PACIFIC BIRDS HABITAT JOINT VENTURE

IMPLEMENTATION PLAN
2020-2030

Bert Brink Wildlife Management Area/Andrew Huang

www.pacificbirds.org

PACIFIC BIRDS
HABITAT JOINT VENTURE

VISION AND MISSION

Vision The PBHJV-BC partners are part of the larger International PBHJV and are working to achieve the following Vision: *We envision a Pacific Region united for bird habitat conservation.*

Mission The PBHJV plays an important role in facilitating conservation by its many dedicated partners. Its Mission is: *Creating the ideal environment for bird habitat conservation*.

The PBHJV Implementation Plan 2020-2030 was prepared by members of the PBHJV-BC and CIJV Science and Technical Committee, 2021.

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Cover Sidebar Photo: Great Blue Heron/©Ducks Unlimited Canada

TERRITORIAL LAND ACKNOWLEDGEMENT

The Pacific Birds Habitat Joint Venture (PBHJV) acknowledges that the lands on which we work are the traditional lands of many different Indigenous nations across British Columbia. The act of acknowledging these lands, and the signed treaties where applicable, is an act of reconciliation with Indigenous peoples and an expression of respect and gratitude for the land. This action is to remind us that our places of work, where we live and where we gather, are on the traditional lands of First Nations, Inuit and Métis people who historically resided here and still presently do. It is also a recognition that all of us are accountable to these relationships on a daily basis. The aims of the PBHJV through this Implementation Plan involves the conservation, protection and enhancement of wildlife and habitat that directly impacts Indigenous communities. We acknowledge the need for meaningful consultation with Indigenous communities throughout the implementation of this plan.

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ALC	Agricultural Land Commission
ALR	Agricultural Land Reserve
ACAD	Avian Conservation Assessment Database
BBS	Breeding Bird Survey
BC	British Columbia
BCCWS	British Columbia Coastal Waterbird Survey
BCR	Bird Conservation Region
BMP	Beneficial Management Practice
CAD	Conservation Areas Database
CIJV	Canadian Intermountain Joint Venture
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DF&WT	Delta Farmland & Wildlife Trust
DUC	Ducks Unlimited Canada
ECCC	Environment and Climate Change Canada
ENGO	Environmental Non-governmental Organization
ERA	Ecoregional Assessment
EEZ	Exclusive Economic Zone
FEP	Forage Enhancement Pilot Program
GIS	Geographic Information System
HS Models	Habitat-Species Models
IP	Implementation Plan
IPCA	Indigenous Protected and Conserved Areas
IPM	Integrated Pest Management
JV	Joint Venture
MFLNRORD	BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
MPA	Marine Protected Area
NABCI	North American Bird Conservation Initiative
NACP	Natural Area Conservation Plan
NAWCA	*North American Wetlands Conservation Act*
NAWMP	North American Waterfowl Management Plan
NCC	Nature Conservancy of Canada
NTBC	The Nature Trust of British Columbia
NTS	National Tracking System
NWA	National Wildlife Area
PBHJV	Pacific Birds Habitat Joint Venture
PBHJV-BC	British Columbia Pacific Birds Habitat Joint Venture
PCJV	Pacific Coast Joint Venture
PECP	Pacific Estuary Conservation Program
PIF	Partners in Flight
SARA	*Species at Risk Act*
SWBC	Southwest British Columbia
USFWS	U.S. Fish and Wildlife Service
WMA	Wildlife Management Area
WSP	Wetland Stewardship Partnership

EXECUTIVE SUMMARY

The Pacific Birds Habitat Joint Venture (PBHJV) is a partnership between government and non-governmental groups established to conserve birds and their habitat along the West Coast of Canada and the United States. It includes the Pacific coastal areas of British Columbia (BC), Washington, Oregon and Northern California, as well as all of Alaska, Hawaii and the Pacific Islands. The overall direction is coordinated by an International Management Board. Activities within Canada are coordinated by a BC Steering Committee comprised of major partner representatives.

Squamish Estuary, BC/Andrew Huang

The PBHJV-BC landscape is characterized by wide variations in altitude and a complex coastline, creating a multitude of productive marine and terrestrial habitat types. Waterfowl use is primarily during the migrating, staging and overwintering periods. Forty species of ducks, swans and geese occur regularly in coastal BC, with the most abundant wintering species being Lesser Snow Goose, Mallard, American Wigeon, Northern Pintail, Barrow's Goldeneye and Surf Scoter.

The PBHJV-BC is also home to a diversity of other bird species, including 39 species of shorebirds and an estimated 5.6 million colonial seabirds of 15 species. The region's wetlands, lakes, riparian and nearshore areas support a variety of loons, grebes, herons, raptors and more than one hundred species of passerines, many of which are long-distance neotropical migrants.

One particular estuary in the PBHJV—the Fraser River Delta—supports the most important migratory and wintering areas for waterfowl, shorebirds, landbirds and raptors in Canada. This is based on the large number of birds that frequent the area. The Fraser River Delta is also the only Important Bird and Biodiversity Area in Canada that is designated as "in danger" by BirdLife International, and is in the process of being designated as a Key Biodiversity Area.

The PBHJV-BC partners have identified 19 priority waterfowl species (Trumpeter Swan, 4 geese species and 14 duck species). Population objectives for each priority species were set as no-net-loss in the winter; partners must conserve enough habitat to meet their needs during this time period. Forty-eight priority non-waterfowl species were also identified; Partners in Flight's (PIF) Avian Conservation Assessment Database (ACAD) was a critical source of information used in this prioritization

process. Partners identified five priority habitat types in the PBHJV-BC: 1) estuaries, 2) agricultural land, 3) freshwater wetlands, 4) nearshore shallow marine waters and 5) riparian forests. In general, these habitat types were selected due to their high potential to support current populations of priority waterfowl and non-waterfowl species. Conservation activities are therefore focused on these habitat types.

Through a series of "Open Standards" workshops, PBHJV partners co-developed a list of limiting factors for birds and bird habitat in the region, and subsequently identified key strategies along with 5- and 10-year objectives. These include habitat securement, restoration and management objectives to guide conservation actions in priority habitat types and for the conservation of priority species. Human Dimension objectives were also developed to address knowledge gaps related to private landowners, governments, general public, recreational users and Indigenous communities.

Great Blue Heron/©Ducks Unlimited Canada/Tim Fitzgerald

PBHJV-BC partners use several conservation planning tools and models to direct management actions and investments, including the Regionally Significant Wetland Areas in BC, the Pacific Estuary Conservation Program's (PECP) estuary ranking, Ducks Unlimited Canada's (DUC) Waterfowl Priority Areas and Conservation Plans, Nature Conservancy of Canada's (NCC) Conservation Planning System and the Nature Trust of BC's (NTBC) Relative Ecological Assessment. The PBHJV partners will continue to evaluate progress through various habitat and population monitoring programs. To complete the adaptive management cycle, data analysis and tracking will then further refine conservation planning tools to better inform strategies and investment decisions.

CHAPTER 1 – OVERVIEW OF THE PACIFIC BIRDS HABITAT JOINT VENTURE

INTRODUCTION

The Pacific Birds Habitat Joint Venture (PBHJV) (originally the Pacific Coast Joint Venture-PCJV) is a partnership of government and non-governmental organizations with the collective aim of conserving birds and bird habitat. In 1991, the PCJV was established as the first international Joint Venture in response to the waterfowl conservation challenges raised in the North American Waterfowl Management Plan (NAWMP) (Pacific Coast Joint Venture 1991). This international public-private partnership extended from San Francisco Bay north to the British Columbia-Alaska border, west of the Coast Mountains, and included government and nongovernmental conservation organizations in California, Oregon, Washington and BC. In 2015, the PCJV was renamed the Pacific Birds Habitat Joint Venture (or "Pacific Birds" for short) to reflect the inclusivity of bird habitat in the entire boundary.

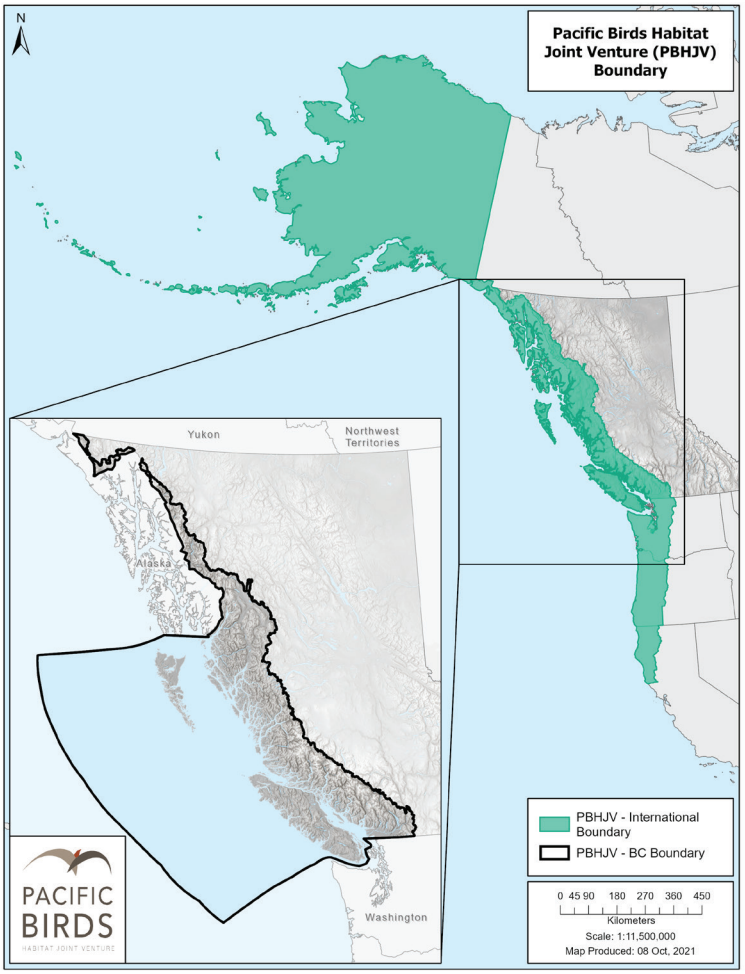

Figure 1. PBHJV boundary (not shown in the international boundary (green) are the Hawaii and U.S. Pacific Islands)

The BC portion of the PBHJV (**Figure 1**), hereafter referred to as the PBHJV-BC, is characterized by its diversity and productivity. Variations in elevation create widely contrasting terrestrial ecological zones within the region, ranging from mild, humid coastal rain forest to cool boreal forest and alpine conditions at higher elevations. The coastline is composed of complexes of islands, bays, straits and fiords, giving rise to a diversity of open ocean, intertidal in the nearshore marine and estuaries. Marine ecosystems are among the most biologically productive in the world in terms of nutrients and planktonic growth, due to upwelling and freshwater inputs from many large rivers; this provides excellent habitat for sea ducks, waterfowl and shorebirds. The ocean-influenced climate is characterized by high precipitation in winter, a long growing season in summer and moderate temperatures throughout the year. The PBHJV-BC is an important area for several bird groups. Pockets of high-quality waterfowl habitat (estuaries, freshwater wetlands, farmlands) are interspersed along the rocky, steep-sided shorelines. Large numbers of waterbirds winter in bays, surge narrows, tidal flats and estuaries. These areas face multiple challenges, such as the Fraser River Delta in southern BC which is the only Important Bird and Biodiversity Area in Canada designated as "in danger" by BirdLife International.

The PBHJV partnership plays a critical role in addressing additional threats facing birds in these important areas. While the overarching threat of climate change impacts all PBHJV areas, other threats persist such as habitat loss due to urban development, harmful agricultural practices and reduced water quality. The PBHJV-BC works to mitigate these threats by securing lands containing critical habitat for birds and by completing habitat restoration and enhancement activities to improve habitat functions. PBHJV partners work with landowners to encourage the adoption of beneficial management practices and commitment to cooperative management agreements. In conjunction with adjacent JVs across the continent, these PBHJV efforts allow for greater habitat connectivity to improve the sustainability of bird populations.

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HISTORY

Established in 1991 as the North American Waterfowl Management Plan's (NAWMP) first Joint Venture with an international scope, the PBHJV is a partnership of governments, Indigenous Groups, organizations and conservation groups along the Pacific Coast of Canada and the United States. The PBHJV was called the Pacific Coast Joint Venture until 2015. The PBHJV initially targeted waterfowl and wetlands within the Middle-Upper Pacific Coast, but has since expanded to include the Pacific Coast of Alaska (2001), northwest California and the Willamette Valley of Oregon (2004), Hawai'i (2005), Interior and Northern Alaska (2010) and the rest of the U.S. Pacific Islands (2015). In 2005, the BC Steering Committee, which guides the work of JV partners in BC, developed a new Strategic Plan and Biological Foundation that covered all birds and their habitats within the JV area. This included terrestrial habitats and marine waters within the 200-mile Exclusive Economic Zone (EEZ).

Since its inception in 1991, the PBHJV has refocused efforts in several areas, largely in response to direction from the NAWMP Plan Committee which meets annually to provide feedback on the JV's progress. The 2005 Continental Assessment resulted in more emphasis on program evaluation and adaptive management, and the NAWMP 2012 Update augmented efforts to increase public awareness and support, all key components to advancing waterfowl conservation. Together, these priority updates have allowed partners to work cooperatively on the most pressing national and international issues and better complement the work of adjacent JVs such as the Canadian Intermountain Joint Venture (CIJV) and the Prairie Habitat Joint Venture (PHJV).

The Plan Committee continues to advise the PBHJV. Recommendations from 2019 included recognizing "Human Dimensions" to engage non-traditional stakeholders in conservation efforts, drawing on the endeavors of both the NAWMP Human Dimensions Work Group and the North American Bird Conservation Initiative (NABCI) Human Dimensions sub-committee. The Plan Committee has also recommended further study into the projected impacts of sea level rise on the Canadian Pacific coastline, as well as increased use of GIS support tools to inform "Open Standards" planning. Other recommendations have included increasing collaboration with other JVs on projects of shared priority, continuing to cooperate with the Sea Duck Joint Venture and emphasizing how scientific elements contribute to efficient and prioritized habitat planning.

ACCOMPLISHMENTS

Since 1991, PBHJV-BC partners have secured, enhanced and/or supported stewardship on 2.9 million hectares (7.2 million acres) (**Table 1**) and developed a strong science foundation. According to the Canadian NAWMP National Tracking System (NTS), as of December 2020, approximately $230 million CDN has been invested in the PBHJV-BC since its launch in 1991. The majority of financial contributions have come from the Canadian federal government (27%), followed by Canadian provincial and territorial governments (24%) and the U.S. government (12%) (**Table 2**). While the NTS does not provide a spatial depiction of the areas conserved by PBHJV-BC partners, it acts a mechanism for all JV partners to broadly track their investments under various NAWMP initiatives/activities.

Table 1. PBHJV-BC partner conservation accomplishments (1991-2020)

Activity	Expenditures ($)	Percentage of Amount Invested (%)	Hectares	Acres
Communications & Education	2,001,315	0.88	n/a	n/a
Conservation Planning	10,813,743	4.77	n/a	n/a
Habitat Science	5,730,481	2.53	n/a	n/a
Habitat Retention - Medium (10-99yrs)	4,590,839	2.03	34,461	85,155
Habitat Retention - Permanent	165,695,088	73.12	21,587	53,343
Habitat Retention - Short Term (<10yrs)	7,558,807	3.34	2,743,851	6,780,193
Land & Water Policy	1,413,672	0.62	n/a	n/a
Management (Habitat Assets)	15,531,524	6.85	49,058	121,225
Upland Restoration	4,327,102	1.91	12,413	30,673
Wetland Restoration	8,932,176	3.94	67,857	167,678
Total	**226,594,747**		**2,929,227**	**7,238,266**

Source: Canadian NAWMP National Tracking System, March 2021

Table 2. PBHJV-BC partner contributions since inception (1991-2020)

Source	Contributions ($)	Percentage of Contributions (%)
Canadian Federal Government	62,270,946	26.56
Canadian Provincial & Territorial Governments	56,130,859	23.94
Canadian Regional & Local Governments	18,800,797	8.02
Canadian Non-profit Organizations	28,596,078	12.20
Canadian Corporations	729,275	0.31
Canada: Private	8,670,939	3.70
U.S. Federal Government	31,390,829	13.39
U.S. Non-federal Sources	27,832,684	11.87
Other	15,593	0.01
Total	**234,438,000**	

Source: Canadian NAWMP National Tracking System, March 2021

ADMINISTRATIVE STRUCTURE

The PBHJV-BC's activities are coordinated by a Steering Committee that includes representatives from its major partners. The PBHJV-BC Steering Committee is currently chaired by a representative from Environment and Climate Change Canada (ECCC). ECCC also supports the partnership by providing a PBHJV-BC Coordinator to coordinate activities.

Wilson's Warbler/Yousif Attia

The PBHJV-BC Steering Committee forms part of the PBHJV Board, which is co-chaired by a Canadian and a U.S. Board member. The PBHJV Board oversees the international activities of the PBHJV and ensures the various PBHJV Steering Committees are working together toward larger, PBHJV-wide goals.

CHAPTER 2 – THE PBHJV LANDSCAPE AND DESCRIPTION OF THREATS

LANDSCAPE/HABITAT CHARACTERIZATION AND ASSESSMENT

The 35,500-kilometre BC coastline has a diversity of habitats that includes bays, islands and inlets, rivers, rocky shorelines, sandy beaches, fertile floodplains, offshore marine waters and steep forested mountain slopes. Interspersed on this rugged coast are scattered pockets of highly productive estuaries and floodplains. The main habitat types providing resources for waterfowl are estuaries, associated agricultural lands, freshwater and brackish wetlands, shallow nearshore waters with abundant crustaceans as well as shellfish and/or herring spawn sites. Riparian forests also provide important habitat for non-waterfowl bird groups, including songbirds, owls and aerial insectivores.

One particular estuary in the PBHJV—the Fraser River Delta (**Figure 2**)—is the most important migratory and wintering area in Canada for waterfowl, shorebirds, songbirds and raptors. The floodplains, tidal flats and estuaries of the Delta provide critical feeding and resting opportunities for approximately 1.7 million birds annually, including 1.4 million shorebirds, 240,000 waterfowl and 61,000 seabirds (Butler et al. 2021). A total of 263 species of birds, or nearly half of all 550 species of birds reported for BC, occur annually on the Delta. Of these, 29 species occur in globally, continentally or nationally significant numbers (Butler et al. 2021).

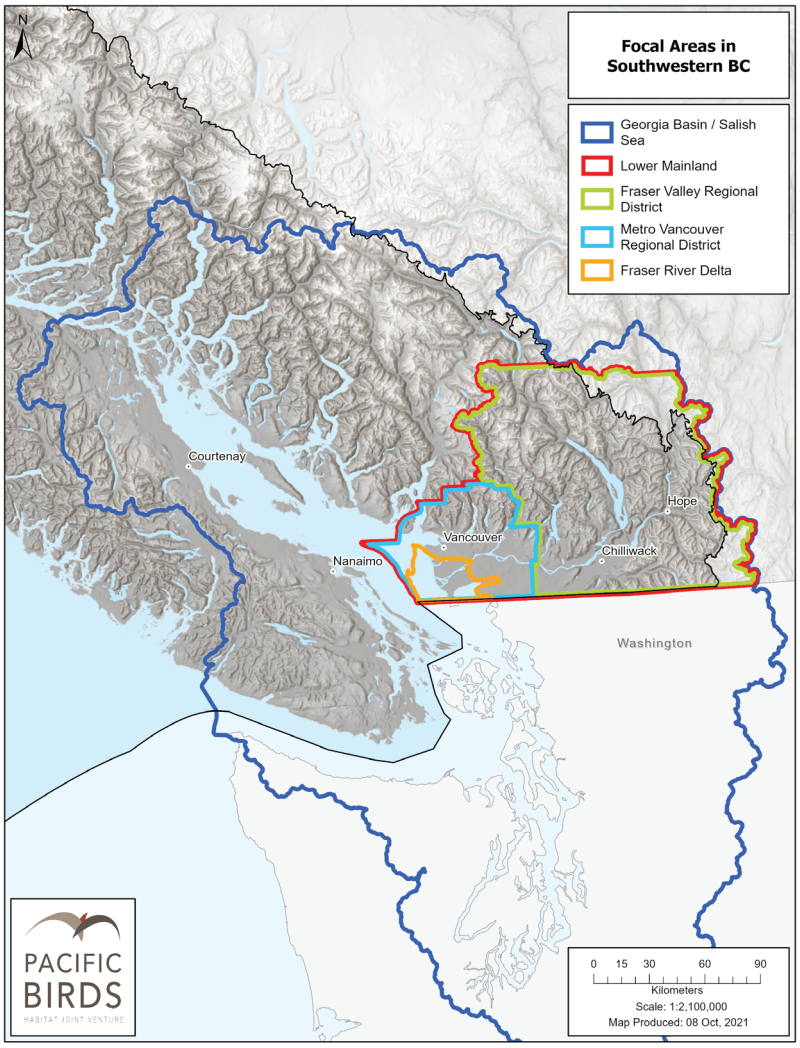


Figure 2. Focal Areas in Southwestern BC

Ecological Setting

The PBHJV-BC is a diverse landscape of estuaries, coniferous forests, alpine areas and shrublands (**Table 3**; **Figure 3**). Since the PBHJV boundary extends out to the boundary of Canada's Exclusive Economic Zone (EEZ, 200 nautical miles), the proportion of marine water is higher than other habitat types (71.4% of total PBHJV area in BC). Although offshore marine waters are significant and support internationally important seabird species, the highest species diversity is found in the shallow marine waters and coastal estuaries. Estuaries comprise only 0.8% of the landscape area (excluding marine water) but they are a focus of many PBHJV-BC programs as they provide a large amount of food energy and are essential habitat for migrating and wintering waterfowl.

Table 3. Land cover types within the PBHJV-BC

Land Cover Type	Area (ha)	Percentage
Barrenland	518,696	11.94%
Coniferous Forest	1,997,731	45.98%
Cropland	1,867	0.04%
Deciduous Forest	48,829	1.12%
Estuary	33,817	0.78%
Fresh Water	137,822	3.17%
Grassland	167,473	3.85%
Intertidal Zone	50,613	1.17%
Marine Water	10,828,027	na
Mixed Forest	169,393	3.90%
Riparian: Coniferous Forest	80,066	1.84%
Riparian: Deciduous Forest	3,980	0.09%
Riparian: Grassland	1,175	0.03%
Riparian: Mixed Forest	19,530	0.45%
Riparian: Shrubland	7,392	0.17%
Shrubland	285,999	6.58%
Snow and Ice	597,239	13.75%
Subtidal Zone	166,147	3.82%
Urban and Built-up	5,404	0.12%
Wetland	51,214	1.18%
Total	**15,172,415**	**100%**

The next most abundant habitat type is the extensive coniferous forest (46.0%) consisting mainly of cedar and western hemlock at low- to mid-elevations and mountain hemlock or Engelmann spruce/subalpine fir at higher elevations. On the extreme south coast, there is a narrow band of forest that has formed within a rain shadow at elevations below 150 metres. The coniferous forest is part of the coastal Douglas-fir ecosystem which is characterized by plants adapted to a drier climate than the rest of the coast, consisting of some broadleaf forests as well as mixed coniferous/broadleaf woodlands and pockets of grasslands.

Burns Bog, BC/Andrew Huang

The mountainous terrain of PBHJV-BC has a significant amount of subalpine and alpine areas: Snow and Ice (13.8%), Barrenland (12.0%) and Shrubland (6.6%). Except for a few small coastal communities, the main urban areas are in the extreme south coast in the coastal Douglas-fir area where the proportion of the landscape dominated by urban and agricultural uses is greater.

The land cover data for coniferous, deciduous and mixed forests, grasslands, crop lands, barren lands, urban and built-up areas and snow and ice areas in this Implementation Plan are derived from the 2015 Commission for Environmental Cooperation (CEC) Land Cover. This data on land cover has a spatial resolution of 30 metres. Additional grassland data from the Grassland Conservation Council (GCC) was used, derived at a scale of 1:20,000 using the most up to date imagery as of 2015. Land cover classes were defined using the Land Cover Classification System developed by the Food and Agriculture Organization (FAO) of the United Nations. The wetland and water classes, the latter of which lumps together lakes, rivers, bays, channels and manmade waterbodies, were drawn from the BC Government 1:20,000 Freshwater Atlas (developed using aerial photography). Pacific Estuary Conservation Program (PECP) estuaries, derived using ArcGIS, were identified using BC Terrain Resource Inventory Mapping (TRIM) 1:20,000 dataset and the BC NTS Watershed Atlas 1:50,000 dataset. The Exclusive Economic Zone (EEZ) was used as an outer limit of the PBHJV-BC Region. All of these datasets represent a snapshot in time.

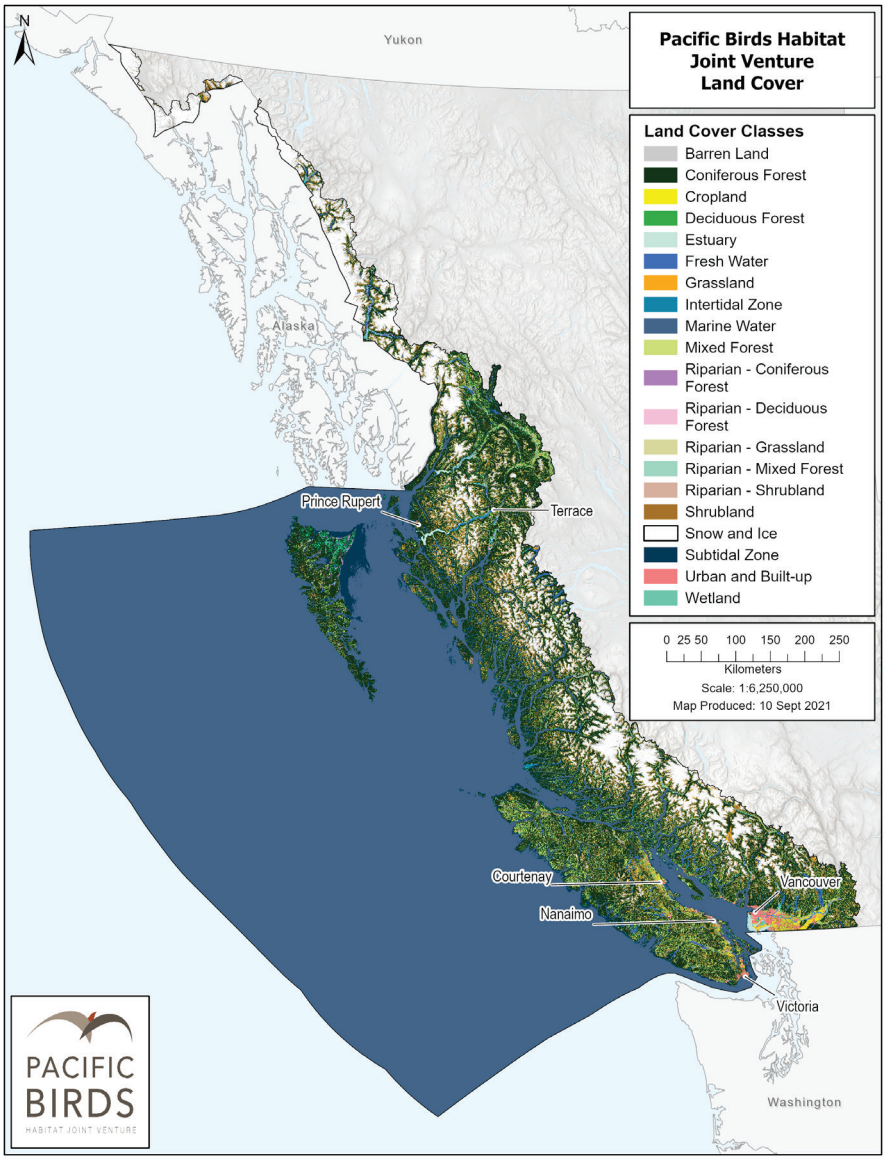


Figure 3. Land cover types for PBHJV-BC

Despite the somewhat patchwork approach for estimating habitat structure at the PBHJV-BC scale, the partners are satisfied that it represents the best available data. The 1:20,000 BC Freshwater Atlas is a particularly useful database in spite of only periodic updates.

PRIORITY HABITAT TYPES

Partners have identified five priority habitat types in PBHJV-BC: 1) estuaries, 2) agricultural land, 3) freshwater wetlands, 4) nearshore shallow marine waters and 5) riparian forests. In general, these habitat types were selected due to their high potential to support the current populations of priority waterfowl species (**Chapter 3**) as well as non-waterfowl species (**Chapter 4**). Conservation activities—whether it be land acquisition, restoration, enhancement and/or stewardship—should therefore be focused on these habitat types to benefit the priority species. For details on how the habitat types were defined, see **Appendix 1**.

Blackie Spit, BC/©Ducks Unlimited Canada/Tim Fitzgerald

Estuaries

Estuaries in BC are widely recognized as highly productive ecosystems. While comprising only less than 3% of the Province's coastline, they are important to a wide variety of species, including an estimated 80% of all waterbirds and other coastal wildlife. Estuaries also provide important ecological goods and services such as water filtration, detritus breakdown and nutrient recycling. However, estuaries are threatened by a large number of anthropogenic influences, including habitat loss and alteration, conversion to agriculture (through diking), freshwater diversion, pollution and invasive species. In general, estuaries and associated deltas include multiple cover types (e.g., agriculture, urban, intertidal, subtidal), but for the purpose of this Implementation Plan beyond this section, estuaries include only the intertidal cover type.

Estuaries contain a unique combination of tidal wetlands and adjacent floodplain habitats or deltas. Tidal wetlands are generally owned by the Crown (Province of BC), and provide a good source of natural foods, such as eelgrass and invertebrates, for waterfowl and other wildlife. Conversely, many floodplains are privately owned, and especially near urbanized areas they are often highly modified. While most floodplain areas were historically high marsh wetlands, over the past century most floodplains were diked and converted to agricultural crops (such as grains, grasses and vegetables) or developed for settlement.

BC estuaries provide the first foraging opportunity for fall migratory birds travelling to wintering sites along the coast. These reserves are essential to ensure survival during further migration and inclement weather. Local bird movements in the Pacific Northwest indicate that the Fraser River Delta and Puget Sound (in the U.S. PBHJV) are a functionally integrated habitat complex, and roughly equivalent in bird use. Numerous waterfowl breeding in various parts of the Pacific Flyway (including Asia, Alaska, interior BC, Canadian Arctic, Western Boreal Forest and Prairie Pothole Region) either migrate through or winter in the Fraser Delta.

Agricultural Land

Within PBHJV-BC, agricultural lands are concentrated along valley bottoms and on floodplains. The largest areas of agricultural land occur in the lower Fraser Valley and along the east coast of Vancouver Island. Some of the best quality agricultural lands occur in the floodplain areas behind large estuaries. Historically these areas were often high marsh wetlands that have been diked, drained and converted to agricultural use.

Snow Geese on agricultural land in Delta, BC/Amy Thede

While development of agricultural land has resulted in the loss of considerable freshwater wetland, floodplain and high tidal marsh habitats, the crops grown on these lands provide a significant source of energy for migrating and wintering waterfowl as well as critical refuge during extreme weather conditions. Waterfowl have adapted to feeding on the carbohydrate-rich food sources available in agricultural fields, including remnant grain, vegetables (particularly potatoes) and grasses on pastures and hayfields. Waterfowl use is particularly high on fields near estuaries because the food supply in the estuary declines during late fall, and waterfowl populations in some areas are then reliant on these crops as food resources.

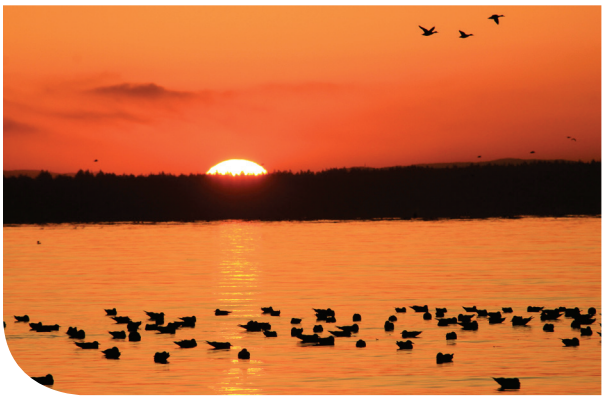
Freshwater Wetlands

Freshwater wetland ecosystems within the PBHJV-BC include shallow open water, swamps, marshes, fens and bogs. Wetlands are characterized by seasonal or year-round water, either at or above the soil surface or within the root zone of plants. The extremely high productivity of these habitats, combined with their diversity of habitat niches, means that wetlands provide essential habitat for many species. In addition, wetlands play an important role in maintaining water quality via biofiltration and regulating rainfall run-off by acting as storage sites for surface water.

Freshwater wetlands and marshes are somewhat rare within the PBHJV-BC, but they are still important sources of food and refuge (e.g., safe roosting sites) for waterfowl. While the PBHJV is most important to waterfowl during migration and wintering periods, breeding activity also occurs in many wetlands. These wetlands provide habitat for a wide variety of other waterbirds, including many that cannot use agricultural areas as alternative feeding sites (e.g., herons, grebes, bitterns, etc.).

Burns Bog, BC/Andrew Huang

Wetlands within the PBHJV-BC are severely geographically restricted. The region's mountainous terrain means that wetlands typically only occur within floodplains along valley bottoms. Most human infrastructure and development are located in these same floodplain habitats, resulting in great pressures on wetland habitats. For instance, Finn et al. (2021) estimated that of the 659 square kilometres of floodplain habitat that existed historically in the Lower Fraser, only 15% remains accessible to Pacific salmon. Similarly, a recent study (Willamson 2020), using a method for tracking loss in freshwater wetlands in the Lower Fraser since 1989, showed steady, incremental losses due to agricultural and urban expansion (4.8% in 1999-2009; 5.4% in 2009-2019).



Nearshore shallow marine habitat/©Ducks Unlimited Canada/Tim Fitzgerald

Nearshore Shallow Marine Waters

The numerous fiords and islands of BC's convoluted coast give rise to 35,500 kilometres of intertidal habitat within the PBHJV-BC. This extensive coastline is dominated by rock, gravel and mixed sand/gravel habitat (together accounting for 93% of the coast). Softer sediments, such as pure sand and mud, are relatively rare. The majority of the coast is also protected (in terms of wave exposure; i.e., has a maximum wave fetch of less than 50 kilometres) and typically experiences calm conditions to low waves. Little of the coastline is classified as exposed or very exposed or experiences large swells regularly.

Shallow marine areas are defined from the mean high watermark extending seaward to the 20-metre depth contour. These areas include both an intertidal and a subtidal component, and provide habitat for sea ducks, shorebirds and a wide variety of seabirds and other waterbirds. Preliminary surveys on the east and west coasts of Vancouver Island suggest that there are hundreds of thousands of sea ducks wintering in coastal habitats, primarily scoters and goldeneyes, as well as tens of thousands of diving ducks, primarily Lesser and Greater Scaup (CWS 2003). Away from estuaries, rocky shores support specialist shorebirds, such as Black Oystercatcher and Surfbird, while sea ducks, such as Harlequin Ducks and Barrow's Goldeneye, gather to feed on crustaceans and mussels. Sand and gravel substrates that support clams attract scoters, and sandy beaches and flats support migrating and wintering shorebirds, such as Sanderling and Dunlin. Mudflats, typically found within estuaries, support large numbers of dabbling ducks and shorebirds.

South Arm Marshes Wildlife Management Area, BC/Andrew Huang

Riparian Forests

Riparian forests are wooded areas of land adjacent to the banks of streams, lakes and wetlands. They include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Streamside vegetation protects water quality and provides a "green zone" of vegetation that stabilizes streambanks, regulates stream temperatures and provides a continual source of woody debris to the stream channel (BC Environment 1995). Riparian forests frequently contain the highest faunal and floral diversity, and serve as corridors connecting habitats and facilitating wildlife movement throughout the forest landscape, linking hillsides to streams and upper headwaters to lower valley bottoms.

Many passerine species, including PBHJV-BC priority species, such as Pacific Wren, Golden-crowned Kinglet, Townsend's Warbler and Varied Thrush, are tightly associated with forested riparian areas. Marine-derived nutrients from Pacific salmon can be transferred to riparian forests, fertilizing forests and increasing invertebrate abundance, which then ultimately provide an important food source for songbirds (Field and Reynolds 2011). Studies conducted in the central coast of BC showed that compared to watershed size and forest composition, Pacific salmon biomass is a more important predictor for songbird abundance and diversity in riparian forests during the breeding season (Wagner and Reynolds 2019). Riparian habitat in the valley bottom also provides crucial stopover sites for numerous bird species, allowing migrants to rest and fuel up on fat before departing to their next destination (de Zwaan et al. In Prep; Skagen et al. 2005). Despite their small representation across the PBHJV landscape (**Table 3**), riparian areas support a disproportionately large number of bird species and greater densities of birds than other forested habitats.

KEY THREATS AND HABITAT TRENDS

Declines of bird populations have been well-documented across North America, most notably the publication by Rosenberg et al. (2019): *Decline of the North American Avifauna*. The study quantified for the first time the total decline in bird populations in Canada and the United States, and revealed an alarming net loss of 2.9 billion breeding adult birds since the 1970s. The declines were found across almost all major biomes, including western forest—the major biome found in PBHJV—which showed a 29% decrease in overall bird abundance (the third steepest decline after boreal forest and grasslands). Sixty-four per cent of bird species in the western forest are in decline. The major cause of bird declines is loss of habitat, in particular due to agricultural intensification and urbanization. Other factors include domestic cats acting as predators, bird/window collisions and a decline in insects due to overuse of pesticides across the landscape. The study calls for a radical shift in conservation strategies.

During a joint PBHJV and CIJV technical committee workshop held in February 2020, partners developed a list of key threats and limiting factors for the priority habitat types. These habitats were subsequently ranked based on severity, duration, persistence and extent of negative impact. As a result, the following overarching threats were identified for the CIJV region.

Residential and Commercial Development

Wetland ecosystems, lakes and other water features are subject to many stressors associated with human activities wherever they occur in low-lying areas suitable for agriculture and settlement. Draining or infilling wetlands located near human developments or in areas suitable for agriculture results in permanent loss.

Habitat losses are particularly significant in Southwestern BC due to historic settlement and the rapid rate of urbanization. Historically, within the Lower Mainland basin, an estimated 85% reduction in freshwater wetlands and a 51% reduction in deciduous/mixed forests associated with wetlands and streams has occurred between 1827 and 1990 (Boyle et al. 1997). A recent 5-year Sensitive Ecosystem Inventory for Metro Vancouver found a total loss of 1,640 hectares (4,052 acres) (0.9%) of sensitive and modified ecosystems for the region, with old field having the highest rate of loss (under 20%), primarily due to residential development and transportation. (Metro Vancouver 2019). While incremental losses of wetlands continue today, there appears to be a decrease in the rate of loss over the three decades (Williamson 2020). Although outright loss of

an entire wetland is less likely today, gradual encroachment ("nibbling") continues and only compounds the effects of historic losses and compromises wetland function. The human population in the Greater Vancouver area is expected to increase from 2.8 million people in 2021 to 3.8 million by 2050 (CBC 2021). With a limited land base to support a growing population, wetlands in the Fraser Lowland will continue to diminish at an unsustainable rate.

Urban pressures can also result in the direct loss of agricultural habitat for waterfowl. The BC Agricultural Land Reserve (ALR) program has protected farmland and encouraged agricultural production since 1974, and waterfowl have undoubtedly benefited. However, although the total amount of land in BC's ALR has increased by 1% since 1974, ALR farmland in Metro Vancouver has decreased by 10%. Developers and municipalities can apply to the Agricultural Land Commission (ALC) to have land removed from the ALR, and this pressure is expected to increase as the population grows.

The limited remaining wetlands on Vancouver Island also continue to undergo ecosystem change through habitat loss and degradation. Human population in Victoria and Nanaimo—two of the most populous metropolitan areas on southern and eastern Vancouver Island—has increased by approximately 7% from 2011 to 2016, a higher rate than Metro Vancouver (Statistics Canada 2017). Therefore, losses of wetlands and other priority habitat types are expected to increase as residential and commercial development becomes more widespread and common in rural areas.

Non-compatible Agriculture

At the time of European settlement (mid-1800s), the Fraser River estuary and floodplain were covered in forests and deciduous tree/shrub complexes or marshes that were subject to periodic river flooding and tidal action. By 1930, extensive farmland was created by dyking and forest clearing. This amount had increased by 1.5 times by 1990 (Boyle et al. 1997). However, since then there has been a shift from low intensity crops, such as grains, corn and pasture that have high waterfowl and shorebird forage values, to more intensive agricultural operations that have low waterfowl and shorebird forage values. Newer crops, such as berries, tree nurseries and greenhouses, provide no residual crops or winter cereals for waterfowl, yet these types of agriculture are becoming more common. This transition occurs as producers compete in new markets and struggle with high land prices. Along with residential and commercial development, these kinds of non-compatible agriculture are the largest threat to PBHJV-BC priority habitat types such as freshwater wetlands, estuaries and riparian forests. According to the most recent report on wetland loss in the Fraser Lowland, agricultural expansion accounted for 61% of the total wetland loss from 2009-2019 (Williamson 2020).

Climate Change and Severe Weather

Climate change has been ranked as one of the most widespread, and potentially impactful, threats to wetlands in the Lower Fraser Basin (Veridian Ecological Consulting, Ltd. 2004). Wetlands of cool, moist climates, such as bogs with stable hydrology, will be negatively impacted, while marshes with fluctuating water tables and higher nutrient levels may benefit (Wilson and Hebda 2008). Most climate change models predict that mean temperatures in the Fraser River Delta will be warmer throughout the year, winters will be wetter with proportionately less snow, and summers will be dryer (Taylor 2004). There are several potential consequences, but it is believed that the one most relevant to waterfowl and non-waterfowl is sea level rise. Current estimates predict that globally, sea levels will rise by 20-60 centimetres by 2100 under most climate change scenarios, but in the Fraser River Delta this will be partially offset by isostatic rebound, a process where land rises in response to the removal of glacial ice (IPCC 2007). Taking this into account, Thomson et al. (2008) forecasted a sea level rise of 19 centimetres (+/- 12 centimetres) by 2100, with associated consequences for intertidal habitats and wetlands.

The Fraser River Delta is considered an area of high sensitivity to sea level rise impacts, such as dike-breaching, flooding of salt marshes, salt intrusion in freshwater marshes and increased shoreline erosion (Shaw et al. 1998; Poulter et al. 2009). Intertidal marshes and mudflats may decrease in size as ecological zones try to migrate, but many are restricted by dikes and erosion protection measures. A rise in sea level would also decrease rocky intertidal habitat availability impacting shorebird species. Species restricted to wetland habitats may be limited by the amount of currently available habitat, and they may also face increasing limitations due to continuing loss of wetlands due to urban, industrial and agricultural development. Kirwan and Murray (2008) predicted that, under a moderate scenario of sea level rise, Westham Island would see a 15-35% loss of marshland in the next century due to low marsh erosion and constriction of high marsh vegetation against a dike at the landward edge. While the effects on mudflats and sedge/rush zones are probably negative, the possible effects on eelgrass are unclear—this zone may simply migrate landward until it reaches unsuitable substrates or a dike.

Invasive Non-native, Alien Species and Problematic Native Species

Invasive species within wetlands, such as purple loosestrife and yellow flag iris, continue to increase in abundance. In addition, *Spartina* spp. (cordgrass) is a significant concern amongst wildlife agencies along the Pacific Coast. This plant is capable of out-competing other vegetation and converting tidal marshes, eelgrass beds and mudflats into monotypic stands of *Spartina*. Once established, these monotypic stands change sediment deposition patterns, produce significantly less food for migratory birds and have been shown to effectively exclude shorebirds and waterfowl from once-productive habitat in Washington State (Patten and O'Casey 2007).

With the continual loss of tidal wetlands and agricultural habitat for waterfowl, existing populations of waterfowl are concentrated on fewer remaining habitats. As a result, locally high bird abundances can create a loss of existing natural tidal habitats, leading to economic impacts on agricultural communities and challenges for wildlife organizations to manage habitat for waterfowl. One example is Lesser Snow Geese that winter on the Fraser River Delta and are part of a sub-population that nests on Wrangel Island in Russia, the last remaining population in Asia. This population has been increasing over the last few decades and there is concern that these geese may be impacting tidal marshes and food availability for themselves and other species on the Delta. Canada Geese are also a concern because the non-migratory resident population on the east coast of Vancouver Island is increasing and studies indicate they are impacting habitat quality for other waterfowl species including the migratory Canada Geese populations. Dawe et al. (2011) demonstrated a significant impact of resident Canada Geese on local estuaries and tidal marsh habitat on the east coast of Vancouver Island through intensive grazing and grubbing of native salt marsh vegetation.

Pollution (Effluents, Oil Spills and Overuse of Pesticides)

Despite the generally steep inaccessible coastal terrain, coastlines and nearshore marine waters may be impacted by disturbance and spills from commercial and recreational boat traffic and pipelines. In 2007, a road crew's excavator accidentally dug down and pierced the Kinder Morgan pipeline, causing a massive rupture that spilled more than 250,000 litres of oil into a Burnaby neighbourhood and 70,000 litres into nearby Burrard Inlet (National Observer 2021).

Heavy exposure to oil often results in acute lethal effects to birds. Chronic oiling—or the high frequency and episodic releases of oil into the environment—is also known to cause a wide range of sub-lethal health effects to marine birds—many classes of hydrocarbons found in oily discharges (most notably polycyclic aromatic hydrocarbons or PAHs) act as carcinogens or mutagens. During the chronic phase of oil exposure, adverse effects to marine birds can be manifested in several ways, including inhibition of thermoregulation, immune suppression, oxidative stress in the liver and kidneys, depressed reproductive performance and susceptibility to disease (Morandin and O'Hara 2015; Willie et al. 2017). Exposure can result from direct contact with oil contaminants in water (e.g., from operating vessels or larger spill incidents), or through indirect ingestion of contaminated food (e.g., vegetation, marine benthos, fish). Chronic oiling can also impede the flight energetics of migratory birds. Recent studies conducted on Western Sandpipers showed that even light to modest oiling will increase the difficulty and energetic costs of locomotion for their daily and seasonal activities such as foraging, predator evasion and long-distance migration. Reduced maneuverability can also lead to increased mortality from predation (Maggini et al. 2017a; Maggini et al. 2017b).

Pesticides can kill birds rapidly following exposure or cause sub-lethal effects such as disorientation duration migration (Eng et al. 2017), reduced energy expenditure (English et al. 2021), loss of body weight and delayed migration departure (Eng et al. 2019). Neonicotinoids, in particular, are a type of pesticide commonly applied in the agricultural landscape across North America. In the blueberry fields of Southwestern BC, high levels of neonicotinoids were found in the cloacal fluid of Rufous Hummingbirds (Bishop et al. 2020). There may also be indirect effects of pesticides, such as reduction in prey and changes in vegetation, that reduce habitat quality. Li et al. 2020 showed that increase in neonicotinoid use was associated with significant reductions in bird biodiversity, relative to areas without neonicotinoid use, particularly for grassland and insectivorous birds.

Other Key Threats and Bird Groups of Conservation Concern

For many landbirds, in addition to direct habitat loss across breeding, wintering and migration stopover habitat, cat predation and bird-window collisions are also major contributors to population declines. In fact, they are the leading causes of human-related bird mortality in North America. In Canada alone, an estimated 140 million birds are killed by cats (Calvert et al. 2013), and 16-42 million birds are killed via window strikes (Machtans et al. 2013). A recent study showed that overwintering passerines in the Lower Mainland are highly susceptible to window collisions, most notably Varied Thrush and Spotted Towhee (De Groot et al. 2021).

Another group of birds of serious conservation concern are aerial insectivores. Populations of North American aerial insectivores have been dwindling since the 1980s. These declines are likely driven by the cumulative effects of several threats, including broad-scale ecosystem modifications and widespread pesticide use, affecting prey abundance and impacting the insect community at a continental scale. The common diet of this diverse group of species suggests that their decreasing population trends are attributed to the reduction in insect prey availability across their breeding, migratory or wintering ranges (Hallmann et al. 2014; Imlay et al. 2018; Nebel et al. 2020; Smith et al. 2015).

ASSESSING THE CONSERVATION ESTATE

The high biological value and increasing vulnerability of PBHJV-BC has long been recognized. Many organizations, working independently and in partnerships, have invested significant human and financial resources in regional conservation efforts. Conservation achievements include a range of habitat acquisitions, protection and stewardship programs, development and implementation of strategies and tools to guide conservation efforts and successful communications and outreach programs.

Conservation Areas Database

PBHJV-BC and CIJV partners have collaborated for a number of years as part of the BC Non-governmental Organization (NGO) Conservation Areas Database (CAD) Working Group to develop a comprehensive, standardized inventory of BC's NGO areas (also known as private conservation lands). These areas include properties designated as Fee Simple, Registerable Interests and Unregisterable Interests and complement the inventories created by federal and provincial governments for federal and provincial protected areas. The BC NGO CAD is a province-wide database consisting of spatial boundaries and attributes, and allows for the precise and accurate tracking of PBHJV-BC conservation areas. NGO conservation areas where full title is held by a conservation organization ("fee simple") as of 2019 are included in the Canadian Protected and Conserved Areas Database (CPCAD) to allow for national reporting.

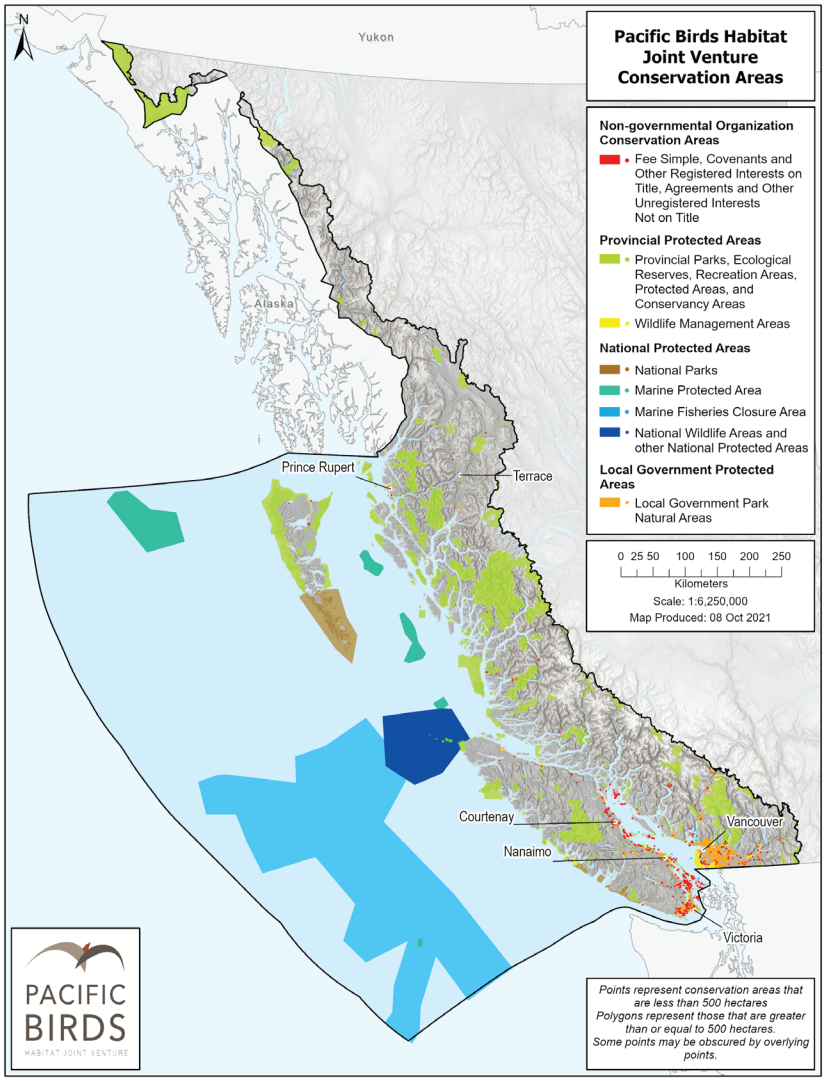


Figure 4. Conservation Areas within PBHJV-BC

Since 2013, PBHJV-BC partners have been producing a yearly summary report outlining the full conservation estate of the Province. This includes lands from nongovernmental organizations (for full list, see **Appendix 2**), National Wildlife Areas, provincial protected areas (e.g., Provincial Parks, Conservancies, Wildlife Management Areas), National Parks and the undeveloped portions of municipal and regional government parks. **Table 4** also includes marine protected areas (MPAs). A majority of the conservation estate within the PBHJV-BC is made up of various types of provincial designations. The remaining lands are a mixture of federal designations, local government park natural areas and NGO securement. While the NGO-protected lands, in particular, represent a small overall percentage of the conserved landscape in BC, they consist of numerous smaller properties and often protect features of very high ecological significance. Overlaying the government and NGO conservation areas with a land cover dataset in a GIS yields the hectare breakdown by category (**Table 4**). The total area in the PBHJV-BC designated for conservation purposes is nearly 15 million hectares (37 million acres); 20% of the land base and 24.5% of the marine area within PBHJV-BC is protected.

Table 4. All conservation areas in PBHJV-BC pre-1991 to December 2020

	PBHJV-BC			Province of BC	
Conservation Area Type	*Area Conserved (Hectares)*	*% of JV Landbase Protected*	*% of JV Marine Area Protected*	*Area Conserved (Hectares)*	*% of BC Landbase Protected*
Federal					
National Park	183,521	0.78%	0.05%	614,187	0.62%
National Wildlife Area or Other National Protected Areas	1,157,813	0.01%	2.54%	1,159,618	0.00%
Marine Fisheries Closure Area	8,218,697	0.00%	18.06%	8,218,697	0.00%
National Marine Conservation Area	347,389	0.00%	0.76%	347,389	0.00%
Marine Protected Area	861,010	0.00%	1.89%	861,010	0.00%
Provincial					
Provincial Park, Protected Area, Ecological Reserve, Recreation Area or Conservancy	4,311,325	18.80%	0.96%	14,132,747	14.45%
Wildlife Management Area	39,055	0.04%	0.07%	253,656	0.24%
Local Government					
LGPNA[1] Regional District	38,026	0.18%	<0.01%	42,137	0.04%
LGNPA Municipality	27,051	0.13%	<0.01%	33,593	0.04%
Non-governmental Organizations					
NGO Fee Simple	10,614	0.05%	<0.01%	115,504	0.12%
NGO Registerable Interest	7,924	0.04%	<0.01%	22,233	0.02%
NGO Unregisterable Interest[2]	6,212	0.03%	<0.01%	90,045	0.09%
Total[3]	**15,210,217**	19.99%	24.46%	**45,898,301**	15.52%

1. LGPNA = Local Government Park Natural Area
2. This area value contains some uncertainty as it contains values sourced directly from Ducks Unlimited Canada and may change as geometries for these securements are refined within the BC NGO Conservation Areas Database. Only those Unregistered Interests of 10-year term or longer have been included in the database.
3. As there can be more than one Conservation Area Subtype with interest in a conservation area, summing the area values for all conservation tenure types would lead to an overvaluation in the total conserved area. The "Total" area values remove the overvaluation and reflect the true conserved area. Total area values may change as uncertainty is reduced for NGO Unregisterable Interests.

Data Sources: BC Gov DataBC; Canadian Protected and Conserved Areas Database; BC Non-governmental Organizations Conservation Areas Database

Partners have recently improved the functionality to the CAD so the area conserved can be tracked over time for most securement types, by including information on the date of securement with each parcel. Currently, securement date information is available for national protected areas (National Parks and National Wildlife Areas), some provincial protected areas (e.g., WMAs), and the NGO categories (fee simple acquisitions, encumbrances and land-use agreements). There is currently spatial data showing PBHJV-BC properties secured by partners from JV commencement (1991) which also includes features such as *North American Wetlands Conservation Act* (NAWCA)-funded projects and landcover (**Figure 5**; **Table 5**). Currently, three of the partners (DUC, NCC and NTBC) are the recipients of grants under NAWCA. The use of NAWCA funding is dictated solely by the individual grantees and monies must be used for the benefit of wetlands and waterfowl according to the terms of the grant agreements.

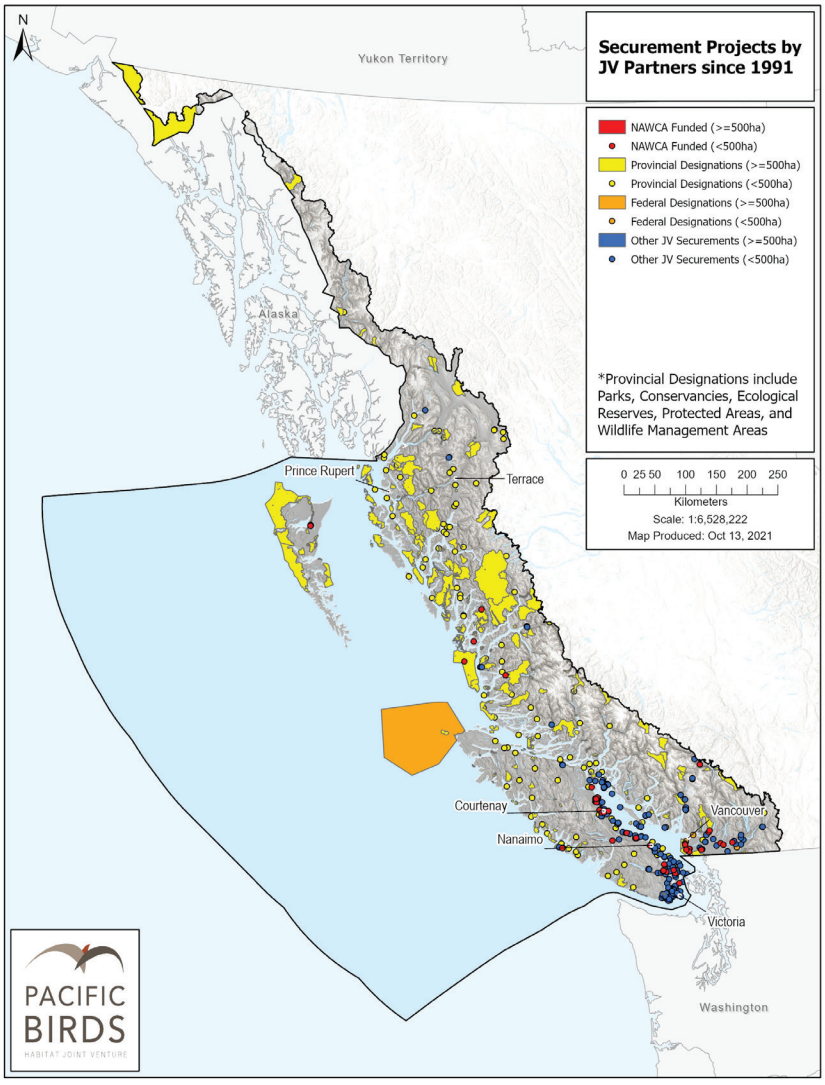


Figure 5. Securement Projects in the PBHJV-BC, broken down into four categories: 1) NAWCA Funded, 2) Provincial Designations, 3) Federal Designations and 4) Other JV Securements

Table 5. Land cover types (hectares) on PBHJV-BC properties secured since 1991

PBHJV-BC Priority Habitat Type	NAWCA Funded	Provincial Designations*	Federal Designations	Other JV Securements
Agricultural	507	106	39	140
Estuaries	223	31,169	2	234
Freshwater Wetlands	400	47,867	51	220
Riparian Forests	500	75,164	67	612
Nearshore Shallow Marine	7	133,557	9,881	7

* Provincial designations include: Parks, Conservancies, Ecological Reserves, Protected Areas and Wildlife Management Areas

CHAPTER 3 – PRIORITY WATERFOWL SPECIES

In coastal BC, 40 species of ducks, swans and geese occur regularly at various stages of their life cycles, but the PBHJV-BC is most important to migrant and wintering birds, when Pacific Flyway birds converge on coastal estuaries during northward and southward travels.

In excess of one million waterfowl winter along the BC coast, including 2 species of swans, 12 populations of 5 species of geese and 23 species of ducks. The most abundant wintering species are Lesser Snow Goose, Mallard, American Wigeon, Northern Pintail, Barrow's Goldeneye and Surf Scoter. Other sea ducks are likely abundant but wintering population estimates are less reliable at present.

American Wigeon/©Ducks Unlimited Canada/Tim Fitzgerald

Important populations of geese and swans winter in BC. Approximately 50% of the Pacific Coast population of Trumpeter Swans winter in Southwestern BC, primarily in the Strait of Georgia, and this population has been increasing in recent years. Approximately 130,000 of Lesser Snow Geese, over half of the Wrangel Island population, winter in the Fraser River Delta. An estimated 7,000 Pacific Brant winter along the BC coast, including a few hundred Western High Arctic Brant (*hrota* subspecies) in the Fraser River Delta. In spring, reserves acquired while staging are critical to successful northward migration and reproduction. During spring staging, PBHJV supports about half of the Northern Pintails reproducing in Alaska, nearly all Wrangel Island Lesser Snow Geese and all North American Pacific Brant.

Also during the spring migration is the herring spawn season which results in scoters numbering in the tens of thousands at key locations such as Hornby and Denman Islands. The Pacific population of Harlequin Duck also has a large local population which winters along exposed rocky shorelines. Smaller wintering groups of Long-tailed Duck and Bufflehead use the shallow coastal waters to forage for crustaceans and other aquatic invertebrates.

PRIORITY WATERFOWL SPECIES

In 2015, priority species for waterfowl were selected according to their categorization in four sources of information:

1) Minimum "high" nonbreeding importance or need in the 2004 NAWMP Implementation Framework (NAWMP 2004)
2) Identified in the PCJV-BC 2005 Strategic Plan (PCJV British Columbia Steering Committee 2005),
3) Ranked as 1-3 in any of first three goals in the Province of BC's Conservation Framework
4) Identified by JV Technical Team as "of regional management concern"

The following considerations have been added for this Implementation Plan:

5) Identified as having a negative population size trend in 20 years of BC Coastal Waterbird Surveys (Ethier et al. 2020)
6) Meet threshold for inclusion in 2012 Map of Areas of Continental Significance to Waterfowl (NAWMP Science Support Team Significant Areas Map Committee Project of 2011)

Based on these latest considerations, Hooded Merganser was added to the list of priority waterfowl species and no species were removed from the 2015 list. Only species with significant local populations (>10,000 wintering; >25,000 migrants) are considered priority waterfowl species in this Implementation Plan. Despite lower numbers, Trumpeter Swan and Brant are retained as priority because of their relatively significant numbers to the overall populations of these species (**Table 6**).

Table 6. PBHJV-BC priority waterfowl

Order	Family	Priority Waterfowl Species	Priority Habitat Type				
			Agricultural	*Freshwater Wetlands*	*Estuaries*	*Nearshore Shallow Marine*	*Riparian Forests*
Waterfowl	Swans	Trumpeter Swan	x	x	x	x	
	Geese	Pacific Brant (incl. W High Arctic Brant)				x	
		Lesser Snow Goose (Wrangel Island pop)	x		x		
		Cackling Goose	x	x	x	x	
		Canada Goose	x	x	x	x	
	Ducks	American Wigeon	x	x	x	x	
		Barrow's Goldeneye			x	x	x
		Black Scoter			x	x	
		Bufflehead		x	x	x	x
		Harlequin Duck				x	
		Hooded Merganser		x	x	x	x
		Long-tailed Duck			x	x	
		Mallard	x	x	x	x	
		Northern Pintail	x		x	x	
		Scaup (incl. Greater and Lesser Scaup)		x	x	x	
		Surf Scoter			x	x	
		White-winged Scoter			x	x	
		Wood Duck	x	x	x		x

POPULATION ESTIMATES AND OBJECTIVES

Table 7 lists the wintering population estimates and objectives for priority waterfowl species. The population estimate for each species refers to the average number observed during midwinter (December-January) in the last 5 years.

The population objective for each species is based on "no net loss" in winter and partners must conserve enough habitat to meet their needs during this time period, the assumption being that migration needs will be accounted for by the same habitat program. The PBHJV-BC lacked the data to use the more common 'historical baseline' approach (Sanderson 2006) and believe the level of information necessitated this 'status quo' approach.

Waterfowl population objectives have been defined from either population assessment programs and/or from habitat-species models, and, in the case of Pacific Brant, from historical survey data. Some of the habitat-species models were generated from expert opinion and unpublished data (Breault, pers. comm.) based on years of survey information. Population objectives for Lesser Snow Goose, Brant, Canada Goose and Trumpeter Swans are tied to continental objectives through their respective Pacific Flyway Management Plans.

Table 7. Population objectives for PBHJV-BC priority waterfowl species

Priority Species	PBHJV-BC Midwinter Population Estimate & Objective	Primary Data Source
Lesser Snow Goose (Wrangel Island pop.)	130,000	2
Pacific Brant	7,000	2
Canada Goose / Cackling Goose	30,000	2
Trumpeter Swan (Pacific Coast population)	8,000	1
American Wigeon	135,000	2
Barrow's Goldeneye	32,000	4
Bufflehead	45,000	2
Harlequin Duck	25,000	1
Long-tailed Duck	15,000	2
Mallard	175,000	2
Northern Pintail	59,000	2
Scaup spp.	32,000	2
Surf Scoter	270,000	3
White-winged Scoter	34,000	3
Black Scoter	10,500	3
Wood Duck	4,000	3
ALL	**1,011,500**	

Waterfowl population objectives are based on "no net loss"; therefore, population objectives are set to equal to current mid-winter population estimates as of 2014 (Sanderson 2006)

Data sources:

1 - Population Assessment programs
2 - Pacific Flyway Council Management Plans
3 - Habitat-Species Models
4 - Fleming et al. 2019

The PBHJV-BC also incorporated (modified) non-breeding estimates provided by Fleming et al. (2019) used Mid-winter Waterfowl Survey (MWS) and harvest data to 'step-down' continental waterfowl population objectives to each non-breeding planning region. Fleming et al. (2019) provided non-breeding population abundance objectives for the PBHJV as a whole, and the BC portion of these objectives were estimated based on expert opinion.

Some species are present in higher numbers during migration (e.g., Cackling Goose in fall; scoters and Harlequin during herring spawn; Brant in March); these estimates are not included because migration data are scant for most species.

LIMITING FACTORS FOR WATERFOWL

This Implementation Plan is based on the premise that waterfowl population abundance in the PBHJV-BC is primarily limited by wintering, migrating and staging habitat rather than by breeding habitat. Consistent with other wintering JVs (Weller and Batt 1989), the main limiting factor for non-breeding waterfowl in the PBHJV-BC is assumed to be dietary energy supply from food resources, which is determined by the availability of waterfowl habitats and the productivity of those habitats. Habitat availability is a function of both the area of a given habitat and the ability of waterfowl to access nutrients. Habitat productivity is the amount of nutrients produced in a given area of habitat, and their suitability for staging, migrating or wintering waterfowl. An inadequate food energy supply can have direct impacts on survival, and even non-lethal effects on body condition may impact demographic parameters such as reproductive success and productivity.

In addition to outright habitat loss, waterfowl may be impacted by a number of other factors. The following bullets outline the current understanding of these additional potential limiting factors:

Inspecting artificial nesting structures built for Mallards/Delta Waterfowl

- In the future, waterfowl populations may be limited by sea level rise. Sea level rise is a significant threat to intertidal and estuarine habitats, as well as low-lying agricultural lands. Impacts include dike breaching, flooding of salt marshes, salt intrusion into freshwater marshes and increased shoreline erosion. Intertidal marshes and mudflats may decrease in size as ecological zones shift but are restricted by the dikes and erosion protection measures. The PBHJV-BC's Fraser River Delta is the only Important Bird and Biodiversity Area designated as "in danger" in Canada by BirdLife International.
- Disturbance is an additional potential limiting factor, as it can reduce habitat availability. Middleton (2014) indicate that sources of disturbance, such as adjacent roads, industrial or residential areas, can exclude American Wigeon from portions of agricultural fields, effectively reducing the availability of this habitat type. In addition, anthropogenic disturbance in foreshore and nearshore habitats (e.g., walkers/hikers, dogs, watersports such as kite-surfing and paddling) can limit waterfowl access to important habitat features such as eelgrass beds, herring spawn sites and roost sites.
- Historically introduced populations of Canada geese that are now year-round residents continue to grow and are negatively impacting estuarine habitats in Southwestern BC. If this trend continues, availability of habitat for other waterfowl (including migratory Canada Geese) may be reduced.
- Harvest rates in the PBHJV-BC are minimal compared to other JVs and are not considered a limiting factor on waterfowl survival. An assessment of the extent of sports harvest mortality towards overall waterfowl vital rates was undertaken in the PBHJV in 2007-2008. The sports harvest rate was determined from waterfowl banding and recovery data collected between 1970 and 2006 in BC. Only nine species had sufficient data to warrant an analysis: Mallard, Canada Goose, Lesser Snow Goose, Barrow's Goldeneye, Bufflehead, Lesser Scaup, American Wigeon, Green-winged Teal and Ring-necked Duck. Mallard, Canada Goose and Lesser Snow Goose had the highest harvest rates (~10%) while the other species had harvest rates ranging from 1-4%.
- Other potential limiting factors, such as disease and environmental contaminants, are assumed to have minor impacts on waterfowl populations based on current CWS monitoring programs (Breault 2021), although they may be of significance in localized areas.
- To date, shellfish aquaculture does not appear to be having a negative impact on sea ducks, and in some cases even appears beneficial (Zydelis et al. 2006; Zydelis et al. 2009). However, due to high overlap between shellfish aquaculture activity and sea duck habitat (e.g., Baynes Sound) and the continued growth of this industry, research into this issue should continue.

CHAPTER 4 – PRIORITY NON-WATERFOWL SPECIES

The PBHJV is not only home to waterfowl, but a diversity of other bird species. North Pacific estuaries and rocky shores are known to be one of the most important global regions for shorebirds. Thirty-nine species of shorebirds occur regularly in the PBHJV-BC region, with up to 18 species present during winter. For example, the majority of the world's breeding populations of Western Sandpiper and the *pacifica* subspecies of Dunlin (3 million and 600,000 respectively) migrate along the BC coast (Butler et al. 2021). Almost a quarter of the world's population of Black Oystercatchers breed along the PBHJV-BC coast, and the highest densities of Black Turnstones in North America spend the winter here.

Black-throated Gray Warbler/Yousif Attia

The PBHJV-BC also supports globally significant numbers of seabirds, with an estimated 5.6 million colonial seabirds of 15 species breeding at 503 sites in BC (PCJV British Columbia Steering Committee 2005). Marbled Murrelet (Red-listed by the International Union for the Conservation of Nature [IUCN] as *Endangered*) is widely distributed in coastal BC, breeding in upland old growth trees and foraging in marine waters during winter and summer. The majority of the federally listed species-at-risk, Great Blue Heron (*fannini* subspecies), resides in the Salish Sea. The largest number occur around the Fraser River Delta, with the Tsawwassen colony alone holding about 12% of the entire Canadian population. The region's wetlands, lakes, rivers and nearshore areas also support a variety of loons, grebes, herons and raptors such as Bald Eagle, Short-eared Owl and Northern Harrier. Valley bottom riparian habitats also provide important migration stopover habitat for a variety of passerines, including warblers, flycatchers, sparrows, swallows and thrushes. Many are long-distance neotropical migrants, making annual return trips from the PBHJV region to as far south as Brazil (e.g., Olive-sided Flycatcher) and Peru. Some are only temporary migrant visitors, using estuaries as critical stopover sites (e.g., Wandering Tattler). Some are resident species found year-round in the temperate climate of the Pacific Northwest (e.g., Pacific Wren).

PRIORITY NON-WATERFOWL SPECIES

Non-waterfowl priority species were identified using a wide range of existing information for species found in Bird Conservation Region (BCR) 5, which encompasses the same approximate geographic area as the PBHJV-BC (ECCC 2013). In an effort to better align with Partners in Flight's (PIF) overall conservation strategies, this Implementation Plan's prioritization process relied heavily on species-specific information drawn from PIF's Avian Conservation Assessment Database (ACAD), including population trends, action codes and continental/regional importance (Panjabi et al. 2005). The ACAD was a critical source for the data used in Rosenberg et al. (2019), the renowned study that showed an alarming decline of 2.9 billion birds across North America since the 1970s. As such, the selected list of non-waterfowl priority species is part of a larger effort to address these significant, continent-wide losses of birds and bird habitat. The resulting priority list for this Implementation Plan contains a total of 48 species. Non-waterfowl bird species were categorized based on the *2019 State of Canada's Birds Report* (NABCI 2019) into the following eight groups:

1) Forest Birds
2) Birds of Prey
3) Aerial Insectivores
4) Seabirds
5) Grassland Birds
6) Shorebirds
7) Wetland Birds
8) Other Birds (includes species found in urban and shrub habitats)

In this Implementation Plan, the process for selecting the list of non-waterfowl priority bird species is as follows:

- Step 1: Extract the list of BCR 5 bird species from the 2020 PIF Avian Conservation Assessment Database (ACAD)
- Step 2: Include only species with meaningful occurrence in the BC portion of the PBHJV, based on eBird records and distribution maps from Birds of the World
- Step 3: Include all species federally listed as a Species at Risk (Special Concern, Threatened, Endangered or Extirpated)
- Step 4: Include all species with a PIF Action Code of either Critical Recovery, Immediate Management or Management Attention
- Step 5: For species with a PIF Action Code of Planning and Responsibility, include only if the species meets one of the following criteria: a) designated as a Common Bird in Steep Decline by PIF; b) is on the PIF Watchlist (red or yellow); or c) has >50% of continental distribution found in BC (either breeding or wintering). In addition, Planning and Responsibility species with threats that PBHJV-BC partners have little to no influence on are excluded (e.g. plastic pollution, oil spills, fish nets entanglement, over-predation on islands)

Through this process, a list of 48 priority species for all bird groups in all habitats across the PBHJV-BC was developed (**Table 8**). The majority of priority species identified were forest birds, totaling 22 species (44%). This is unsurprising as many passerines occupy forested habitats in PBHJV-BC, and Passeriformes is the largest order of birds and among the most diverse orders of terrestrial vertebrates. In addition, many forest-dwelling birds have undergone steep population declines (Rosenberg et al. 2019), including Varied Thrush, Pacific Wren, Evening Grosbeak and Olive-sided Flycatcher, and therefore are on PIF's list of species of high conservation concern. Wetland birds were the second most prominent group (17%), followed by seabirds (13%) and shorebirds (10%).

In terms of conservation status, 19 species (40%) are federally listed as a Species at Risk, including Black Swift, Barn Swallow, Ancient Murrelet and Great Blue Heron (*fannini* subspecies). Sixteen species are on the PIF Watchlist, including Rufous Hummingbird (Yellow Watchlist) and Wandering Tattler (Red Watchlist). Common Birds in Steep Decline include many forest birds such as Western Wood-Pewee, Pine Siskin and Wilson's Warbler.

Table 8. List of PBHJV-BC non-waterfowl priority species, their associated bird group and Partners in Flight Action Codes		
Species Name	**Bird Group**	**Conservation Action**
Black Swift	Aerial Insectivores	Immediate Management / Recovery Objectives
Common Nighthawk	Aerial Insectivores	Planning and Responsibility / Recovery Objectives
Barn Swallow	Aerial Insectivores	Recovery Objective
Northern Goshawk (*laingi* subspecies)	Birds of Prey	Recovery Objective
Peregrine Falcon	Birds of Prey	Recovery Objective
Rufous Hummingbird	Forest Birds	Immediate Management
Band-tailed Pigeon	Forest Birds	Immediate Management / Recovery Objectives
Varied Thrush	Forest Birds	Management Attention
Black-throated Gray Warbler	Forest Birds	Management Attention
Chestnut-backed Chickadee	Forest Birds	Management Attention
Pacific Wren	Forest Birds	Management Attention
Sooty Grouse	Forest Birds	Management Attention
Pine Siskin	Forest Birds	Management Attention
Spotted Owl	Forest Birds	Management Attention / Recovery Objectives
Olive-sided Flycatcher	Forest Birds	Management Attention / Recovery Objectives
Evening Grosbeak	Forest Birds	Management Attention / Recovery Objectives
Purple Finch	Forest Birds	Management Attention
Willow Flycatcher	Forest Birds	Management Attention
Cassin's Vireo	Forest Birds	Management Attention
Golden-crowned Kinglet	Forest Birds	Management Attention
Wilson's Warbler	Forest Birds	Planning and Responsibility
Western Screech-Owl	Forest Birds	Recovery Objective
Townsend's Warbler	Forest Birds	Planning and Responsibility
Vaux's Swift	Forest Birds / Aerial Insectivores	Management Attention
Western Wood-Pewee	Forest Birds / Aerial Insectivores	Management Attention
Lesser Yellowlegs	Forest Birds / Shorebirds	Planning and Responsibility
Barn Owl	Grassland Birds	Recovery Objective
Bullock's Oriole	Other Birds	Management Attention
White-tailed Ptarmigan	Other Birds	Management Attention
Brewer's Blackbird	Other Birds	Planning and Responsibility
Marbled Murrelet	Seabirds	Immediate Management / Recovery Objectives
Cassin's Auklet	Seabirds	Immediate Management / Recovery Objectives
Ancient Murrelet	Seabirds	Management Attention / Recovery Objectives
Common Murre	Seabirds	Management Attention

Table 8. *Continued*		
Species Name	**Bird Group**	**Conservation Action**
Pelagic Cormorant	Seabirds	Management Attention
Western Gull	Seabirds	Planning and Responsibility
Short-billed Dowitcher	Shorebirds	Planning and Responsibility
Wandering Tattler	Shorebirds	Planning and Responsibility
Red Knot (*roselaari* subspecies)	Shorebirds	Recovery Objective
Red-necked Phalarope	Shorebirds	Recovery Objective
Clark's Grebe	Wetland Birds	Management Attention
California Gull	Wetland Birds	Management Attention
Belted Kingfisher	Wetland Birds	Management Attention
Common Loon	Wetland Birds	Management Attention
Great Blue Heron (*fannini* subspecies)	Wetland Birds	Management Attention / Recovery Objectives
Mew Gull	Wetland Birds	Planning and Responsibility
Western Grebe	Wetland Birds	Planning and Responsibility / Recovery Objectives
Horned Grebe	Wetland Birds	Recovery Objective

NON-WATERFOWL OBJECTIVES

Non-waterfowl objectives, including population objectives, were not set for priority non-waterfowl species. Instead, conservation actions were determined by adopting the Action Codes determined by PIF for each species:

- IM (Immediate Management): Conservation action is needed to reverse or stabilize significant, long-term population declines in species where lack of action may put species at risk of extirpation.
- MA (Management Attention): Management or other on-the-ground conservation actions are needed to reverse or stabilize significant, long-term population declines where threats are moderate, or to reverse high threats in species that are not currently experiencing steep long-term declines.
- PR (Planning and Responsibility): Long-term planning actions are needed to ensure that sustainable populations are maintained in regions with high responsibility for these species.

For any species listed under the federal *Species at Risk Act* (SARA), in addition to the PIF Action Codes, conservation actions also include recovery objectives stated in Recovery Strategies or Management Plans, when available. See **Chapter 7** for overall PBHJV strategies and delivery.

CHAPTER 5 – HABITAT CONSERVATION DESIGN

Conservation specialists with Ducks Unlimited Canada monitoring the Fraser River Estuary/ Ducks Unlimited Canada

CONSERVATION PLANNING TOOLS AND MODELS

PBHJV-BC partners use several conservation planning tools and models to direct management actions and investments to address the limiting factors affecting waterfowl and other bird species. Some tools have been developed by independent organizations and shared with the partners, while other tools have been developed cooperatively (**Table 9**).

Table 9. Summary of PBHJV-BC conservation planning tools and models

Decision Tool	Purpose
Regionally Significant Wetland Areas in BC	Prioritizes areas with regional and continental significance for waterfowl, as well as areas with wetlands and associated uplands that hold high ecological values for birds.
Ducks Unlimited Canada (DUC) Waterfowl Priority Areas and Conservation Plans	Prioritizes areas with highest waterfowl values and highest habitat loss to secure foraging habitat; sets habitat-specific objectives.
Pacific Estuary Conservation Program (PECP) Estuary Ranking	Prioritizes estuaries for securement of waterfowl foraging habitat (agricultural and tidal habitat). Link to report here. An online interactive map of the PECP ranked estuaries can be found here.
Nature Conservancy of Canada (NCC) Conservation Planning System	A 3-phase conservation planning system used by NCC to identify the highest-priority areas for conservation and to guide conservation actions.
PBHJV Sea Duck Models (in progress)	Identifies shallow marine and estuarine areas of high sea duck use to target conservation action.
Coastal Waterbird Distribution Models	Projects probability of occurrence for each species over the entire coast of BC, and identifies sites of high bird species richness, diversity and uniqueness.
Nature Trust of BC (NTBC) Relative Ecological Assessment	A spatial evaluation of provincial ecological values that form seven criteria used by NTBC to identify the highest priority properties for conservation; one of the seven criteria focuses on wetlands.

Regionally Significant Wetland Areas

Regionally significant wetland areas are updates to broad planning areas used in previous JV Implementation Plans and augmented with recent information (**Figure 6**). The inputs include:

- "Areas of Continental Significance to Waterfowl"—contain wetlands and associated uplands that meet continental waterfowl population thresholds and have been used in NAWMP planning since 2012
- "Areas of Regional Significance to Waterfowl"—contain wetlands and associated uplands that JV partners have identified as supporting regionally significant waterfowl populations and/or have documented high historic wetland loss in BC
- "Pacific Estuary Conservation Program (PECP) Ranked Estuaries"—include Classes 1, 2 and 3 out of a possible 5, based on various ecological and physical parameters as well as documented waterbird populations

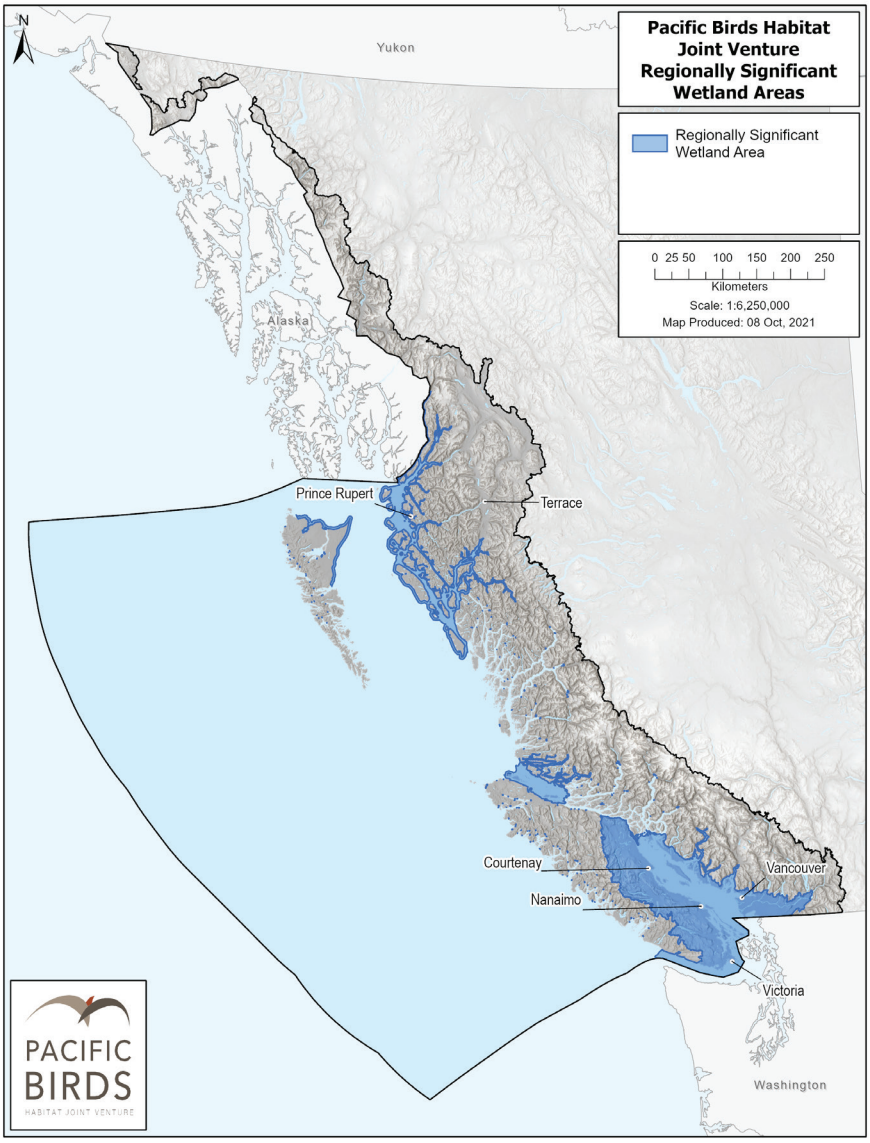


Figure 6. Regionally significant wetland areas in BC

While the actual number of birds using any individual wetland within these broad areas will vary depending on site conditions, generally wetlands and their associated uplands (grasslands, trees, shrubs, riparian vegetation, etc.) in these areas have higher use by wetland birds than other areas in the PBHJV. Wetlands and their associated uplands form complexes that support wetland birds but also many other species of wildlife, including species at risk. A high percentage of migratory birds and other wildlife in BC use wetlands and associated uplands for all or part of their life cycles, and therefore conservation of these habitat complexes have multiple, enduring benefits.

PBHJV partners target the majority of their conservation efforts and funding into these broad planning areas in order to have the greatest benefit to waterfowl and other wetland species. However, conservation opportunities outside of these broad planning areas are considered on a case-by-case basis to allow for inclusion of sites with exceptional local ecological values.

Ducks Unlimited Canada Waterfowl Priority Areas and Conservation Plans

DUC waterfowl priority areas target DUC's resources to areas with the highest need and where activities will benefit the most birds. Other factors considered in setting Priority Areas are wetland density, risk and/or degree of habitat loss and partnership opportunities. Within the PBHJV-BC, the highest priority is the Fraser Delta, followed by East Coast Vancouver Island (**Figure 7**). For both Priority Areas, DUC has prepared comprehensive landscape plans to identify habitat threats, set habitat objectives and outline a conservation program for meeting objectives (DUC 2004; DUC 2012). DUC also prioritizes landscapes within 10 kilometres of significantly productive estuaries.

Within Priority Areas, programs are targeted towards areas where there is a strong overlap of high waterfowl values and high risk of habitat degradation. Specific "delivery watersheds" are then selected after consideration is given to public profile, landowner receptiveness and concurrent partner stewardship programs.

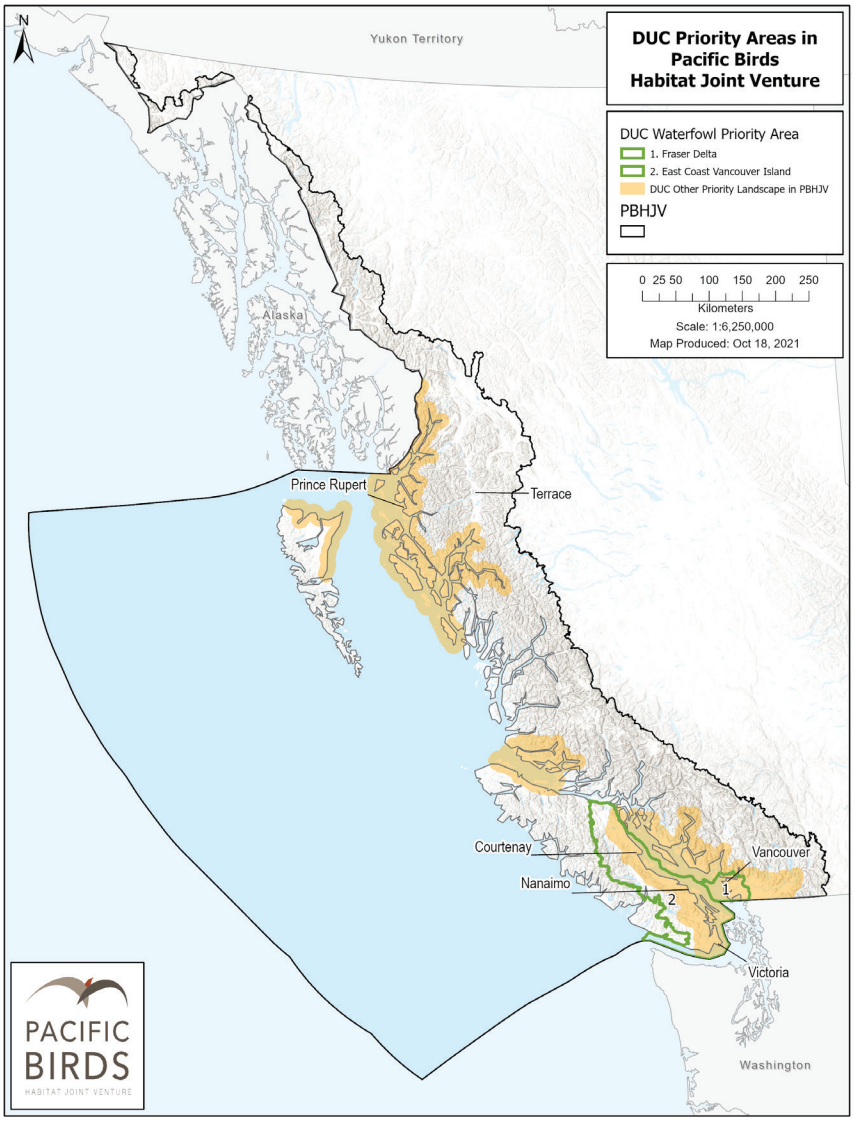


Figure 7. DUC Waterfowl Priority Areas in the PBHJV-BC

Nature Conservancy of Canada Conservation Planning System

Guided by the best available conservation science, NCC protects areas of natural diversity for their intrinsic value and for the benefit of future generations. Work is focused on various landscapes throughout Canada that have been specifically identified as important for biodiversity conservation, in part through Conservation Blueprints (CBs) and Ecoregional Assessments (ERAs).

The ERA identifies a suite of conservation sites that could contribute to the long-term survival of all viable plant and animal species and natural communities in an ecoregion, including wetlands. The ERA follows a methodology of portfolio design described in Designing a Geography of Hope (Groves et al. 2000). One of the outcomes is a spatial matrix of biodiversity value versus threats, highlighting the urgency for conservation action. Ecoregional plans cross political boundaries and are in place for the whole of the PBHJV-BC.

The results of the ERA aid in the identification of specific focal areas, which in addition to a combination of other priority conservation considerations, such as watershed boundaries and protected area corridors, help NCC to identify natural areas. Beginning in 2007, NCC developed Natural Area Conservation Plans (NACP) for those areas. These plans identify NCC conservation goals for that particular geography and support strategic decision making and efficiency of resources at all levels. Conservation goals are identified and prioritized, then developed followed by implementation and tracking to allow for adaptation. NCC staff and partners view the planning process as iterative and ongoing, rather than a once-a-decade exercise. At the Natural Area scale, conservation actions include securement, management, restoration, enhancement, outreach and communications. NCC has defined six Natural Areas within PBHJV-BC: 1) the Salish Sea, 2) Central Coast Rainforest 3) Haida Gwaii 4) Clayoquot Sound and 5) Fraser West 6) West Chilcotin (**Figure 8**).

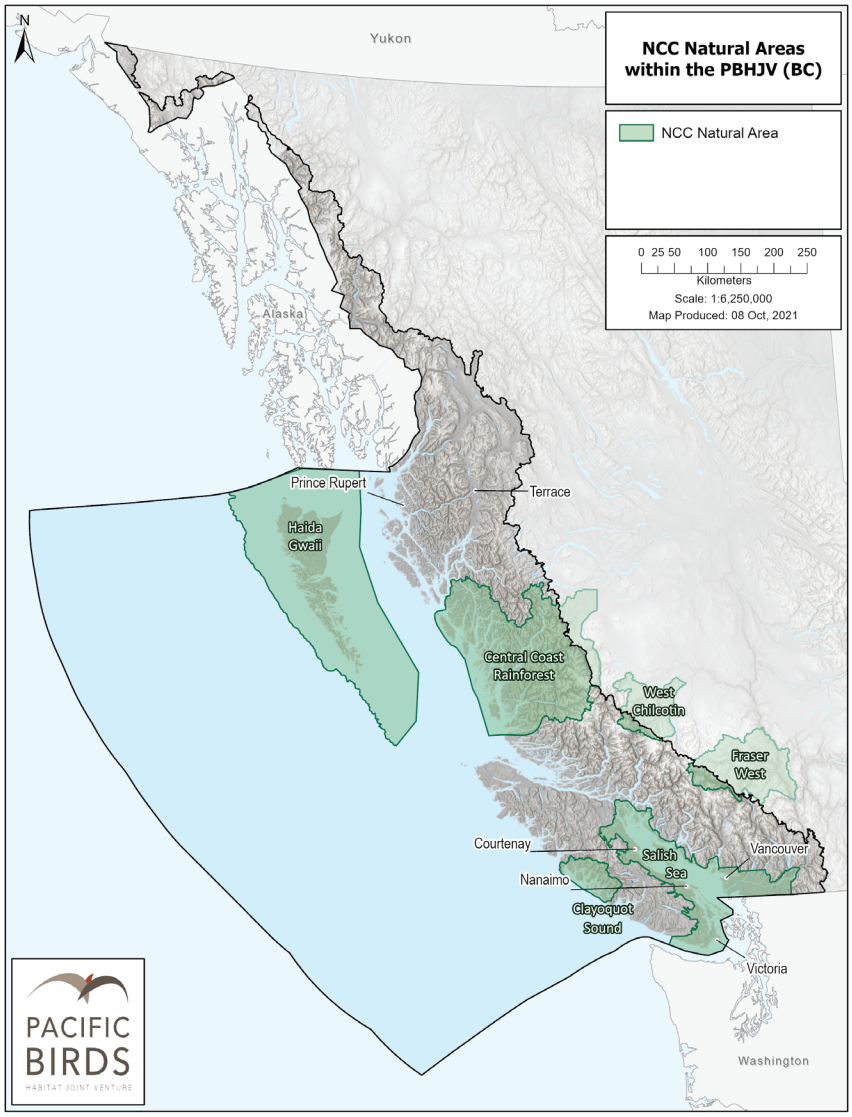


Figure 8. Nature Conservancy of Canada Natural Areas within the PBHJV-BC boundary

One of the major areas of conservation action is protection of key lands that capture biodiversity targets and help alleviate defined threats. Examples within the PBHJV-BC include the protection of the foreshore of an estuary in Bella Coola called Tidal Flats Conservation Area and of a key valley bottom forested riparian area in a floodplain near Pemberton called Ryan River Conservation Area. For each conservation area secured, NCC creates a 5-year Management Plan using Conservation Standards that links goals, a smaller set of targets, threat analyses and a set of conservation actions to alleviate major threats which NCC can influence.

At all planning levels, threats and conservation actions are defined according to the standardized classification developed by the International Union for Conservation of Nature (IUCN). Conservation targets have been defined for wetland habitats (along with individual bird species at risk or bird groups such as waterfowl). Waterfowl and wetland-related information is incorporated within other PBHJV planning documents where appropriate.

Nature Trust of British Columbia Relative Ecological Assessment

The Nature Trust of British Columbia's (NTBC) Relative Ecological Assessment (REA) is a tool for evaluating the relative ecological value of conservation opportunities across BC landscapes (**Figure 9**). The criteria used to evaluate ecological value fosters effective conservation planning decisions. The ecological values are used to identify how a potential conservation acquisition ranks relative to The NTBC's current portfolio of conservation properties at the time when each analysis is run. The tool has been continuously improved as new conservation concepts, associated spatial data with provincial coverage and technological advances have become available. Currently this automated tool runs using ArcGIS programming (Python & ArcPy), R statistical software and the Google Maps web mapping platform.

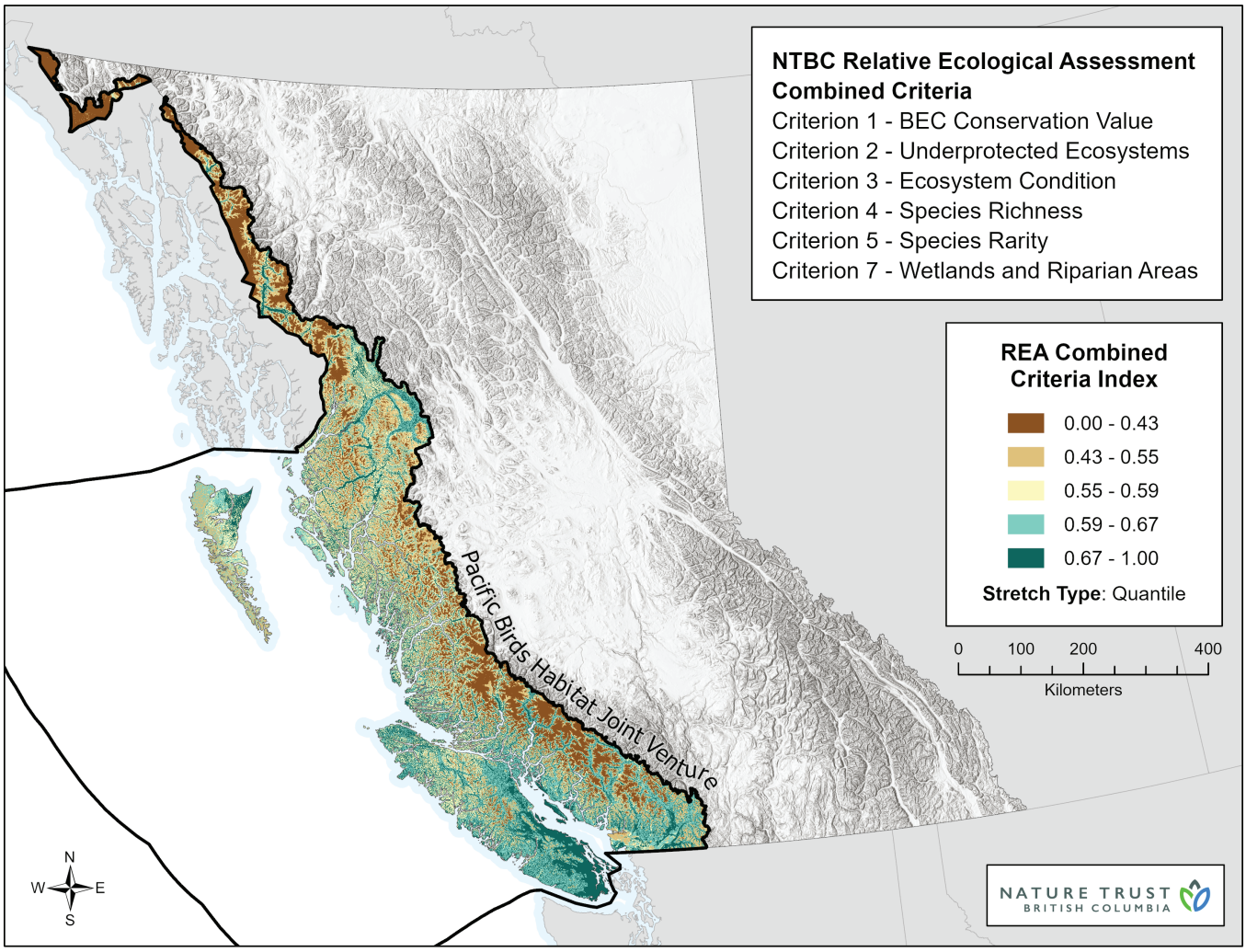


Figure 9. Nature Trust of BC's relative ecological assessment combined criteria values within the PBHJV-BC

The REA tool, applies seven criteria to evaluate potential conservation acquisitions. These criteria are based on a series of spatial datasets that have been mapped for the entire Province of BC. This approach provides a common set of values to evaluate conservation acquisitions across BC. Many of these values have been derived from *Taking Nature's Pulse: The Status of Biodiversity in British Columbia*, produced in partnership with conservation NGOs and provincial, federal and local governments focused on developing a science foundation for biodiversity action (Austin et al. 2008).

The seven ecological criteria are biogeoclimatic zone conservation values, under-protected ecosystems, ecosystem condition, species richness, presence of rare species and ecosystems, viability or connectivity with other protected areas and wetland and riparian ecological values. An index is calculated for each criterion based on the spatial ecological values associated with the conservation acquisition (i.e., parcels or polygons). Individual potential conservation acquisitions are given an overall score by summing the index values and then comparing them to the values for existing conservation lands, thereby providing a relevant scale for evaluating conservation value in BC.

Pacific Estuary Conservation Program Estuary Ranking Project

The Pacific Estuary Conservation Program (PECP) Estuary Ranking Project provides a quantifiable regional overview of estuary habitats that links existing biophysical data and attributes to assist in conservation planning. The PECP coordinates efforts to secure and enhance estuary habitats with high ecological value along the coast. Partners include Environment and Climate Change Canada, DUC, BC Ministry of Forest, Lands, Natural Resource Operation and Rural Development, BC Ministry of Environment and Climate Change Strategy, the Habitat Conservation Trust Foundation, NCC and NTBC. Data from the BC Coastal Waterbird Survey of Birds Canada significantly contributed to the project. The goal is to provide an objective, BC-wide assessment of estuary occurrence and ecological importance to waterbirds. The first report was published in 2007.

In this 2019 update, estuaries across the BC coast were identified, mapped and ranked using GIS tools and standardized criteria (PBHJV 2019). The ranking process was improved from earlier versions by updating or introducing new variables, including estuary size, species rarity, waterbird density, herring spawn and fish escapement. The end product is a spatially explicit regional overview and prioritization of estuaries for conservation action.

A total of 436 estuaries in BC were identified, mapped and ranked from Class 1 (most important) to Class 5 (least important) (PBHJV 2019). Estuaries in Classes 1, 2 and 3 tend to be large in area with significant intertidal deltas or adjacent saltmarshes and abundant intertidal vegetation and mussels. While many lower-ranked estuaries were small, they also lacked data and therefore may still have considerable ecological value, which could be clarified as new data become available. A total of 315 estuaries (72%) were ranked in the top three Importance Classes. Northern and Central Mainland has the most Class 1-3 estuaries (42%) and 59% of the total land area. Northern and Western Vancouver Island has the next highest percentage of Class 1-3 estuaries (31%), but only 12% of the land area, and therefore has the highest density of Class 1-3 estuaries.

The largest Class 1 estuary by far is the Fraser River Estuary. At 21,696 hectares (53,612 acres), it contains 36% of all the estuarine area in BC. The Fraser River Delta has a multitude of international designations and recognitions, including: Ramsar Wetland of International Importance, an Important Bird Area (IBA), WHSRN (Western Hemisphere Shorebird Reserve Network) site, Key Shorebird Site (Shorebird Conservation Strategy), Key Sea Duck Site (Sea Duck Joint Venture) and a Key Biodiversity Area (in progress). Unfortunately, this estuary is also one of the most threatened and modified estuaries in BC, due to factors such as loss of intertidal habitat to development, diking and conversion from natural estuary habitat to intense agriculture and pollution. In fact, the Fraser River Estuary is the only IBA in Canada designated as “in danger” by BirdLife International.

PBHJV partners and others can use the ranking report and data in multiple ways. It will help practitioners evaluate and compare habitat securement, restoration or stewardship opportunities at the level of the entire provincial coastline. It will also contribute to the preparation for environmental emergencies such as oil spills, including prioritizing areas for first response in case of significant events. PECP will also provide context for impact assessment associated with large development projects. For example, it can help determine project impacts on wetlands and wetland functions and/or offset plans.

Birds Canada Coastal Waterbird Survey Abundance Mapping

Birds Canada's BC Coastal Waterbird Survey (BCCWS) is a long-term monitoring program involving mainly volunteer-collected data during the fall, winter and spring months. The community/citizen science program began in 1991, and since then approximately 1,600 volunteers have contributed an estimated 50,000 hours to monitoring waterbird populations. The BCCWS data has been used to identify areas with high winter and migration stopover use by waterfowl and other waterbirds, and highlight differences in the spatial distributions of various bird groups/guilds particularly in non-estuarine areas. Maps are available online showing waterbird abundance for specific seasons or regions. The Fraser River Estuary contains the highest density of waterbirds from December to February in the South Coast of BC, followed by coastlines on the southeastern tip of Vancouver Island (**Figure 10**).

In addition to abundance mapping, the BC Coastal Waterbird Survey (BCCWS) dataset has been used to investigate the status and trends of waterbirds, and to determine potential impacts of natural and human-induced environmental changes on their populations. Based on a 2020 study, populations of 12 out of 50 waterbird species in the Salish Sea have declined over the past two decades (Ethier et al. 2020). The same was true for just 3 species on the Pacific Ocean coast. These results suggest that birds living in the Salish Sea are exposed to stronger human-caused pressures than those along the outer Pacific Coast. Further, species feeding on aquatic invertebrates in the benthos (the rocks, sand or mud along the coast that are almost always underwater) are the ones that appear to be declining the most. This group includes all three scoter species (Surf, White-winged and Black), Long-tailed Duck, Black Turnstone and Dunlin. Similarly, fish-eating species also showed to be at high risk of declines. Long-distance migrants overall are also showing relatively steeper declies than short-distance migrants or local breeders. In contrast, 36 and 32 species in Salish Sea and Pacific Ocean coasts, respectively, showed stable population trends. Additional research is needed to fully understand how various pressures can affect waterbird abundance and distribution, including dredging, pollutants, fishing, shipping activity and climate change.

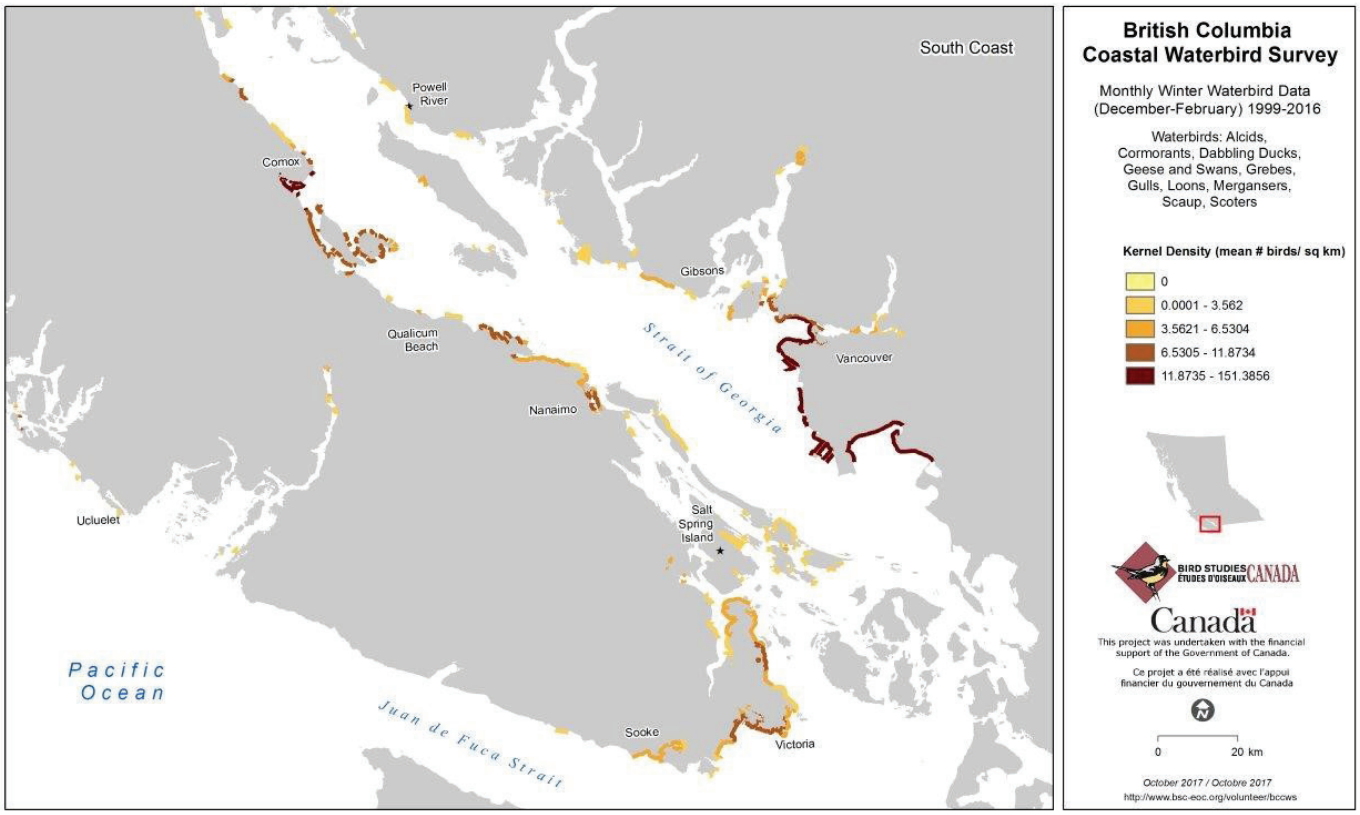


Figure 10. BC Coastal Waterbird Survey waterbird abundance from December to February in the South Coast of BC (1999-2016)

Sea Duck Models

Several PBHJV partners have been collaborating to produce habitat-species models to define and predict the habitat use of sea ducks and other waterbirds along the BC coast.

By identifying areas associated with large numbers of birds, specific habitat could be prioritized for conservation actions. The partners also plan to eventually evaluate temporal patterns and spatial changes in the abundance and distribution of sea ducks.

Partners identified 10 sea duck species of interest and have so far built habitat use models for four of these species (representing a range of habitat associations) in the "R" statistical modeling environment, using mixed-effects compound Poisson models with additive random-effects of site and year.

Surf Scoter/©Ducks Unlimited Canada/Tim Fitzgerald

The modeling project uses:

1) The BC Biophysical ShoreZone habitat mapping dataset collected by the Province of BC (collected using oblique, low-tide aerial video imagery (Howes 2001))
2) The BC Coastal Waterbird Survey (BCCWS) long-term dataset collected by Bird Studies Canada "Citizen Scientists"
3) Supplementary habitat datasets (BC Freshwater Atlas, clam beds, TRIM, and shellfish tenures) collected from various sources

For the species modeled thus far (Bufflehead, Surf Scoter, White-winged Scoter, Red-breasted Merganser), the best explanatory models have included information from a range of habitat characteristics, including coastal substrate type, food sources, number of freshwater inputs, bathymetry, shelter and safety-associated features.

One model (Bufflehead) has been expressed spatially in a GIS. A validation exercise conducted for this species indicated the model does a good job of tracking the relative abundance of Bufflehead among sites. Partners are continuing to refine and validate the existing models, and plan to spatially express the model for Surf Scoters in the future.

Assumptions

- Bird survey information is representative of habitat use along the entire BC coast, despite the relatively concentrated nature of its collection in Southwestern BC
- Current explanatory-type models can be used to predict areas of high sea duck use

Addressing Key Uncertainties

The current model selection approach balances model complexity with the model's ability to fit the current data. There is no assessment as to how well it might perform in predicting abundance for areas outside of the main bird survey zones. The partners have been trying to address this through expansion of survey routes into new areas.

Partners are testing the predictive capacity of these models by expressing them spatially and comparing the outputs to other independent georeferenced datasets, or partitioned datasets from the Coastal Waterbird Surveys.

TRUEMET Model

In 2012, DUC used a bioenergetic model (TRUEMET) to explicitly link wintering bird population objectives to habitat objectives for farmland in the Fraser River Delta. It was assumed that foraging habitat limits wintering waterfowl populations during their stay on the Fraser River Delta.

TRUEMET has an "energy demand" input (related to waterfowl population needs) and an "energy supply" input (related to habitat characteristics), and these inputs combine to provide a forecast whether there is adequate foraging habitat (or a surplus or deficit) for a given population level (**Figure 11**). DUC used this approach to convert the food energy needs of Fraser River Delta waterfowl populations (excluding sea ducks) into a foraging habitat objective.

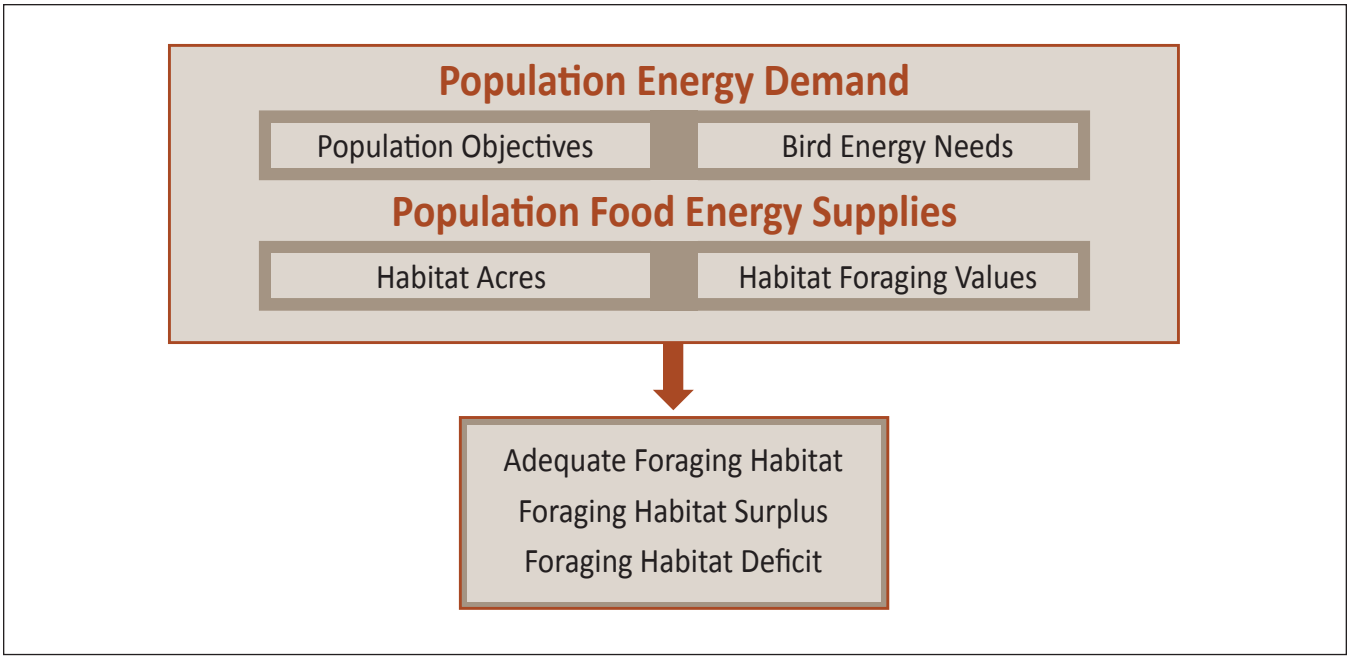


Figure 11. Inputs of the TRUEMET Model

For the TRUEMET model, energy demand was derived from the target population of each waterfowl species during each month of the non-breeding season (defined for the Fraser River Delta as September through April), and the daily energy needs of an individual bird. The daily energy needs of an individual bird were determined from scientific literature. Energy supply was derived from a current inventory of habitats and the food value of those habitats.

The modeling linkage between energy needs and availability predicted long-term habitat needs in the Delta (e.g., quantitative habitat objectives for agricultural land) under different habitat/population scenarios, including future losses of agricultural habitats.

Use of TRUEMET was limited to the major dabbling duck species and Lesser Snow Goose, combined into two foraging guilds:

1. Grazers: American Wigeon and Snow Goose
2. Dabblers: Mallard, Northern Pintail and Green-winged Teal.

The model did not address sea ducks and intertidal geese (e.g., Brant) due to a lack of information about the energetics of their food sources (e.g., shellfish). Intertidal habitats were mostly excluded from energy supply calculations due to uncertainties about natural food sources. Model results indicated that grazers experienced an excess of energy through the non-breeding season, but predicted a deficit by midwinter within 20 years under likely scenarios. For dabblers, the demand exceeded supply by December, and the situation only worsened under future scenarios.

Dabbler energy supply dropped to near-zero for late winter under all scenarios due to the depletion of upland foods, but bird observations contradict this, and there are likely inaccuracies among the input parameters for this guild. Nevertheless, the model is generally believed to be correct in suggesting that dabblers are stressed by winter's end due to: i) documented depletion of some food sources (e.g., remnant potatoes), and ii) a similar modeling result in North Puget Sound.

It is clear that in the absence of partner intervention, agricultural lands in the Fraser River Delta will eventually be unable to support current waterfowl populations. TRUEMET results indicate that wintering dabblers are already energetically stressed, and conditions will only worsen as more agricultural land is converted to non-beneficial crop types or is lost to development. Crop surveys regularly conducted by PBHJV-BC partners in the Fraser River Delta show a clear and continual loss of agricultural land base to urban/industrial uses since 2000. In fact, this declining trend was more serious than the 2012 TRUEMET projection (**Figure 12**). While TRUEMET has not yet been used to model conditions on the east coast of Vancouver Island, trends in agricultural habitats there are likely similar.

Assumptions

- Foraging habitat is the primary limiting factor of wintering and migrating waterfowl.
- Waterfowl acquire resources mainly from agricultural and intertidal habitats during the wintering/staging period, and the energetic model accurately captures the energetic resources available in the first category of these. Intertidal habitats are assumed to be at less risk of loss given the extent of their designation as Wildlife Management Areas. Food sources in freshwater wetland habitats provide comparatively less waterfowl energetic resources.
- Trends in habitat availability are predictable and will follow previous land use and development patterns.
- Bird movements correspond to food depletion patterns, and survival rates should be high where food resources are not depleted below population needs.

Addressing Key Uncertainties

The use of TRUEMET still only applies to the major dabbling and "grazing" duck species, as well as Lesser Snow Goose. Estuarine-dependent species, such as sea ducks and Brant, were not addressed due to a lack of information about energetic resources available to them in intertidal habitats, and therefore another strategy is needed to develop habitat objectives which more explicitly address their needs.

The energy supply/demand relationship of intertidal habitats was mostly excluded from TRUEMET energy supply calculations because research and analysis to-date is incomplete from these habitats. DUC has recently initiated research to quantify the energy supply available to sea ducks from various vegetative and aquatic invertebrate sources.

PBHJV partners have recently updated knowledge of the carrying capacity of the agricultural landscapes, via an updated crop cover dataset. This will enable re-running of the TRUEMET model with more current energy supply estimates.

SENSITIVITY AND SPATIAL DATA ANALYSES

Statistical analysis of key parameters (to examine their influence on model results) is a longer-term priority for the PBHJV-BC that will be addressed once habitat-species models are better defined and replicated for more than a single time period. The following is a preliminary list of key parameters likely to influence population response variables or habitat objectives:

1. Population size of individual species
2. Energetic values of various habitat types
3. Rates of habitat conversion
4. Distance to edge or disturbance
5. Degree of intactness of habitats
6. Effects of sea level rise on intertidal habitat availability
7. Prevalence of invasive species

PBHJV-BC conservation planning may be limited by the following aspects of the spatial databases currently available:

1. The static nature of available datasets limits the ability to track trends in estuary and wetland distribution
2. There is a lack of fine scale coverage for most of the PBHJV-BC region
3. Predictive capability for modeling the effects of sea level rise on estuary intertidal zones is still undeveloped
4. The condition of habitats on conservation lands is not well known due to limitations in monitoring capacity, although we've recently begun work to better characterize performance of conservation lands in terms of bird distribution
5. Estuary condition is not specifically addressed by any of the available datasets, although inferences may be drawn from some of the sources (e.g., CAD)

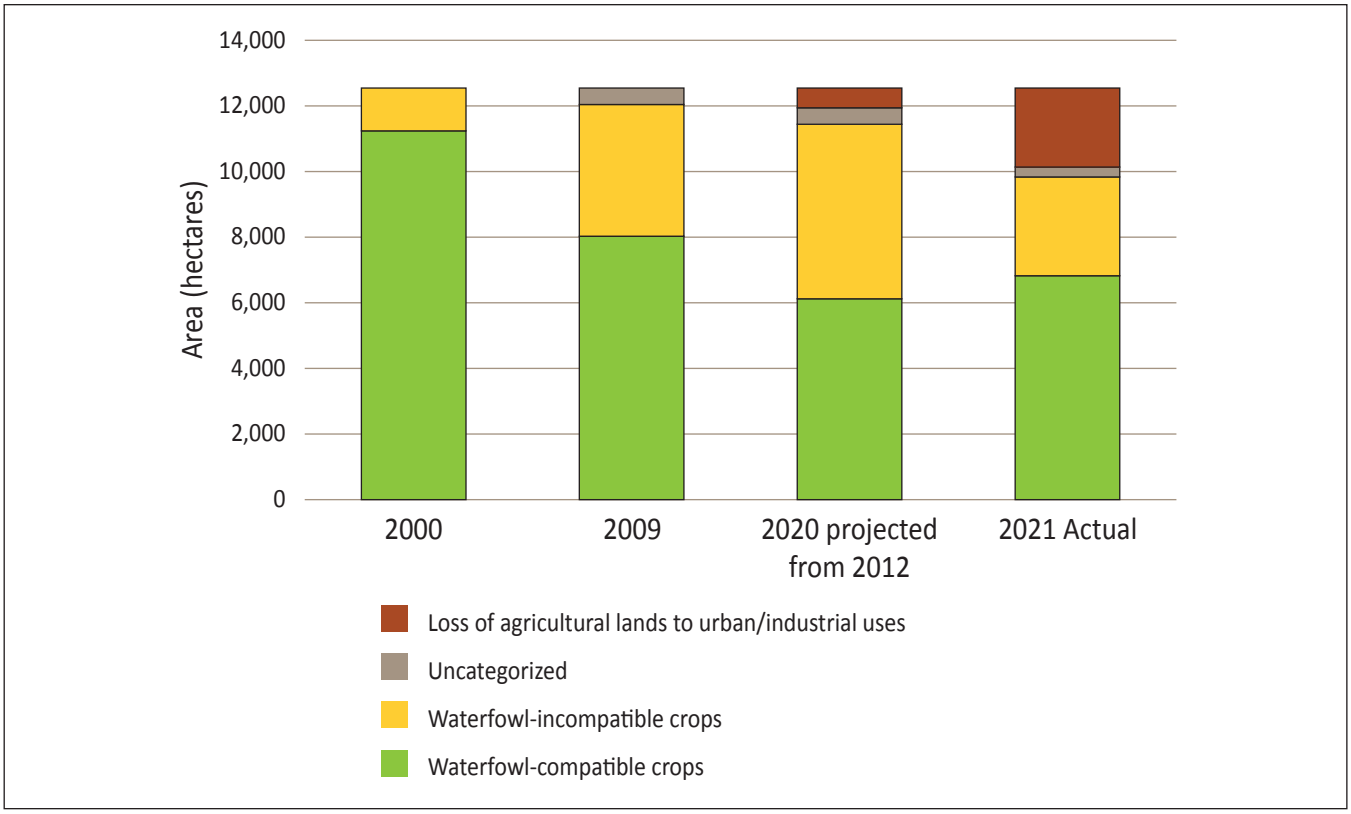


Figure 12. Changes in agricultural land base in the Fraser River Delta from 2000-2021

CHAPTER 6 – HUMAN DIMENSIONS AND COMMUNICATIONS

INTRODUCTION

Human dimensions (HD) is a field of study that applies the social sciences to examine human-wildlife relationships to provide information to inform the effective application of wildlife conservation efforts (Manfredo 2008; Dayer et al. 2019). HD explores what people think and do related to conservation, incorporates that understanding into decision-making about conservation policies and programs and evaluates the impact of those efforts on both human behaviour and conservation targets much like biological data is integrated into conservation (Dayer et al. 2019). Combining expertise from the fields of HD with insights from biological science can improve conservation approaches and outcomes, and lead to a better understanding of why people engage or do not engage in conservation. When it is incorporated in conservation design and planning by conservation programs such as Joint Ventures, HD research can help to efficiently mobilize resources (Dayer et al. 2019).

NAWMP HUMAN DIMENSIONS UPDATES

The 2012 NAWMP Revision introduced the role of people in the conservation of waterfowl and wetlands with the inclusion of a third goal. Goal 3 aims for: "growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation" (NAWMP 2012). The recently revised "supporter objective" calls for increased waterfowl conservation support among various constituencies to at least the levels experienced during the last two decades. While challenging the NAWMP community to broaden and increase its base of conservation support, the 2012 NAWMP Revision extended a further call-to-action to waterfowl management practitioners to integrate waterfowl management decisions by more fully understanding how they contribute to all NAWMP goals and objectives. Although the incorporation of people-centered objectives adds complexity to integrated decision making, gaining an understanding of the HD within the PBHJV provides a powerful, versatile and far-reaching tool to make progress on all objectives.

The 2014 NAWMP Addendum established the following objective: "Increase waterfowl conservation support among various constituencies to at least the levels experienced during the last two decades" (NAWMP 2014). The 2014 Addendum distributed this objective among three constituent groups: active waterfowl hunters, North American citizens who appreciate and take action to support wetlands and waterfowl conservation and landowners participating in habitat conservation programs.

The 2014 NAWMP Addendum identified initial quantifiable objectives for these groups based on:

- Average number of hunters in Canada and the U.S. from 1999-2013 (1.2 million and 178,000, respectively)
- Average number of waterfowl viewers traveling more than 1 mile from home from 1996-2011 (14.4 million; comparable data not available for Canada or Mexico) or out of state (4.6 million)
- Number of birdwatchers in Canada (4.7 million; 18% of the population)
- 1999-2013 sales of Migratory Bird Hunting and Conservation Stamp (commonly referred to as the Federal Duck Stamp) in the United States (1.6 million; $23.5 million revenue) and Migratory Game Bird Hunting Permits in Canada (~178,000; $3.2 million revenue)

The 2018 NAWMP Update reiterated the importance of incorporating social sciences to realize the third goal of increasing the numbers of waterfowl hunters and other conservationists across North America—to effectively connect people with waterfowl habitat. Delivering on public expectations and applying HD principles will facilitate the application of adaptive frameworks and integration decisions to conservation challenges across all JV regions (NAWMP 2018). This recognizes that HD insights are required to effectively address most waterfowl management challenges, from understanding factors contributing to both habitat loss and conservation, to managing harvest, to dealing with issues surrounding human conflicts with overabundant species.

HUMAN DIMENSIONS WORKING GROUP

The HD Working Group, formed in response to the 2012 NAWMP Revision, is developing the scientific and technical foundations to define objectives for hunters, birders and other potential supporters. The PBHJV-BC Coordinator sits on the committee. In 2013, the PBHJV recruited Dr. Howard Harshaw (University of Alberta) to serve as the Canadian Joint Venture representative for this group and to ensure that the Canadian public is actively engaged in HD studies for NAWMP. In 2017 the Working Group finalized and conducted a survey of waterfowl hunters and viewers to understand motivations for wildlife conservation and factors influencing recruitment and retention of waterfowl hunters and viewers (Harshaw 2018a). In 2018, the HDWG and the Public Engagement Team were merged to better coordinate JV capacity and provide specific guidelines for HD in subsequent Implementation Plans.

METHODS FOR CURRENT CHAPTER DEVELOPMENT

Many PBHJV partners have already embarked on activities that help to achieve Goal 3; however, it has never been explicitly included in PBHJV activities, nor have these activities always been focused on the specific outcome of waterfowl conservation. In this Implementation Plan, PBHJV-BC partners have refined their activities to include a HD vision through a series of workshops and webinars, and have worked with the Working Group and HD experts to develop this chapter.

In 2020, the two-year Mitacs Project was initiated and led by Drs. Howard Harshaw and Katherine Sainsbury at the University of Alberta. The project objectives are to increase the HD capacity of the PBHJV community and to develop and measure repeatable indicators of conservation and nature-based recreation involvement among the Canadian public. The project involves three studies that will (1) identify relevant stakeholders with interests in waterfowl and wetlands conservation, (2) identify measures of conservation and nature-based recreation involvement and (3) test and implement these measures in a national web-based survey of waterfowl and wetlands conservation stakeholders. The project results will be incorporated into ongoing PBHJV plans and planning.

HUMAN DIMENSIONS LANDSCAPE

People have lived in the regions of the PBHJV-BC since time immemorial including:

- Coast Salish people such as Hul'qumi'num
- Tsleil-Waututh Nation
- Tsartllip
- Tsawout Nation
- Tseycum
- Pauquachin
- Songhees First Nation
- Esquimalt First Nation
- T'sou-ke First Nation
- Scia'new First Nation
- Stz'uminus First Nation
- Halalt First Nations
- Cape Mudge First Nation
- Cowichan Tribes
- Qualicum First Nation
- Malahat First Nation
- Nanoose First Nation (Snaw-Naw-As)
- Snuneymuxw First Nation
- Tla'amin First Nation
- Tsawwassen First Nation
- Semiahmoo First Nation
- Sto:lo Nation
- Squamish Nation
- Musqueam Nation
- Sts'ailes
- Sq'éwlets (Scowlitz)
- Kwantlen First Nation
- Katzie First Nation
- Kwikwetlem First Nation

- Laich-kwil-tach people such as
  - Campbell River First Nation
  - We Wai Kai Nation
  - Wei Wai Kum First Nation
  - Homalco First Nation
- Nuu-chah-nult nations such as
  - Dididaht
  - Huu-ay-aht
  - Hupacasath Tse-shaht
  - Uchucklesaht
  - Ahousaht
  - Hesquiaht
  - Tla-o-qui-aht
  - Toquaht
  - Yuu-cluth-aht
  - Ehattesaht
  - Kyuquot/Cheklesaht
  - Mowachaht/Muchalaht
  - Nuchatlaht
- Kwakwaka'wakw people such as
  - Kwakwaka'wakw Nation
  - Ko'moks First Nation
  - Kwakuitl First Nation
  - Gwa'sala'Nakwaxda'xw
  - Namgis First Nation
  - Quatsino First Nation
- Tsimshian people such as
  - Kitkatla First Nation
  - Laxkwalaams Indian Band
  - Metlakatla First Nation
  - Kitselas Band
  - Kitsumkalum Band
- and other Indigenous communities on the central and northern coast such as
  - Heiltsuk Nation
  - Wuikinuxv Nation
  - Nuxalk Nation
  - Haisla Nation
  - Haida Nation

CREDIT: (College of New Caledonia 2020).

Presently about 3.7 million people live in the PBHJV-BC region, of which, 2.5 million reside in Metro Vancouver, one of the densest (855 people/km^2) and fastest changing metropolitan areas in Canada (Statistics Canada 2017). Metro Vancouver has seen rapid population growth (average +6.5% from 2011-2016), and is expected to increase to 3.8 million by 2050 (CBC 2021). Vancouver is an immensely ethnically diverse area, with 49% of its population self-identifying as a member of a visible minority, including South Asian (12%), Chinese (20%), North American Indigenous (3%), Latin American (2%) and Middle Eastern (4%). Furthermore, the Canadian portion of the Georgia Basin area, which includes Metro Vancouver, the Fraser Valley and Southeastern Vancouver Island (**Figure 2**), is home to roughly 3.4 million people, about 93% of the human population in PBHJV-BC and 73% of all people in BC (Statistics Canada 2017). The Georgia Basin is also home to hundreds of thousands of waterfowl, shorebirds and seabirds that migrate through or winter in the area. At the heart of the area lies the Fraser River Delta, where both migratory birds and people occur in high densities and in close proximity.

DUC, CWS and Delta Farmland & Wildlife Trust (DF&WT) have been collaboratively mapping the extent of crops in the Fraser River Delta since the late 1990s. The purpose is to track the quantity of wildlife-compatible crops that are available for foraging waterfowl and shorebirds in winter. Historically, the Agricultural Land Reserve (ALR) in Delta, composed of 9,533 hectares (23,556 acres), grew mainly vegetable (3,304 hectares or 8,164 acres in 1997) and grass/forage (2,334 hectares or 5,767 acres in 1997). Preliminary analysis of the extent of crop types in the Fraser River Delta for the years 1997, 2000, 2009, 2017 and 2020 indicate that the total area of wildlife compatible crops (pasture, hay, grain and vegetables) has declined (PBHJV 2021). The total area in blueberries and cranberries has increased by approximately 300% over this time period. These crops do not provide foraging opportunities for wintering waterfowl or shorebirds. There has been a corresponding decline in vegetable fields, grain fields, hay fields and pasture fields. Compounding this is the loss of open-soil agriculture fields to urban uses and to greenhouses.

Challenges arise when waterfowl and urban populations overlap in the PBHJV-BC. For example, in the Georgia Basin, there are conflicts between expanding populations of urban resident Canada Geese and wintering Lesser Snow Geese and aviation safety, agricultural interests, recreational users and landowners/managers. Grazing by these overabundant geese can degrade the remaining estuarine saltmarsh habitat, cause crop damage and loss and damage parks, school yards and recreation fields. Excessive droppings in parks and other public areas also cause conflict with members of the public using these spaces. Local governments are under increasing pressure from the public to manage these geese populations. The problem geese issue presents an opportunity for PBHJV-BC partners to engage with local governments and the public around waterfowl conservation, management and hunting. Hunting remains one of the best tools for controlling waterfowl populations and manage their distribution. Wildlife management discussions provide an opportunity for PBHJV-BC partners to engage local governments on the need to maintain areas open for hunting. Similarly, they may also serve as a forum for outreach to the public about the role hunting plays in both conservation and management.

Providing opportunities for waterfowl hunters is a challenge in the PBHJV-BC. On the central and north coasts and Haida Gwaii, access to the landscape is the major limitation. There are few human settlements, and the people in these communities have minimal access to areas frequented by ducks (due to weather, remoteness and transportation). First Nations land rights also often limit where non-Indigenous people can hunt. The situation is different in the Georgia Basin, where the large majority of the human population and the most valuable habitat for waterfowl occur. There is more public access to good waterfowling areas, but hunters are only a small percentage of the ever-increasing urban population, and some residents oppose hunting. Furthermore, most municipalities have enacted bylaws restricting firearm usage, usually for public safety reasons. Where municipal boundaries extend over wetlands, estuarine habitat and agricultural land, these bylaws can effectively prohibit waterfowl hunting.

When important waterfowl areas overlap with a densely populated urban area, there are opportunities to build stronger relationships between waterfowl, agricultural, hunting and urban communities. For example, the locavore movement (which favours locally produced foods) advocates for local agriculture and waterfowl-compatible crops. The emergence of the “urban hunter” who is interested in consuming wild, ethically harvested meat is gaining ground in Metro Vancouver and the Fraser Valley (e.g., eatwild.ca). These centres of human population in key waterfowl habitat areas consequently encourage efforts to secure and enhance habitat for waterfowl within the PBHJV-BC very near or within population centers. Furthermore, revenue generated from hunting license sales goes towards Wildlife Habitat Canada (WHC) and the Habitat Conservation Trust Foundation (HCTF), which are two key funding partners for the PBHJV-BC.

ENGAGEMENT WITH INDIGENOUS GROUPS

For decades, conservation practices in Canada have been heavily influenced by European colonialism. This approach continues to guide and shape the way we protect biodiversity to this day. Conservation initiatives have been known to force outside values on Indigenous peoples, promote inequity and prevent Indigenous peoples from using the land to sustain their livelihoods and practice their traditional ways of life (Gooden and 't Sas-Rolfes 2020). Meaningful engagement with Indigenous communities will be an effective way to advance reconciliation. Indigenous knowledge is currently an under-used resource that can inform PBHJV-BC's conservation planning, implementation and evaluation. To that end, PBHJV-BC partners are committed to conservation planning and implementation that includes collaboration and reconciliation with Indigenous peoples.

Members of the Nuxalk Guardian Watchmen install an instrument to measure sediment deposition in the Asseek Estuary located within the traditional territory of the Nuxalk First Nation, British Columbia./Karen Barry

A recently published report offered numerous recommendations for NCC to effectively engage with Indigenous groups in its conservation planning processes (Kennedy et al. 2021). These recommendations are applicable to other JV partners' conservation practices as well, ranging from the initial outreach, to relationship building, to the project implementation level. They include:

- conducting preliminary research to help identify appropriate ways to reach out to Indigenous communities for a given project
- co-creating conservation plans to ensure that Indigenous values and knowledge play a central role in the project
- ensuring that benefits to partnership are reciprocal; ensuring adequate funding is allocated for relationship building
- ensuring that the Indigenous Knowledge collected truly represents the community member's varied beliefs and experiences
- creating the space for both Indigenous and Western science knowledge systems to contribute equally and in parallel to better understand the system of interest

Given the comprehensive list of recommendations, PBHJV-BC partners will prioritize and incorporate the most relevant into their conservation practices, whether it be land securement, habitat restoration/enhancement, monitoring or conservation planning.

CONNECTING PEOPLE TO NATURE

The PBHJV-BC's priorities are currently focused on maintaining and growing awareness among partners and the public. This priority is supported by expanding the PBHJV-BC's circle of support to non-traditional constituents through outreach and awareness programs, beneficial management practices and stewardship partnership programs, citizen/community science and volunteer programs and research, policy and government initiatives. Presented below are some current examples of PBHJV-BC HD activities being undertaken.

Outreach and Public Awareness

PBHJV-BC partners are increasingly gaining knowledge on the public's general perception of and engagement with PBHJV-BC-relevant conservation initiatives. For instance, in 2016-2018 a Canada/U.S. public opinion survey was conducted to understand the social and recreational activities of birders and hunters in relation to wetland and migratory bird conservation in the Pacific Flyway (Harshaw 2018a; Harshaw 2018b). The survey results found that identity as "conservationist" is strong in both communities, and that >50% of birders are willing to pay fees to access lands for bird watching. However, involvement

in social/political activities related to conservation is low. The survey also showed that barriers to pursuing recreational activities in nature include distance, crowdedness and abundance and diversity of birds. Furthermore, according to a 2020 survey conducted by Canada's Privy Council Office, it was found that 48% of the surveyed Canadians said they value nature more now than before the pandemic, and that the vast majority (84%) of Canadians agree that they must take care of nature in order to take care of themselves. However, PBHJV-BC partners recognize that more specific, fine-grained information is needed on this topic, including public support for bird conservation, wildlife value orientations, pro-environmental behaviours, participation in types of nature-based recreational activities, awareness of wetland benefits (e.g., ecological goods and services) and use of wetlands and other PBHJV-BC priority habitat types.

Currently, each PBHJV-BC partner conducts outreach or public education according to their own mandate. Many partners have extensive outreach networks. For example, Birds Canada runs several citizen/community science programs in the PBHJV-BC, including the Christmas Bird Count, Project FeederWatch, the Beached Bird Survey, the BC Coastal Waterbird Survey and (jointly with BC Nature) the Important Bird Area Caretaker Program. These programs engage volunteers in various ways to support bird conservation, often by collecting data on birds that help to determine distributions and population trends.

The PBHJV-BC relies on these partner-led networks as well as other sources to gather and diseminate critical data. A key objective identified by the 2018 NAWMP Update is to ensure that information gathered and messages distributed expand beyond current JV partner spheres of influence to reach non-traditional constituents. Supporters of current partners (e.g., DUC members and volunteers, Birds Canada volunteers) are typically already engaged and supportive of bird conservation, and are not necessarily representative of the general public.

The PBHJV-BC Board will determine if there is a need to reach out to a broader audience, including birdwatchers, nature photographers, nature-based recreationists of all types, Indigenous groups and those concerned about other environmental issues such as climate change and sustainability. If such a need is supported, the PBHJV-BC will need to actively engage and work with additional partners that have connections with these broader groups, particularly those with experience in public outreach and education.

Birds Love Delta Campaign

In 2018, the Municipality of Delta developed the Delta's Birds and Biodiversity Conservation Strategy to help protect and preserve Delta's rich natural heritage. The development of the Strategy was informed through the collaboration of environmental community groups, the agricultural community, tourism and business associations, federal and regional government staff and Delta staff across departments. This collaboration tied together efforts and provided focus for the effective application of resources and efforts to conserve and enhance habitat and bird species in this key area for wintering and migrating waterfowl. PBHJV-BC partners, such as the Canadian Wildlife Service, Ducks Unlimited Canada and Birds Canada, were included in the strategy development.

The Strategy is guided by five goals:

1. Delta's habitats are protected, enhanced and resilient
2. The community understands and values Delta's natural resources
3. Collaborative partnerships are fostered with a shared vision for biodiversity protection and enhancement
4. Delta and the Fraser River Estuary are established as a world-class centre for birds and biodiversity
5. Delta works to conserve its heritage as a working landscape that is significant for birds and biodiversity

Environment and Climate Change Canada supported the development of the strategy with funding contributing to a communication and social sciences study on the motivations that drive residents to support the conservation of bird habitat including agricultural lands, coastal marshes, natural spaces and beaches. Information was gathered through telephone surveys in 2019 and will be used to inform future activities to engage residents in the conservation of migratory bird habitat.

Engaging the Agricultural Sector

The productive habitats of the Fraser River estuary and its associated delta attract not only birds but also agricultural operations, inevitably leading to resource conflicts, specifically with waterfowl grazing on forage crops. The increasing trends toward supporting local food production means more opportunity to combine food production and habitat conservation, particularly winter forage for waterfowl. The PBHJV-BC continues to support habitat stewardship programs that encourage and support local farmers to grow bird-friendly crops, such as those operated by the Delta Farmland & Wildlife Trust (DF&WT).

Established in 1993, DF&WT is "a non-profit organization that promotes the preservation of farmland and wildlife habitat on the Fraser River delta (Cities of Delta and Richmond) through cooperative land stewardship" (DF&WT 2013). In addition to DF&WT's ongoing habitat stewardship programs that have been in place since 1990 (e.g., Winter Cover Crop, Hedgerow Planting, Grassland Set-Aside), they are also operating several other more recent programs and research projects. These include the Forage Enhancement Pilot (FEP) Program, assessment of waterfowl use of agricultural lands in Delta and Richmond and surveys of ecosystem benefits and cost-benefit analysis of DF&WT stewardship programs.

During winter, waterfowl graze on perennial forage crops like orchard-grass, fescue, ryegrass and timothy that are meant to produce feed the following year for dairy cattle. The crop loss and damage caused by grazing waterfowl represents a considerable cost to many farmers in Delta; the resultant lower forage yields, reduced harvest quality, fewer cuts and sometimes destroyed plantings that require re-seeding can have sizeable financial impacts. Impacts from waterfowl may also result in soil problems such as compaction and ponding. Some farmers and forage producers must now re-seed forage fields annually (as opposed to every 5+ years) at a cost upward of CAD $142 per hectare. The situation has brought farmers and producers to a point where many are reconsidering their current management practices and introducing significant changes that are less beneficial to waterfowl, such as converting forage fields from perennial to annual crops. This will only drive waterfowl grazing pressures elsewhere, transferring the issue to farmers with remaining forage and winter crops (NAWMP 2018). The 2-year FEP Program was initiated in 2017 to provide additional financial assistance to grass forage producers enrolled in the Agriculture Wildlife Program by over- and re-seeding forage fields in the spring as a response to the intense waterfowl grazing in Delta (Bondar 2019). In 2019-20, acreage enrolled in the program totaled about 198 hectares (490 acres). It provided support to the enhancement and continued provision of high-valued fields for both dairy cattle feed and waterfowl foraging habitat. Metrics to determine the programs success and comments from the forage producers survey are still under review.

Research supported by DF&WT, in partnership with other PBHJV-BC partners, is providing more data to support the benefits of DF&WT programs as well as understanding ways to manage forage lands more effectively for waterfowl and farmers. For instance, based on the results from a recent survey, the FEP program was positively regarded by Delta farmers to offset the impacts of waterfowl damages (Zbeetnoff and Kerr 2020). Further, Delta farmers recognize the ecological services provided by DF&WT's programs such as winter cover crop and grassland set-aside programs (Kerr 2020). These values include adding soil organic matter, improving soil structure and reclaiming excess nutrients and preventing soil erosion (Zbeetnoff and Kerr 2020).

Since 2018, ECCC has funded DUC to implement an agricultural stewardship coordination project that in early 2021 is bringing together regional partners including DF&WT, Metro Vancouver, UBC Faculty of Land and Food Systems, Farmland Advantage, Birds Canada, Township of Langley, City of Surrey, City of Delta and the BC Ministry of Agriculture and Habitat Conservation Trust Foundation. Staff from conservation groups and government agencies have identified a significant funding gap for conservation activities on agricultural land in the Lower Fraser Valley and decided to host a workshop to explore solutions. Conservation is a broad term that is being used to describe the range of activities that enhance ecosystem goods and services provided by agricultural land such as food production, nutrient recycling, wildlife habitat, water management and carbon sequestration. Two workshops were held in early 2020 to bring together expertise to identify potential long-term funding mechanisms and explore what can be accomplished through partnerships and engagement.

Furthermore, DUC, NTBC and ECCC have all secured agricultural lands of importance to migratory birds through fee simple acquisition. These PBHJV-BC partners then work with local farmers to continue their cultivation of crops used by migrating and wintering birds such as waterfowl and shorebirds. The Fraser River Delta is the site of many of these wildlife-friendly farms while others are located in the Cowichan River Estuary and Comox Estuary. Given the high costs of farmland in these areas, this is one conservation tool to keep crops with relatively low economic value growing in important waterfowl landscapes.

Diversity, Equity, Justice, and Inclusion in Birding

Wildlife recreation is associated with greater engagement in conservation behaviours (Cooper et al. 2015). For example, recreationists in the United States who identified as both birders and hunters were more involved in conservation behaviours than people who identified as only a birder or hunter (Cooper et al. 2015). Furthermore, people who identified as outdoor recreationists participate in more conservation behaviours than non-recreationists (Cooper et al. 2015).

Diversity is also a key component in conservation because the more diverse the participants in conservation, the greater portion of society has a stake in how conservation is implemented. Wildlife and habitat are held in public trust according to the North American model of wildlife conservation which implies equitable access to it (Rutter 2020); however, research has shown that barriers for accessing nature or viewing wildlife exist for marginalized groups, whether it be language, cultural, discrimination, social connection or socio-economic barriers (Rutter 2020; Krymkowski et al. 2014; Scott and Tenneti 2021). Based on recent research conducted in Eastern Canada on systemic barriers in nature spaces (Scott and Tenneti 2021), it was recommended that organizations should increase the comfort level for participants through guided activities and education, and to create more diverse cultural spaces.

Bird walk in the Fraser River Delta, BC/Andrew Huang

In response to this marginalization and increased understanding of Diversity, Equity, Justice and Inclusion (DEJI) research, in fall of 2020 and 2021, Birds Canada and CWS hosted a series of bird walks to diverse communities in partnership with local partners (BC Bird Trail and Stanley Park Ecology Society). The bird walks were held in the Lower Mainland and Fraser River Valley, each catered to marginalized groups including the Chinese-speaking and Arab-speaking communities, People of Colour, LGBTQ+ and Women and Femme. In 2020, a of total 37 people signed up across 7 walks, or 5.3 people per walk with the maximum participation limited to 6 people due to Covid-19 restrictions. The high level of participation and positive results from a post-walk questionnaire whereby participants felt their awareness for birds increased in the supportive environment suggests great interest from these communities. Based on this interest and success, PBHJV-BC partners will be pursuing the development of DEJI-related projects and events to build a more inclusive and diverse human engagement environment in the future.

Other Joint Venture Partner Public Outreach

Many PBHJV-BC partners, like NTBC and DUC, have demonstrated the power of engaging with people through direct conservation and stewardship actions for the benefit of waterfowl habitat conservation. Through community specific conservation projects, PBHJV-BC partners can engage with the public, increase an awareness of the importance of habitat and generate a social investment at the same time as physically improving the quality of waterfowl habitat. Examples of these socio-ecologically beneficial projects are captured annually in NAWMP *Habitat Matters* reports (NAWMP 2020).

Opportunities for Hunters

PBHJV-BC partners will continue efforts to maintain hunting opportunities. Both provincial and federal wildlife agencies are supportive of continued waterfowl hunting in the Georgia Basin. Much of the area suitable for waterfowl and open to hunting in the Fraser Valley and delta is privately owned agricultural land, and hunters require landowner permission. However, provincial partners have worked to keep public land open to hunting, such as Robert's Bank, Boundary Bay and South Arm

Marshes Provincial Wildlife Management Areas, which are some of the largest protected areas in the Fraser River Delta and together protect most (over 21,000 hectares or 51,892 acres) of the remaining estuarine habitat. Also in the Lower Fraser Valley, a licensing system which addresses some concerns (e.g., ensuring hunters have suitable liability insurance in this densely populated area) has been developed to maintain hunting opportunities, particularly for crop protection, and to provide a set and significant financial benefit should accidents occur.

Over the past several decades, there has been a decline in participation and retention of waterfowl hunters across the continent (Watson and Boxall 2005). This is partly due to increased urbanization and the resulting shift in social structures around traditional hunting. To address NAWMP's Goal 3: "Growing the numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation" and better understand the shifting motivations, behaviours, attitudes and priorities of Canadian hunters (NAWMP 2012), a continental survey was conducted in 2017 to help inform waterfowl hunting and wetland management policies. The core team to develop and deliver the North American Waterfowl Hunting Survey included HD Working Group members from the Atlantic, Mississippi, Central and Pacific Flyways.

The study surveyed adult Canadian waterfowl hunters and integrated several fields of research, including outdoor recreation, environmental sociology and wildlife management. The survey elicited waterfowl hunter participation characteristics, information about identity and knowledge about, interest in, and preferences for waterfowl and wetland conservation. The results of the survey were compiled into technical reports for each flyway sampled (Harshaw 2018a). The results of the survey serve as a baseline for future studies, such as the 2021 Canadian public survey that is part of the Mitacs Project described previously.

NEW DIRECTIONS FOR HUMAN DIMENSIONS

During the development of the HD chapter, PBHJV-BC partners identified potential short- and long-term directions for HD applications.

Food Security and Habitat Protection

The PBHJV-BC will build on existing work to reach the diverse interests of non-traditional and traditional NAWMP constituents. The work of PBHJV-BC partners, like DUC, ECCC and DF&WT, to conserve and steward waterfowl habitat, highlights the critical link between healthy habitat and a healthy and sustainable food supply. This connection provides an engagement opportunity that goes beyond traditional constituents who support waterfowl (hunters and birders) to constituents such as farmers and consumers interested in a reliable food supply. Promoting beneficial management practices on agricultural lands that are linked to food security could potentially draw in non-traditional constituents while indirectly benefiting birds. Metro Vancouver has recently presented a discussion paper linking regenerative farming, food security and carbon storage with ecological services. This once again highlights how the co-benefits of programs that maintain sustainable agricultural practices or address climate change threats, such as carbon credit purchase for carbon stored in agricultural soils, indirectly contribute to conservation (Metro Vancouver 2020).

Another example related to food security is the Shared Waters Alliance, an international working group with representatives from government, First Nations and community groups focused on the water quality of the Canadian-U.S. shared waters of Boundary Bay, a locally, nationally and globally significant area for wildlife. The primary driver of this working group, which includes PBHJV-BC partners, like ECCC and DUC, is to address shellfish harvesting closures due to bacteriological contamination on both sides of the border. Pollution, such as toxic chemicals and microplastics in high concentrations, enter the food web through shellfish, birds, fish, whales and even people, and can cause sickness and death for some animals while compromising food sources for people. Shared Water Alliance partners in the United States have made strides to address pollution sources and restore the food, social and ceremonial shellfish harvest for local First Nations—these efforts encouraged the renewal of the alliance in Canada in 2018. While addressing the threat of marine pollution to wildlife and improving local water quality, reinitiating the Shared Waters Alliance addresses food security for the local Indigenous community of Semiahmoo First Nation.

Canadian Public Preferences Survey

A national public survey will be administered to test indicators of conservation and nature-based recreation involvement and preferences. The new data will be collected by this survey and incorporate measures of stakeholder involvement in pro-conservation behaviours and nature-based recreation to establish a baseline. The data collected will inform PBHJV-BC priorities, and provide an opportunity to engage with new stakeholder groups to explore whether there are compatible interests.

Attitudes at Regional Scales

Results from national surveys, such as the Importance of Nature to Canadians survey (1999, 2000), Canadian Nature Survey (2012), NAWMP hunter bird water surveys (2016) and the Canadian Public Opinion Poll on support for protecting natural ecosystems (2020) provide insight into broad scale support and attitudes for conservation. Human dimensions data collection conducted at the regional scale while much more limited would help identify new constituencies and more effectively engage with traditional constituents living within the PBHJV-BC boundaries. Incorporating conservation value related questions into regional polls through partners, such as Metro Vancouver, Birds Canada, DF&WT and municipalities, could shape a stronger understanding of the support, attitudes, interest and awareness of PBHJV-BC conservation actions, priority species and habitat areas. Regional results outlining finer scale human conservation awareness and importance could also be connected to spatial datasets to enhance the depth of conservation planning and incorporate social values in project prioritization. Building on regional knowledge will direct partner activities more effectively and highlight the need for new tools or methods of engagement or the opportunity to renew existing engagement tools and streams.

Through the Mitacs Project's web-based survey, partners intend to capture the public's interests in agriculture with regards to promoting the co-benefits of sustainable agriculture towards food security and ecological services. Developing this awareness and understanding of the importance of agriculture to a larger constituent base will expand funding opportunities in support of wildlife-friendly agricultural practices.

Mainstreaming Stewardship Practices

Currently Birds Canada is working to develop methods for quantifying the benefits of agricultural stewardship practices for the purpose of supporting further investment into stewardship practices. These methods will be developed within the context of food sector supply chain management benchmarking. DUC also supports the development of beneficial management practices in various industries and ecosystem types and that support bird habitat (e.g., wetland BMPs). Within the PBHJV-BC, the future mainstreaming of these stewardship practices by partners will focus on the agri-food industry through increased awareness and knowledge building on the benefits of beneficial stewardship practices.

KNOWLEDGE GAPS

The PBHJV-BC partners identified several knowledge gaps that will shape short- and medium-term HD priorities. The general theme of human dimensions knowledge gaps is to develop a deeper understanding of the motivations of current and potential constituents in the PBHJV-BC region. As the more rigorous applications of the social sciences is relatively recent for the PBHJV-BC, partners will look to literature, existing research and information and pathways to engage with the regional communities—this knowledge will be developed as the current Implementation Plan moves forward. A draft research plan prioritizing and informing a rough timeline to address knowledge gaps is currently being developed.

- *Landowners*: How can PBHJV-BC partners better incentivize participation in programming such as Beneficial Management Practices (e.g., Wetland Stewardship Policy, Green By-law Toolkit) or farmer stewardship programs (e.g., winter cover crop)?

- *Governments*: How do the different levels of government and the general public they represent value the different lands, uses and ecosystem services (e.g., food security, biodiversity) provided by habitats important to waterfowl such as agricultural lands and wetlands? How do values align with the conservation of important bird habitat such as estuaries, agricultural lands and wetlands? What are the key messages and governmental priorities that could promote continuous funding for the PBHJV? What are the most effective ways to engage with provincial and federal governments on new and existing programs?

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- *Corporations/Industry*: How can PBHJV-BC partners better engage with industry (e.g., Port of Vancouver, Vancouver International Airport) to encourage contributions to JV efforts or implement PBHJV-BC partners' conservation activities? Developing understanding of the tools and messages that could spark industry interest in PBHJV partnerships and/or funding opportunities.
- *Citizen/Community Scientists/Volunteers*: How can the PBHJV-BC partners expand the diversity of participation in citizen/community science and volunteer programs and link participation to positive conservation outcomes? PBHJV-BC partners would like to better understand how to maximize repeated participation (e.g., incentives) while avoiding volunteer fatigue.
- *General Public*: The PBHJV-BC needs to collect baseline information on current trends in public use in priority habitat types. Addressing this knowledge gap could feed data into various other knowledge gap areas such as recreation users, and support stronger engagement with different levels of government.
- *Recreational and Other Users*: How can PBHJV-BC partners better understand the causes of land management issues and engage with problematic recreational users (e.g., ATVs/mountain bikes/non-compliant hunters/dog walkers) and other users (e.g., homeless camps)? How can PBHJV-BC partners mitigate misuse impacts on conservation lands without relying on resource intensive measures?
- *Indigenous Communities*: PBHJV-BC partners need to better understand potential beneficial practices for engaging with Indigenous communities with the aims of gauging and supporting Indigenous community capacity for developing opportunities for long-term/sustainable collaborations.
- *Non-Traditional Constituents*: How can PBHJV-BC partners better understand the motivations of non-traditional constituents to most effectively engage with new partners and grow the constituent base with limited resources? How can PBHJV-BC partners incorporate Diversity, Equity, Justice and Inclusion principles into HD work, such that diverse communities are engaged in meaningful ways?

HUMAN DIMENSIONS OBJECTIVES

Workshops held by PBHJV-BC and CIJV partners in 2020 helped to inform this Implementation Plan. Keeping in line with Goal 3, partners are focused on maintaining current constituents, such as farmers, hunters, birders and recreationists, as well as growing support with non-traditional partners. The following is a summary of the objectives developed during the workshops. The complete table can be found in the appendices (**Appendix 3**) and more detailed information is provided under the chapters covering Delivery Methods (**Chapter 7**) and Monitoring and Evaluating Performance (**Chapter 8**).

1. *Address knowledge gaps identified at HD workshops by 2029*: Develop a deeper understanding of the motivations for various current and potential constituents in the PBHJV-BC/CIJV region as discussed in the previous section.
2. *Effectively communicate and develop awareness of the importance of JV species and habitat by 2029*: Develop and distribute targeted communications materials about the importance of waterfowl and habitat (e.g., promoting the benefits of ecological goods and services). Determine, via knowledge gained through research and surveys, how to engage more effectively with the public, partners, stakeholders, funders and potential new partners.
3. *Increase waterfowl and wetland conservation support among various constituencies to at least the levels experienced during the last two decades by 2029:* Regional numbers of hunters and birdwatchers in Canada needs to be determined as a baseline. Engaging with and developing support in non-traditional constituencies is also included under this objective.
4. *Build HD capacity and understanding in the JVs by 2029*: Better document HD work of PBHJV-BC partners (e.g., identify HD tools and data already established and develop appropriate metrics) and incorporate new information/ tools generated from ongoing projects into the current Implementation Plan.

CHAPTER 7 – STRATEGIES AND DELIVERY

The PBHJV-BC partnerships is committed to translating this Implementation Plan into on-the-ground actions. To check that the conservation planning approach is effective for the most important issues affecting priority species in the PBHJV-BC, the technical team underwent training and applications in the Open Standards adaptive management conservation planning process and Miradi software. Open Standards for the Practice of Conservation is a widely adopted set of principles and practices that bring together common concepts, approaches and terminology for conservation project design, management and monitoring (CMP 2021). Developed by the Conservation Measures Partnership and regularly updated in collaboration with the broader community, this open-source, strategic process helps conservation teams achieve lasting impacts (CMP 2021). The Open Standards are organized into a number of steps which formalize the concept of an adaptive management implementation planning and delivery cycle. The approach has been applied by the PBHJV-BC technical team throughout the development of this Implementation Plan. See applicable components covered in **Chapters 7 and 8** whereby PBHJV activities can be initiated, monitored and evaluated to better direct and engage partners.

KEY STRATEGIES AND OBJECTIVES

The following section lays out key strategies and 5- and 10-year objectives and 5- and 20-year conservation costs developed by the technical team during Open Standards planning workshops and technical team review meetings from 2018-2021. Broad strategies were developed under each of the traditional NAWMP Initiatives with specific, measurable and priority objectives identified under each strategy. Indicators and available data sources were also developed and will be further covered under **Chapter 8** – Monitoring and Evaluation. Full strategy table and associated Miradi results chains for some strategies were developed during this conservation planning process. Specific waterfowl, non-waterfowl and HD objectives do not fall under the following initiatives and are discussed in depth under each chapter (**Chapter 3** – Priority Waterfowl, **Chapter 4** – Priority Non-Waterfowl and **Chapter 6** – Human Dimensions).

As part of the process for determining habitat objectives under Habitat Retention (Permanent, Medium and Short-term), Wetland Restoration, Upland Restoration and Management (Habitat Assets), the PBHJV-BC partners calculated the total hectares of unconserved areas within the PBHJV region for each of the five priority habitat types. Multiple selection criteria were also applied to priority habitat types in order to narrow the geographical scope such that habitat objectives are focused on the most ecologically significant and/or priority areas. See **Appendix 4** for maps showing the extent of each priority habitat type (conserved vs. unconserved) after selection criteria have been applied.

Habitat Retention – Permanent

Habitat retention is the protection or preservation of functional waterfowl habitat and the provision of suitable habitat for other bird species. Such protection may be either in perpetuity (i.e., is permanent) or for a defined time frame.

Strategy	JV Examples	Objective(s)
Land Acquisition Strategy	***Fee Simple Acquisition***: Purchase of lands for conservation ***Fee Simple Donation***: Receipt of donated lands for conservation ***Conservation Encumbrance – Paid***: Purchase of conservation covenants for conservation ***Conservation Encumbrance – Donated***: Receipt of donated restrictive covenants for conservation ***Biodiversity and Carbon Sequestration Co-Benefits Strategy***: Acquire lands that have high carbon sequestration capacity while benefiting wildlife	Securement and crown designation of 947 hectares (2,340 acres) by 2024, including the following priority habitat types: • Agricultural Land: 12 hectares (30 acres) • Freshwater Wetlands: 16 hectares (47 acres) • Estuaries: 69 hectares (171 acres) • Nearshore Shallow Marine: 2 hectares (5 acres) • Riparian Forests: 212 hectares (524 acres)
Crown Designation Strategy	***Crown Designation***: Designation of WMAs, Ecological Reserves, NWAs, MPAs, IPCAs, Provincial Conservancies, etc.	

Habitat Retention – Medium Term

Non-permanent methods of securement may be for medium-term (10-99 years) timeframe. These methods of securement typically use various conservation land-use agreements.

Strategy	JV Examples	Objective(s)
Conservation Land-Use Agreement Strategy	***Conservation Cooperative Land-use Agreements***: 30-year Conservation Agreements for wetland/upland protection, wetland creation/enhancement; On-Farm Program ***Crown Agreements***: Crown Land Agreements	Securement of 147 hectares (363 acres) by 2024, including the following priority habitat types: • Freshwater Wetlands: 18 hectares (44 acres) • Estuaries: 101 hectares (250 acres) • Riparian Forests: 28 hectares (69 acres)

Habitat Retention – Short Term

Short-term habitat retention is the protection (or preservation) of functional waterfowl habitat and the provision of suitable habitat for other bird species for a period less than 10 years.

Strategy	JV Examples	Objective(s)
Stewardship Strategy	***Conservation Cooperative Land-use Agreements***: Grassland Set-asides, Grass Margin and Hedgerow Stewardship Programs; Spartina control (prevention and post-invasion control) on non-PBHJV-BC lands	Stewardship of 24,516 hectares (60,580 acres) by 2024, including the following priority habitat types: • Agricultural Land: 6,612 hectares (16,339 acres) • Estuaries: 17,904 hectares (44,242 acres)

Wetland and Upland Restoration

Restoration is the creation or improvement of wetland, estuarine and upland habitat and the services it provides to waterfowl and other birds and wildlife. PBHJV-BC partners restore habitat on lands that have been degraded where it is efficient and effective to do so.

Strategy	JV Examples	Objective(s)
Wetland Restoration/ Enhancement Strategy	***Hydrological Restoration***: Engineered Wetland Program—installation of water controls to restore or enhance wetland habitat ***Ecological Restoration***: Vegetation control (e.g., control of willow, hardhack, cattail to maintain marsh conditions) ***Biodiversity and Carbon Sequestration Co-Benefits***: Restore habitat types that have high carbon sequestration capacity while benefiting wildlife	Restoration and enhancement of 1,316 hectares (3,252 acres) of wetland habitat by 2024, including the following priority habitat types: • Freshwater wetlands: 158 hectares (390 acres) • Estuaries: 130 hectares (321 acres) • Nearshore shallow marine: 1,028 hectares (2,540 acres)
Upland Restoration/ Enhancement Strategy	***Ecological Restoration***: Vegetation control (e.g., control of willow, hardhack, cattail to maintain marsh conditions) ***Extension***: Integrated Pest Management ***Incentive***: Grassland Set-asides, Grass Margin and Hedgerow Stewardship Programs; Cover Crop Programs ***Biodiversity and Carbon Sequestration Co-Benefits***: Restore habitat types that have high carbon sequestration capacity while benefiting wildlife	Restoration and enhancement of 1,636 hectares (4,043 acres) of upland habitat by 2024, including the following priority habitat types: • Agricultural Land: 1,540 hectares (3,805 acres) • Riparian Forests: 94 hectares (232 acres) Increased engagement with Health Canada (Pest Management Regulatory Agency) and partners involved in pesticide research and education by 2029 Increased JV awareness and support where applicable to other associations in pesticide research and education for reduced usage by 2029
Invasive Species (Wetland/Upland) Management Strategy	***Ecological Restoration***: Invasive species removal of wetland and upland habitats (e.g., purple loosestrife, yellow flag iris, etc.); Spartina program (on PBHJV-BC-secured lands) ***Incentive***: Funding support for Invasive Plant Species Council	Reduced invasive species populations on PBHJV-BC lands by 2029

Land and Water Policy

Land and Water Policy is the creation or alteration of policies (incentives or regulatory-based) which affect land use to more sustainable practices through providing science-based arguments to support the value of proposed changes. The PBHJV-BC coordinates much of its policy activities through the Wetland Stewardship Partnership (WSP), a complementary, collaborative association of three levels of government (federal, provincial and municipal), industry, and several key ENGOs with the goal of conserving, restoring and managing wetland ecosystems throughout BC.

Strategy	JV Examples *indicates developed results chain	Objective(s)
Government Relations Strategy	***Agriculture Policy***: Maintain ALR boundaries; Work with ALR for conservation covenants (policy); Allow conservation covenants on land to restrict developments ***Wetland Policy***: Development & promotion of Wetland Ways guidelines, Wetland policy creation and implementation, Development & promotion of Green Bylaws Toolkit ***Integrated Land Use Planning***: Work with coastguards and other departments for timing and where marine traffic is, including speed limits for boats; Informing development planning - estuary, wetlands, etc.,* Community group input into local government planning.* ***Government & Industry Relations***: Maintain government funding,* Tax incentives to protect areas on private land,* Promote enforcement of boating practices, CWS Reg. Director engage with local government,* Increase hunting bag limits and decrease spatial restrictions (i.e., allow hunting in more places)	Increased use of conservation covenants on farmland by 2029 Maintain ALR boundaries by 2029 Increased engagement with the ALC by 2029 Government to move towards a no net loss policy for wetlands (including estuaries) by 2029 Broader uptake of stewardship principles at local government level by 2029 Increased provincial government engagement with the JV by 2029 Increased level of provincial government funding by 2029 Increased level of partnership with Indigenous Groups by 2029 Increased level of support for IPCA development by 2029

Management (Habitat Assets)

The management of all assets owned by PBHJV-BC partners, such as infrastructure and interest, includes maintenance of the waterfowl productivity of existing projects and the provision of suitable habitat for other priority bird species.

Strategy	JV Examples	Objective(s)
Habitat Assets Management Strategy	***Engineered Wetlands***: Constructed and engineered wetland maintenance (e.g., vegetation management) ***Natural Wetlands***: Access management (e.g., signs, trails and livestock exclusion fencing) ***Wetland/Upland Rebuild***: Major repairs/project rebuilds (water controls) ***Biodiversity and Carbon Sequestration Co-Benefits Strategy***: Conduct habitat stewardship work to both sequester carbon and enhance wildlife value	Management of 14,302 hectares (35,341 acres) by 2024, including the following priority habitat types: • Agricultural Land: 1,186 hectares (2,931 acres) • Freshwater Wetlands: 3,028 hectares (7,482 acres) • Estuaries: 2,815 hectares (6,956 acres) • Nearshore Shallow Marine: 318 hectares (786 acres) • Riparian Forests: 2,345 hectares (5,795 acres) Achieve a long-term 'sustainable' conservation estate by 2029

Conservation Planning

PBHJV-BC partners use a variety of tools to guide conservation actions and plan future activities. Some of these tools are developed individually for specific purposes; others are developed jointly. The major conservation planning tools currently being used, and those under development, are discussed more fully under Conservation Planning Tools (**Chapter 5**).

Strategy	JV Examples	Objective(s)
Conservation Planning Strategy	***Program Coordination***: JV Coordinator role, Implementation Plans, etc. ***Planning Tools***: Development of planning tools such as the TRUEMET energetics model, sea duck model, estuary ranking project, pelagic seabird model, coastal waterbird distribution model, all-bird priority areas and BC Coastal Waterbird Survey mapping	Implementation Plans and updates accepted by PBHJV Board and North American Wetlands Conservation Council (Canada) by 2021 Maintenance and update to planning tools used by JV partners by 2029

Science

Science is essential to adaptive management, wherein it plays an integral part in the cyclical processes of planning, implementation and evaluation, and it helps ensure population and habitat goals are achieved in a cost-effective fashion. Scientific activities are undertaken for a number of reasons, including:

- To advance our level of knowledge of wetlands, estuaries and water-associated birds in BC
- To improve our understanding of waterfowl species distribution
- To inform planning processes and priorities by identifying new conservation threats
- To test fundamental assumptions of our models and conservation programs
- To measure progress towards our goals

Monitoring and evaluation are elaborated on in **Chapter 8**.

Strategy	JV Examples *indicates developed results chain	Objective(s)
Monitoring and Evaluation Strategy	***Habitat Program Evaluation***: Maintaining ongoing monitoring and evaluating activities; Assessment of the effectiveness of partner conservation activities, such as analyses of cover crop programs; Monitoring and evaluating implementation of plan ***Physical Science***: Sea level rise modeling ***Habitat/Landscape Inventory***: Mapping, inventory (use of existing habitat inventory information; GIS support, etc.); availability of tools/ data looking at trends using remote sensing and satellite imagery ***Waterfowl/Wildlife Science***: BC Coastal Waterbird Survey, Beached Bird Survey, Christmas Bird Count, Breeding Bird Survey; FRDNPS study; Buffers/disturbance study ***Social Science***: Human Dimensions communications and outreach (see **Chapter 6** for objectives); Hunter Birdwatcher National Survey; MITACS project	Increased science-related government funding money by 2029 Maintain waterfowl monitoring program by 2029 Develop assessment of non-traditional conservation treatments (e.g., non water controls) by 2029 Develop targeted habitat and species tracking program by 2029 Partner with ongoing initiatives/building on planning work of Conservation Land Management Program Assess species response on conservation lands to show effectiveness of JV conservation lands by 2029
Knowledge Gap Strategy	Collection of new information and filling of knowledge gaps Better data collection to inform emergency responses for oil spills in particular areas Research impacts of new pesticides on wildlife ***Economic Science***: EG&S research*	Better compilation and prioritization of important gaps for JV partners by 2029

Communications and Education

The PBHJV-BC aims to inform and educate the public and partners, to demonstrate leadership on issues which relate to government or industry policies and to encourage new partnerships and funding opportunities. Specific activities are associated with the promotion of NAWMP and the JVs and associated programs under this Initiative.

Strategy	JV Examples *indicates developed results chain	Objective(s)
Communications and Education Strategy	***Communications & Education***: General communications and marketing – social media, websites, project signage, press releases, etc.; Communication for winning hearts and minds for agricultural lands to local government and public audiences* Educate and engage local government planners* ***Outreach of Conservation Successes***: Promote agriculture stewardship; Project Webfoot	Increased profile, awareness of PBHJV-BC and partners by 2029 Increased internal reporting to the JV board by 2029 Increased international collaboration with PBHJV-BC by 2029

Crop Damage

Compensate landowners for damages caused by waterfowl and actions taken by landowners to prevent (control/limit) future damage caused by waterfowl.

Strategy	JV Examples *indicates developed results chain	Objective(s)
Crop Damage Strategy	***Crop Damage Compensation***: Crop Cover Programs	Assess the magnitude of crop damage in key areas by 2029

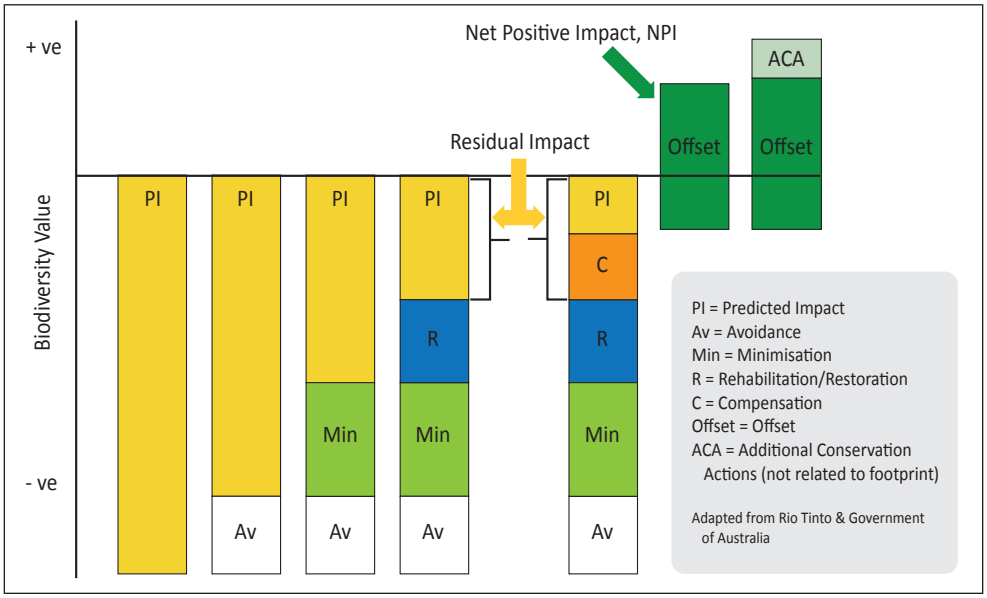
Compensatory Mitigation

Involves creation, preservation, restoration and/or enhancement of wetlands or uplands as compensation for impacts on other wetlands or uplands. Aligned with provincial, territorial, federal and/or other specific project requirements for mitigation.

Strategy	JV Examples *indicates developed results chain	Objective(s)
Compensatory Mitigation Strategy	***Policy Application***: Work with provincial and federal Impact Assessment practitioners to ensure offset/mitigation policies/guidelines are followed (e.g., Environmental Mitigation Policy for BC, Federal Policy on Wetland Conservation) ***Compensation Programs***: Work with recipients of compensatory funds to ensure birds and bird habitat benefit from mitigation practices	Work with Impact Assessment stakeholders and recipients of compensatory funds to achieve no net loss of bird habitat, following mitigation hierarchy to avoid, minimize, restore and offset (**Figure 13**)

Figure 13. Mitigation hierarchy steps (Darbi 2020)

Predicted impact from projects decreases as mitigation steps are followed in the hierarchy of avoidance, minimization, restoration, and compensation. When conducted appropriately, offset and additional conservation actions can result in a net positive impact on biodiversity value.



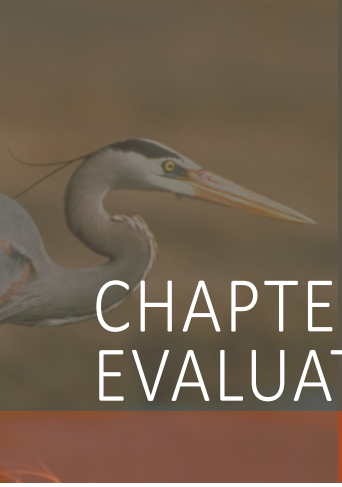
FIVE AND TWENTY-YEAR COSTS FOR TOTAL CONSERVED HECTARES

Summary/disclaimer/description of budget preparations

Table 10. Five-year costs for total conserved hectares for PBHJV-BC activities

Activity	Projected 5 Year Cost ($)	Comments
Habitat Retention – Permanent	$10,106,000	Cost estimated based on what PBHJV-BC partners expect to collectively accomplish until 2024, taking into account of cost per hectare ($/ha), antici-pated funding, availability of resources, and other factors
Habitat Retention – Medium Term (10-99yrs)	$11,000	
Habitat Retention – Short Term (<10yrs)	$1,866,000	
Wetland Restoration	$7,077,000	
Upland Restoration	$1,049,000	
Management (Habitat Assets)	$14,302,000	
Land and Water Policy	$73,848	Cost projected based on both PBHJV-BC and CIJV 2015-2019 investments in this initiative according to the NAWMP NTS + 10%, then split in half be-tween the two JVs. The two JVs share very similar Land & Water Policy objectives, many of which are province-wide that spans across both JVs
Conservation Planning	$2,664,158	Cost projected based on PBHJV-BC 2015-2019 in-vestments in the three initiatives (Conservation Planning, Science, and Human Dimensions) ac-cording to the NAWMP NTS + 10%
Science		
Human Dimensions		
Communication and Education	$364,759	Cost projected based on PBHJV-BC 2015-2019 in-vestments in this initiative according to the NA-WMP NTS + 10%. Note that some communication costs may be nested within direct program ex-penditures (e.g. habitat retention, habitat restora-tion) and therefore not accounted here
Crop Damage	$0	Costs associated with the damage itself addressed via cover crop programs, which is nested within either upland restoration or short-term habitat retention (i.e., “Stewardship”). Costs associated with assessment of crop damage is nested under Science above
Compensatory Mitigation	$0	Costs for staff time, contractors, consultation, planning and on-the-ground work are primarily covered by industry partners
Total Conserved Cost	**$37,513,765**	

The PBHJV 20-year objective for total “Conserved Hectares” is 16,292 ha (40,258 acres), which was roughly estimated by multiplying the sum of the 5-year habitat objectives of Securement (Habitat Retention – Permanent and Medium) and Restoration (Wetland and Upland Restoration) initiatives by 4. The 20-year cost for “Conserved Hectares” is projected to be $88,924,800, and likewise was roughly estimated by taking the total 5-year costs of these Securement and Restoration initiatives, multiplied by 4, plus an additional 20% to account for inflation cost. This is a rolling projection that will be updated every 5 years.



CHAPTER 8 – MONITORING AND EVALUATING PERFORMANCE

ADAPTIVE MANAGEMENT

As a result of the Open Standards workshops and technical team meetings from 2018-2021, PBHJV-BC partners have developed the previously discussed conservation strategies and objectives (**Chapter 7**). To monitor the progress and effectiveness of implementation and to provide positive feedback opportunities to adapt the Implementation Plan, the partners have also connected indicators with relevant data sources for each strategy as well as results chains to expand on specific strategy themes. The following table (**Table 11**) serves as a high-level work and monitoring plan to guide the application of this Implementation Plan over the next 5-10 years.

Table 11. PBHJV-BC implementation plan work plan and monitoring table

NAWMP Initiative	Objective	Actions required to achieve monitoring	Indicator(s)	Data Source(s)
Habitat Retention – Permanent	Securement and crown designation of 947 hectares (2,340 acres) by 2024	Update spatial area (polygon) of newly secured land into provincial and national databases (e.g., BC NGO CAD, CPCAD)	Increase in hectares/acres conserved through purchase or donation of lands or through restrictive covenants	BC NGO Conservation Areas Database; Canadian Protected and Conserved Areas Database; NAWMP National Tracking System (NTS)
			Increase in hectares/acres conserved through crown land designation	
Habitat Retention – Medium Term (10-99 years)	Securement of 147 hectares (363 acres) by 2024		Increase in hectares/ acres conserved through conservation and/or Crown agreements	
Habitat Retention – Short Term (<10 years)	Stewardship of 24,516 hectares (60,580 acres) by 2024		Increase in hectares/ acres stewarded through conservation programs	See above. DF&WT's stewardship programs are tracked in-house. Hectares of invasive species treated and extent of infestation are tracked in the provincial IAPP (Invasive Alien Plant Program)
Wetland Restoration	Restoration and enhancement of 1,316 hectares (3,252 acres) of wetland habitat by 2024	Develop proper restoration polygons to include in database	Change in hectares/acres restored/enhanced wetlands and estuaries through partner conservation programs	NAWMP NTS; PBHJV Internal Spatial Database; IAPP (Invasive Alien Plant Program)
	Reduced invasive species populations on PBHJV-BC lands by 2029		Net decrease in invasive species populations on PBHJV-BC lands	

Table 11. *Continued*

NAWMP Initiative	Objective	Actions required to achieve monitoring	Indicator(s)	Data Source(s)
Upland Restoration	Restoration and enhancement of 1,636 hectares (4,043 acres) of upland habitat by 2024	Develop proper restoration polygons to include in database	Change in acres/hectares restored/enhanced uplands through JV partner conservation programs	NAWMP NTS; PBHJV Internal Spatial Database; IAPP
	Increased engagement with Health Canada (Pest Management Regulatory Agency) and partners involved in pesticide research and education by 2029	Work with BC Ministry of ECCC to develop an IPM-based (Integrated Pest Management) tracking system to compile work done that can be reported on as well as build guidance on where the PBHJV-BC can provide support	Change in risk of regional contamination by pesticides performance index to generate a JV baseline; Change in numbers of relevant agencies, projects and/or programs involved in pesticide management and outcomes of involvement; Change in risk of pesticide contamination of water on cropland according to Agriculture and Agri-Food Canada's Pesticides Indicator; Change in BC regulation on pesticides (including rodenticides); Change in # of municipality bans on pesticides (including rodenticides)	Census of agriculture; Shared Waters Alliance water quality monitoring; Internal PBHJV tracking
	Increased JV awareness and support where applicable to other associations in pesticide research /education for reduced usage by 2029			
Land & Water Policy	Increased use of conservation covenants on farmland by 2029	Streamlined process for approval of covenants within ALC; Track ALC policy in all regions and engage with ALC staff to promote acceptance of conservation covenant; Track new conservation covenants on farmland in polygon form in NGO Cons Areas Database	Change in level of conservation covenants on farmland	BC NGO Conservation Areas Database
	Maintain ALR boundaries by 2029	Work with ALC staff to develop a JV-relevant ALR tracking system at regional and provincial scales.	Change in number of hectares/acres of ALR	ALR Map: https://www.alc.gov.bc.ca/alc/content/alr-maps/maps-and-gis
	Increased engagement with the ALC by 2029	Track ALC policy in all regions and engage with ALC staff to promote acceptance of conservation covenants; Reporting out on favourable approvals by ALC placing covenants on ag lands; Favourable reception by local farm community regarding covenants and adoption of agricultural practices considerate of wildlife habitat	Change in JV partner participation in ALC programs, committees, initiatives	Internal PBHJV-BC tracking

Table 11. *Continued*

NAWMP Initiative	Objective	Actions required to achieve monitoring	Indicator(s)	Data Source(s)
Land & Water Policy *(continued)*	Government to move towards a no net loss policy for wetlands (including estuaries) by 2029	Engage with provincial and federal government to request for a tracking scheme as it relates to use of wetland offset/mitigation guidelines (e.g., Federal Policy on Wetland Conservation, Environmental Mitigation Policy for BC)	Increase in application of wetland offset/mitigation guidelines to government and industry activities	CWS; BC Ministry of FLNRORD; BC Ministry of ECC
	Broader uptake of stewardship principles at Local Government level by 2029	Work with municipalities to develop local government tracking system; Potential to update the IBA form to BC Nature to include a report on the local governments adoption of bird friendly guidelines	Change in level of use of Green Bylaws Toolkit; Change in number of communities with bird advisory groups	Municipal Governments; Internal PBHJV-BC tracking
	Increased provincial government engagement by 2029	Secure dedicated provincial resources on technical team and/or Board	Change in partner participation in provincial programs and initiatives (CDFCP, BC Coastal Marine Strategy)	Internal PBHJV-BC tracking
	Increased level of provincial government funding by 2029	Secure dedicated provincial resources on technical team and/or Board	Change in provincial dollars affecting provincial policies that pertain to priority habitats	Internal PBHJV-BC tracking; Province of BC
	Increased level of partnership with Indigenous Groups by 2029	Develop an Indigenous engagement tracking system	Change in the number of active partnerships through programs, agreements and projects	Guardian Program, co-management agreements, partnership projects
	Increased level of support for IPCA development by 2029	Track IPCAs and development; Incorporate conservation planning into IPCA; Develop knowledge sharing agreement	Change in the level of engagement with respective IPCA committees	IPCA committees
Management (Habitat Assets)	Achieve a long-term 'sustainable' conservation estate by 2029	Rebuild priority aging water-control infrastructure as necessary	Maintenance or improvement of habitat functionality on PBHJV-BC lands	Internal PBHJV partner infrastructure tracking
	Management of 14,302 hectares (35,341 acres) by 2024	Track restoration projects as polygon in conservation databases	Change in hectares/acres restored/enhanced through partner programs	BC NGO Conservation Areas Database
Conservation Planning	Implementation Plans and updates accepted by PBHJV Board and North American Wetlands Conservation Council (Canada) by 2021	Annual reporting; Development of dashboard metrics to present to the Board and relevant partners	Implementation Plan endorsement, including updates by Board	PBHJV-BC IP; JV Board updates; technical team documents
	Maintenance and update to planning tools used by partners by 2029		Change in integration and evaluation of partner planning tools	

Table 11. *Continued*

NAWMP Initiative	Objective	Actions required to achieve monitoring	Indicator(s)	Data Source(s)
Science	Increased science-related government funding by 2029	Continue updating the NAWMP National Tracking System as well as federal government funding tracking systems (e.g., Grants & Contributions)	Increase science-related government funding	NAWMP NTS; CWS
	Maintain waterfowl monitoring program by 2029	Partners to jointly develop a tracking system for waterfowl monitoring	Change/update data for waterfowl population objectives	CWS; DUC
	Develop assessment of non-traditional conservation treatments (e.g., non-water controls) by 2029	Develop assessment of non-traditional conservation treatments; Compare with available research on traditional conservation treatments	Improve partner understanding of applications of non-traditional conservation treatments	Technical team documents; Internal PBHJV-BC tracking
	Develop targeted habitat and species tracking program by 2029	Tracking lands/projects completed in areas that have been identified by a tool(s) as being important (i.e., identify the tool and score/ranking of the implemented/completed project/acquisition, etc.); Review available tools/data for trends using remote sensing and satellite imagery	Improve partner effectiveness in integrating planning tools for conservation planning	Technical team documents; Academic publications
	Assess species response on conservation lands to show PBHJV-BC effectiveness by 2029	Conduct field surveys on PBHJV-BC properties targeting priority species; proper data management to allow for statistical analysis	Improve partner knowledge of effectiveness of habitat conservation work	Technical team documents; Academic publications; Birds Canada's NatureCount
	Partner with ongoing initiatives/building on planning work of Conservation Land Management Program	Continue collaboration with Conservation Land Management Program and other initiatives and develop monitoring/tracking plans	Change in PBHJV-BC contribution (funding, technical expertise, or otherwise) to the Conservation Land Management Program or other initiatives	Conservation Land Management Program (South Coast and West Coast)
	Better compilation and prioritization of important gaps for JV partners by 2029	Develop overall list of knowledge gaps; Prioritize knowledge gaps; Develop research plan that addresses priority knowledge gaps	Change in resource use to effectively address knowledge gaps by partners	IP; Technical team documents
Communications & Education	Increased profile, awareness of PBHJV-BC and partners by 2029	Partners to jointly develop a 'standard' tracking system for communication, and education	Increase website, social media, press release hits; Improve results from polls or surveys	Partner communications tracking systems
	Increased internal reporting to the PBHJV-BC Board by 2029	Implement biannual reports to Board; Develop dashboard metrics	Improve internal reporting processes and communications	Board meetings; Technical team documents
	Increased international collaboration with PBHJV-U.S. by 2029	Development of joint communications/knowledge-sharing agreement with PBHJV-U.S.	Improve communications and knowledge sharing with PBHJV-U.S.	International board meetings; Technical team documents; PBHJV website

Table 11. *Continued*

NAWMP Initiative	Objective	Actions required to achieve monitoring	Indicator(s)	Data Source(s)
Human Dimensions	Address knowledge gaps identified at HD workshops by 2029	Development/implementation of formal research plan to address knowledge gaps identified in HD workshops	Change in number of knowledge gaps addressed	Internal PBHJV tracking
	Effectively communicate and develop awareness of the importance of PBHJV species and habitat by 2029	Development and distribution of effective communications materials; Development of a communications plan	Change in awareness of PBHJV species and habitat to targeted audiences	Partner communications tracking systems
	Increase waterfowl conservation support among various constituencies to at least the levels experienced during the last two decades by 2029	Regional #s to be generated; Metrics and tracking program to document constituents and partnerships across all PBHJV partners	Number of JV constituents engaged in waterfowl conservation (hunters/ birdwatchers); Number of new or non-traditional partners; Change in revenue ($)in PBHJV-BC generated through Migratory Game Bird Hunting Permits	Migratory Game Hunting Permits; Partner engagement tracking
	Build HD capacity and understanding by 2029	PBHJV-BC partners to participate in MITACS webinars and development of national survey; Development of formal research plan to address knowledge gaps identified in HD workshops with prioritization and timeframe for implementation; Incorporation of national survey results into programming where applicable	Change in level of awareness of HD by partners; Change in level of partner awareness/ understanding of the social science landscape in the PBHJV-BC; Change in the application of HD and incorporation of social science results in PBHJV-BC programs	Mitacs Project; National Hunter/ Birdwatcher Survey
Crop Damage	Assess the magnitude of crop damage in key areas by 2029	Work with DF&WT to ensure crop damage in the Fraser River Delta continues to be monitored and reported	Change in crop damage locations/size/intensity; Change in enrollment in DF&WT FEP Program; Change in compensation to farmers for wildlife damage.	DF&WT vegetation and waterfowl surveys; DF&WT FEP program reporting; BC Agriculture Wildlife Program
Compensatory Mitigation	Work with Impact Assessment stakeholders and recipients of compensatory funds to achieve no net loss of bird habitat, following mitigation hierarchy to avoid, minimize, restore and offset	Engage with provincial and federal government to request for a tracking scheme as it relates to use of bird habitat offset/mitigation guidelines (e.g., Federal Policy on Wetland Conservation, Environmental Mitigation Policy for BC)	Increase in application of bird habitat offset/mitigation guidelines to government and industry activity	ECCC, BC FLNRORD, Port of Vancouver, BCWF, South/West Coast Conservation Land Management Program

CONSERVATION TRACKING SYSTEM

The PBHJV-BC partnership tracks coarse funding and hectare accomplishments via the Canadian National Tracking System (NTS). However, because the NTS is not spatially explicit, it cannot be used to inform conservation decision-making and planning. The BC NGO Conservation Areas Database (CAD) outlined in **Chapter 2** is more useful in making the link between conservation actions and progress toward objectives. The CAD is administered by two PBHJV-BC partners (NTBC and DUC), with all partners contributing information as needed to update it on a yearly basis. The database includes the conservation areas of nearly all NGOs in BC. A subset database has been created for those projects involving PBHJV-BC partners since the inception of the PBHJV-BC in 1991. This also includes provincial or CWS designations since 1991. With a full list of all PBHJV-BC properties, the types of uses for this information include coordinating land management activities on adjacent properties owned by different conservation organizations, identifying property encroachment violations and reporting on designations and ownership type.

By overlaying the PBHJV properties database with other GIS datasets, partners can conduct a wide variety of spatial analyses such as determining amount of species at risk critical habitat protected by PBHJV actions.

HABITAT INVENTORY AND MONITORING PROGRAMS

One of the PBHJV's main objectives is to inventory and monitor net changes in essential habitat types to determine gains and losses (net change in landscape condition), as well as areal extent for some habitat types or influences. PBHJV-BC will focus on those habitats relating to the limiting factors that are of greatest concern (**Appendix 5**), and work to address the habitat drivers and information needs identified in previous sections. For example, monitoring land cover enables the partnership to estimate the types and amounts of habitat secured overtime in a spatially explicit approach. Monitoring estuaries and wetlands improves the accuracy and applicability of habitat-species models in estimating population sizes and distributions. Monitoring the occurrence of invasives, such as *Spartina*, can help to assess the effectiveness of intertidal restoration programs. Comparing regularly updated habitat mapping with regularly updated conservation area mapping and economic tenure mapping can help to identify trends, pressures and gaps.

Habitat datasets that are updated on a regular basis to indicate trends vary in scale and frequency. As the costs of satellite imagery and processing have gone down, more land cover datasets are becoming available on a regular basis. For the purposes of the PBHJV, these types of datasets have sufficient resolution and accuracy to provide broad trends. One example is the Agriculture Canada National Crop Inventory which is released each year and indicates the general extent of wildlife-compatible crops throughout the PBHJV-BC. The Commission for Environmental Cooperation produces a land cover dataset every five years for all of North America with several classes such as forests (deciduous, coniferous, mixed), shrubs and built-up. This can be compared to the Priority Habitat Types to indicate five year trends in gains and losses. A new wetland mapping program in Canada that uses satellite imagery, new processing algorithms, and field data is designed to fill gaps in wetland classes and trends.

While satellite-based mapping can provide broad trends, finer-scale habitat mapping and trend analysis based on orthophoto analysis is also important, particularly in urban areas in order to detect smaller, incremental losses (e.g., highway widening, agricultural expansion).

POPULATION MONITORING PROGRAMS

The main objective for PBHJV-BC is to quantify bird numbers and assess population status to monitor trends and to evaluate the efficacy of habitat-based conservation efforts. Understanding population numbers and dynamics also supports habitat-species models, which in turn, drives conservation planning tools. PBHJV-BC population monitoring integrates results from various regional, national and international monitoring programs. These programs (**Appendix 6**) are mainly run by CWS and Birds Canada, although the Washington State government has monitored populations of Lesser Snow Geese and sea ducks in partnership with the U.S. Fish and Wildlife Service and the Sea Duck Joint Venture.

Population monitoring programs often involve multiple partners playing different roles such as planning, overseeing, in-field data collection and data analysis. In collaboration with Birds Canada, CWS conducted an analysis to determine whether habitat conservation actions implemented along the BC coast have affected occupancy of over-wintering bird species. Considering 65 species that include target waterfowl, as well as shorebirds, alcids and raptors, CWS analyzed changes in the probability of occupancy in response to conservation actions implemented by PBHJV-BC partners and funded by ECCC. Dynamic (multi-year) occupancy models were fitted using Birds Canada's community science dataset from the BC Coastal Waterbird Survey Program, consisting of 240 routes distributed within the Salish Sea, west Vancouver Island and North Coast regions.

Preliminary analysis shows that in response to habitat conservation actions, 13 species exhibited improved site colonization rates and an additional 10 species had reduced site extinction rates (De Zwaan 2021). Colonization rate refers to the arrival of individuals to areas of suitable habitat that are currently uninhabited, whereas extinction rate refers to the opposite (departure of individuals). Species exhibiting greater colonization rates included mostly dabbling ducks or goose species, but also shorebirds (e.g., Sanderling, Greater Yellowlegs), gulls (e.g., Ring-billed Gull) and raptors (**Figure 14**). Declining extinction rates were largely observed in non-target species, such as Great Blue Heron, Black Turnstone and Dunlin. Ten species with improved colonization rates and seven species with reduced extinction rates in response to habitat conservation actions are also experiencing a decrease in the proportion of sites occupied across the entire study area (**Figure 14**). These results suggest that conservation sites with ECCC investment are potentially acting as a refuge and/or a buffer against declining occupancy rates within the larger meta-population.

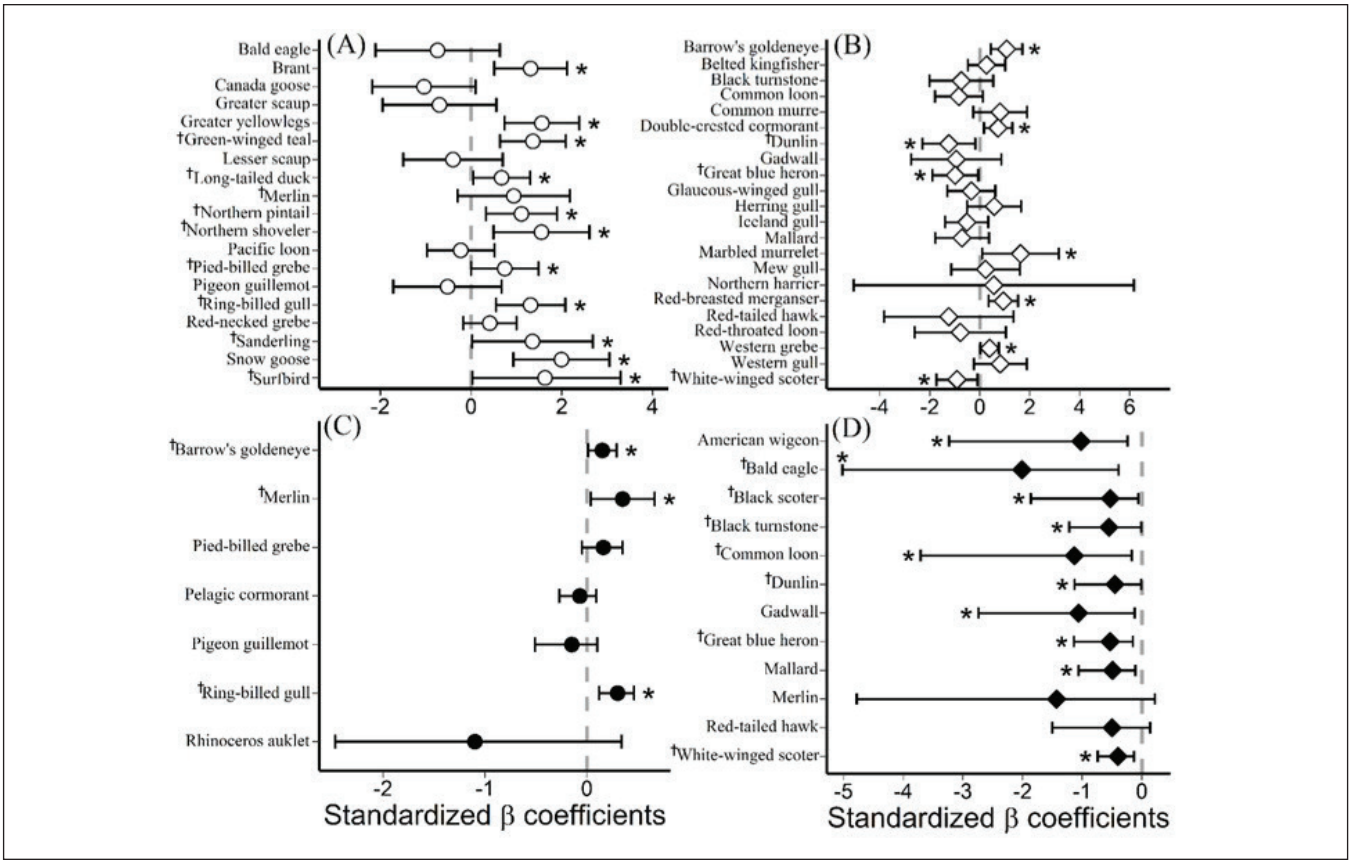


Figure 14. Effect sizes for all species that included conservation status (yes/no) in the top model for colonization (A) and extinction rate (B), as well as the proportion of conservation area effects on colonization (C) and extinction rate (D).

Circle points indicate colonization rate, while diamonds are extinction rate effect sizes. White fill refers to protection status and black fill indicates proportion of area conserved. All significant effects, where the 95% CI does not include 0 (the dashed grey line) are indicated by an asterisk. Species with a dagger superscript "†" indicate those with improved colonization or reduced extinction rates in response to conservation actions and exhibiting declines in proportion of sites occupied across entire study area. Figure modified from de Zwaan (2021).

INTEGRATION OF INFORMATION – PBHJV DATA MONITORING SOURCES

Table 12 summarizes the current monitoring programs conducted by PBHJV-BC partners. The results inform the monitoring and evaluation of habitat objectives, species population objectives and the various conservation planning tools. Details of habitat and population monitoring programs are found in the appendices.

Table 12. Integration of monitoring data sources for PBHJV-BC

Category	Monitoring Program/Study/ Tool Name	Purpose/Focus (habitat, species, conservation planning tools)	Responsible Organization(s)
Habitat Inventory & Monitoring	Crop Inventory	Agricultural land	Agriculture Canada
	Agricultural Land Use Inventory	Agricultural land	BC Ministry of Agriculture
	Fraser River Delta Crop Cover Surveys	Agricultural land, TRUEMET Model	DUC/DF&WT
	BC Freshwater Atlas	Freshwater wetlands	Province of BC
	Sensitive Ecosystem Inventories	Freshwater wetlands, Riparian Forests	Various Organizations
	Canadian National Wetland Inventory	Coastal and freshwater wetlands	ECCC-CWS
	PECP estuary polygons, rankings and tenures (leases/licenses)	Estuary, PECP, NAWCA Priority Areas, DUC Priority Areas	NTBC
	PECP estuary adjacent Delta land cover	Estuary, PECP, NAWCA Priority Areas, DUC Priority Areas	ECCC-CWS
	Spartina monitoring	Estuary, invasives	DUC, Conservation Land Management Program
	Estuary Resilience Study	Estuary	PBHJV partners as part of the West Coast Conservation Land Management Program
	Fraser River Estuary Marsh Monitoring Program	Estuary	PBHJV Partners as part of the South Coast Conservation Land Management Program
	Biological Shore Zone Mapping	Shallow marine, Sea Duck Model	Province of BC
	Use of shallow marine areas in coastal BC	Shallow marine	ECCC-CWS
	CEC Land Cover	Agriculture, Riparian Forest	CEC
Population Monitoring	Species-specific winter surveys of Lesser Snow Goose, Dusky Canada Goose, and Pacific Brant	Wintering waterfowl of significance	ECCC-CWS / Washington Dept Fish and Wildlife
	BC Winter Sea Duck Surveys	Nearshore waterfowl	ECCC-CWS / Washington Dept. of Fish and Wildlife
	BC Breeding Bird Atlas	All bird groups	Birds Canada
	BC Coastal Waterbird Survey (BCCWS)	Waterbirds including waterfowl	Birds Canada
	BC Beached Bird Survey	Seabirds	Birds Canada
	Breeding Bird Survey (BBS)	All birds/waterfowl and non-waterfowl objectives	ECCC-CWS

Table 12. *Continued*

Category	Monitoring Program/Study/ Tool Name	Purpose/Focus (habitat, species, conservation planning tools)	Responsible Organization(s)
Population Monitoring *(continued)*	Winter Waterfowl Monitoring in the Fraser River Delta Agricultural Lands	Agricultural land/Waterfowl	DF&WT / ECCC-CWS / DUC
	Multi-species survey on PBHJV properties in BC	Priority habitat types / Landbirds, shorebirds, marsh birds and other bird groups	ECCC-CWS
	Marsh Monitoring Survey	Protected versus unprotected habitat, marsh birds	Birds Canada / WildResearch
	Coastal Marine Bird Monitoring	Seabirds	ECCC-CWS
	Indigenous-led Marine Bird Monitoring	Seabirds	ECCC-STB & CWS / Birds Canada
	Pelagic Bird Monitoring	Seabirds	ECCC-CWS

Figure 15 depicts the PBHJV-BC's adaptive management approach. Investments (1 - green) in various land-based strategies (e.g., land securement, habitat restoration) are informed by the implementation of other strategies (e.g., conservation planning tools, HD initiatives). Together, these strategies address the key threats (2 - yellow) identified in this Implementation Plan for birds and bird habitat. By removing or mitigating threats related to habitat loss and degradation, priority bird species would in principal respond positively (3 - red) as evaluated through the population monitoring programs (**Appendix 6**). Likewise, habitat trends and land base changes resulting from key habitat threats are evaluated through various habitat monitoring programs (**Appendix 5**). Through the analysis of data generated from habitat and species monitoring programs (4 - purple), progress can be tracked through reports and internal databases (5 - grey). These results would ultimately be communicated to the PBHJV-BC Board and other relevant partners, allowing them to make decisions to further inform strategic investments in projects and initiatives.

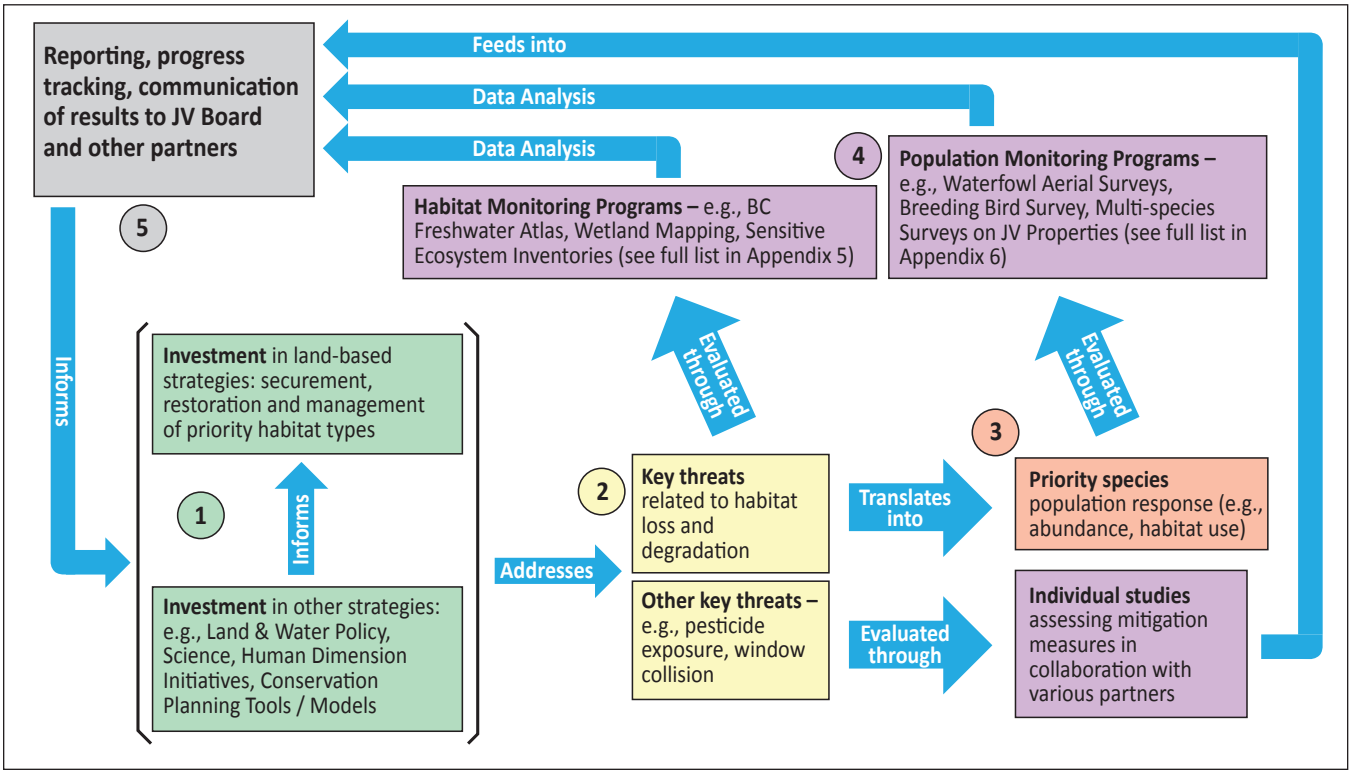


Figure 15. PBHJV-BC adaptive management approach

REFERENCES

Austin, M A, D J Buffett, G G Nicolson, E Scudder, and V Stevens. 2008. *Taking Nature's Pulse: The Status of Biodiversity in British Columbia*. Victoria, BC: Biodiversity BC, 268. www.biodiversitybc.org.

BC Environment. 1995. *Riparian Management Area Guidebook*. British Columbia: Forest Service, British Columbia.

BC Ministry of Environment. 2021. Province of BC's Conservation Framework. http://www.env.gov.bc.ca/conservationframework/.

Bishop, C.A., M.B. Woundneh, F. Maisonneuve, J. Common, J.E. Elliott, and A.J. Moran. 2020. "Determination of neonicotinoids and butenolide residues in avian and insect pollinators and their ambient environment in Western Canada (2017, 2018)." *Science of The Total Environment* 737:139386.

Bondar, D. 2019. *Forage Enhancement Pilot Final Report*. Delta, BC: Delta Farmland & Wildlife Trust.

Boyle, C A, L Lavkulich, H Schreier, and E Kiss. 1997. "Changes in land cover and subsequent effects on Lower Fraser Basin ecosystems from 1827 to 1990." *Environmental Management* 21 (2): 185-196.

Breault, Andre. 2021. "Personal communication." Canadian Wildlife Service.

Butler, R W, D W Bradley, and J Casey. 2021. "The status, ecology and conservation of internationally important bird populations on the Fraser River Delta, British Columbia, Canada." *British Columbia Birds* 32:1:52.

Calvert, A. M., C. A. Bishop, R. D. Elliot, E. A. Krebs, T. M. Kydd, C. S. Machtans, and G. J. Robertson. 2013. "A synthesis of human-related avian mortality in Canada." *Avian Conservation and Ecology* 8 (2): 11.

Canadian Wildlife Service (CWS). 2003. *Migratory Birds Conservation Plans: Compendium Report*. Delta, BC: Canadian Wildlife Service, Environment and Climate Change Canada, Pacific &Yukon Region, 303.

CBC. 2021. *Metro Vancouver projected to add more than 1 million residents by 2050*, according to planners. May. Accessed May 2021. https://www.cbc.ca/news/canada/british-columbia/additional-1-million-residents-metro-van-by-2050-1.6008299.

College of New Caledonia. 2020. *Traditional Territories of BC: Indigenous Territory Guide*. College of New Caledonia. https://cnc.bc.ca/docs/default-source/default-document-library/indigenous-territory-guide.pdf?sfvrsn=60123e83_0.

Conservation Measures Partnership (CMP). 2021. *About Conservation Standards*. https://conservationstandards.org/about/.

Cooper, C, L Larson, A Dayer, R Stedman, and D Decker. 2015. "Are Wildlife Recreationists Conservationists? Linking hunting, birdwatching, and pro-environmental behavior." *Journal of Wildlife Management*. 79 (3): 446-457. https://wildlife.onlinelibrary.wiley.com/doi/abs/10.1002/jwmg.855.

Darbi, M. 2020. "Discussion of the Development of a Typology of Biodiversity Offsets." In *Biodiversity Offsets Between Regulation and Voluntary Commitment*. Cham: Springer.

Dawe, N.K., W.S. Boyd, R. Buechert and A.C. Stewart. 2011. "Recent, significant changes to the native marsh vegetation of the Little Qualicum River estuary, British Columbia; a case of too many Canada Geese (Branta canadensis)?" *Journal of the British Columbia Field Ornithologists* 21: 11-31.

Dayer, A., A. Gramza and J. Barnes. 2019. *Incorporating Human Dimensions into Joint Venture Implementation Plans*. NABCI, 12. https://nabci-us.org/wp-content/uploads/2019/05/Incorporating-Human-Dimensions-into-Joint-Ventures.pdf.

De Groot, K L, A N Porter, A N Norris, A C Huang, and R Joy. 2021. "Year-round monitoring at a Pacific coastal campus reveals similar winter and spring collision mortality and high vulnerability of the Varied Thrush." *Ornithological Applications* In Press.

De Zwaan, D R, A C Huang, Q McCallum, K Owen, M Lamont, and W Easton. 2021. *Mass gain and stopover dynamics among migrating songbirds are linked to seasonal, environmental, and life-history effects*.

De Zwaan, D. 2021. *Pacific Bird Habitat Joint Venture habitat-based conservation actions: impacts on winter occupancy of coastal bird species in British Columbia, 1993–2019*. Technical Report, Delta, BC: Environment and Climate Change Canada – Canadian Wildlife Service.

Delta Farmland & Wildlife Trust (DF&WT). 2013. "Annual Report." Annual Report, Delta, BC. https://deltafarmland.ca/wp-content/uploads/2017/07/DFWT-2013-Annual-Report1.pdf.

Ducks Unlimited Canada (DUC). 2004. "A Proposal for Habitat Conservation on the East Coast of Vancouver Island." Surrey, BC, 19.

Ducks Unlimited Canada (DUC). 2012. "Fraser River Delta Waterfowl Habitat Conservation Plan: 2012 Update and New 25-Year Plan." Surrey, BC.

Eng, M L, B J Stutchbury, and C A Morrisey. 2017. "Imidacloprid and chlorpyrifos in-secticides impair migratory ability in a seed-eating songbird." *Scientific Reports* 7: 15176.

Eng, M L, B J Stutchbury, and C A Morrissey. 2019. "A neonicotinoid insecticide reduces fueling and delays migration in songbirds." *Science* 365: 1177–1180.

English, S G, N I Sandoval-Herrera, C A Bishop, M Cartwright, F Maisonneuve, J E Elliott, and C Welch Jr. 2021. "Neonicotinoid pesticides exert metabolic effects on avian pollinators." *Scientific Reports* 11 (2914): 2914:11. doi:https://doi.org/10.1038/s41598-021-82470-3.

Environment and Climate Change Canada (ECCC). 2013. *Bird Conservation Strategy for Bird Conservation Region 5: Northern Pacific Rainforest*. Delta, BC: Canadian Wildlife Service, Environment and Climate Change Canada, 128. http://www.nabci.net/Canada/English/pdf/BCR%205%20PYR%20FINAL%20Feb%202013.pdf.

Ethier, D, P Davidson, G H Sorenson, Barry, K L, K Devitt, Jardine, C B, D Lepage, and D W Bradley. 2020. "Twenty years of coastal waterbird trends suggest regional patterns of environmental pressures in British Columbia, Canada." *Avian Conservation & Ecology* 15 (2).

Field, R D, and J D Reynolds. 2011. "Sea to sky: impacts of residual salmon-derived nutrients on estuarine breeding bird communities." *Proceedings to the Royal Society B: Biological Sciences* 278:3071-8.

Finn, R J, L Chalifour, S E Gergel, S G Hinch, D C Scott, and T G Martin. 2021. "Quantifying lost and inaccessible habitat for Pacific salmon in Canada's Lower Fraser River." *Ecosphere* 12 (7).

Fleming, K K, Mitchell, M K, M G Brasher, J M Coluccy, J D James, M J Petrie, D D Humburg, and G J Soulliere. 2019. *Derivation of Regional, Non-breeding Duck Population Abundance Objectives to Inform Conservation Planning in North America — 2019 Revision*. Technical Report, North American Waterfowl Management Plan Science. https://www.fws.gov/migratorybirds/pdf/management/NAWMP/DerivationofNon-breedingDuckPopulationAbundanceObjectives.pdf.

Gooden, J, and M 't Sas-Rolfes. 2020. "A review of critical perspectives on private land conservation in academic literature." *Ambio* 49:1019-1034.

Groves, C, L Valutis, D Vosick, B Neely, K Wheaton, J Touval, and B Runnels. 2000. *Designing a Geography of Hope: A Practitioner's Handbook for Ecoregional Conservation Planning*. The Nature Conservancy.

Hallmann, C A, Ruud, P B, C A Foppen, M van Turnhout, H de Kroon, and E Jongejans. 2014. "Declines in insectivorous birds are associated with high neonicotinoid concentrations." *Nature* 511: 341–343.

Harshaw, H W. 2018b. *North American Birdwatching Survey Canadian Pacific Flyway Technical Report*. Edmonton, Alberta: University of Alberta.

Harshaw, H. W. 2018a. *North American Waterfowl Hunting Survey Canadian Pacific Flyway Technical Report*. Edmonton, Alberta: University of Alberta.

Howes, D E, M A Zacharias, and R J Harper. 1997. *British Columbia Marine Ecological Classification: Marine Ecosections and Ecounits, Resources Inventory Committee Approved Standard*. The Resource Inventory Committee Coastal Task Force. http://www.ilmb.gov.bc.ca/risc/pubs/coastal/marine/index.htm#marineecoclass.methods.

Howes, D. 2001. *BC Biophysical Shore-Zone Mapping System - A Systematic Approach to Characterize Coastal Habitats in the Pacific Northwest*. Puget Sound Research, 11.

Imlay, T. L., J. Mills Flemming, S. Saldanha, N. T. Wheelwright, and M. L. Leonard. 2018. "Breeding phenology and performance for four swallows over 57 years: Relationships with temperature and precipitation." *Ecosphere* 9.

Intergovernmental Panel on Climate Change (IPCC). 2007. *Contribution of working groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland: IPCC, 104.

Kennedy, J, J Crawford, K Gillette, and S Tuttle. 2021. *Effectively and Respectfully Engaging Indigenous Knowledge Systems Throughout the Conservation Planning Process at NCC*. Vancouver: University of British Columbia.

Kerr, G. 2020. *Ecosystem Services Assessment of Delta Farmland & Wildlife Trust Stewardship Programs*. Delta, BC: Delta Farmland & Wildlife Trust.

Kirwan, M.L., and A.B. Murray. 2008. "Ecological and morphological response of brackish tidal marshland to the next century of sealevel rise: Westham Isl, British Columbia." *Global and Planetary Change* 60 (3-4): 478-486.

Krymkowski, D, R Manning, and W Valliere. 2014. "Race, ethnicity, and visitation to national parks in the United States: Tests of the marginality, discrimination, and subculture hypotheses with national-level survey data." *Journal of Outdoor Recreation and Tourism* 7. 10.1016/j.jort.2014.09.008.

Li, Y, R Miao, and M Khanna. 2020. "Neonicotinoids and decline in bird biodiversity in the United States." *Nature Sustainability* https://doi.org/10.1038/s41893-020-0582-x.

Machtans, C. S., C. H. R. Wedeles, and E. M. Bayne. 2013. "A first estimate for Canada of the number of birds killed by colliding with building windows." *Avian Conservation and Ecology* 8 (2): 6.

Maggini, I, L V Kennedy, K H Elliott, K M Dean, R MacCurdy, A Macmillan, C A Pritsos, and C G Guglielmo. 2017. "Trouble on takeoff: Crude oil on feathers reduces escape performance of shorebirds." *Ecotoxicology and Environmental Safety* 141:171-177.

Maggini, I., L.V. Kennedy, A. Macmillan, K.H. Elliott, K. Dean, and C.G. Guglielmo. 2017. "Light oiling of feathers increases flight energy expenditure in a migratory shorebird." *Journal of Expeirmental Biology* 220:2372-2379.

Manfredo, MJ. 2008. *Who cares about wildlife? Social science concepts for exploring human-wildlife relationships and conservation issues*. New York: Springer.

Metro Vancouver. 2020. Agriculture: *A Discussion Paper to support Climate 2050 and the Clean Air Plan*. Discussion Paper, Vancouver, BC: Metro Vancouver.

Metro Vancouver. 2019. *Metro Vancouver Regional District Climate Action Committee Regular Meeting*. May. Accessed May 2021. http://www.metrovancouver.org/boards/ClimateAction/CAC_2019-May-17_AGE.pdf.

Middleton, H. A. 2014. *The Influence of Intensive Land Use Types on the Foraging Distribution of Ducks Wintering in the Fraser River Delta, British Columbia*. PhD Dissertation, Burnaby, BC: Simon Fraser University, 139.

Morandin, L A, and P O'Hara. 2015. "Offshore oil and gas, and operational sheen occurrence: is there potential harm to marine birds?" *Environmental Review* 24:1-34.

National Observer. 2021. *Kinder Morgan Pipeline*. Accessed June 2021. https://www.nationalobserver.com/kinder-morgan-pipeline.

Nebel, S., J. Casey, M.-A. Cyr, K. J. Kardynal, E. A. Krebs, E. F. Purves, M. Bélisle, R. M. Brigham, E. C. Knight, C. Morrissey, and R. G. Clark. 2020. "Falling through the policy cracks: implementing a roadmap to conserve aerial insectivores in North America." *Avian Conservation and Ecology* 15 (1): 23.

North American Bird Conservation Initiative (NABCI). 2019. *The State of Canada's Birds, 2019*. Environment and Climate Change Canada, Ottawa, Canada.

North American Waterfowl Management Plan (NAWMP). 2020. "Habitat Matters: 2020 Canadian NAWMP Report."

North American Waterfowl Management Plan (NAWMP). 2018. "North American Waterfowl Management Plan Update: Connecting People, Waterfowl, and Wetlands."

North American Waterfowl Management Plan (NAWMP). 2012. "North American Waterfowl Management Plan: People Conserving Waterfowl and Wetlands."

North American Waterfowl Management Plan (NAWMP). 2014. "Revised Objectives for Waterfowl Conservation Planning Addendum."

North American Waterfowl Management Plan (NAWMP). 2004. *Strenghtening the Biological Foundation - Strategic Guidance*. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales.

Pacific Birds Habitat Joint Venture. 2021. "Fraser Lowland Agricultural Crop Survey - Change Analysis 1997-2020." Delta, BC.

Pacific Birds Habitat Joint Venture. 2019. *Identified Estuaries of British Columbia Ranking Project: 2019 Update*. Pacific Estuary Conservation Program, 44.

Pacific Coast Joint Venture. 1991. *Pacific Coast Habitat: A Prospectus*. Vancouver, BC: Canadian Wildlife Service and United States Fish and Wildlife Service, 27.

Panjabi, A. O., E. H. Dunn, P. J. Blancher, W. C. Hunter, B. Altman, J. Bart, C. J. Beardmore, H. Berlanga, G. S. Butcher, S. K. Davis, D. W. Demarest, R. Dettmers, W. Easton, H. Gomez de Silva Garza, E. E. Iñigo-Elias, D. N. Pashley, C. J. 2005. "The Partners in Flight handbook on species assessment." Partners in Flight Technical Series. http://www.rmbo.org/pubs/downloads/Handbook2005.pdf.

Patten, K, and C O'Casey. 2007. "Use of Willapa Bay, Washington, by shorebirds and waterfowl after Spartina control efforts." *Journal of Field Ornithology* 78 (4): 395-400.

PCJV British Columbia Steering Committee. 2005. "Pacific Coast Joint Venture Strategic Plan and Biological Foundation." Vancouver, BC, 77.

Poulter, B., R.L. Feldman, M.M. Brinson, B.P. Horton, M.K. Orbach, S.H. Pearsall, E. Reyes, S.R. Riggs, and J.C. Whitehead. 2009. "Sea-level rise research and dialogue in North Carolina: Creating windows for policy change." *Ocean and Coastal Management* 52 (3-4): 147-153.

Rosenberg, K V, A M Dokter, P J Blancher, J R Sauer, A C Smith, P A Smith, J C Stanton, et al. 2019. "Decline of the North American avifauna." *Science* 120-124.

Rutter, J. 2020. "Social Science Perspectives on Ethno-racial Diversity in Wildlife Viewing and Conservation (Webinar)." Virginia Polytechnic Institute and State University, September 10. https://video.vt.edu/media/0_4ng4izo.

Sanderson, E W. 2006. "How Many Animals Do We Want to Save? The Many Ways of Setting Population Target Levels for Conservation." *BioScience* 56: 911-922.

Scott, J L, and A Tenneti. 2021. *Race and Nature in the City - Engaging Youth of Colour in Nature-Based Activities*. Toronto, ON: Nature Canada.

Shaw, J., R.B. Taylor, S. Solomon, Christian, H.A., and D.I. Forbes. 1998. "Potential impacts of global sea-level rise on Canadian coasts." *The Canadian Geographer* 42 (4): 365-379.

Skagen, S, R Hazlewood, and M L Scott. 2005. *The importance and future condition of western riparian ecosystems as migratory bird habitat*. USDA Forest Service.

Smith, A. C., M. A. Hudson, C. M. Downes, and C. M. Francis. 2015. "Change points in the population trends of aerial-insectivorous birds in North America: Synchronized in time across species and regions." *PloS One* 10:e0130768.

Statistics Canada. 2017. *Census Profile, 2016 Census*. Accessed June 2021. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm.

Taylor, E. 2004. "Impacts of future climate change on the Fraser River delta and its urban estuary." In *Fraser River Delta, British Columbia: Issues of an urban estuary*, by D.C. Mosher, J.L. Luternauer, and D.E. Bilderback B.J. Groulx, 99-110. Vancouver, BC: Geological Survey of Canada Bulletin 567.

Thomson, R E, B D Bornhold, and S Mazzotti. 2008. *An examination of the factors affecting relative and absolute sea level in coastal British Columbia*. Canadian Technical Report of Hydrography and Ocean Sciences 260., Fisheries and Oceans Canada and BC Ministry of Environment, 49.

Veridian Ecological Consulting, Ltd. 2004. "Provincial and regional threats to wetlands in BC, a compilation of information from "Biodiversity Conservation in BC: An assessment of Threats and Gaps – Holt et al 2003"." South Slocan, BC, 19.

Wagner, M A, and J D Reynolds. 2019. "Salmon increase forest bird abundance and diverstiy." *PLOS One* 14(2): e0210031.

Watson, D.O. and Boxall, P.C. 2005. *Trends in hunter participation in Alberta, 1990 to 2000: An analysis of the hunter licensing system databases*. Information Report NOR-X-404, Edmonton, AB: Natural Resources Canada Northern Forestry Centre.

Weller, M.W. and B.D.J. Batt. 1989. "Waterfowl in winter: Past, present and future." In *Waterfowl in Winter*, by M.W. Weller, 3-8. University of Minnesota Press.

Williamson. 2020. "Wetland Loss to Human Encroachment in the Fraser Lowland: Results from 2009 to 2019 and Trend Analysis Since 1989."

Willie, M, D Esler, W S Boyd, P Molloy, and R C Ydenberg. 2017. "Spatial variation in polycyclic aromatic hydrocarbon exposure in Barrow's goldeneye (Bucephala islandica) in coastal British Columbia." *Marine Pollution Bulletin* 118:167-179.

Wilson, S.J. and J.R. Hebda. 2008. *Mitigating and adapting to climate change through the conservation of nature*. Saltspring Island, BC: The Land Trust Alliance of British Columbia, 58.

Zbeetnoff, Darrell, and Gillian Kerr. 2020. *Cost-Benefit Analysis of Delta Farmland & Wildlife Trust Stewardship Programs*. Delta, BC: Delta Farmland and Wildlife Trust.

Zydelis, R., D. Esler, M. Kirk and S. W. Boyd. 2009. "Effects of off-bottom shellfish aquaculture on winter habitat use by molluscivorous sea ducks." *Aquatic Conservation: Marine and Freshwater Ecosystems* 19 (1): 34-42.

Zydelis, R., D. Esler, W. S. Boyd, D. L. Lacroix, and M. Kirk. 2006. "Habitat use by wintering Surf and White-winged Scoters: Effects of environmental attributes and shellfish aquaculture." *Journal of Wildlife Management* 70 (6): 1754-1762.

APPENDICES

https://drive.google.com/drive/folders/1Cy0WPzmNA1HHn_JIecbhyTE-e6DkSa1i?usp=sharing

Appendix 1: **Definitions for PBHJV Priority Habitat Types**

Appendix 2: **List of Non-governmental Organizations and their conservation hectares (acres) secured in PBHJV**

Appendix 3: **Discussions from the 2020 PBHJV/CIJV Human Dimensions workshop**

Appendix 4: **Maps of PBHJV Priority Habitat Types after applying selection criteria**

Appendix 5: **Habitat inventory/monitoring programs in the PBHJV**

Appendix 6: **Population inventory/monitoring programs in the PBHJV**

PACIFIC BIRDS HABITAT JOINT VENTURE'S GUIDING PRINCIPLES

- **Commitment:** Our work is driven by a strong commitment to conserving the environments that birds depend upon.
- **People:** We respect differing backgrounds, viewpoints and cultures and seek to find common ground for habitat conservation.
- **Ingenuity:** We embrace innovation and creativity while striving to find solutions to complex habitat conservation challenges.
- **Sincerity:** We approach our partnerships based on open relationships and active communications, and we work with resolve to live up to our promises.
- **Collaboration:** We believe all partners have something to offer so we purse collaborative approaches to conservation projects.
- **Good Science:** We base our decisions on science that is objective, data driven, and defensible.
- **A Bird's Eye View:** We approach our work with a flyway and landscape perspective in order to best support the life-cycle needs of migratory birds.

WHAT IS A JOINT VENTURE

A Joint Venture is a regional partnership of the North American Waterfowl Management Plan. Each Joint Venture relies on sound science and a partnership approach to conserve high-priority migratory bird wetland and associated upland habitat in Canada, Mexico and the United States. There are four Habitat Joint Ventures, including the PBHJV, and three Species Joint Ventures within Canada.

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A SHARED VISION:
Canada's NAWMP Habitat Joint Ventures

CONNECTING PEOPLE
through
SOUND SCIENCE
at the
LANDSCAPE LEVEL
using a
PARTNERSHIP APPROACH
for long-term
CONSERVATION IMPACT

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