
8. Land Claim Agreements	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Broad distributions of birds reasonably well known, though limited fine scale information in some areas	1	unlikely to have much influence on land claims except, perhaps, in context of negotiation over harvest			
8. Land Claim Agreements	Shorebirds - Arctic	2	Broad distributions of birds reasonably well known, though limited fine scale information	1	Many of most important concentration areas already known, thus reducing risk			
8. Land Claim Agreements	Shorebirds - Boreal	2	Broad distributions of birds reasonably well known, though limited fine scale information	1	Many of most important concentration areas already known, thus reducing risk			
8. Land Claim Agreements	Shorebirds - other	1	Major concentration areas reasonably well known	1	Generally sufficient, and unlikely to have a big influence on land claims unless Species at Risk issues arise			
8. Land Claim Agreements	Waterfowl - Seaducks	1	Sufficient distribution and relative abundance information in most relevant areas	1	Generally sufficient, but possible some risk of gaps for negotiation of harvest			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
8. Land Claim Agreements	Waterfowl - geese and swans	1	Major concentration areas and timing well known - good information on overall population size and trends - may not have quite as much information in some claim areas	1	Very important species in negotiations, but probably sufficient information for most negotiation; possibly some risks of local overexploitation			
8. Land Claim Agreements	Waterfowl - other	1	Broad distributions of birds reasonably well known; most concentration areas outside breeding season also well known	1	Probably sufficient information for most negotiation purposes			
9. Threats to Public and Economy	Landbirds - Prairie	1	Sufficient distribution and relative abundance information at coarse scales	0	Not aware of any control measures for landbirds in Canada (e.g., crop depredation); unlikely to require management for disease or other threats; may be issues related to control outside Canada for some species			
9. Threats to Public and Economy	Landbirds - Arctic	1	Sufficient distribution and relative abundance information at coarse scales	0	Not aware of any control measures for landbirds in Canada (e.g., crop depredation); unlikely to require management for disease or other threats; may be issues related to control outside Canada for some species			
9. Threats to Public and Economy	Landbirds - Boreal	1	Sufficient distribution and relative abundance information at coarse scales	0	Not aware of any control measures for landbirds in Canada (e.g., crop depredation); unlikely to require management for disease or other threats; may be issues related to control outside Canada for some species			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
9. Threats to Public and Economy	Landbirds - other	1	Sufficient distribution and relative abundance information at coarse scales	0	Not aware of any control measures for landbirds in Canada (e.g., crop depredation); unlikely to require management for disease or other threats; may be issues related to control outside Canada for some species			
9. Threats to Public and Economy	Seabirds - Pelagic	1	Sufficient distribution and relative abundance information at coarse scales	0	Not aware of any issues			
9. Threats to Public and Economy	Seabirds - colonial	1	Sufficient distribution and relative abundance information in most areas where potential threats (e.g., gulls near airports)	1	Control measures at many airports affect some gull species and other birds; need to make sure do not have population level impacts; currently control mainly involves species with thriving populations, but risk could increase if any species show declines			
9. Threats to Public and Economy	Seabirds - Other (e.g., jaegers)	1	Sufficient distribution and relative abundance information at coarse scales	0	Not aware of any issues			
9. Threats to Public and Economy	Waterbirds - Marsh	2	Broad distributions of birds reasonably well known, but limited local or trend information (should this be lower?)	0	Unlikely to be major issues with disease or economic impacts with this group, though may sometimes hit planes			
9. Threats to Public and Economy	Waterbirds - Inland Colonial	1	Sufficient distribution and relative abundance information in most areas where potential threats (e.g., gulls near airports)	1	Control measures at many airports affect some gull species and other birds; need to make sure do not have population level impacts; currently control mainly involves species with thriving populations, but risk could increase if any species show declines			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
9. Threats to Public and Economy	Waterbirds - Other (e.g., loons, grebes, cranes)	1	Sufficient distribution and relative abundance information in most areas where potential threats	1	Some issues related to crop damage from cranes; loons & grebes may sometimes hit planes, but no specific control measures likely; have been some disease outbreaks with loons (e.g., cholera), but actions unlikely to be limited by monitoring data			
9. Threats to Public and Economy	Shorebirds - Arctic	2	Broad distributions of birds reasonably well known, but limited local or trend information (should this be lower?)	0	Some control at airports, but probably fairly limited; need for status information to manage this is low; not aware of any issues with crop depredation, though some species feed on berries on migration; possible issues of long distance disease transmission, but would require research not monitoring			
9. Threats to Public and Economy	Shorebirds - Boreal	2	Broad distributions of birds reasonably well known, but limited local or trend information (should this be lower?)	0	no known issues			
9. Threats to Public and Economy	Shorebirds - other	1	Major concentration areas and trends reasonably well known	0	No known concerns; possibly some control at airports, but likely very minor			
9. Threats to Public and Economy	Waterfowl - Seaducks	1	Sufficient distribution and rel abundance in most areas; specialized survey in some areas (east coastal block survey; some research in west)	1	Probably sufficient data to address any issues in relation to depredation on aquaculture (scare / displacement); possible vectors for avian influenza & issues with avian cholera, but neither limited by monitoring of birds themselves			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
9. Threats to Public and Economy	Waterfowl - geese and swans	1	More than enough data on overall populations, trends, demography and concentration areas in most areas; however, sometimes need very precise information (e.g., around airports, and concentrations in relation to disease and ducks/poultry farms)	1	More than enough information in most areas; if fine scale information is required (e.g., around airports) or better data on impacts (e.g., crop damage, disease transmission to poultry farms) can be dealt with on case-by-case basis			
9. Threats to Public and Economy	Waterfowl - other	1	More than enough data on overall populations, trends, demography and concentration areas in most areas; however, sometimes need very precise information (e.g., around airports, and concentrations in relation to disease and ducks/poultry farms)	1	More than enough information in most areas; if fine scale information is required (e.g., around airports) or better data on impacts (e.g., crop damage, disease transmission to poultry farms) can be dealt with on case-by-case basis			
10. SAR Listing - COSEWIC	Landbirds - Prairie	2	Adequate trend information on most species; Of 26 species, 2 have limited and 10 very poor trend information incl. 2 listed and 1 candidate for status review.	2	Inappropriate status decisions for some grassland species with poor trend data could impact major land uses (agriculture, oil/gas)		B-s 2, B-d 2,E-b 2,E-c 2,	B-s 2 – Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 2-Failure to detect declines in a timely manner could limit opportunities for conservation before species become at risk (although generic grassland conservation may benefit them anyway),E-b 2-Incorrectly listing species could lead to increased burden on industry, although if leads to benefits to other grassland species, may still be worthwhile,E-c 2-Listing species that do not require it, could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
10. SAR Listing - COSEWIC	Landbirds - Arctic	3	Limited or poor trend information for most species though relatively few landbirds rely on arctic; Of 18 species, 9 have limited, and 7 have very poor trends, 3 of which are peripheral in Canada	1	Risks / threats / consequences thought to be not as high as many parts of Canada, nor are consequences of incorrect listing to industry; new surveys such as Arctic PRISM will help fill gaps as they mature, although some high priority Canadian species in low arctic such as Harris Sparrow and Smith's Longspur will not be adequately monitored by PRISM			
10. SAR Listing - COSEWIC	Landbirds - Boreal	3	Limited or poor trend coverage for most species, though existing coverage is in southern boreal where risks are highest - Of 88 species, 37 have limited and 17 very poor trend information incl 1 listed and 2 candidate species	2	COSEWIC decisions based on limited trend information (i.e., trend information largely from other parts of range) are already being made here, with potential to influence large-scale industry (forestry, oil, mining) and be controversial; however, unlikely to stop development		B-s 2, B-d 3,E-b 2,E-c 2,	B-s-2 – Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 3-Failure to detect declines in a timely manner could limit opportunities for conservation, both in Canada and elsewhere, and increase risk to species, E-b 2-Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit.,E-c 2-Listing species that do not require it, could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized
10. SAR Listing - COSEWIC	Landbirds - other	3	limited or very poor for many western (BC) landbirds; of 61 species, 14 have limited and 31 have very poor trend information incl. 3 listed species	3	large number of BC species with poor trend information face important threats (forestry, urban development, climate change); high risk of mistakes in listing (e.g., failing to list species that meet criteria)	BC atlas will help with distributional information, but only when repeated will it provide trend info	B-s 2, B-d 3,E-b 2,E-c 2,	B-s2 –Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 3-Failure to list species that meet criteria, due to lack of data could reduce opportunities for their conservation, both in Canada and elsewhere - risk high because of number of species and potential threats,E-b 2-Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit.,E-c 2-Listing species that do not require it, could lead to wasted resources developing

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
								plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized,
10. SAR Listing - COSEWIC	Seabirds - Pelagic	3	Poor trend information for all species, of 14 species, 4 have limited and 8 have very poor trend info	2	Risks often highest elsewhere in broad pelagic ranges; but Canadian risks to species can still be high (oil exploration / transport, bycatch). Mistakes have consequences for international negotiations		B-s 2, B-d 2,B-i 2,E-c 2,C-i 2,	B-s2 –Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 2-Failure to list species that meet criteria, due to lack of data could reduce opportunities for their conservation, both in Canada and elsewhere, B-i 2-Weak data to support listing, or failure to list species that deserve it, could reduce ability to influence international partners in conservation, E-c 2-Listing species that do not require it, could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized, C-i 2-Credibility risk of international criticism if species listed based on data that others perceive as inadequate,
10. SAR Listing - COSEWIC	Seabirds - colonial	2	Good or adequate trend information for 50% of species, of 38 species, 12 have limited and 7 have very poor trend information (+1 additional disjunct population), 2 of which do not breed in Canada	1	Many species with poor data are also low Canadian responsibility, but there are concerns about poor monitoring for a few high responsibility species (Black Guillemot, Sabine's Gull); also many major colonies are visited at very infrequent intervals, increasing biological risks		B-s 1, B-d 2	B-s 1-Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 2-Failure to detect declines in a timely manner could limit opportunities for conservation, both in Canada and elsewhere, thus increasing risk to species

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
10. SAR Listing - COSEWIC	Seabirds - Other (e.g., jaegers)	3	Of the 4 species in this group, very poor trend information on all 3 jaeger species, adequate on remaining sp.	1	Widely distributed in areas with limited threats - unlikely to have major consequences if mistake made in listing; some information will be forthcoming from Arctic PRISM and checklists			
10. SAR Listing - COSEWIC	Waterbirds - Marsh	3	Poor trend information for most; of 11 species, 6 have limited and 3 have very poor trends incl 1 listed species	2	Listing of wetland species could have significant economic consequences; currently only listed species have limited range; also, some species are harvested in U.S. increasing consequences of listing	Risk could be reduced with improved Marsh Monitoring Program, even if concentrated in more heavily used areas	B-s 2, B-d 2,E-b 2,	B-s 2-Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 2-Failure to detect declines in a timely manner could limit opportunities for their conservation, both in Canada and elsewhere, thus increasing risk to species, E-b 2-Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit, although wetland habitats often protected under other legislation anyway.,
10. SAR Listing - COSEWIC	Waterbirds - Inland Colonial	2	Good information for some species, but not most; of 15 species, limited information for 4 species and very poor trend information for 7, mostly those at edge of range in Canada (may have better information from some regional surveys that are not collated)	1	Most poorly monitored species are peripheral in Canada and may not be breeding in Canada; may have adequate information on these species from U.S.A.			
10. SAR Listing - COSEWIC	Waterbirds - Other (e.g., loons, grebes, cranes)	2	Adequate trend information for most; of 12 species, 2 have limited and 3 (grebes) have very poor trend info, 1 of which is a candidate for COSEWIC review (WEGR)	1	May have sufficient other information (population size) to reduce mistakes in COSEWIC, especially as 2 of those have usable trend information (CBC for WEGR, BBS for PBGR)			

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
10. SAR Listing - COSEWIC	Shorebirds - Arctic	3	Most species poorly monitored with current data; of 25 species, 4 have limited and 18 have very poor trend info, including 4 of 5 currently on COSEWIC candidate list. With a fully implemented PRISM, only ~ 3 of 25 species would have very poor trend info, 2 of which are peripheral species.	3	Mistakes in listing quite likely and could have substantial consequences -- 5 species currently COSEWIC candidates - status could easily be miscategorized based on current information Weak data also limit recovery planning.	Completion of first full round of Arctic PRISM would reduce risk even on first iteration, by providing reliable information on population size, but only after 2nd iteration would trend information be available -- will not help current assessments.	B-s 2, B-d 3,B-i 2,E-b 3,E-c 3,C-i 2,	B-s 2-Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 3-Failure to detect declines in a timely manner could limit opportunities for conservation, both in Canada and elsewhere, thus increasing risk to species; even if species are listed, limited data could reduce effectiveness of recovery measures, B-i 2-Weak data to support listing, or failure to list species that deserve it, could reduce ability to influence international partners in conservation, E-b 3-Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit, although wetland habitats often protected under other legislation anyway., E-c 3-Listing species that do not require it, could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized, C-i 2-Credibility risk of international criticism if species listed based on data that others perceive as inadequate,
10. SAR Listing - COSEWIC	Shorebirds - Boreal	3	None adequately monitored; of 9 species, 2 have limited and 7 have very poor trend information including 1 candidate species	2	Similar issues to Landbirds - Boreal, though fewer species. Incorrect decisions have potential to affect large-scale industry (forestry, oil, mining) and be controversial; however, unlikely to stop development	Arctic PRISM will reduce gap for 1 species	B-s 2, B-d 2,E-b 2,E-c 2,	B-s 2-Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 3-Failure to detect declines in a timely manner could limit opportunities for conservation, both in Canada and elsewhere, thus increasing risk to species; even if species are listed, limited data could reduce effectiveness of recovery measures, E-b 2-Incorrectly listing species could lead to increased burden on industry, even if birds do not require it or benefit, E-c 2-Listing species that do

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
								not require it, could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized,
10. SAR Listing - COSEWIC	Shorebirds - other	2	About half species well monitored; of 13 species, 1 has limited and 5 have very poor trend information including 1 listed species	2	Some species (e.g., Long-billed Curlew, American Avocet, Black-necked Stilt, oystercatchers) if incorrectly listed, could have significant economic consequences. Some species-specific surveys or coastal waterbird surveys could fill gaps		B-s 2, B-d 2,E-b 2,E-c 2,	B-s 2-Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 3-Failure to detect declines in a timely manner could limit opportunities for conservation, both in Canada and elsewhere, thus increasing risk to species, E-b 2-Incorrectly listing species could lead to increased burden on industry or other development, even if birds do not require it or benefit, E-c 2-Listing species that do not require it, could lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized,
10. SAR Listing - COSEWIC	Waterfowl - Seaducks	2	Most are poorly monitored; of 13 species, 6 have limited and 4 have very poor trend info, including 1 candidate for COSEWIC assessment (KIEI). Some species have split ranges and at least 2 additional species have very poor trends in disjunct population(s) which could potentially be listed separately.	2	Consequences of mistakes on COSEWIC listing have significant impacts on harvest and aboriginal issues, including risk of legal challenges for allowing harvest on declining species		J-r 2,B-s 1, B-d 2,E-c 2,C-a 2,	J-r 2-Incorrectly listing species could lead to legal risk of being challenged on current and recent hunting regulations, and difficult to defend challenge with inadequate monitoring data, B-s 1-Failure to list species that meet criteria could reduce opportunities for their conservation, B-d 2-Failure to detect declines in a timely manner could limit opportunities for conservation, both in Canada and elsewhere, thus increasing risk to species; also risk of inappropriate harvest management, E-c 2-Listing species that do not require it, could

Program outcome	Species group	Gap level	Rationale for gap level	Risk level	Rationale for risk level	Mitigation options	Risks by category	Risk details
								lead to wasted resources developing plans (e.g., recovery plans, defining Critical Habitat, doing research), and redirection of conservation dollars towards these species when other species should have been prioritized, C-a 2-Risk of challenges from aboriginal groups if any harvested species are listed based on weak or inconclusive data,
10. SAR Listing - COSEWIC	Waterfowl - geese and swans	1	Of 8 species, 2 have limited and one has very poor trend information (Cackling Goose -- due mainly to identification challenges)	1	Unlikely to make mistakes in classification; most species doing well, and unlikely to have management consequences unless populations decline dramatically.			
10. SAR Listing - COSEWIC	Waterfowl - other	1	Of 17 species, 5 have limited and 1 has very poor trend information (Cinnamon Teal); limitations mainly due to significant parts of range outside monitored areas (e.g., scaup).	1	Risks of mistakes are low, because poorly monitored species are also well monitored outside of Canada; however consequences of mistakes are high because would affect hunting.			

APPENDIX C – Environment Canada Avian Monitoring Committee: Terms of Reference

Mandate: The purpose of the Avian Monitoring Committee (AMC) is to provide an advisory, auditing and coordinating role to all avian monitoring and inventory programs managed or supported by Environment Canada. For clarity this includes associated monitoring activities within the migratory bird, species at risk, habitat or other programs. The Committee may audit surveys and provide advice on any aspect of survey design, operations, costs, information needs and assess the usefulness of information generated.

Reporting: The AMC shall report to the Migratory Birds Sub-Activity.

Accountability: Approvals of recommendations of the AMC and the Migratory Birds Sub-Activity and decisions on subsequent program changes will come from the Directors (regional and national) accountable for managing Migratory Birds within Environment Canada. Management and accountability of monitoring programs will continue to follow organizational chains-of-command from Program Managers through their Director.

Scope: The AMC shall consider all proposed or existing monitoring and inventory programs managed or supported by Environment Canada whose concept, design, or purpose is to provide information on the conservation and management (i.e., status (inventory) and trends (monitoring)) of migratory bird populations over time. The information may include data on distribution, abundance, relative abundance, or demographic parameters such as survival or reproduction. The AMC shall also consider research programs designed to improve or develop protocols for use in monitoring programs. It may consider programs operated by other organizations if the program contributes to Environment Canada's information needs supporting migratory bird conservation, recovery and management.

Activities: To fulfill its mandate, the AMC will, in consultation with Program Managers:

- Identify monitoring information needs to support decision making for bird conservation and management.
- Establish Environment Canada standards or guidelines, including for peer review as appropriate, to assure effective monitoring programs. These would include, but not be limited to: program documentation; tracking of records and costs; survey design protocols and analytical techniques; database structure and management; data and information accessibility; data analysis and reporting.
- Establish processes to guide the interaction between the AMC and Managers / Directors responsible for delivery of inventory and monitoring programs.
- Ensure that the utility of existing avian monitoring programs are reviewed and/or audited regularly (usually about every five to ten years) against contemporary program needs and standards, and make recommendations on the development, improvement or discontinuation of programs or parts of programs. Novel monitoring programs may need a more frequent review.
- Assess proposed new or revised monitoring programs against contemporary program needs and standards and to make recommendations in advance of program implementation.
- Identify gaps in monitoring programs and potential risks associated with those gaps, and, if appropriate, make recommendations for strategies to fill those gaps.
- Respond to requests from Managers / Directors to undertake specific studies or reviews or for recommendations on monitoring programs within their responsibility.
- Work with Program Managers, to track and report on the implementation of AMC recommendations and the status of monitoring programs.
- Assess progress on managing and analysing data from monitoring programs, reporting on the results and synthesizing data to assess the status of species, and make recommendations on ways to maximize the reliability of the conclusions and value of the results for decision making.
- Provide a forum for discussion of new technologies and methodologies appropriate to all stages of monitoring inventory programs from data collection and analyses to information management.
- Request that technical reports or analyses be carried out by EC staff and/or externally (e.g., contractors) in order to effectively fulfill its mandate. Recommendations may be made from these reports.

Membership: The membership shall consist of both Managers and technical members.

<u>Managers:</u>
Canadian Wildlife Service:
National Capital Region, two members:
Manager**, Species Abundance and Distribution (Chair) – NCR Region
Manager**, Species Population and Standards Management – NCR Region

Regional Managers (five members):
(Normally these shall be the Manager – Population Conservation or the Manager – Northern Conservation.)

Atlantic** – one member
Quebec** – one member
Ontario** – one member
Prairie and Northern** – one member
Pacific and Yukon** – one member

** Unit Heads may also be the representative with the Director's approval.

Wildlife and Landscape Science Directorate
Wildlife Research Division Manager– one member

Technical members:

Chair (or designate*), EC Landbird Committee
Chair (or designate*), EC Inland Waterbird Committee
Chair (or designate*), EC Waterfowl Committee
Chair (or designate*), EC Seabird Committee
Chair (or designate*), EC Shorebird Committee

* The Chair may appoint an alternative member of the bird technical committee to serve as the representative

Members-at-Large:
Two other technical committee members not from the positions identified may be selected by the AMC to serve terms of up to three years.

Other Participants
Additional Managers or Heads, including those from Species at Risk or Habitat programs, may be invited to participate in discussions of programs that are of particular relevance to them.

When appropriate, representatives from partner organizations, with an interest in particular programs may be invited to participate in discussions of those programs.

Co-Chairs:
The permanent co-chair of this Committee will be the Manager, Species Abundance and Distribution (Chair) – NCR.

The second co-chair will rotate among the Manager members from CWS regions. This co-chair will be selected by the AMC and will serve a term of two years.

Administration: The AMC will establish its own rules regarding the operation of the committee and will be guided by the following:

- The AMC shall develop and make known a process by which EC staff will have a formal mechanism to bring monitoring issues to the committee for its consideration.
- The AMC will develop an annual work plan outlining priorities and programs to be reviewed, with projections extending over a 3-year time frame. This shall be presented each year to Directors through the Migratory Birds Sub-Activity.
- Meetings should be conducted largely through teleconferences, e-mail exchanges or other similar non-travel mechanisms.
- Meetings will be held as required and should be frequent enough to provide advice, recommendations and feedback in a timely fashion.
- The Committee shall normally operate by consensus. If consensus cannot be achieved then issues should be referred the Migratory Bird Sub-Activity for decisions.
- The AMC will be supported by a Secretariat.

Secretariat: A Secretariat, reporting to the Co-chairs and normally housed within the Species Abundance and Distribution Section, Canadian Wildlife Service, shall provide support for all of the functions of the AMC, as resources permit. Secretariat responsibilities will include but not be limited to:

- Managing the logistics associated with Committee processes including:
  - scheduling Committee meetings and keeping records of meetings
  - maintaining a review schedule for all programs to ensure they are reviewed regularly
  - managing annual processes and interactions between monitoring Program Managers and the Committee
  - tracking and reporting on implementation of recommendations
- Facilitating the exchange and dissemination of information, protocols, techniques, guidelines and standards within the migratory bird monitoring community to promote effective management of programs and information.
- Managing a permanent and complete document management system for all aspects of Environment Canada's monitoring programs including programs objectives and descriptions, techniques and methodologies, meta-data descriptions etc.

Clarification of Responsibilities: The responsibilities of the AMC have been described in the above sections of this Terms of Reference.

For clarity within this Terms of Reference responsibilities that are not held by the AMC are briefly described here.

Monitoring Program Managers and staff, through their respective Director, will be responsible for:

- The accountability and effective management and delivery of all aspects of monitoring programs within their control. This includes managing programs and information to determined standards and guidelines.
- The assessment, response and adaptation to programs, as appropriate, based on recommendations and advise from the AMC.
- The representation and resources to participate to the AMC.
- The response to requests to provide analysis or to provide information for audits.
- The making of requests to the AMC to undertake specific studies or reviews or to provide recommendations on any of the monitoring programs within their responsibility.