

Recommendations for a Puget Sound Estuary Avian Monitoring Strategy

*Prepared for the Puget Sound Ecosystem Monitoring Program
(PSEMP) on behalf of the PSEMP Marine Birds Work Group*



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Executive Summary

Avian monitoring in Puget Sound estuaries consists of a number of independent monitoring programs that apply disparate survey designs, protocols, and objectives in their monitoring efforts. The lack of regional coordination precludes our ability to evaluate avian responses to large-scale environmental change, including habitat loss, degradation, succession, restoration and climate change, and limits our interpretation of the effectiveness of site-level management actions.

In this report we describe the results of the second phase of a multi-phase effort to understand avian response to tidal restoration and build a more strategic and unified regional approach to avian monitoring in estuaries. In winter 2018/2019, the Puget Sound Ecosystem Monitoring Program (PSEMP) Marine Birds Work Group convened avian stakeholders associated with estuarine habitats in coastal Washington, Puget Sound and the greater Salish Sea to solicit input on avian information needs. Participants hailed from state, federal and tribal governments, conservation NGOs and academia. Strong support was voiced for a regional, coordinated approach that provides stakeholders with information that will result in greater scientific credibility for management and conservation decisions at the local and regional scale. The need to cultivate greater social and political support for estuary restoration, and bird conservation more specifically, emerged as a critical enabling condition for the advancement and long-term success of a coordinated regional monitoring strategy.

Take-Aways

■ Estuary stakeholders need access to credible data at multiple spatial and temporal scales to understand and communicate the status of bird populations, understand the mechanisms driving their population trends, weigh the implications of different management actions, reduce human conflict, and invest strategically in conservation outcomes for birds and other species.

■ Development of a coordinated monitoring framework will facilitate the integration of birds into estuary restoration efforts and will dramatically improve our ability to deliver conservation outcomes for birds in a time of rapid environmental change.

■ Birds are a significant engagement tool for conservation because they occur in all habitats, are easily accessible, and are highly charismatic. They can help connect people to our capital investments in nature, and they provide an indicator of marine and estuarine ecosystem health for managers and decision-makers.

■ Immediate next steps to advance the development of a regional monitoring framework include: 1) convene a leadership team to champion the project and secure funding, 2) build momentum and support by identifying synergies with other estuary values and maintaining communication, and 3) form technical work groups to begin tackling science needs.

Letter to Readers

The recommendations in this report reflect an evolving set of themes around our interest in bringing birds to the forefront of estuary management and restoration. Originally designed as a set of questions around science and monitoring priorities—understanding bird responses to tidal restoration in our region and exploring stakeholder information needs—our outreach efforts to estuary managers, biologists, and other avian stakeholders have sparked a multifaceted vision that would compel the integration of birds into estuary management and restoration efforts. Cultivation of greater social and political support for the shared benefits of bird and habitat conservation is a vital component of this vision.

Our stakeholder discussions underscored the diversity of values that birds represent to different people. To some, they are a source of wonder, inspiration, and connection to the natural world. Others value them for sport, food, or as part of their cultural legacy. Still others view them as a pest, economic threat, or nuisance. One pressing example is Washington's wintering snow goose population, which gathers in large numbers in the Skagit Valley, attracting throngs of tourists. This phenomenon benefits the local economy through tourism dollars, but can also be detrimental to local agricultural producers. Balancing the needs of birds with a wide array of stakeholders is a complex challenge, and requires credible data and a willingness to listen, learn, and focus on multi-benefit solutions.

Our conversations accentuated the universal, unmet need for sustained monitoring support and the recognition that technological advances in data collection, synthesis and communication methods are critically needed. In a world where big data is increasingly being applied to optimize economic performance, natural resource management and protection in our region remains constrained by a 20th century approach. Much work has yet to be accomplished before the public, decision-makers, and funders support monitoring and ecosystem conservation to the degree needed to sustain Puget Sound and the greater Salish Sea as wild and prolific places. Yet birds are indicators of ecosystem health and have a strong public constituency that advocate on their behalf. They also provide a tangible outcome from our investments in nature, and can help drive public interest in the shared benefits of healthy watersheds, wetlands, and marine waters.

A rigorous, coordinated approach to bird monitoring is just one component of transforming our approach to avian management and conservation. To be successful, we must partner with diverse organizations and affinity groups to revitalize the public's relationship with and access to nature. We must also invite expertise from the tech sector, who can work with us to design 21st century solutions to data collection and analysis challenges. And finally, we must re-envision our institutional cultures so that we can reduce administrative barriers and better leverage one another's skills, expertise and data towards common goals. Together, we can ensure that birds are included in a whole systems approach to Puget Sound and Salish Sea conservation that sustains wild places, wildlife, and the people and cultures who depend on them.



Trina Bayard, *Director of Bird Conservation*

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Project Background and Overview

Project Scope

The Salish Sea is an inland sea encompassing Puget Sound to the south, the Strait of Juan de Fuca, the Strait of Georgia in Canada, and all of their connecting waters. Puget Sound is considered a complex estuarine system, and can be further broken down into three estuarine types, including large river deltas, embayments, and their interconnecting beaches (Shipman 2008). For the purposes of this report, we define estuaries as the bays and tidal wetlands associated with major river deltas, including open water, sand and mud flats, eelgrass, saltmarshes, brackish marshes, and in some areas, fertile agricultural lands that were formerly tidal habitats. Our geographic scope is aimed at Puget Sound, with the recognition that the inclusion of the greater Salish Sea and our respective outer coasts is likely warranted. Therefore, to the extent that capacity for this project has allowed, we have invited participation and input from practitioners in Willapa Bay and Grays Harbor on Washington's outer coast, and the Fraser River Delta in British Columbia. The scope of this report, set by our funding parameters, focuses on the 16 major river deltas of Puget Sound, along with the Fraser River Delta in British Columbia (Figure 1).

Birdlife of Puget Sound and the Salish Sea

The shallow bays, mudflats, and wetlands that form at local river mouths provide habitat for over 70 species of shorebirds, waterfowl, secretive marsh birds, and other marine bird species (Buchanan 2006). Waterfowl species diversity is exceptionally high and three estuaries in the Salish Sea are recognized as sites of significant importance for migratory shorebirds by the Western Hemisphere Shorebird Reserve Network. Dozens of Important Bird Areas have been designated within the Salish Sea, which identify areas where migratory waterfowl, shorebirds, and birds of prey congregate in globally, nationally, or regionally significant numbers (Figure 2).

Beginning at the Fraser River's Boundary Bay in Canada and moving south, 10 estuarine bays and associated tidal wetlands are recognized by the Audubon/Bird Life International Important Bird Area program for their role in supporting large concentrations of migratory birds. These areas typically include a mix of open water, sand and mud flats, eelgrass, saltmarshes, brackish marshes, and in some areas, fertile agricultural lands. Together, these habitats support regionally and globally significant numbers of waterfowl, shorebirds, and birds of prey. In US waters, these estuarine bays and wetlands include Samish, Padilla, Skagit and Port Susan Bays in the north Sound, Nisqually Delta, Eld and Totten Inlets in the south Sound, and Dungeness and Sequim Bays on the Olympic Peninsula.

There are no historical records available from which we might measure the extent of marine and coastal bird population declines since Euro-American settlement and the agricultural conversion of estuaries between the late 1800s and early 1900s (Petrie 2013). More recent avian census efforts suggest that there are



Figure 1. Historic extent of major river deltas in the U.S. Salish Sea (Simenstad et al. 2011).

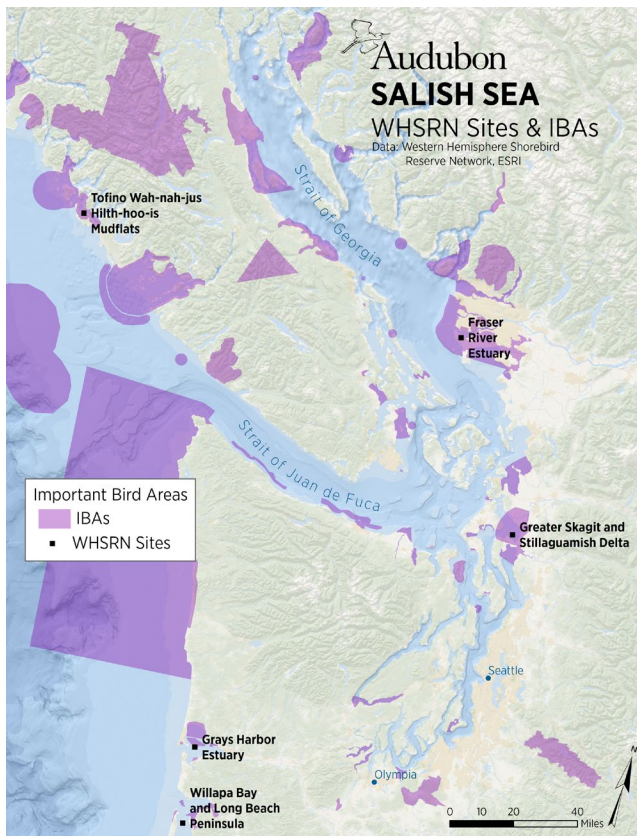


Figure 2. Designated Important Bird Areas (IBAs) and Western Hemisphere Shorebird Reserve Network (WHSRN) sites in the greater Salish Sea and beyond.

considerably fewer birds wintering in Puget Sound today than there were in the 1970s, with some species experiencing variable population change over that time, others showing steady declines, and others stable or increasing (Bower 2009, [PSP Marine Bird Vital Signs](#)). Recent analysis by N. Vilchis and colleagues suggests that diving birds that consume forage fish are most likely to be experiencing decline in our region (Vilchis et al. 2014).

Problem Statement

The loss and degradation of estuary habitat in our region has been severe, with approximately 74% of Puget Sound river delta tidal wetlands lost in the last 150 years (Figure 3; Simenstad et al. 2011). Two thirds of British Columbia's Fraser River Delta habitats have been lost to urban and industrial development ([pacificbirds.org](#)). Restoration of tidal estuary habitats has been a top priority for the Puget Sound recovery community (e.g., U.S. EPA, Puget Sound Partnership, and implementation partners), yet progress is slow

(Cereghino 2015). Approximately 2,791 acres of estuarine tidal wetlands in Puget Sound were restored between 2006 and 2016 (Puget Sound Partnership 2017) and nearly US\$80 million spent (RCO 2017). In Puget Sound, many estuary restoration projects are initiated in support of salmon recovery, particularly the federally listed Chinook salmon (*Oncorhynchus tshawytscha*). Significant, dedicated restoration and monitoring support and funding for migratory birds has been uncommon.

In order to implement effective management of estuarine bird species and their habitats, it is critical to understand the range of impacts of salmon or ecosystem-focused estuary restoration to birds. Additionally, uncertainty exists over the local and regional status and trends of some estuarine-associated avian species and species-specific responses to management actions and policy decisions; in many cases, even basic life history information is lacking. The conservation and management community is limited in its ability to evaluate the effectiveness of conservation and management actions for birds, and has few tools to anticipate how landscape change and other human pressures, particularly climate change, are likely to impact birds over time.

Improving our understanding of these questions is about more than birds and bird conservation. Birds are a relatively untapped resource in our region that can help connect people to nature, and that serve as indicators of marine and estuarine ecosystem health for managers and decision-makers. For birds to serve us in this way, however, we need a robust monitoring system that facilitates data collection and analysis at the right scale.

Project Overview

In 2017, the Marine Birds Work Group affiliated with the Puget Sound Ecosystem Monitoring Program embarked on a multi-phase project with the ultimate goal of developing a more strategic and unified regional approach to avian monitoring in estuaries. The initial focus was aimed at compiling the state of knowledge on the effects of tidal restoration on birds (Phase I). Following additional thought and discussion with estuary conservation partners, the scope of the project has since expanded to encompass monitoring and information

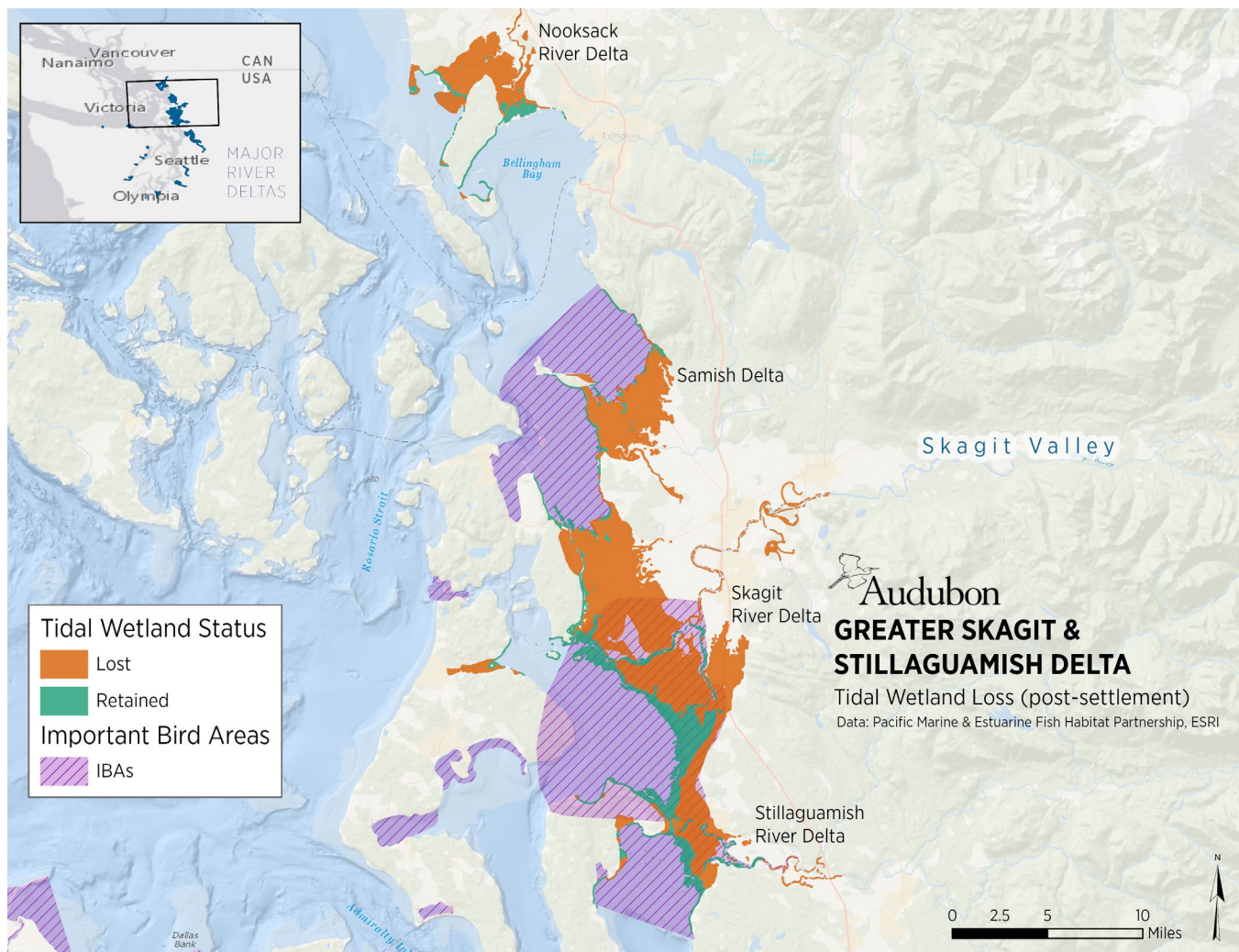


Figure 3. Tidal wetland loss in the greater Skagit and Stillaguamish Delta in relation to the Samish/Padilla, Skagit and Port Susan Bay IBAs. Approximately 64,000 acres, or 74% of river delta tidal wetlands have been lost since the 1900s (Simenstad et al. 2011).

needs in river delta estuaries more broadly, recognizing the need to interpret local effects in the context of larger temporal and spatial processes. Phase II of the project, synthesized in this report, has involved regional workshops to better understand avian monitoring needs and objectives amongst local practitioners, including estuary habitat and restoration managers, avian scientists and wildlife biologists working in coastal Washington, Puget Sound and the Salish Sea. The next phase of the project (Phase III) will involve the development of a coordinated avian monitoring framework and associated leadership structures, data warehousing and support, and communication platforms.

Phase I

In Phase I of the project, we inventoried bird monitoring projects associated with tidal restoration in Puget Sound river deltas and synthesized what was learned in

these projects. We also collected information on other regions of WA, OR, northern CA, and British Columbia. The results of this inventory suggest that current site-level approaches to avian monitoring preclude interpretation of the outcomes of restoration and management actions at the local or regional scale, and greatly limit our ability to deliver conservation outcomes for birds more broadly. Shared regional objectives that can guide the development of a coordinated bird monitoring framework, inform progress towards population and habitat targets, and allow for adaptive management are critically needed (Koberstein et al. 2017).

Key Findings

- Twenty-one dike removal projects were initiated in Puget Sound between 1994 and 2016. Of those 21 projects, 14 included some form of bird monitoring effort.

- Avian monitoring efforts are not standardized. There is considerable variation in methodological and analytical approaches, objectives and performance standards.
- Pre- and post- restoration monitoring is inconsistent across sites and time. Project managers are constrained from sampling at biologically relevant scales.
- Monitoring reports provide summaries of avian response, with very little or no use of statistical methods.
- Justification for restoration activities and associated bird monitoring is not tied to regional or population-level bird conservation objectives.

2018 Salish Sea Ecosystem Conference

In 2018, T. Hass and others convened estuarine ecologists and bird monitoring experts at the Salish Sea Ecosystem Conference in Seattle, WA, to share the results of the 2017 Koberstein et al. inventory and synthesis and explore opportunities for building a systematic and streamlined framework for future avian monitoring. Presentations and discussions focused on the feasibility of a framework that builds on the body of monitoring work in the Salish Sea; accounts for temporal and area-dependent tradeoffs in habitat quality and predator pressure; is scalable and compatible with peer programs along the Pacific flyway; and establishes common and reciprocal monitoring goals for estuaries and birds (Hass et al. 2018).

Participants in the session generally agreed that the responses to restoration by the shorebird “guild” are not expected to be uniform across broad temporal and spatial scales, and will depend highly on the tidal elevation, distance to terrestrial cover, and specific estuarine microhabitats present at individual sites. In contrast, the prospects for successful monitoring of estuarine waterfowl pre- and post-restoration were thought to be more suitable for systematic sampling across the Salish Sea.

Phase II

The goal of Phase II was to: 1) identify common themes around avian monitoring needs that could be used to guide the development of a scientifically rigorous, coordinated monitoring framework and, 2) to

strengthen ties among estuary habitat and restoration managers, avian scientists and wildlife biologists.

The recognition that site-level approaches to monitoring are insufficient to evaluate avian responses to conservation and management is well-known, and is not unique to our region. In 2007, the U.S. North American Bird Conservation Initiative (NABCI) published a report describing key steps needed to improve the efficiency and effectiveness of bird monitoring efforts ([U.S. NABCI 2007](#)). The report describes four categories in need of improvement, which can serve to guide our efforts to design a regional monitoring framework:

- Improvements in effectiveness: better alignment of monitoring programs with clearly articulated management or conservation objectives and priorities;
- Improvements in scope: increasing the number of species for which we can make more informed conservation or management decisions;
- Improvements in utility: especially in the areas of statistical design and data management and accessibility; and
- Improvements in coordination and efficiency: leading towards standardization and synergy among agencies and organizations and across spatial scales.

The NABCI report explains how these improvements can help us deliver conservation outcomes for birds, increase our knowledge of ecological systems, and enhance decision-making. The Northeast Coordinated Bird Monitoring Partnership ([NECBM](#)), articulates these benefits further:

“Anticipated benefits include better integration of monitoring into conservation decision-making, robust survey design and analysis, consistent field methods, improved data management, and more frequent and informative reporting. A coordinated approach could also increase power to detect spatial patterns and temporal trends, while placing local results into a regional context. Coordinated surveys that incorporate structured decision-making have the potential to increase the relevance of bird monitoring to management and conservation. Finally, gains in efficiency could reduce the cost of monitoring and enable greater attention to historically neglected bird groups.”



Report Overview

The recommendations in this report are derived from input gathered at two regional workshops in December 2018 (South Sound) and March 2019 (North Sound) and targeted one-on-one discussions. The 42 participants at our workshops hailed from 5 tribes, various levels of 3 state and 2 federal agencies, 2 Canadian institutions, 10 NGOs, and one academic institution. A list of participants and their affiliations are included in Appendix A. The discussion questions and a condensed version of responses are included in Appendix B. Workshop participants were surveyed prior to the workshop; a summary of their responses is included in Appendix C.

Our daylong workshops were designed as small-group discussion modules to solicit participation and creative thinking. Participants were asked a series of discussion questions about their vision for success, the challenges and constraints that need to be overcome to transform our current approach, and the specific avian information needs related to population status and trends, life history information, human pressures, and ecological processes that are currently unmet.

The content generated by these discussions is organized into five sections:

Section 1: Defining success. We explain what successful coordinated bird monitoring in our region looks like according to workshop participants.

Section 2: Information needs. We review themes around the information needs and priorities identified by workshop participants.

Section 3: Socio-political context. We describe the social and political context in which we operate and the cultural changes that are needed to bring birds to the forefront of estuary management and conservation.

Section 4: Enabling conditions. The specific elements and associated actions that are needed to build and sustain a coordinated regional monitoring network.

Section 5: Recommendations and next steps. We synthesize workshop input on potential immediate next steps and provide recommendations to consider for a regional monitoring framework.

Section 1: Defining Success

Participants spoke to a range of potential benefits that could be realized through a coordinated avian monitoring framework, namely that it would facilitate the collection of integrated and complementary data collection for bird populations and their habitats that results in scientifically robust:

- Prioritization and evaluation of management, conservation, and restoration actions at different scales;
- Evaluation of ecological processes affecting bird populations and their habitats;
- Evaluation of habitat relationships;
- Evaluation of human pressures/threats, including climate change;
- Species status assessments; and
- Communication and public outreach materials.

Social benefits would include enhanced partnerships, a new community of practice, enriched relationships with stakeholders, greater public engagement, and an improved ability to obtain funding. More collaboration would drive innovative research, information sharing, and efficiency of effort—we could do more with less.

Section 2: Avian Information Needs

Workshop participants were asked a series of questions designed to provoke discussion about their vision for a coordinated approach and the different kinds of information needs they experience in their roles as field biologists, management, or conservation practitioners (see Appendix B for condensed responses).

1. What are the management actions that potentially impact birds and their food and habitat resources that you would like to understand better?
2. How could bird monitoring data potentially be used to benefit management and conservation of estuaries?
3. What are the ecological processes that potentially impact birds and their food and habitat resources that you would like to understand better?

4. What are the human pressures that potentially impact birds and their food and habitat resources that you would like to understand better?
5. What questions do you have about species or habitat use?

The following themes emerged that speak to the participants' desire for enhanced functionality—a perceived core benefit of a regional framework approach.

Be strategic. Baseline status and trends information, hypothesis-driven data collection, bird-habitat relationships, and leveraging existing fish and habitat datasets were identified as priorities. These distinct yet complementary types of information are needed to prioritize species and places for conservation actions, guide strategic habitat management and conservation actions across local and regional scales, and to inform adaptive management feedback loops.

Reduce conflict and increase engagement. Life history information on ecological relationships, daily and seasonal patterns in site use, and information about species population trends at the regional scale can help reduce conflict with stakeholder groups when all parties have access to credible information. This information can also be used to build support and appreciation for bird conservation.

Bring birds to the forefront of planning and policies. Information on population-level responses to management and policy decisions, a better understanding of avian life history needs, and stronger integration of avian data with other natural resource values can help us identify emerging conservation issues, avoid and mitigate human impacts on birds and estuarine systems, and pursue multi-benefit solutions. Information collected at broader scales can lend context and credibility to recommendations for land use and protection policies at the local scale.

NABCI has identified seven themes for bird monitoring objectives that are commonly identified as priorities across the bird monitoring community nationwide ([U.S. NABCI 2007](#)). We have organized stakeholder input into these themes to aid in translating stakeholder information needs into monitoring objectives for our region:



Determine the Status and Trends of Populations

- Conduct species status assessments for priority species and determine trends
- Compare local, regional, and range-wide population trends
- Make monitoring data (and syntheses) more accessible to natural resource management community and public

Determine Causes of Population Change

Site Level

- Increase understanding of climate change impacts on estuarine food webs (e.g., sea-level rise, ocean acidification, changes in hydrology, changes in sediment loads, changes in temperature, species range shifts)
- Investigate avian behavioral responses to human disturbance (public recreation, dog-walking, bird-watching, hunting, management activities), predators, and aquaculture practices

- Investigate the potential direct and indirect impacts of on-site vegetation management (e.g., burning, mowing, herbicide use) on birds
- Investigate avian response to tidal restoration
- Investigate habitat-based carrying capacity, including of agricultural areas

Landscape Level

- Investigate the cumulative effects of estuary restoration on species and avian community
- Investigate the potential direct and indirect impacts of agricultural practices (e.g., pesticides, seasonal flooding, cowbird parasitism, cover crops, conversion from one type to another)
- Investigate the potential direct and indirect impacts of storm water contaminants, agricultural run-off, wastewater treatment outfall, and micro-plastics
- Investigate the potential direct and indirect impacts of boat and vessel traffic and contaminants
- Increase understanding of the role of decadal climatic variation (e.g., el Nino, PDO, ENSO, PNA, NAO, AMO) in driving population change

- Increase understanding of how watershed management decisions impact estuary habitat (e.g., dams, water usage, channels, sediment, floodplain restoration)
- Increase understanding of how habitat fragmentation and land cover changes impact bird use of estuary habitats

Set Population Objectives and Species/Management Priorities

- Identify priority species for monitoring, management and conservation
- Set spatially explicit population and habitat goals for priority species

Inform Management and Policies to Achieve Conservation

- Evaluate current habitat capacity and model future habitat capacity under climate change
- Develop and pursue adaptation strategies to mitigate climate change impacts, including sea-level rise on wetland habitats
- Increase understanding of habitat relationships for priority species to better inform management practices
- Investigate avian use of agricultural habitats
- Investigate role of waterbirds in propagating wetland communities and influence on wetland biodiversity
- Increase understanding of the relative importance of different human threats to priority species and habitats in order to prioritize conservation efforts
- Design monitoring to inform adaptive management questions
- Investigate which (avian) species and guilds benefit from fish habitat restoration
- Investigate and quantify the ecosystem services provided by birds
- Investigate waterfowl effects on water quality
- Monitor changes in agricultural crops, e.g., conversion of row crops to berry farms and resulting changes in bird use
- Ensure that waterfowl and shorebird population targets are integrated into regional Puget Sound/Salish Sea conservation planning and landscape strategies

- Use information on waterfowl and shorebird habitat requirements to inform urban growth management policies
- Work across disciplines to integrate responses of birds and fish to habitat management and restoration

Evaluate Conservation Efforts

- Increase understanding of non-target impacts of single species management, including identification of potential indicator or umbrella species
- Increase understanding of avian response to tidal restoration and different approaches to tidal restoration
- Increase understanding of avian response to vegetation management (techniques, timing, vegetation targets)

Inform Conservation Design

- Investigate species movement among estuaries and the mechanisms driving movement
- Model potential future habitat conditions under climate change and sea level rise
- Identify shorefront properties that could play a role in facilitating marsh migration
- Increase understanding of the role of agriculture in providing food and roosting habitat
- Increase understanding of habitat use dynamics across different time scales – diurnally, tides, seasons, migratory stopover periods and mechanisms driving occurrence and movement
- Set spatially explicit management and conservation priorities that integrate climate change impacts

Assess Human Dimensions

- Increase understanding of human values related to birds, bird-watching, and hunting and of how to bridge the gap between birders and hunters
- Increase understanding of multi-benefit solutions to habitat protection and climate mitigation that benefit birds, people, and ecosystem services
- Increase understanding of farmer's concerns related to climate change

Section 3: Socio-Political Context

Targeted management objectives and public investment in shorebirds, waterfowl, and other estuarine bird species are not only warranted, they are critical to the health of our marine system. When we take care of the needs of birds, we invest in the health of our entire ecological system.

Yet, a cursory review of materials related to Puget Sound management and recovery, e.g., nearshore restoration guidance and prioritization reports, the Puget Sound Partnership Estuary Strategic Initiative, and natural resource agency budget proposals, yields scant mention of birds. Salmon, shellfish, orcas and water quality tend to be the primary drivers of conservation efforts in our region, yet Puget Sound and the greater Salish Sea forms a critical link in the migratory cycle of many marine and coastal bird species. Moreover, birds provide an array of ecological, cultural, and economic benefits to the Puget Sound and greater Salish Sea region.

Shorebirds, waterfowl, raptors and songbirds find food and shelter in the protected bays, wetlands and agricultural fields in our region. Access to these birds – whether for observation, hunting, photography, or simple enjoyment, brings economic and cultural benefits to coastal communities. Numerous festivals occur throughout the region in celebration of birds, bringing additional tourist dollars and opportunities for new audiences to connect with nature. Birds also provide ecosystem services to river delta estuaries via dispersal of seeds and invertebrates, and as herbivores and predators (Green and Elmberg 2014).

Estuary managers, biologists and stakeholders face considerable barriers to implementing management and monitoring programs in support of natural resources generally and birds specifically. Underlying these challenges is a lack of adequate support—whether that be staff capacity, funding support, institutional support or public engagement—to design and implement monitoring programs at biologically appropriate scales, build relationships and trust with local stakeholders, analyze data and communicate results, use a structured approach to inform and direct further management actions, and engage the public.

Resource managers are also constrained by insufficient access to technology and the cost-savings and increased data generation that tech solutions might offer for species and systems inventory, monitoring, analysis and reporting (Atanbori et al. 2016). Although new technology exists on birding apps to identify birds through visual and auditory data (e.g., [Birdsnap](#), [Birdsong ID](#)) and computer vision biometric techniques are the subject of ongoing inquiry for conservation applications (e.g., Weinstein 2017), pairing this capability with broad scale monitoring is still in its infancy. Working with the local tech community to harness advancements in computer vision and machine learning (e.g., [Microsoft AI for Earth](#), [Google AI for Social Good](#)) could yield significant benefits for bird monitoring and ecosystem recovery.

Section 4: Enabling Conditions

Workshop participants emphasized that for a coordinated, regional approach to be successful, we must implement a significant outreach and engagement component – both of entities positioned to support this work, such as funders, policy-makers, institutional leadership, Puget Sound recovery leaders; the public, including local communities, economic interests, agricultural stakeholders, hunters and birders; and discipline specialists, including estuarine, fisheries and avian ecologists, quantitative ecologists, tribes, state and federal agencies and conservation NGOs. Such a broad outreach effort will require a significant investment in coordination, convening, and communication. Greater capacity for stakeholder relationship development and trust building has been identified as a foundational need by other estuary restoration stakeholders (e.g., [Puget Sound Partnership Estuaries Implementation Strategy](#); Cereghino 2015). Other conditions that need to be addressed include:

Capacity — funding, leadership, qualified staff and volunteers, internal and external communication channels.

Scope and common purpose — a clear geographical scope of interest, both for estuaries and within the region, and shared objectives and goals across a broad suite of stakeholders and institutional mandates.

Broad relevance — Common public values, (e.g., salmon, water quality, agriculture, tribal harvest,



climate change resilience, recreation) are integrated, generating interest and support among funders, decision-makers and the public.

Quantitative expertise and rigor — a monitoring approach that handles variability in the system (topographic, currents, substrate, elevation, weather, tides), site access constraints, and seasonal changes in avian occurrence.

Credible scientific underpinnings and evidence-based decision making — a statistically robust yet practical framework that allows us to deliver conservation outcomes at multiple scales.

Integrated data storage and management — a common database, warehouse, or catalog for data storage and resources for data management, analysis, and synthesis.

Institutional culture and barriers to collaboration — a parallel process that considers transboundary and institutional barriers, diverse and divergent priorities, mandates, and data sharing concerns, and an explicit change management approach to move practitioners from disparate methods and protocols to a unified approach.

Section 5: Recommendations and Next Steps

The information needs and potential monitoring objectives identified by workshop participants are considerable and will likely expand with engagement of other stakeholders. Based on our outreach efforts to date, *understanding how and why bird populations are changing, and collecting data that can inform multi-benefit management and policy, appear to be the areas of greatest need and interest for our region.*

Monitoring Program Design

Several collaborative efforts have been attempted or are underway in coastal areas that reflect similar needs and challenges, including the Saltmarsh Habitat and Avian Research Program ([SHARP](#)) and the Gulf of Mexico Avian Monitoring Network ([GOMAMN](#)). These networks have formed out of a growing need for data-driven conservation planning. These programs have abundant reports, examples, and lessons-learned that our emerging network can make use of. There is also growing literature on potential analytical approaches

to large-scale monitoring programs (e.g., Pavlacky et al. 2017, Schaub and Abadi 2011) and integration of diverse count-based datasets and protocols (Miller et al. 2019), that can be used to explore relevant sampling designs.

The design for a coordinated monitoring framework will require an iterative process with stakeholders, quantitative ecologists and data management experts to determine a sustainable, least cost solution that meets our region's core monitoring objectives and integrates with existing estuary restoration efforts. There are several core principles that we suggest the framework adhere to:

Limit the focus. A monitoring framework that allows us to pinpoint drivers of population change at the local level is a high priority for stakeholders. Being cognizant of the fact that birds are affected by processes that occur throughout their annual cycle and in ways that are inherently species-specific, we recommend focusing the regional monitoring framework on a select number of priority species.

Commit to statistical rigor. Randomized sampling and inclusion of methods that account for detection biases (e.g., surveyor differences, variation in species occurrence over time and space) and spatial clustering are key considerations for a rigorous sampling design. Consider the relevance and feasibility of a statistical approach that: 1) estimates abundance, 2) quantifies demographic parameters, or 3) enables a combined approach (e.g., Integrated Population Model, integrated count-based models) for stakeholder information needs. Institutional cultural change and technical support is needed to foster *a priori* hypothesis development related to adaptive management, rather than general surveillance monitoring.

Integrate existing protocols. A number of regional and national survey frameworks have been developed by species experts that we recommend be considered for integration into a regional sampling framework. Potential survey frameworks, protocols, or datasets to consider include:

- Shorebirds: [Standards for Monitoring Nonbreeding Shorebirds in the Western Hemisphere](#), including the International Shorebird Survey.
- Seabirds: [Puget Sound Seabird Survey](#). [BC Coastal Waterbird Survey](#).

- Secretive wetland birds: [Secretive Wetland Bird Surveys. Standardized North American Marsh Bird Protocol](#).
- Waterfowl: [Mid-Winter Waterfowl Inventory](#).

Next Steps

There are a number of practical steps identified in our workshops that we can pursue right away to create the enabling conditions for a coordinated monitoring framework. These steps address challenges related to leadership, building political, institutional and public support, and preliminary steps around science needs.

Develop Leadership and Capacity

Establish an identity and leadership team. Develop name, mission, scope, study area. The leadership team should include representatives from major institutional partners, including tribes, agencies, and NGOs. The leadership team can provide guidance, secure buy-in from partners/groups, and solicit core participants, leaders, and contributors.

Build capacity. Identify and pursue funding pathways for next steps, e.g., scientific framework development or identification of common interests with other estuary stakeholder efforts. Exert influence on funding prioritization.

Build Momentum and Support

Broaden our relevance. Engage and include a diverse group of stakeholders through meetings and information-sharing workshops. Communicate regularly to potential funders, agency leadership, policy-makers, Puget Sound recovery leaders, agricultural communities, industry, and the public. Explore synergies with other estuary restoration efforts (e.g., PSNERP, PSP Estuary Strategic Initiative).

Initiate conversations with the tech community.

Establish connections with the tech community and explore areas of mutual interest and problem-solving opportunities.

Explore and initiate communication tools for practitioners.

Consider a listserv, discussion platform, and central website. Host information-sharing workshops for people to share current work/efforts. Provide regular updates.

Tackle Science Needs

Synthesize existing information. Disseminate the results of the 2017 Avian Monitoring Inventory in Puget Sound more broadly. Conduct an inventory of current monitoring efforts, protocols, and data sets within the Salish Sea.

Form technical work groups:

- *Review existing framework monitoring designs and robust statistical approaches.* Target participation from individuals with quantitative expertise. Investigate lessons learned from other regional monitoring networks (e.g., see examples below). Evaluate the potential utility and feasibility of using integrated population models (IPM) as a framework to integrate count data and demographic data (Schaub & Abadi 2011, Saunders et al. 2018, Zipkin & Saunders 2018).
- *Set species and management objective priorities.* Consider information gaps and common monitoring objectives identified in workshops and reach consensus on shared management objectives. Identify species and metrics of interest, actionable goals and objectives linked to management needs e.g., Pacific Birds Habitat and Population Objectives for Wetlands and Waterbirds in the Puget Sound Lowlands Ecoregion (Petrie 2013).

Address data storage and sharing challenges. Consult with Avian Knowledge Network (U.S.) and Nature Counts (Canada) and establish MOU's/agreements for data sharing early on.

Conclusion

Avian and estuary conservation stakeholders from Puget Sound and beyond have voiced broad support and enthusiasm for an overhaul of avian monitoring and conservation efforts in our region. Workshop

participants generated a considerable list of information needs that are unmet by the current site-level approach, and identified key institutional and cultural changes that are needed to foster a regional monitoring framework. Bringing birds to the forefront of estuary management and conservation efforts can yield multi-benefit solutions that enhance public support for ecosystem restoration.

Take-Aways

Estuary stakeholders need access to credible data at multiple spatial and temporal scales to understand and communicate the status of bird populations, understand the mechanisms driving their population trends, weigh the implications of different management actions, reduce human conflict, and invest strategically in conservation outcomes for birds and other species.

Development of a coordinated monitoring framework will facilitate the integration of birds into estuary restoration efforts and will dramatically improve our ability to deliver conservation outcomes for birds in a time of rapid environmental change.

Birds are a significant engagement tool for conservation because they occur in all habitats, are easily accessible, and are highly charismatic. They can help connect people to our capital investments in nature, and provide an indicator of marine and estuarine ecosystem health for managers and decision-makers.

Immediate next steps to advance the regional monitoring framework concept include: 1) convene a leadership team to champion the project and secure funding, 2) build momentum and support by identifying synergies with other estuary values and maintaining communication, and 3) form technical work groups to begin tackling science needs.

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References

- Atanbori J, Wenting D, Murray J, Appiah K, Dickinson P. 2016. Automatic classification of flying bird species using computer vision techniques. *Pattern Recognition Letters* 81:53-62.
- Bower JL. 2009. Changes in marine bird abundance in the Salish Sea: 1975 to 2007. *Marine Ornithology* 37: 9-17.
- Buchanan JB. 2006. Nearshore Birds in Puget Sound. Puget Sound Nearshore Partnership Report number 2006-05. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.
- Cereghino PR. 2015. Recommendations for Accelerating Estuary Restoration in Puget Sound. Prepared for the Puget Sound Partnership and Washington Department of Fish and Wildlife by NOAA Fisheries Restoration Center, Seattle, WA. 20 pp.
- Green AJ, Elmberg J. 2014. Ecosystem services provided by waterbirds. *Biological Reviews* 89(1): 105-122.
- Hass T, Bayard T, Hope D. 2018. "Shorebird Monitoring in the Salish Sea" Salish Sea Ecosystem Conference. 604. <https://cedar.wvu.edu/ssec/2018ssec/allsessions/604>
- Koberstein, M, Slater, G, Bayard, T, Hass T. 2017. Avian Monitoring in Support of the Estuaries Vital Sign in Puget Sound: Inventory and Assessment. Report to the Puget Sound Partnership, Tacoma, WA. <https://pspwa.box.com/v/Koberstein2017>
- Miller DA, Pacifici K, Sanderlin JS, Reich BJ. 2019. The recent past and promising future for data integration methods to estimate species' distributions. *Methods in Ecology and Evolution* 10(1): 22-37.
- Pavlacky DC Jr, Lukacs PM, Blakesley JA, Skorkowsky RC, Klute DS, Hahn BA, Dreitz VJ, George TL, Hanni DJ. 2017. A statistically rigorous sampling design to integrate avian monitoring and management within Bird Conservation Regions. *PLoS ONE* 12(10): e0185924.
- Petrie M. 2013. Habitat & population objectives – wetland birds and waterbirds – North Puget Lowlands Ecoregion. Prepared for Pacific Coast Joint Venture. <https://pacificbirds.org/>
- Puget Sound Partnership. 2017. "Restoration of Puget Sound Estuaries: Indicator and Target Description." <https://www.psp.wa.gov/vitalsigns/estuaries.php>
- RCO. 2017. Washington State Recreation and Conservation Office PRISM database. https://www.rco.wa.gov/prism_app/about_prism.shtml
- Saunders SP, Cuthbert FJ, Zipkin EF. 2018. Evaluating population viability and efficacy of conservation management using integrated population models. *Journal of Applied Ecology* 55: 1380-1392.
- Schaub M, Abadi F. 2011. Integrated population models: A novel analysis framework for deeper insights into population dynamics. *Journal of Ornithology*. 152(1): 227-237.
- Shipman H. 2008. A Geomorphic Classification of Puget Sound Nearshore Landforms. Puget Sound Nearshore Partnership Report No. 2008-01. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.
- Simenstad CA, Ramirez M, Burke J, Logsdon M, Shipman H, Tanner C, Toft J, Craig B, Davis C, Fung J, et al. 2011. Historical Change of Puget Sound Shorelines: Puget Sound Nearshore Ecosystem Project Change Analysis. Puget Sound Nearshore Report No. 2011-01. Published by Washington Department of Fish and Wildlife, Olympia, Washington, and U.S. Army Corps of Engineers, Seattle, Washington.
- U.S. North American Bird Conservation Initiative Monitoring Subcommittee. 2007. Opportunities for Improving Avian Monitoring. U.S. North American Bird Conservation Initiative Report. 50 pp. Available from the Division of Migratory Bird Management, U.S. Fish and Wildlife Service, Arlington, VA; <http://www.nabci-us.org/>
- Vilchis LI, Johnson CK, Evenson JR, Pearson SF, Barry KL, Davidson P, Raphael MG, Gaydos JK. 2014. Assessing ecological correlates of marine bird declines to inform marine conservation. *Conservation Biology* 29(1): 154-163
- Weinstein BG. 2017. A computer vision for animal ecology. *Journal of Animal Ecology* 87(3):533-545.
- Zipkin EF, Saunders SP. 2018. Synthesizing multiple data types for biological conservation using integrated population models. *Biological Conservation* 217: 240-250.

Supplemental Materials (Appendices)

Available at <https://pspwa.box.com/v/avian-supp-materials-2019>

- Appendix A: Registered Workshop Attendees and Participants
- Appendix B: Meeting Summaries (December 3, 2018; March 4, 2019)
- Appendix C: Pre-workshop Survey Responses



Recommendations for a Puget Sound Estuary Avian Monitoring Strategy

*Prepared for the Puget Sound Ecosystem Monitoring Program
(PSEMP) on behalf of the PSEMP Marine Birds Work Group*