PACIFIC BIRDS HABITAT JOINT VENTURE (BC): **IMPLEMENTATION PLAN**

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Waterfowl and Associated Habitats 2015-2020

North American Waterfowl Management Plan
Plan nord-américain de gestion de la sauvagine
Plan de Manejo de Aves Acuáticas de Norteamérica

PACIFIC BIRDS
HABITAT JOINT VENTURE

Prepared by the Members of the PBHJV (BC) Science and Technical Committee, 2015

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Executive Summary

In 1991, the precursor of the PBHJV, the Pacific Coast Joint Venture (PCJV) was established as the first international Joint Venture under the North American Waterfowl Management Plan (NAWMP). The Joint Venture operated successfully under the PCJV moniker until 2014, when it was renamed as the Pacific Birds Habitat Joint Venture (PBHJV). It includes all of Alaska and Hawaii, and portions of BC, Washington, Oregon and California, and recognizes the needs of all species of birds. The overall direction is coordinated by an international Management Board, and activities within Canada are coordinated by a BC Steering Committee which includes representatives from its major active partners. This Implementation Plan (IP) focuses on waterfowl and waterbird species and their habitats, although additional information on other bird groups is included where available.

After more than 20 years, over $200 million has been invested into PBHJV habitat projects by BC partners, and this has translated into the securement of over 52,000 hectares, or 129,000 acres. Over that period the PBHJV (BC) conservation approach has evolved in many ways. Initially in the 1990s, the program focused on planning and program delivery to secure, enhance, restore, and manage wetlands. In 2005, the Continental Assessment refocused efforts towards program evaluation and adaptive management, and in the same year, a new strategic plan and biological foundation was produced to expand efforts to cover all birds and their habitats within the PBHJV area. With the NAWMP 2012 Update, the PBHJV recognizes that increasing public awareness and support is a key component to advancing waterfowl conservation.

The PBHJV (BC) landscape is characterized by high habitat diversity throughout all five of its ecological Planning Areas. Wide variations in altitude and a complex coastline create a multitude of productive marine and terrestrial habitats, and many species of birds have evolved to take advantage of these niches. Waterfowl use of the British Columbia (BC) portion of the Pacific Birds Habitat Joint Venture, or PBHJV (BC), is primarily during the migrating, staging and overwintering periods. Forty species of ducks, swans and geese occur regularly in coastal BC at various stages of their life cycles, and approximately 1 million waterfowl winter along the BC coast. The most abundant are Lesser Snow Goose, Mallard, American Wigeon, Northern Pintail, Barrow's Goldeneye, and scoters. Large numbers of other water-associated birds (including 39 species of shorebirds and an estimated 5.6 million colonial seabirds) winter in bays, surge narrows, and estuaries. The Fraser River Delta has been ranked as the most important migratory and wintering area in Canada for waterfowl, waterbirds and shorebirds, based on numbers of individuals using the area.

Priority species for waterfowl were identified from three primary sources: 1) the 2004 NAWMP Implementation Framework, 2) the 2005 PCJV Strategic Plan, and 3) the provincial BC Conservation Framework. Population objectives for each priority species were set as no net loss of current average midwinter populations, assuming that most migrant populations will also be accounted for in these objectives. Non-waterfowl priority species and population objectives

were identified from Environment and Climate Change Canada's Bird Conservation Region 5 conservation strategy.

The four primary habitat types providing food for waterfowl are estuaries, agricultural lands, freshwater wetlands and shallow marine waters. Although estuaries comprise only 0.12% of the landscape, they remain a focus of many PBHJV programs due to their food-rich combination of tidal wetlands and adjacent floodplains. Near urbanized areas, floodplains have often been highly modified and converted to agricultural crops, resulting in the loss of considerable natural habitat. However, crops grown on these lands can also provide a significant source of energy for some birds. Freshwater wetlands are also relatively rare ecosystems, but they are still important sources of food and refuge for many waterfowl and waterbirds. Shallow marine areas in the PBHJV are extensive and provide habitat for sea ducks, shorebirds, and a wide variety of seabirds and other waterbirds.

Waterfowl abundance in the PBHJV is primarily limited by wintering and staging habitats, and more specifically by foraging habitat. Habitat loss continues to have the greatest impact on the availability of food energy. Historically, estuaries and freshwater wetlands suffered dramatic losses, particularly in Southwestern BC where they were drained and converted to other uses. Today, ongoing losses are driven mostly by rapid population growth and urban sprawl, including the conversion of traditional soil-based croplands (e.g., grains, vegetables, pastures) to more intensive uses that generally do not support wildlife. While outright loss of an entire wetland is much less likely today, gradual human encroachment continues. Waterfowl habitat may also be impacted by other factors, such as disturbance, pollution from marine spills, and climate change. A growing concern is the effects of climate change related sea level rise (SLR), which may include dike-breaching, flooding of salt marshes, salt intrusion into freshwater marshes, and increased shoreline erosion.

PBHJV partners use decision support tools to direct management actions, including Ducks Unlimited Canada's (DUC) waterfowl prioritization and planning, the Pacific Estuary Conservation Program's (PECP) estuary ranking, Nature Conservancy of Canada's (NCC) conservation planning system, the Provincial Conservation Framework, and Canadian Wildlife Service's (CWS) regional conservation planning. The PBHJV is currently bringing together a number of single-species or -habitat models into a comprehensive tool which explicitly incorporates multiple habitats, ecological values, threats, land tenure, program type, and conservation opportunity.

Habitat objectives have been identified to guide conservation actions in the major habitat types considered in this IP. The original 1993 objectives were revised in 2003 using more comprehensive information, and the numbers have been updated for 2014 using improved habitat inventory data. The total habitat objective has been set to 484,295 hectares to be accomplished through habitat retention programs (367,854 still to be secured), and 34,385 hectares via habitat restoration. The habitat still to be secured includes 1,771 hectares in agricultural lands, 187,699 hectares in freshwater wetlands, 40,984 hectares in estuaries, and 137,400 hectares in shallow marine waters.

Partners have employed a variety of landscape, bioenergetic, and habitat-species models to develop and refine habitat objectives. This work includes the use of a bioenergetic model (TRUEMET) to explicitly link bird population objectives to foraging habitat objectives for Fraser Delta farmlands, and an estuary ranking project which prioritized 442 BC estuaries for conservation. To track and coordinate their efforts in securing lands for conservation, PBHJV partners have developed a province-wide database of spatial boundaries of nongovernment and government conservation lands. To date, 18% of the land and 1% of the marine portion of the Joint Venture has been conserved. In habitat terms, conserved lands include 45% of estuarine intertidal areas and 27% of freshwater wetlands, but only 3% of agricultural land. Of the total habitat objectives identified in this plan, 23.8% of the habitats are secured under long and medium term conservation.

Habitat retention programs focus on securing high-value habitats that are at significant risk of loss or degradation. Permanent methods include fee simple acquisition or conservation covenants on private lands, as well as designations of Crown-owned lands, such as Wildlife Management Areas. Due to high land prices, acquisitions are reserved for exceptionally significant habitats. Non-permanent securement involves various conservation land use agreements and even annual agreements which promote planting of winter cover crops (grasses, legumes, or grains) to protect the soil and provide forage for grazing waterfowl. Secured conservation lands are managed in accordance with the concept of minimal ecological management.

Restoration is typically undertaken on degraded land through methods such as installing engineered water control structures, breaching dikes, or removing human structures. Several partners also engage in ecological restoration by removing invasive species and/or planting native species. Another example is the use of agreements to promote waterfowl-friendly farming. Several JV partners also work to restore habitat under compensatory mitigation programs.

The PBHJV (BC) coordinates much of its policy activities through the Wetland Stewardship Partnership (WSP), a complementary partnership of government and nongovernment partners that reviews and provides advice on water policy and habitat mitigation strategies to various levels of government. Communication, education, and public outreach activities are generally undertaken by each of the PBHJV (BC) partners according to the individual mandates of the organizations and their capacity. Partnerships are a core philosophy of the PBHJV (BC), and member organizations actively work to expand relationships with industry, government, and academic agencies to help meet program objectives.

The PBHJV (BC) Science and Technical Committee has embraced a strong collaborative science program to inform planning processes and achieve population and habitat goals in a cost-effective fashion. Partners inventory and monitor changes in major habitat types to determine net change in landscape condition; however, many datasets are static and there is a lack of fine-scale coverage (e.g., freshwater wetland mapping) for most of the JV. A pilot exercise is planned

to track fine-scale trends in freshwater wetland distribution and spatial attributes in BC. Baseline information to monitor demographic parameters for almost all species is lacking, but partners monitor select populations to assess status and trends and to support habitat-species models.

Ongoing research activities include quantifying the intertidal energy supply available to sea ducks to support TRUEMET bioenergetic modeling, and predicting impacts of climate-change related sea level rise (SLR) on important estuaries in order to quantify expected habitat trends and target mitigation actions. Partners are also developing habitat association models for important sea ducks to better identify essential areas for these species.

Goal 3 of the 2012 NAWMP Revision is: growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation. To address this goal, PBHJV (BC) partners will refine these activities in the upcoming five years and work with a Human Dimensions Working Group and a Public Engagement Team to implement appropriate strategies. While the PBHJV (BC) currently has no coordinated strategy for public engagement, many PBHJV partners already have extensive outreach networks, and Environment and Climate Change Canada has announced a National Conservation Plan with the goal of connecting people to nature. The PBHJV (BC) will determine the level of activity the JV will take in the future to help achieve this goal.

Providing opportunities for waterfowl hunting is a challenge, particularly in the Georgia Basin of Southwest BC, where the large majority of the human population and the most valuable habitat for waterfowl occur. Hunters are a small percentage of an increasing urban population, and there are many restrictions on hunting for safety or land ownership reasons. Fortunately, provincial and federal wildlife agencies are supportive of continued waterfowl hunting in the Georgia Basin, and the PBHJV favours the expansion of special licensing programs. Partners who are already doing so will continue to work to maintain currently available hunting opportunities. The PBHJV will also continue to support programs that encourage and support local farmers to grow bird-friendly crops.

Despite its accomplishments, the PBHJV (BC) is still challenged by several knowledge gaps for priority species and habitats, and the need to improve habitat program delivery through activities that influence policy and the development of new partnerships. Addressing these challenges over the next five years must be done within the context of the 2012 NAWMP Revision, and this Implementation Plan is consistent with the goals and objectives in that document. The PBHJV is also working to increase coordination between its Canadian and US portions, involving cross-regional planning and projects. For instance, BC partners are exploring the use of Miradi software to assist with conservation planning and formalize an adaptive management cycle. The next iteration of this Plan (Phase 2) will include a wider range of habitat types. In the interim, the PBHJV has identified a series of priority actions in the final section of this Plan to advance conservation over the next five years.

Scope and Format

Phase 1 of the British Columbia Pacific Birds Habitat Joint Venture (PBHJV) Implementation Plan (IP) focuses on waterfowl species and their habitats and includes discussions on other water-associated birds where information is sufficiently available. Waterfowl use of the British Columbia portion of the PBHJV is primarily during the migrating, staging and overwintering periods; consequently this IP is focused on these stages of the annual cycle. Discussion of waterfowl breeding values is beyond the scope of this document. Waterfowl habitat use during these stages of the annual cycle includes freshwater wetlands, estuaries, shallow marine areas, and agricultural land; therefore, this IP focuses on these habitat types. Additional information on landbirds, shorebirds and waterbirds found in these habitats is presented where it is available.

When the North American Bird Conservation Initiative (NABCI) planning process is completed for the Bird Conservation Regions contained in the PBHJV, the IP will be updated to address all priority habitats and species as Phase 2.

This IP meets the "Desired Characteristics for Habitat Joint Venture Partnerships" expressed by the Plan Committee in its March 2010 Guidance on NAWMP Joint Venture Progress Reporting and Implementation Plan Endorsement. The format of this IP is consistent with the technical expectations outlined in that document.

The PBHJV landscape in BC is highly diverse, and includes coastal mountains, estuaries, wetlands and forests in its natural areas.

1: Introduction

The Pacific Coast Joint Venture (PCJV) was established as the first international Joint Venture in 1991[1] in response to the waterfowl conservation challenges raised in the North American Waterfowl Management Plan (NAWMP).[2] 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 nongovernment conservation agencies in California, Oregon, Washington and British Columbia (BC). In 2015, the PCJV was renamed the Pacific Birds Habitat Joint Venture (PBHJV) to reflect the inclusivity of the bird habitat in the entire boundary.

Initially the PBHJV focused on waterfowl, wetlands and nearshore marine waters within the Middle-Upper Pacific Coast, an area of major concern identified in the original 1986 North American Waterfowl Management Plan. Since then, the PBHJV has since expanded in both geographic area and scope. In 2001, coastal Alaska joined the partnership and completed the ecological continuum north from San Francisco Bay, and in 2002 Hawaii joined, bringing an important link to wintering habitat for some Alaskan species as well as its own unique, endemic birds[3]. The remainder of Alaska joined in 2011. The PBHJV (Figure 1) now recognizes the needs of all species of birds and works cooperatively on national and international issues with adjacent habitat Joint Ventures and other conservation initiatives. A Joint Canada-US Management Board coordinates the overall work of the PBHJV and a local Steering Committee guides the work of the partners within BC[4].

Figure 1: Pacific Birds Habitat Joint Venture Region

The British Columbia portion of the PBHJV (Figure 2), hereafter referred to as the PBHJV (BC) [5], is characterized by its diversity and productivity. Variations in altitude 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,

[1] Pacific Coast Joint Venture 1991
[2] US Fish and Wildlife Service and Environment Canada 1986
[3] Smith 2003
[4] BC Partners include Ducks Unlimited Canada, Environment Canada's Canadian Wildlife Service, the Nature Conservancy of Canada, The Nature Trust of BC, the Province of British Columbia, The Land Conservancy of British Columbia, and Bird Studies Canada.
[5] www.pacificbirds.org/britishcolumbia

nearshore, and intertidal habitats. 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 seaducks, 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.

ROCKY NEARSHORE HABITAT ON THE EAST COAST OF VANCOUVER ISLAND (PHOTO K. BARRY)

Figure 2: Map of PBHJV (BC) area

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 and shorebirds winter in bays, surge narrows, tidal flats, and estuaries, and one estuary in particular (the Fraser River Delta) has been ranked as the most important migratory and wintering areas in Canada for these birds. Environment and Climate Change Canada has developed all-bird Conservation Strategies in each of Canada's Bird Conservation Regions (BCRs) to serve as a framework for implementing bird conservation across Canada. This IP incorporates many of the elements of the Conservation Strategy for BCR 5[6], particularly as it pertains to non-waterfowl species.

As the program has developed, the PBHJV (BC) has responded to direction provided by the NAWMP Plan Committee. The Continental Assessment conducted in 2005 refocused efforts towards program evaluation and adaptive management. In the same year, the BC Steering Committee developed a new Strategic Plan and Biological Foundation[7] that expanded its efforts to cover all birds and their habitats within the PBHJV area, including terrestrial habitats and marine waters within the 200 mile Exclusive Economic Zone (EEZ). With the NAWMP 2012 Update[8] and Action Plan[9], the PBHJV recognizes that increasing public awareness and support is a key component of waterfowl conservation.

This IP focuses on waterfowl and their habitat: freshwater wetlands, estuaries, shallow marine areas, agricultural areas. The next iteration of this IP will be expanded to include priority bird species across all habitat types. In subsequent years, once the IP has been updated to address all priority habitats, the waterfowl habitat component will be reviewed and the entire document will be updated at 5-year intervals

[6] Environment Canada 2013
[7] PCJV (BC) Steering Committee 2005
[8] NAWMP 2012a
[9] NAWMP 2012b

PBHJV Vision

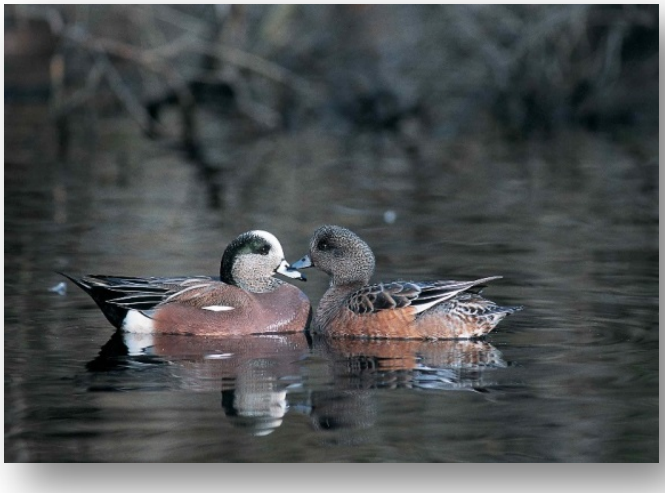
The PBHJV (BC) partners make up the larger International PBHJV and are working to achieve the following Vision:

A Pacific Region United for Bird Conservation. By working together, we will ensure wild birds thrive in abundant and diverse habitats that we all help safeguard for future generations.

PBHJV 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.



PAIR OF AMERICAN WIGEON, A PBHJV PRIORITY SPECIES.

PBHJV Conservation Accomplishments

Since 1991, PBHJV (BC) partners have secured or enhanced more than 52,000 hectares, or 129,000 acres (Table 1), supported stewardship on over 3,800,000 acres, and developed a strong science foundation. Partners have invested over $200 million into habitat projects (Table 2), with over 90% of these resources focused in the Southwest BC (SWBC) Planning Area where wildlife values are highest and the pressures from human activity are greatest.

Secured lands include:

- properties secured by Crown designation.
- properties acquired by any partner by fee simple donation and/or purchase.
- properties where any partner has secured a permanent conservation encumbrance (easement or covenant), or where any partner has a medium- or long-term conservation land use agreement (10+ years) with the landowner.

Enhancement includes activities that improve habitat quality on already secured lands, such as DUC's traditional engineered wetland program (hydrological restoration), project rebuilds, and compensatory mitigation (habitat mitigation) works. Enhancement may occur in the same year as securement, or in subsequent years.

Stewardship areas are counted when private landowners voluntarily adopt practices promoted by the JV partners, via Best Management Practice (BMP) implementation, incentive programs, short-term conservation land use agreements, or other extension/outreach programs.

Management costs are incurred when actions are undertaken to maintain secured or enhanced lands, and include annual maintenance, project operation, and ongoing costs such as property taxes.

Table 1: PBHJV (BC) partner conservation accomplishments since inception (1991-2014)[1]

Activity	Expenditures	Acres	Hectares
SECUREMENT	**$ 148,586,649**	**129,005**	**52,208**
Fee Simple Acquisition	$ 133,863,562	20,357	8,238
Conservation Encumbrance[2]	$ 2,485,837	746	302
Conservation Land Use Agreement (min 10yrs)	$ 8,092,584	30,575	12,374
Crown Designation	$ 4,144,666	77,327	31,294
Other	$ 0	0	0
STEWARDSHIP	**$ 4,002,780**	**3,868,230**	**1,565,451**
ENHANCEMENT	**$ 10,479,217**	**94,636**	**38,299**
MANAGEMENT	**$ 6,248,370**	**125,055**	**50,609**
OTHER	**$ 21,008,007**	**0**	**0**
Total[3]	**$ 190,325,023**[4]		

[1] Source: Canadian National Tracking System, November 13, 2014
[2] Known as Conservation Covenants in British Columbia
[3] Secured, enhanced and managed acres are not additive. Areas are first secured, may then be enhanced and are subsequently placed under management
[4] Due to a reporting error in the NTS tracking system, the contributions in Table 1 ($200 million) do not match the accomplishments in this table ($190 million).

Table 2: PBHJV (BC) partner contributions since inception (1991-2014)[1]

Source	Contributions
US	**$ 52,158,068**
Federal Government	$ 27,629,724
All Non-Federal Government	$ 24,528,344
CANADIAN	**$ 148,198,410**
Government	$ 122,017,666
Non-Profit	$ 19,928,256
Other Nongovernment	$ 6,243,395
Unspecified	$ 9,093
OTHER COUNTRIES	**$ 6,500**
Total	**$ 200,362,978**

1 Source: Canadian National Tracking System, November 13, 2014

2: Biological Planning

Spatial Planning Units

In the PBHJV (BC) region, there are five Planning Areas (and reporting units) that have been designated based on ecological and geographic distinctions (Figure 3):

1. Southwestern BC (SWBC)
2. Northern and Western Vancouver Island (NWVI)
3. Northern and Central Mainland (NCM)
4. Queen Charlotte Islands (QCI), also known as Haida Gwaii
5. Pacific Offshore (PO)

The PBHJV (BC) is contained within the Northern Pacific Rainforest Bird Conservation Region (BCR 5)[10].

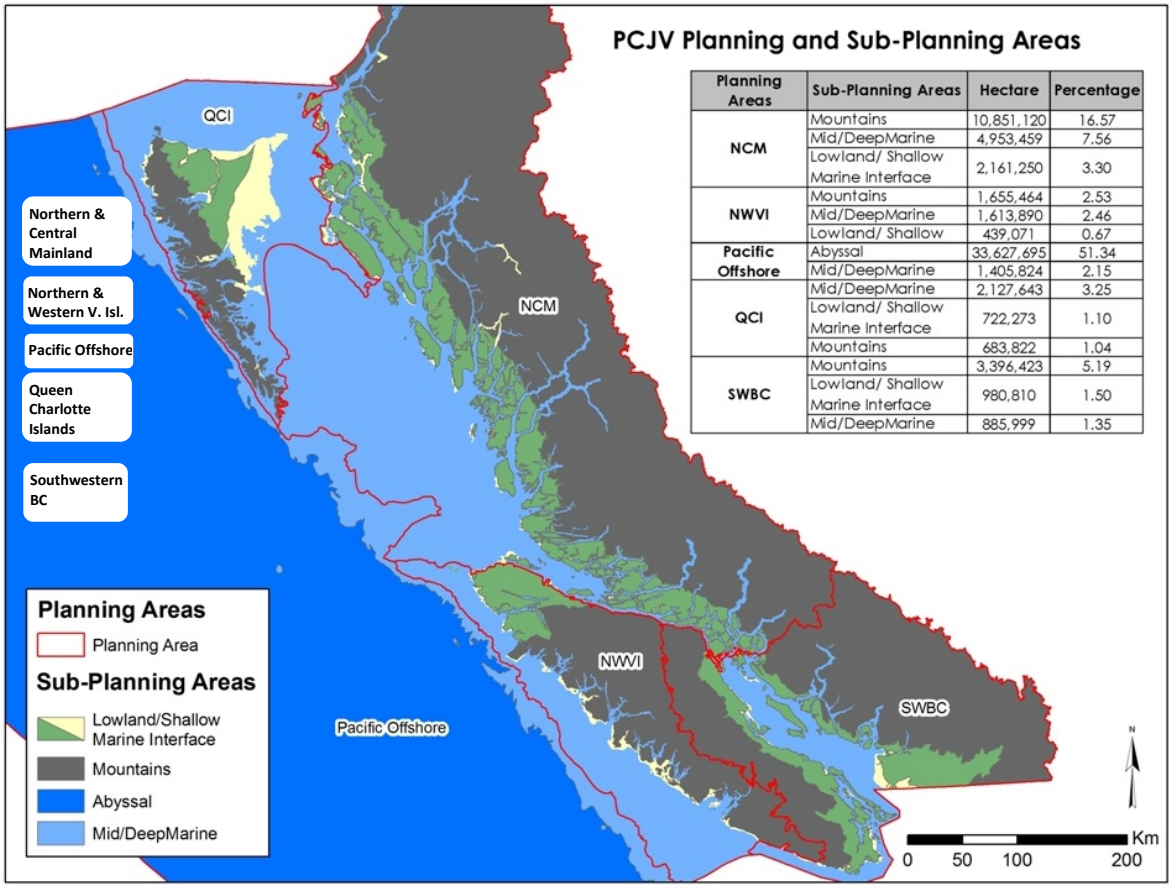


Figure 3: Planning Areas within the PBHJV (BC)

[10] Bird Conservation Regions (BCR) are areas with similar physical features, vegetation, bird communities and habitat issues (Bird Studies Canada 2002) that were based on boundaries in the BC Ecoregion Classification System.

Each Planning Area is a combination of ecosections from the provincial Ecoregion Classification System[11] and ecounits from British Columbia's Marine Ecological Classification system[12] . Each Planning Areas is divided into Subplanning Areas representing the full range of broad landscape types in the JV (see Appendix 1 for further details). Most of the PBHJV's conservation activities occur within the owland/Shallow Marine Interface Subplanning Area, although partners also work within the Mountains landscapes, and all four broad types represent ecologically interconnected features.

All of these Planning Units are used for breeding, staging/migrating, and wintering of water-associated birds, but use of these Planning Areas varies between bird groups and between seasons. For example, the Northern and Central Mainland coast is heavily used by moulting sea ducks and breeding seabirds, while Southwestern British Columbia contains critical migration and staging sites for shorebirds, and is home to the highest density of wintering waterfowl anywhere in Canada.

Within these Planning Units, various JV partners have identified smaller-scale areas where activities are concentrated. For details on the tools used by PBHJV partners to plan and target their conservation activities, see the section on Decision Support Tools (page 57). To set population and habitat objectives, both broad and fine-scale units may be used to match the resolution and extent of available data. For the purposes of this report, habitat objectives are restricted to waterfowl during the wintering and staging/migrating periods because these are the periods of highest abundance.

Priority Bird Species

Bird species can generally be categorized into four broad groups:

1) waterfowl (ducks, geese, and swans)
2) waterbirds (seabirds, coastal waterbirds, wading birds, and marshbirds)
3) shorebirds (a diverse group including sandpipers, plovers, godwits, dowitchers and curlews)
4) landbirds (species having principally terrestrial life cycles; such as raptors, songbirds, swifts, woodpeckers and jays).

Priority species for waterfowl were identified by reviewing the status of each species from four sources of information:

1) the 2004 NAWMP Implementation Framework[13]
2) the PCJV (BC) 2005 Strategic Plan[14]

[11] Demarchi 2011
[12] Howes *et al*. 1997
[13] NAWMP 2004

3) the Province of BC's Conservation Framework[15]
4) the BCR 5 Conservation Strategy[16]

In addition, some species were added due to regional management concern (e.g., Cackling Goose, Canada Goose [resident urban populations], Long-tailed Duck, Mallard, Lesser Scaup and Wood Duck). Appendix 2 provides a list of waterfowl species occurring regularly within the PBHJV and their ranking under the NAWMP and BC Conservation Frameworks.

Non-waterfowl priority species were identified from the BCR 5 Conservation Strategy, which encompasses the same approximate geographic area as the PBHJV (BC). A full priority species list encompassing all species groups and all habitat types has been developed as part of the BCR Conservation Strategy (see Appendix 3 for the complete list). As this IP focuses on waterfowl and waterfowl habitat (freshwater wetlands, estuaries, shallow marine waters and intertidal areas, and agricultural habitats), this document only presents information (where it is available) on non-waterfowl priority species which share these habitats. The resulting priority species list for this IP contains 18 waterfowl species and 48 other wetland, estuarine, and nearshore or intertidal-associated species (Table 3). Priority species not associated with waterfowl habitat will be addressed in subsequent versions of this IP.

[14] PCJV British Columbia Steering Committee 2005
[15] British Columbia Ministry of Environment: http://www.env.gov.bc.ca/conservationframework/
[16] Environment Canada 2013

Table 3: Priority bird species of the PBHJV (BC)

Group	Priority Species (in American Ornithologists' Union taxonomic order)
Waterfowl	Lesser Snow Goose (Wrangel Island population), Pacific Brant (incl. Black and Western High Arctic Brant), Cackling Goose, Canada Goose[1], Trumpeter Swan (Pacific Coast population), Wood Duck, American Wigeon, Mallard, Northern Pintail, Scaup (incl. Greater and Lesser Scaup), Harlequin Duck, Surf Scoter, White-winged Scoter, Black Scoter, Long-tailed Duck, Bufflehead, Barrow's Goldeneye
Other Water-Associated Birds	Common Loon, Yellow-billed Loon, Horned Grebe, Western Grebe, Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, American Bittern, Great Blue Heron (*fannini*), Green Heron, Bald Eagle, Northern Harrier, Rough-Legged Hawk, Black-bellied Plover, American Golden-Plover, Black Oystercatcher, Wandering Tattler, Whimbrel, Ruddy Turnstone, Black Turnstone, Surfbird, Red Knot, Sanderling, Western Sandpiper, Rock Sandpiper, Dunlin, Short-billed Dowitcher, Wilson's Phalarope, Red-necked Phalarope, Heermann's Gull, Western Gull, California Gull, Thayer's Gull, Glaucous-winged Gull, Caspian Tern, Common Tern, Common Murre, Thick-billed Murre, Pigeon Guillemot, Marbled Murrelet, Snowy Owl, Short-eared Owl, Belted Kingfisher, Gyrfalcon, Northwestern Crow, Purple Martin, Violet-green Swallow, Rusty Blackbird

1 Focusing on problem (resident urban) goose populations, and *parvipes* (Lesser), *occidentalis* (Dusky), and *fulva* (Vancouver) subspecies.

Priority Waterfowl Species

The North American Waterfowl Management Plan prioritizes waterfowl species within continental and regional contexts. Species that occur within the PBHJV that have been ranked as having Moderate High or High continental need include:

- Mallard
- American Wigeon
- Northern Pintail
- Lesser Scaup
- Long-tailed Duck
- all three scoter species
- Lesser Snow Goose (Wrangel Island population)
- Canada Geese (Lesser and Dusky subspecies)
- Cackling Goose
- Black and Western High Arctic Brant[17].

[17] NAWMP 2004

In addition to these, within the PBHJV area, Greater Scaup, Barrow's Goldeneye, Bufflehead, Harlequin Duck, Canada Goose (Vancouver subspecies), and Trumpeter Swan have been ranked as having Moderate High, High or Highest non-breeding need[18].

Only species with significant local populations (>10,000 wintering; >25,000 migrants) are considered priority waterfowl species in this IP. Despite lower numbers, Trumpeter Swan and Brant are retained as priority because of their relatively significant numbers to the overall populations of these species.

FLOCK OF SEA DUCKS ON THE EAST COAST OF VANCOUVER ISLAND IN WINTER, BUFFLEHEAD AND GREATER SCAUP (PHOTO E. DEMERS)

Waterfowl Use of the PBHJV

In coastal British Columbia, 40 species of ducks, swans and geese occur regularly at various stages of their life cycles. However, the JV is most important to migrant and wintering birds, when Pacific Flyway birds (Figure 4) converge on coastal estuaries during northward and southward migrations. An estimated 1,000,000 waterfowl winter along the BC coast (Appendix 4), including 2 species of swans, 12 populations of 5 species of geese, and 23 species of ducks[19]. The most abundant wintering species in BC are

Figure 4: The Pacific Flyway

[18] NAWMP 2004
[19] NAWMP 2004

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.

WATERFOWL WINTERING IN A PBHJV MARSH

Approximately 50% of the Pacific Coast population of Trumpeter Swans winter in Southwest British Columbia, primarily in the Strait of Georgia.. Approximately 67,000 Lesser Snow Geese, over half of the Wrangel Island population, winters in the Fraser River Delta Both populations have been increasing in recent years. An estimated 2,500 Pacific Brant winter along the BC coast in the Fraser River Delta, including a few hundred Western High Arctic Brant (*hrota* subspecies).

WATERFOWL FORAGING ON REMNANT CROPS IN WINTER

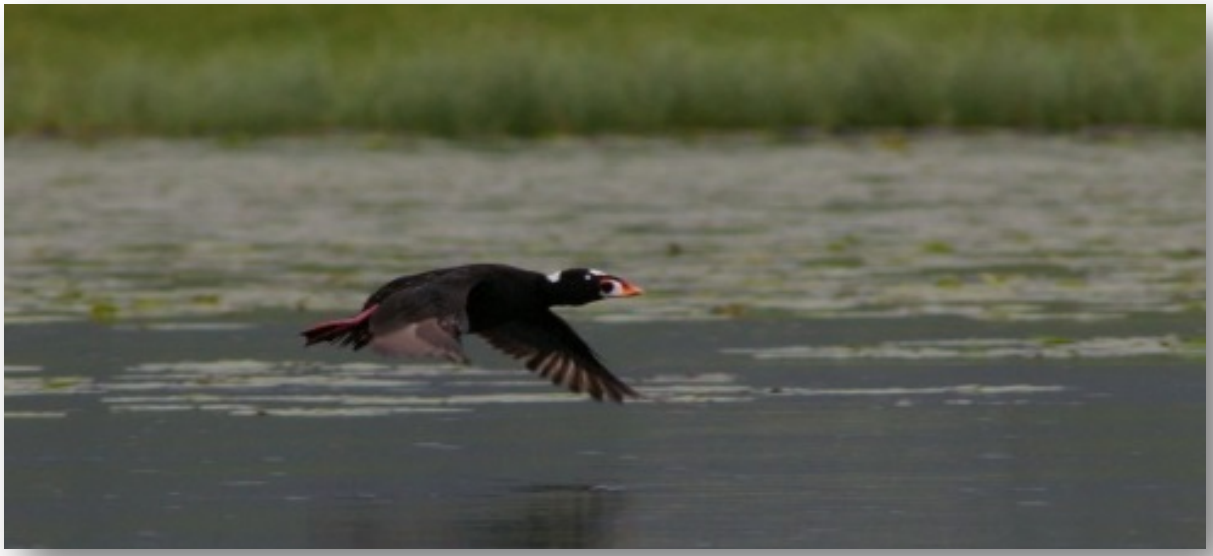
In larger estuaries, such as the Fraser River Delta, many dabbling ducks (primarily Mallard, American Wigeon, Northern Pintail and Green-winged Teal), Snow Geese, and swans use both upland and intertidal habitats. Many large estuaries can support tens of thousands of wintering waterfowl at one time, and the Fraser Delta can sometimes host hundreds of thousands in midwinter. Remnant agricultural crops provide high-calorie foods for birds during migration and farm fields provide critical refuge during extreme weather conditions, such as high tides and storm surges. Because food supply in the estuary declines during late fall, agricultural crops become increasingly important as winter progresses.

PBHJV (BC) estuaries provide the first foraging opportunity for fall migrants travelling to wintering sites along the coast. The carbohydrate-rich agricultural foods are critical to replenishing nutrient reserves used on long flights across sea or mountains. These reserves may be essential to ensure survival during further migration and inclement weather. 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 Black Brant.

The PBHJV also provides important tidal habitats for several sea duck species. 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[20]. During spring

[20] Canadian Wildlife Service 2003

migration and the herring spawn season, scoters often number 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.



SURF SCOTER, A PRIORITY PBHJV SPECIES THAT OVERWINTERS IN HIGH NUMBERS IN BAYNES SOUND, ON THE EAST COAST OF VANCOUVER ISLAND

Non-waterfowl Priority Species

The PBHJV is not only home to waterfowl, but a wide variety of other water-associated species. North Pacific estuaries and rocky shores are known to be one of the most important global regions for shorebirds[21]. 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 population of Western Sandpiper and the *pacifica* subspecies of Dunlin (3 million and 600,000 respectively) migrate along the BC coast[22]. Almost a quarter of the world's population of Black Oystercatchers breeds along the PBHJV (BC) coast, and the highest densities of Black Turnstones in North America spend the winter here[23].

The PBHJV (BC) also supports globally significant numbers of seabirds, with an estimated 5.6 million colonial seabirds[24] of 15 species breeding at 503 sites in British Columbia. An additional species, Marbled Murrelet (Red-listed by the International Union for the Conservation of

[21] Gill *et al.* 1994
[22] Campbell *et al.* 1990
[23] Morrison *et al.* 1995
[24] PCJV (BC) Steering Committee 2005; seabirds are species of gulls, albatrosses, fulmars, shearwaters, storm-petrels, cormorants, auks, murres and puffins.

Nature – IUCN), is widely distributed in BC, breeding in upland old growth trees and foraging in marine waters during winter and summer. The region's wetlands, lakes, rivers and nearshore areas also support a variety of other waterbirds, such as loons, grebes, herons, raptors such as Bald Eagle, Short-eared Owl and Northern Harrier, plus a variety of passerines including, warblers, flycatchers, sparrows, swallows and blackbirds.

In this IP, non-waterfowl priority species were identified primarily from the BCR 5 Conservation Strategy[25]. For the BCR 5 strategy, a master list of over 200 avian species known to regularly occur within the BCR was compiled from the following sources:

- The Birds of British Columbia[26]
- The Atlas of Pelagic Seabirds[27]
- Bird Studies Canada's British Columbia Coastal Waterbird Survey datatset (1999-2007)
- eBird Canada[28]
- NatureServe[29]
- The British Columbia Breeding Bird Atlas[30].

WILSON'S PHALAROPE, A PRIORITY PBHJV SPECIES THAT BREEDS IN WETLANDS IN BC.

Priority bird species for BCR 5 were assessed against specific criteria to determine if they:

1. Met the Partners In Flight (PIF) criteria[31] for Continental or Regional Concern, or for Continental or Regional Stewardship (those having a high proportion of their global population or range within the ecological Planning Area), or

[25] Environment Canada 2013
[26] Campbell *et al.* 1990, 1997, 2001
[27] Kenyon *et al.* 2009
[28] http://ebird.org/content/canada
[29] http://www.natureserve.org/explorer/
[30] http://birdatlas.bc.ca/english/index.jsp
[31] Panjabi *et al.* 2005

2. Were of high National Concern in Canada's Waterbird Conservation Plan[32] and/or are of regional significance, or
3. Were of high National Concern in the Canadian Shorebird Conservation Plan[33] and/or are of regional significance, or
4. Are considered at risk according to provincial or federal designations:
    - Red- or Blue-listed species in British Columbia,
    - Species listed under the Species at Risk Act, and species assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered, Threatened or Special Concern, or
5. Were added based on expert screening and review.

Through the BCR process, a full priority species list for all bird groups in all habitats across the PBHJV (BC) was developed (see Appendix 3). This IP focuses solely on the species that utilize the same habitats as waterfowl; namely freshwater wetlands, estuaries, shallow marine waters, and agricultural lands. Remaining priority species will be integrated into the next iteration of this IP.

Bird Population Objectives

Priority Waterfowl Species

Waterfowl population objectives were defined from either population assessment programs and/or from habitat-species models, and, in the case of Pacific Brant, from historical survey data. 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 4 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 (January-February). Some species tend to be more abundant during migration (e.g., Cackling Goose in fall; scoters and Harlequin during spring herring spawn; Brant in March). These estimates are not included because migration data are scant for most species. The population objective for each species is based on no net loss in winter so partners must conserve enough habitat to meet waterfowl needs during this time period, assuming that migration needs are accounted for by the same habitat program. Some of the habitat-species models were generated from expert opinion and unpublished data (Breault, pers. comm.) based on years of survey information. For most species, population objectives will continue to

[32] Milko *et al.* 2003
[33] Donaldson *et al*. 2000

be set and reviewed using a combination of population assessment programs and habitat-species models. See Appendix 4 for estimated populations for all waterfowl in various habitats.

TRUMPETER SWANS AND MALLARDS FEED IN A WINTER-PLANTED FIELD IN DELTA (PHOTO D. BRADBEER)

Table 4: Population objectives for priority waterfowl species in the PBHJV (BC)

Priority Species	PBHJV Midwinter Population Estimate[1]	Data Source[2]	Data Confidence	Habitats Used					
				Shallow	Estuary	Freshwater Wetland	Commercial Agricultural Land	Agricultural-Residential Mix	Urban
Lesser Snow Goose (Wrangel Isl population)	67,000	2	High	0	30,000	0	37,000	0	0
Pacific Brant	2,500	2	High	2,500	0	0	0	0	0
Canada Goose Cackling Goose (*Branta hutchinsii*) Canada Goose – resident urban population Canada Goose – Lesser (*parvipes ssp*) Canada Goose – Dusky (*occidentalis ssp*) Canada Goose – Vancouver (*fulva ssp*)	30,000	2	Medium	1,000	12,000	3,000	6,000	3,000	5,000
Trumpeter Swan (Pacific Coast population)	8,000	1	High	200	2,000	300	5,500	0	0
Wood Duck	4,000	3	Low	0	500	2,000	500	700	300
American Wigeon	135,000	3	Medium	10,000	100,000	1,000	20,000	1,000	3,000
Mallard	104,000	3	Medium	10,000	65,000	10,000	15,000	2,000	2,000
Northern Pintail	59,000	3	Medium	5,000	44,000	0	10,000	0	0
Scaup spp.	32,000	3	Medium	10,000	20,000	1,000	0	0	1,000
Harlequin Duck	25,000	3	High	25,000	0	0	0	0	0
Surf Scoter	270,000	3	Medium	250,000	20,000	0	0	0	0
White-winged Scoter	34,000	3	Medium	30,000	4,000	0	0	0	0
Black Scoter	10,500	3	Medium	10,000	500	0	0	0	0
Long-tailed Duck	15,000	3	Low	14,500	500	0	0	0	0
Bufflehead	45,000	3	Medium	25,000	15,000	4,000	0	0	1,000
Barrow's Goldeneye	70,000	3	Medium	60,000	10,000	0	0	0	0
ALL	**911,000**			**453,200**	**323,500**	**21,300**	**94,000**	**6,700**	**12,300**

[1] Waterfowl population objectives are based on no net loss; therefore population objectives are set to equal to current midwinter population estimates as of 2014

[2] Data source: 1 - Population Assessment programs; 2 - Pacific Flyway Council Management Plans; 3 - Habitat-Species Models.

Other Water-Associated Priority Bird Species

Population objectives for non-waterfowl priority species (Table 5) were taken from Environment and Climate Change Canada's BCR 5 Conservation Strategy[34]. Within the BCR strategies, population objectives are set based on the species' population trend (PT) score. For each priority species, the PT score for all of BCR 5 (encompassing the south coast of Alaska to northern California) was provided by Partners in Flight (PIF).The PT score for the Canadian portion of the BCR (corresponding to the PBHJV [BC] area) was calculated from Breeding Bird Survey (BBS) data following PIF protocols[35]. Conservatively, the higher of the two PT scores was used to assign a population objective, according to the following rules:

Species that have decreased more than 50% in the last 30 years (PT=5) → ***Double the population***

Species that have decreased more than 15% in the last 30 years (PT=4) →***Increase the population by 50%***

Species with variable or unknown trends (PT=3) →***Maintain the population + assess trends***

Species with stable or increasing trend (PT=2 or 1) →***Maintain the population***

For this IP, population objectives were not set for priority non-waterfowl species which only occur in the region during migration and do not breed or winter in the area. For any species listed under the Species at Risk Act (SARA), objectives defer to those in Recovery Strategies or Management Plans.

Based on this methodology, many species had uncertain or unknown trends (PT = 3), particularly for non-landbirds, and were thus assigned population objectives of "Assess/Maintain" for the BCR 5 conservation strategy[36]. This inability to determine a trend is likely due to relatively low coverage of the region by the Breeding Bird Survey (the low number of survey routes reduces the power of the survey to detect trends) and because many water-associated species are not well captured by BBS techniques.

For some of these species, other more localized data sets may provide better trend information. Historically, the Canadian Wildlife Service (CWS) has conducted counts at several

[34] Environment Canada 2013
[35] Panjabi *et al.* 2005
[36] Environment Canada 2013

breeding locations that could provide trend information for some colonial seabirds, though these surveys are dated and require an update. Bird Studies Canada's BC Coastal Waterbird Survey (See page 30) has over 15 years of data and a 12-year population trend assessment was published for 57 wintering species in the Strait of Georgia[37]. Future updates to this IP will integrate these additional sources of information into trend assessments to refine population objectives for non-waterfowl.

Table 5: Population objectives for priority non-waterfowl (from BCR 5 Conservation Strategy)

Group	Species	Population Objective			
		Increase 100%	Assess/ Maintain	Migrant (no objective)	Recovery objective
Waterbirds	Western Grebe	X			
	Horned Grebe		X		
	Common Loon		X		
	Yellow-billed Loon		X		
	Double-crested Cormorant		X		
	Brandt's Cormorant		X		
	Pelagic Cormorant		X		
	American Bittern		X		
	Great Blue Heron (*fannini*)		X		
	Green Heron		X		
	Heermann's Gull		X		
	Western Gull		X		
	California Gull		X		
	Thayer's Gull		X		
	Glaucous-winged Gull		X		
	Caspian Tern		X		
	Common Tern			X	
	Common Murre		X		
	Thick-billed Murre		X		
	Pigeon Guillemot		X		
	Marbled Murrelet				X
Shorebirds	Wilson's Phalarope		X		
	Red-necked Phalarope		X		
	Short-billed Dowitcher		X		
	Red Knot			X	
	Rock Sandpiper		X		
	Dunlin		X		
	Western Sandpiper		X		
	Sanderling		X		
	Wandering Tattler			X	
	Whimbrel			X	
	Black-bellied Plover		X		
	American Golden-Plover			X	
	Surfbird		X		
	Ruddy Turnstone		X		

[37] Crewe *et al.* 2012

	Black Turnstone		X		
	Black Oystercatcher		X		
Landbirds	Northern Harrier		X		
	Rough-legged Hawk		X		
	Bald Eagle		X		
	Gyrfalcon		X		
	Short-eared Owl		X		
	Snowy Owl		X		
	Belted Kingfisher		X		
	Northwestern Crow		X		
	Rusty Blackbird		X		
	Purple Martin		X		
	Violet-green Swallow		X		

Limiting Factors

Waterfowl

This plan is based on the premise that waterfowl population abundance in the PBHJV is primarily limited by wintering, migrating and staging habitat rather than by breeding habitat. Consistent with other wintering Joint Ventures[38], the main limiting factor for non-breeding waterfowl in the PBHJV is assumed to be food energy supply, 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 in it. Habitat productivity is the amount of nutrients produced in a given area of habitat, and its suitability for staging, migrating, or wintering waterfowl. An inadequate food energy supply can have direct impacts on survival, and even nonlethal effects on body condition may impact reproductive success and productivity.

Multiple habitat types are likely required for waterfowl populations in some areas, such as the Fraser River Delta. Ducks Unlimited Canada (DUC)'s Fraser Plan[1] found that intertidal, wetland and farmland habitats are all necessary for the Fraser River Delta to fully support current populations of dabbling ducks, geese and swans

The four primary habitat types providing food for waterfowl are: 1) shallow marine waters, 2) estuarine intertidal areas (estuaries), 3) freshwater wetlands, and 4) agricultural land. Historically, estuaries and freshwater wetlands have suffered dramatic losses. These losses are particularly significant in Southwest BC; for example in the Fraser River Delta, an estimated 70%

[38] Weller and Batt 1989

of estuarine habitat and 85% of freshwater wetlands have been lost[39,40] and incremental losses continue today[41]. Agricultural land that can support waterfowl, often derived from historical wetlands or estuarine habitat, increased dramatically in the early 1900s, but is now declining with continued conversion to more intensive uses that do not support wildlife, including greenhouses, berries, nursery crops, and residential development. Historic habitat loss and current habitat trends are discussed in more detail in the Waterfowl Habitat Drivers and Trends section (page 42).

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

1. Sea level rise is a significant threat to intertidal and estuarine habitats, as well as low-lying agricultural lands. A pilot project by PBHJV partners is underway to assess the magnitude of habitat loss that may occur under various sea level rise scenarios (see Research, page 102).
2. Disturbance can reduce the availability and quality of habitat. Recently completed studies[42] 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.
3. Historically introduced populations of Canada Geese are now year-round residents and continue to increase. These geese negatively impact estuarine habitats in Southwest BC through overgrazing and grubbing native vegetation which can increase erosion and lead to declines in overall productivity. If this trend continues, availability and quality of habitat for other waterfowl (including migratory Canada Geese) may be reduced.
4. Harvest rates in the PBHJV are small compared to other JVs and hunting is not considered a limiting factor on waterfowl survival. In 2007-2008, the extent of sports harvest mortality towards overall waterfowl vital rates was assessed in the PBHJV. The sports harvest rate was determined from waterfowl banding and recovery data collected between 1970 and 2006 in British Columbia. Only nine species had sufficient data to warrant 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 (about 10%), while the other species had harvest rates ranging from 1 to 4%.

[39] Fraser River Estuary Steering Committee 1978
[40] Boyle *at al.* 1997
[41] Major 2011
[42] Middleton 2014

5. Disease and environmental contaminants are assumed to have minor impacts on waterfowl populations based on current CWS monitoring programs[43], although they may be significant in localized areas.
6. To date, shellfish aquaculture does not appear to be having a negative impact on sea ducks, and in some cases even appears beneficial[44,45]. 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.
7. Not all species are necessarily affected in the same manner by these various factors.

WINTERING WATERFOWL SUCH AS SNOWGEESE ARE REGULARLY DISTURBED BY HUMAN ACTIVITY NEAR RESIDENTIAL AREAS

Other Wetland and Water Birds

Non-waterfowl species face many of the same limiting factors as waterfowl, though the impacts vary depending on the biology of each species. For example, climate change and sea level rise pose a grave threat to shorebirds that rely on intertidal flats, while those that utilize rocky shorelines might be less impacted. 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.

Disturbance is also likely a limiting factor for a variety of non-waterfowl species. Increasing recreational and industrial activities can exclude a number of species from otherwise suitable habitat or reduce habitat suitability. For example, disturbance of shorebirds on beaches and intertidal areas by walkers, dogs, ATVs and other recreational activities can exclude shorebirds from critically important migration stopover sites. Similarly, disturbance around breeding sites, such as seabird and Great Blue Heron colonies, can cause breeding failure.

[43] A. Breault, Canadian Wildlife Service, 2012. Pers. comm.
[44] Zydelis *et al*. 2006
[45] Zydelia *et al*. 2009

Habitat-Species (HS) Relationships

PBHJV partners are using a variety of landscape, bioenergetic, and habitat-species models to develop and refine habitat objectives for priority waterfowl and water-associated birds in various habitat types. Ideally, empirically spatial habitat-species models will be used to determine the amount of habitat needed to maintain a desired population level, or to forecast future conditions and plan conservation actions accordingly. An energetics model (which includes habitat associations) for agricultural lands in the Fraser River Delta has been completed. Models have been and will be used to set habitat objectives as they become available. For habitats and species where models are currently lacking, a simpler inventory-based approach is being used to set interim habitat objectives (see Habitat Objectives, page 69, for details). Models currently in use or under development by various JV partners are detailed below.

TRUEMET Model

PBHJV partner 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 requires an energy demand input (related to waterfowl population needs) and an energy supply input (related to habitat characteristics), and these inputs are combined to forecast whether there is adequate foraging habitat (or a surplus or deficit) for a given population level (Figure 5). DUC used this approach to convert the food energy needs of Fraser River Delta waterfowl populations (excluding sea ducks) into a foraging habitat objective.

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. Energy supply was derived from a current inventory of habitats and the food value of those habitats. For this latter metric, area and energy values were measured for important habitat types.

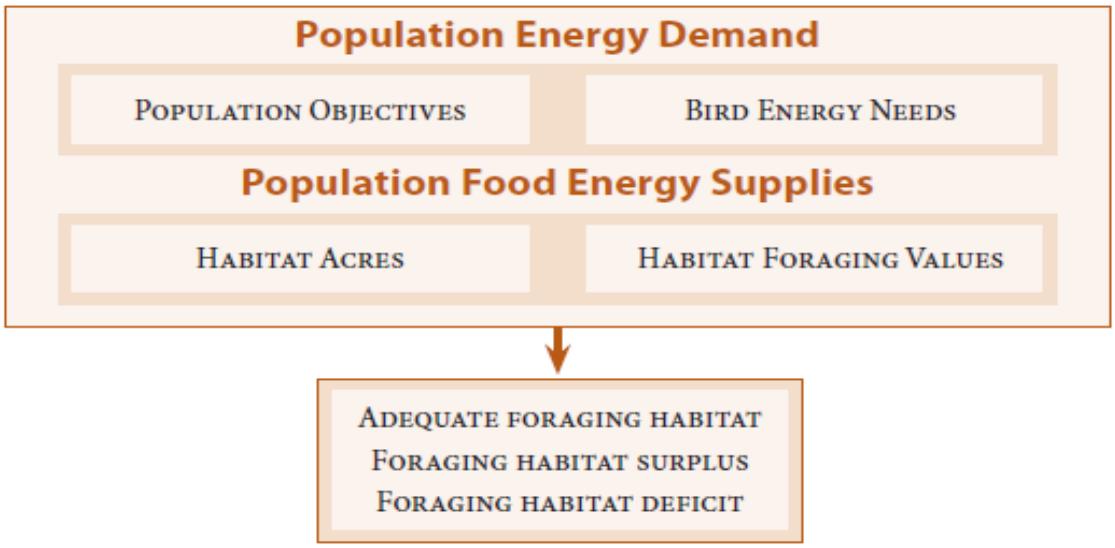


Figure 5: Inputs of the TRUMET Model

In 2003, DUC, DUI and CWS initiated a research program to refine several energy supply parameters. Over 3 years (not including a pilot year), information was collected in the Fraser River Delta and North Puget Sound (FDNPS) area regarding the occurrence and energetics of agricultural crops and intertidal eelgrass, and the movements of radio-tagged Northern Pintail and American Wigeon. Results from this work provided a better understanding of the food energy available to waterfowl to help set targets for conservation.

The daily energy needs of an individual bird were determined from scientific literature, while the population of each waterfowl species was identified under two scenarios: 1) the existing estimated population in the Fraser River Delta, and 2) the proposed population objective in the Fraser River Delta.

Use of TRUEMET was limited to the major dabbling duck species and Lesser Snow Goose. The model cannot yet address other species such as sea ducks and intertidal geese (e.g., Brant) due to a lack of information about the energetics of their food sources (e.g., shellfish).However, other models are being developed for some of these species (see Sea Duck Model, page 64)

The modeling linkage between energy needs and energy availability was used to predict long-term habitat needs in the Fraser River Delta under different habitat/population scenarios and to inform activities of the PBHJV. Results of the TRUEMET model are presented under Carrying Capacity Forecast (page 49).

Pacific Coast Estuary Program (PECP) Estuary Ranking Project and Habitat Use Model

The PECP was formed in 1987 by a group of government agencies and nongovernment organizations[46] to coordinate efforts to protect BC estuaries with high ecological value. The PECP has functioned as one of the main delivery programs for PBHJV (BC) land securement and enhancement.

Given the importance of estuaries in providing food resources to wintering and migrant birds, the PECP partners initiated a landscape-level overview of BC estuaries in the early 2000s to help update their prioritization process. In 2007, the PBHJV partners completed the first iteration of this process. The PECP Estuary Ranking Project[47] prioritized 442 BC estuaries for conservation action (Figure 6) and provided the initial habitat foundation for an estuary habitat-species model.

Figure 6: Location of the 442 identified estuaries included in the estuary ranking model

The ranking project used standard criteria and GIS tools to generate a dataset containing the boundaries of estuaries and a mapping specifications document. Individual estuaries were ranked for their biological importance to waterbirds (ducks, geese, swans, loons, and grebes) using data and five metrics: 1) estuary size, 2) habitat type and rarity, 3) herring spawn occurrence, 4) waterbird use, and 5) intertidal biodiversity. Identified estuaries met specific criteria; a complete census of all estuaries on the BC coast was not conducted.

[46] Partners include the Province of BC, Environment Canada, Ducks Unlimited Canada, the Habitat Conservation Trust Foundation, the Nature Conservancy of Canada, The Land Conservancy of BC and The Nature Trust of British Columbia.
[47] Ryder *et al.* 2007

The initial ranking scheme assumed the component datasets were representative of biological diversity and productivity. In 2014, we refined or replaced some of the inputs during a review of the project (see Decision Support Tools section, page 57).

THE BC COASTLINE HAS OVER 440 ESTUARIES, PROVIDING RICH HABITAT FOR WATERFOWL AND OTHER BIRD SPECIES

To expand on the ranking project and build a stronger model of estuarine habitat-species associations, it was recognized that better waterbird data were required. A plan to improve the waterbird component of the model was developed through two survey feasibility studies[48,49] which evaluated different waterfowl survey designs along the BC coast using available data. Based on this evaluation, a rotating panel design provided the highest power to detect trends in groups of species with the lowest cost. A subsequent study[50] developed the logistics for a rotating panel survey of estuary bird use, which was carried out during the winters of 2008-2009 and 2009-2010.

An estuary model of waterfowl habitat use was constructed in the JMP programming language, and was subsequently translated into the R programming environment in 2012. Model inputs included size of estuary, habitat type (upstream river, tidal, backshore) while the output was a relationship between habitats (estuary size, estuary habitat types) and waterfowl species densities. The 2009 and 2010 waterbird data was entered into the model, and the model was run in 2013 to generate family and species-specific habitat associations and estuary-specific population sizes.

[48] Kenyon 2005
[49] Ryder 2003
[50] Taylor *et al.* 2008

Sea Duck Models

HARLEQUIN DUCK PAIR, TYPICALLY FOUND OVERWINTERING ON ROCKY SHORELINES.

Several JV 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 where large numbers of birds occur, specific habitat could be prioritized for conservation actions. The partners plan to evaluate temporal patterns and spatial changes in the abundance and distribution of sea ducks to better understand the underlying reasons for these distributions and changes. The PBHJV has begun working with the Sea Duck Joint Venture to further these models and find opportunities for partnership.

Partners identified ten 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. Models will be completed for the remaining six species as resources allow. Methodologies included mixed-effects compound Poisson models with cross-random effects and selected models using an information criterion approach.

The modeling project uses data from several sources including:

1) the British Columbia Biophysical ShoreZone habitat mapping dataset collected by the Province of BC,
2) the British Columbia Coastal Waterbird Survey (BCCWS) dataset collected by Bird Studies Canada volunteers, and
3) supplementary habitat datasets (BC Freshwater Atlas, clam beds, TRIM, and shellfish tenures) collected from various sources.

ShoreZone consists of two kinds of interdependent variables: physical and biological. The physical mapping system segments the coastal shoreline into homogenous along- and across-shore units and components within zones. The biological mapping uses this framework to record shoreline biological bio-bands and species data. The system relies on oblique, low-tide aerial video imagery flown at spring low tides as the primary source of information[51].

[51] Howes 2001

The BCCWS dataset is a BC coast-wide, citizen science long-term monitoring program established in 1999. Volunteers record all water-associated birds observed within defined coastal and inshore marine sampling zones on a monthly basis. Standardized counts of all visible birds within the nearshore (<500m) and offshore (>500m) zones are conducted during the non-breeding season (October to March) along a 1 to 2 km predefined shoreline route. Data from 268 of these sites were used in the model, and mean bird density values were calculated for each polygon for the period December to February. Examples of the data collected by the BC Coastal Waterbirds Survey are illustrated on page 65.

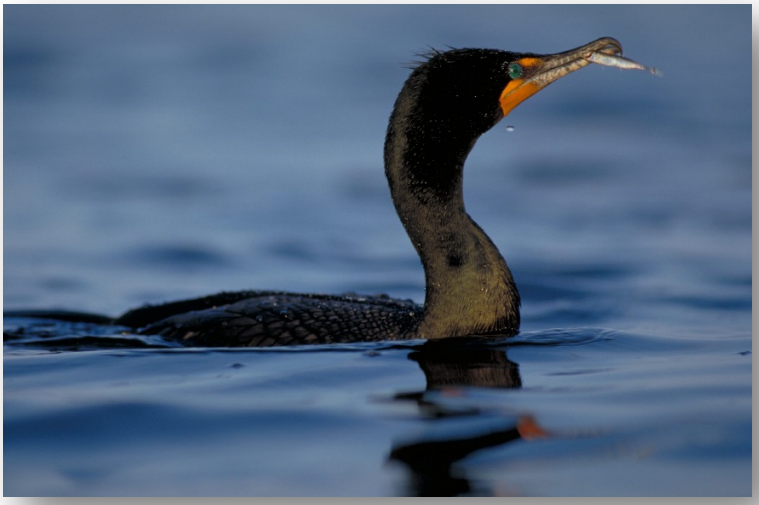
VOLUNTEERS CONDUCTING A BC COASTAL WATERBIRD SURVEY ON THE EAST COAST OF VANCOUVER ISLAND (PHOTO K. BARRY)

For the four species modeled thus far, Bufflehead, Red-breasted Merganser, White-winged Scoter and Surf Scoter, 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. The predictive capacity of the models remains untested, but partners hope to address this deficiency soon.

Coastal Waterbird Distribution Models

Researchers with the Canadian Wildlife Service have generated models using count data from the BC Coastal Waterbird Surveys, coastal habitat information from the BC Biophysical Shore-Zone Habitat Mapping, and terrestrial, oceanic, and interpolated climate variables from freely available remotely sensed data. Boosted regression trees were used to develop distribution

(presence/absence) models for 60 common coastal bird species with diverse habitat requirements. The 60 modeled species range from open ocean foragers such as grebes (Family: Podicipedidae) and cormorants (*Phalacrocorax* spp.), to shorebirds such as sandpipers (Family: Scolopacidae), to more diverse families such as gulls (Family: Laridae). The results from these models were then used to project probability of occurrence for each species over the entire coast of British Columbia. The predicted occurrence values were also used to identify sites of high bird species richness, diversity, and uniqueness. (See Decision Support Tools section, page 57.)



DOUBLE-CRESTED CORMORANT

3: Conservation Design

Landscape/Habitat Characterization and Assessment

Ecological Setting

A complete description of the landscape, bird populations and conservation challenges on the BC coast is provided in the 2005 PCJV Strategic Plan for British Columbia[52]. The 35,500 km[53] British Columbia coastline is an interface for 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 shallow nearshore waters with abundant crustaceans, shellfish and/or herring spawn sites, estuaries, associated agricultural lands, and freshwater and brackish wetlands.

PARTS OF BC'S COASTLINE ARE INDUSTRIAL, YET PROVIDE VITAL HABITAT FOR WINTERING BIRDS (PHOTO ECCC)

[52] PCJV BC Steering Committee 2005
[53] Statistics generated by Living Oceans Society based on BCMCA atlas data (B.C. ShoreZone data) provided by the Province of B.C.

PBHJV (BC) Fast Facts

(From the 2005 PCJV Strategic Plan)

The south coast supports the highest diversity of birds in British Columbia (415 species, or 86% of all species known to occur in the province). This area has 59% of regularly breeding species and 93% of wintering species, including 34 species that winter in BC only on the south coast.

BC estuaries account for only 2.3% of the coastline length but are used by an estimated 80% of all coastal wildlife including foraging by waterbirds and breeding or rearing grounds by some fish species. The Fraser River estuary and floodplain forms the most important migratory and wintering area for waterbirds in the province and is also important for migrating shorebirds. It supports the largest wintering population of raptors in Canada.

The mid and north coast holds the second highest number of birds in BC (375 species or 78% of all species known to occur in the province). This portion of the coast supports 53% of the regularly breeding species and 75% of the wintering species. It is also an important corridor for millions of migrating birds, especially shorebirds and waterfowl.

For the offshore marine, at least 158 species of birds use the area. Over half a million seabirds are in the offshore waters from June through September, while the number that transit through during spring and fall migrations is likely an order of magnitude greater.

The largest cities in BC (Vancouver and Victoria) are located on the south coast estuaries and floodplains, where agricultural and forestry production is also significant. The remainder of the coast consists of scattered small communities, along with forestry, mining and fishing activities. Marine shipping associated with two international ports (Vancouver and Prince Rupert) along with numerous other ports results in significant vessel traffic and risk from marine accidents.

Since 2005, the PBHJV Science and Technical Committee produced more refined estimates and maps of habitat availability using finer-scaled GIS datasets (Table 6, Figure 7). The primary dataset is EOSD[54] (Earth Observation for Sustainable Development) which used Landsat and provincial forestry information to produce 1:70,000 land cover maps. Most of these datasets represent snapshots in time ranging from the early 1990s to 2000. This is considered to be a landscape-scale analysis and therefore, some habitats such as riparian areas are underrepresented at this scale due to their size.

Table 6: Cover types within the PBHJV

Cover Type[1]	Area (ha)	Percentage
Water (lakes, rivers, nearshore marine)	14,845,613	23.9%
Coniferous forest	9,950,261	16.0%
Ice/snow	2,683,979	4.3%
Shrubs / sparse trees	1,706,977	2.8%
Alpine[2]	1,488,051	2.4%
Barren land	889,759	1.4%
Broadleaf forest	861,698	1.4%
Herbs	470,867	0.8%
Rock/rubble	324,727	0.5%
Mixed Wood Forest	293,274	0.5%
Wetlands[3]	240,662	0.4%
Urban	131,931	0.2%
Agriculture[2]	117,456	0.2%
Estuarine Intertidal[4]	74,585	0.1%
Grasslands[2]	1,313	0.0%
No data (incl. offshore marine)	27,936,854	45.0%
Total PBHJV data area	**62,018,013**	100.0%

[1] Data for most cover types is from the EOSDmod dataset, and is current as of 2000 with 25m pixels. The forest classes were retained as-is, while several of the non-forest classes were augmented with other datasets.
[2] Identified using BC Government 1:250,000 Baseline Thematic Mapping (BTM) developed from Landsat and aerial photography. All of these datasets represent a snapshot in time ranging from the early 1990s to 2000.
[3] Derived from the provincial 1:20,000 Freshwater Atlas developed from aerial photography.
[4] Derived from mapping conducted by the Pacific Estuary Conservation Program (PECP) using marine charts and topographic maps.

[54] Earth Observation for Sustainable Development, Natural Resources Canada, Earth Sciences Sector 2009

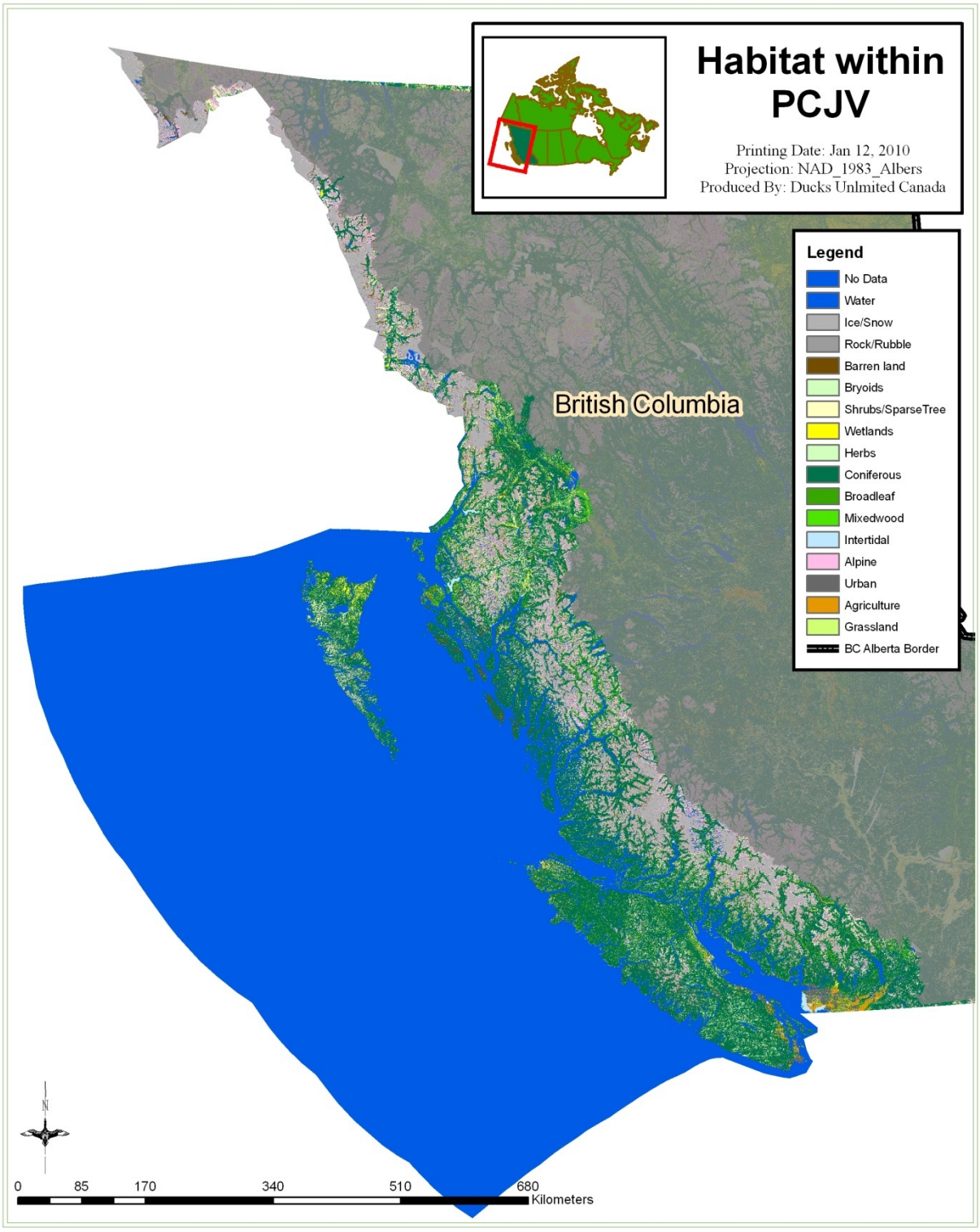


Figure 7: Map of cover types within the PBHJV

Since the PBHJV boundary extends out to the boundary of Canada's Exclusive Economic Zone (EEZ, 200 nautical miles), the proportion of water (including the No Data cover type) is higher than other habitat types (69%). The next most abundant habitat types are extensive coniferous forests consisting mainly of cedar and western hemlock at low- to mid- elevations, and mountain hemlock or Englemann spruce/subalpine fir at higher elevations.

FRESHWATER WETLAND ON CALVERT ISLAND ON THE CENTRAL COAST OF BC (PHOTO K. BARRY)

On the extreme south coast, there is a narrow band of forest that has formed within a rainshadow at elevations below 150m. The coastal Douglas-fir forest 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.

The mountainous terrain of the PBHJV results in a significant amount of alpine areas (2.4%) and associated subalpine habitats mapped in EOSD as Herbs, Ice/snow, Barren Land, Rock/rubble, and Shrubs/sparse trees. 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..

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 0.12% of the landscape area but they are a focus of many PBHJV programs as they provide a large amount of food energy and are essential habitat for migrating and wintering waterfowl.

Despite the somewhat patchwork approach for estimating habitat structure at the JV scale, 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. However, the PBHJV also needs access to finer scale (1:5,000) data on rivers and streams, and on non-wetland habitat classes, including riparian zones, grasslands, shrublands, and agriculture in various categories.

Large rivers such as the Nass on the North Coast may also support large numbers of birds at various times, but most of the waterfowl activity is near their intersections with marine waters, therefore large rivers were not included as a primary habitat type.

NASS RIVER (TOP) AND NORTH COAST ESTUARY

Estuaries

Estuaries occur where rivers meet the ocean, and the PBHJV has identified 442 discrete estuaries along the BC coastline (Table 7). In general, estuaries and associated deltas include multiple cover types (e.g., agriculture, urban, intertidal, subtidal), but for the purpose of this document beyond this section, estuaries include only the intertidal cover type.

While these estuaries encompass only 0.12% of the entire PBHJV area in BC, they provide a significant amount of food for migrating and wintering waterfowl. Many of the larger estuaries are located in the southern portion of the coast in the Fraser River Delta and East Coast of Vancouver Island, in the Southwest BC Planning Area.

Table 7: Summary statistics of BC estuaries

Estuary Size Class (ha)	PBHJV Planning Area					Entire PBHJV
	South-western BC	Northern & Western Vancouver Island	Northern & Central Mainland	Queen Charlotte Islands	Pacific Offshore	
	Area (ha)					*Area (ha)*
0-5	24.7	37.9	138.9	9.8	0	211.4
5-10	63.7	102.4	166.0	39.0	0	371.1
10-20	105.8	404.6	474.9	129.8	0	1,115.1
20-40	238.1	701.1	772.5	334.0	0	2,045.8
40-100	525.0	2,379.3	1,810.9	271.7	0	4,986.9
100-200	1,219.3	645.1	2,016.5	1,081.8	0	4,962.7
200-400	1,199.0	600.3	3,920.4	874.9	0	6,594.6
400-1,000	2,688.5		3,637.8	514.3	0	6,840.6
1,000-25,000	28,471.9		18,984.6		0	47,456.5
ALL	**34,536.0**	**4,870.9**	**31,922.5**	**3,255.3**	**0**	74,584.7

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 urban floodplains were diked and converted to agricultural crops such as grains, grasses and vegetables.

TIDAL WETLAND PROVIDING SALTMARSH HABITAT

Local bird movements in the Pacific Northwest indicate that the Fraser River Delta and Puget Sound (in the US 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 British Columbia, the Canadian arctic, the western boreal forest, and prairie pothole regions) either migrate through or winter in the Fraser Delta. With its mild climate and high productivity, the Fraser Delta supports the highest density of wintering waterfowl and shorebirds in Canada.

Agricultural Land

Within the PBHJV, 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.

DIKES SEPARATE AGRICULTURAL LAND FROM TIDAL MARSHES ON BRUNSWICK POINT

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 can provide a significant source of energy for migrating and wintering waterfowl. Waterfowl have adapted to feeding on the 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, and waterfowl populations in some areas are now reliant on these food sources. The productive farmland of the Fraser River Delta provides essential feeding and resting opportunities for approximately 1 million

FLOODED FIELDS IN FALL CAN PROVIDE EXCELLENT FORAGING OPPORTUNITIES

waterfowl, over 5 million shorebirds, and numerous other species of international concern annually[55].

Freshwater Wetlands

Freshwater wetland ecosystems within the PBHJV 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 and 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, covering only 0.39% of the PBHJV area (or about 1.2 % of the landbase), 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 also 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.).

Wetlands within the PBHJV 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 is also located in these same floodplain habitats, resulting in great pressures on wetland habitats in the PBHJV.

[55] Butler and Campbell 1987

EXAMPLE OF TWO TYPES OF COASTAL FRESHWATER WETLANDS: SOUTH COASTAL MARSH (LEFT) AND NORTHERN COASTAL BOG (RIGHT)

Shallow Marine Waters

The numerous fiords and islands of BC's convoluted coast give rise to 35,500 km 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; Figure 8). 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 <50km) and typically experiences calm conditions to low waves. Very little of the coastline is classified as exposed or very exposed and experiences large swells regularly (Figure 8).

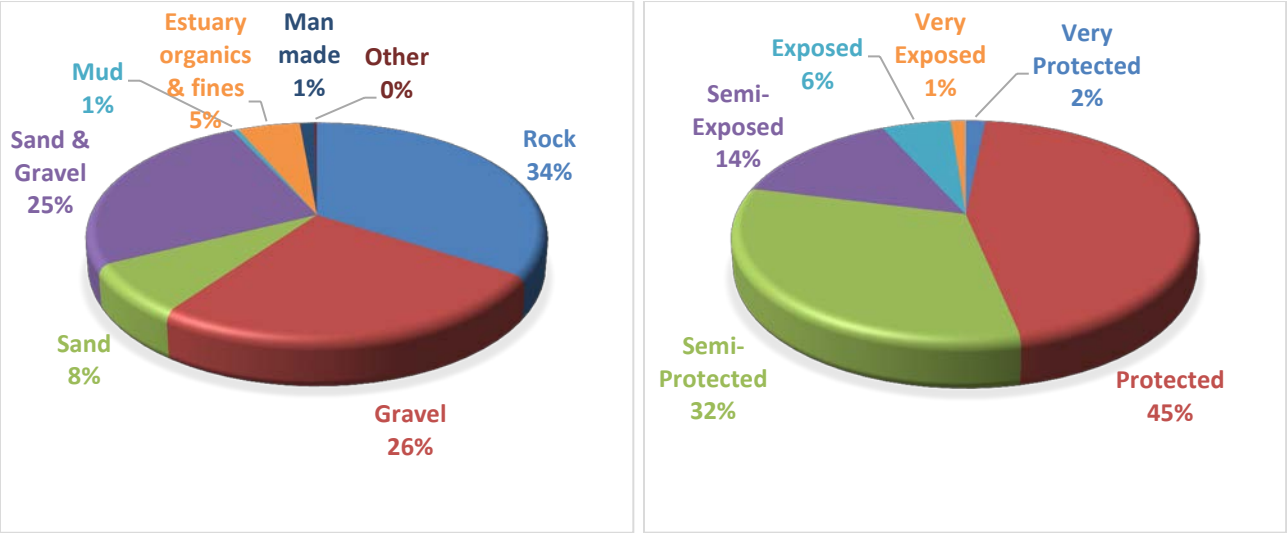


Figure 8: Intertidal substrates and exposure classes on the BC Coast[56]

[56] Statistics generated by Living Oceans Society based on BCMCA atlas data (BC ShoreZone data)

Shallow marine areas are defined from the mean high water mark extending seaward to the 20m 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. 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.

Due to the generally steep terrain of the PBHJV (BC), much of the coastline is relatively inaccessible from land. Nonetheless, coastlines and nearshore marine waters may be impacted by disturbance and spills from commercial and recreational boat traffic. Aquaculture, such as shellfish and finfish, has grown rapidly in recent decades and is extensive in some areas, such as Baynes Sound. Development and disturbance is concentrated near cities and towns, and can disproportionately affect rarer habitat types such as mudflats and beaches where recreational activity is often greater.

MUDFLATS IN A NEARSHORE MARINE ZONE

Waterfowl Habitat Trends and Drivers

The 2005 PCJV Strategic Plan and Biological Foundation[57] identified loss of habitat as the most important factor affecting bird populations in coastal British Columbia.

Trends in habitat availability and the major drivers underlying those trends are discussed further below. Much of this information is focused on Southwest BC, the Fraser River Delta in particular, as the greatest amount of information on historic trends is available in these areas, which also support the greatest numbers of wintering waterfowl and are under the most

[57] PCJV BC Steering Committee 2005

intense development pressure. Habitat trends elsewhere in the PBHJV are largely unknown. It is important for the PBHJV to fill these data gaps, as potential threats from pipelines and shipping developments on the central and north coast are on the increase.

CARGO SHIP AT NANAIMO RIVER ESTUARY WAITING TO LOAD UP IN VANCOUVER PORT (PHOTO K. BARRY)

Habitat Trends

Fraser River estuary habitat has declined 70% from its historic extent[58] and a 32% loss of tidal wetlands in estuaries was recorded along the east coast of Vancouver Island[59]. One study found that loss of estuarine marsh habitat was greater in large and intermediate estuarine systems in the Strait of Georgia (excluding the Fraser River estuary) and ranged from 13-93%, while in small ones the area has remained essentially

ESTUARINE DEVELOPMENT ON NORTH COAST

[58] Fraser River Estuary Steering Committee 1978
[59] Campbell-Prentice and Boyd 1988

static[60]. These losses were a result of continuing threats, including ecosystem conversion and degradation, diverted freshwater flows, marine sediment contamination, and invasive species introductions[61].

In the Metro Vancouver area, the majority of wetland loss, both freshwater and estuarine, occurred at the turn of the 20th century (Figure 9). Compared to historic levels, an estimated 85% reduction in freshwater wetlands, and a 51% reduction in deciduous/mixed forests associated with wetlands and streams occurred at this time. [62]. However, even between 1989 and 1999, 22% of freshwater wetlands (71 of 320) were at least partly converted to urban, agricultural, industrial, and/or transportation uses[63], although three quarters of those wetlands lost less than 15% of their area. A recent update to this study for the 1999-2009 time period showed continued loss of freshwater wetlands in terms of number. Importantly, one-third of all wetlands in the study area were affected to some degree by human encroachment over the 20-year study period [64]. Although outright loss of an entire wetland is less likely today, gradual encroachment continues and only compounds the effects of historic losses and compromises wetland function. Without a provincial wetland strategy, these losses will continue.

The limited remaining wetlands on Vancouver Island also continue to undergo ecosystem change through habitat loss and degradation. Along the east coast of Vancouver Island from the 1950s to 1980s, approximately 142 ha (2%) of freshwater wetlands were converted to rural, urban, logging, and agricultural uses[65].

[60] Levings and Thom 1994
[61] Austin *et al.* 2008, p 134
[62] Boyle *at al.* 1997
[63] Moore *at al.* 2004
[64] Major 2011
[65] Axys Environmental Consulting Ltd. 2005

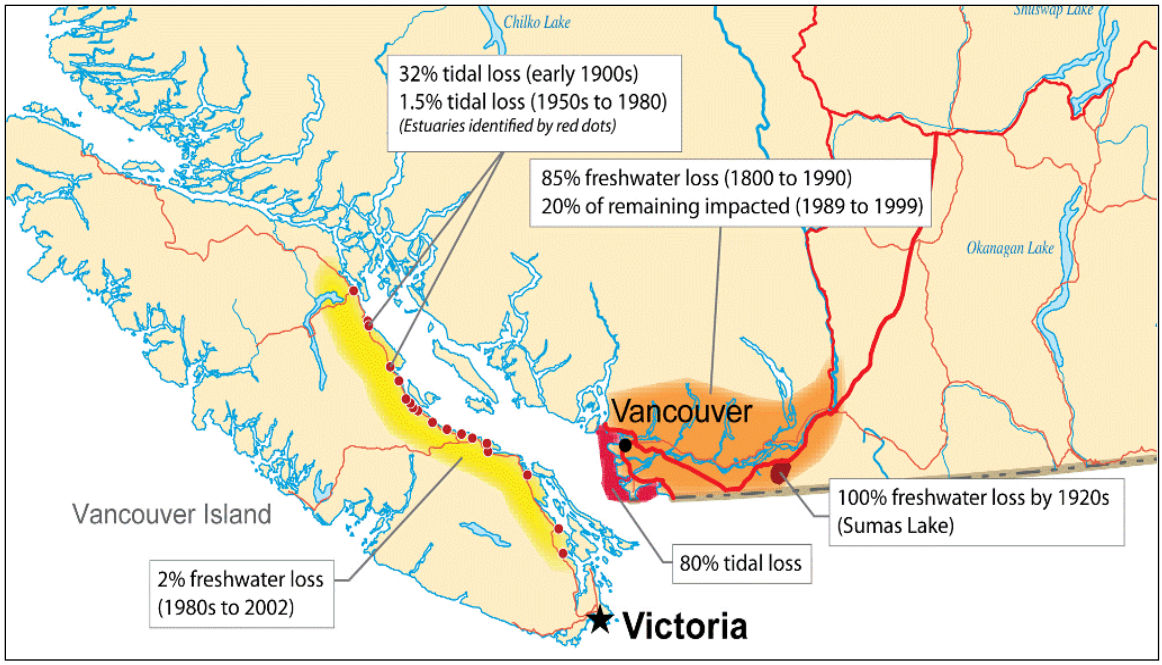
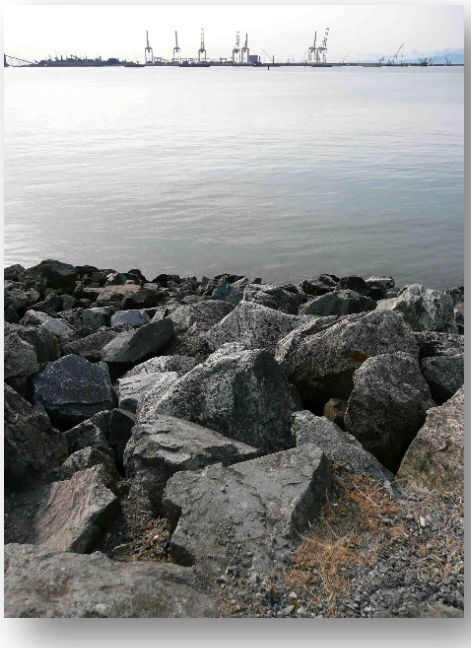


Figure 9: Locations of wetland loss since the early 1900's from various reports[66,67,68,69]



AN ARMOURED JETTY REPLACES ESTUARY AND SHORELINE

The loss of agricultural habitat has been similarly documented. At the time of European settlement (pre-1820), 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[70]. However, since then there has been a shift from low intensity crops, such as grains, corn and pasture, which have high waterfowl and shorebird forage values, to more intensive agricultural operations of berries, greenhouses, and nursery crops. These crops have virtually no forage values for waterfowl.

[66] Boyle *et al.* 1997
[67] Moore and Ward 2004
[68] Axys Environmental Consulting Ltd. 2005
[69] Major 2011
[70] Boyle *at al.* 1997

Direct loss of nearshore habitats has been of lesser magnitude, with some areas being affected by aquaculture installations, jetties, wharves, or similar infrastructure. Shellfish aquaculture has grown in recent decades in BC, and is now a significant contributor to BC's seafood industry. In 2011, 9,400 tonnes of shellfish (mainly oysters and clams) were harvested, making up 38.5% of the total shellfish harvest in BC, with a wholesale value of $31.8 million[71].

Main Drivers

- *Population growth and loss of agricultural land:* According to Metro Vancouver's census information, the human population in the Greater Vancouver area increased by 9.3% to 2.3 million between 2006 and 2011, an increase of 1.8% per year[72]. By 2040, the Greater Vancouver region is projected to support 3.4 million people. Population growth accelerates development for housing, infrastructure, and services, and these urban pressures can result in the direct loss of agricultural lands and 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 Greater Vancouver has decreased by 10%. Developers and lobbyists 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.

- *Changing agricultural & aquaculture practices:* Farming practices have changed as producers compete in new markets and struggle with high land prices. Traditional soil-based agriculture (e.g., vegetables, hay, grain) is beneficial to waterfowl and provides valuable habitat. Conversely, 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. For example, from 2006 to 2011, the area occupied by greenhouses in BC increased 4.2% and blueberries by 76.8%.[73] This loss of open farmland is particularly marked in the Fraser River Delta. Between 2000 and 2009, approximately 3000 hectares of waterfowl-compatible crops–over 20% of the available agricultural land–was converted to waterfowl-incompatible crops or lost as agricultural land entirely.This trend is expected to continue into the future[74]. This is a direct loss of habitat for birds and there are currently no regulations that would prevent further loss by this means.

  With Aquaculture, there is potential for shellfish aquaculture to impact sea ducks, as they typically share the same habitats; for example, 50% of all BC shellfish aquaculture occurs in Baynes Sound, which is also used by thousands of wintering scoters and other

[71] BC Ministry of Agriculture 2011
[72] Metro Vancouver 2011
[73] 2011 Census of Agriculture; http://www.statcan.gc.ca/pub/95-640-x/2012002/prov/59-eng.htm
[74] Ducks Unlimited Canada 2012

waterbirds. To date, shellfish aquaculture activities appear to be neutral[75] or even beneficial[76] to sea ducks, but impacts to other waterbirds remain unknown. More research and monitoring are required in this area.

- *Climate change:* 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[77]. There are several potential consequences, but it is believed that the one most relevant to waterfowl is sea level rise. Current estimates predict that globally, sea levels will rise by by 20-60 cm by 2100 under most climate change scenarios[78], but in the Fraser River Delta this will partially offset isostatic rebound, a process where land rises in response to the removal of glacial ice. Taking this into account, Thomson et al.[79] forecast a sea level rise of 19 cm (+/- 12 cm) by 2100, with associated consequences for intertidal habitats and wetlands.

  The Fraser River Delta is considered an area of high sensitivity[80] to sea level rise impacts, such as dike-breaching, flooding of salt marshes, salt intrusion in freshwater marshes, and increased shoreline erosion[81]. Intertidal marshes and mudflats may decrease in size as ecological zones try to migrate, but many are restricted by dikes and erosion protection measures. Kirwan and Murray[82] predicted that, under a moderate scenario of sea level rise, Westham Island would see a 15 to 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.

  Climate change has been ranked as one of the most widespread, and potentially impactful, threats to wetlands in the Lower Fraser Basin[83]. 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 [84].

- *Invasives:* 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

[75] Zydelis *et al.* 2006
[76] Zydelis *et al.* 2009
[77] Taylor 2004
[78] IPCC 2007
[79] Thompson *et al.* 2008
[80] Shaw *et al.* 1998
[81] Poulter *et al.* 2009
[82] Kirwan and Murray 2008
[83] Veridian Ecological Consulting 2004
[84] Wilson and Hebda 2008

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[85].

- *Disturbance:* This threat can increase the energy expenditures and nutritional requirements of waterfowl and other birds, with cumulative effects that may reduce populations. Disturbance may be direct from human activities, such as marine traffic or recreation, dog-walking and vehicles, when birds become stressed and are flushed and move away from their feeding or resting areas. Sources of disturbance are expected to increase as the human population continues to grow, and human access and use of beaches and nearshore areas increases. Disturbance impacts will likely be concentrated around human population centers although boat traffic can occur anywhere along the coast.

NOTICE FOR USERS OF THE PARKSVILLE QUALICUM BEACH WMA (PHOTO K. BARRY)

In the future, it will be increasingly important to provide areas where birds can find refuge from such disturbance by implementing wildlife protection regulations (e.g., prohibiting dogs off-leash) or timing restrictions for certain human activities.

Disturbance can also be indirect where certain types of land uses are avoided by waterfowl. Research supported by PBHJV partners showed that waterfowl will avoid areas of agricultural fields close to roads and residential housing[86]. Residential subdivisions cast a shadow where no wigeon graze within 200m, and roads resulted in no wigeon grazing within 30m. This equated to a loss of 6-9% of crop area for each waterfowl-compatible crop type (for wigeon), and reduced the amount of available nutrients. Indirect disturbance may be exacerbated by habitat fragmentation as more roads and developments occur. The smallest field size that waterfowl will use is unknown, so researchers cannot yet predict how farmland fragmentation reduces effective habitat quality.

[85] Patten and O'Casey 2007
[86] Middleton *et al.* 2011

- *Expanding populations:* 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 abundances can createa 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. Dawe *et al.*[87] 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.

SNOW GEESE FLYING OVER A TIDAL MARSH ON ROBERTS BANK

Carrying Capacity Forecast

The PBHJV relies on partner science to determine where it should focus its attentions. To evaluate forage, the TRUEMET energetic model was used to assess the carrying capacity of existing agricultural lands in the Fraser Delta for wintering waterfowl, and to forecast future carrying capacities under various habitat scenarios. These assessments were used to determine quantitative habitat objectives for agricultural land in the Delta. Five of the most abundant species were combined into two foraging guilds:

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

[87] Dawe *et al*. 2011

Sea ducks and Brant were excluded due to a lack of information about food energetics, and intertidal habitats were mostly excluded from energy supply calculations due to uncertainties about natural food sources.

Conditions were assessed in 2009 over the wintering period, and a variety of scenarios of future changes in habitat availability were tested, including future losses of agricultural or intertidal habitats. Model results indicated that grazers currently experience an excess of energy through the non-breeding season, but predicted a deficit by midwinter within 20 years (Figure 10). For dabblers, the demand currently exceeds supply by December, and the situation only worsens under future scenarios.

Dabbler energy supply drops 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, DUC believes that the model is generally correct in suggesting that dabblers are stressed by winter's end due to: i) documented depletion of some food sources, and ii) a similar modeling result in North Puget Sound.

To improve model performance, some assumptions must still be tested, particularly for the dabbler guild.As well, the PBHJV must improve its understanding of natural food sources and the energetic needs and habitat associations of sea ducks and Brant so that these species can be better accommodated by partner programs.

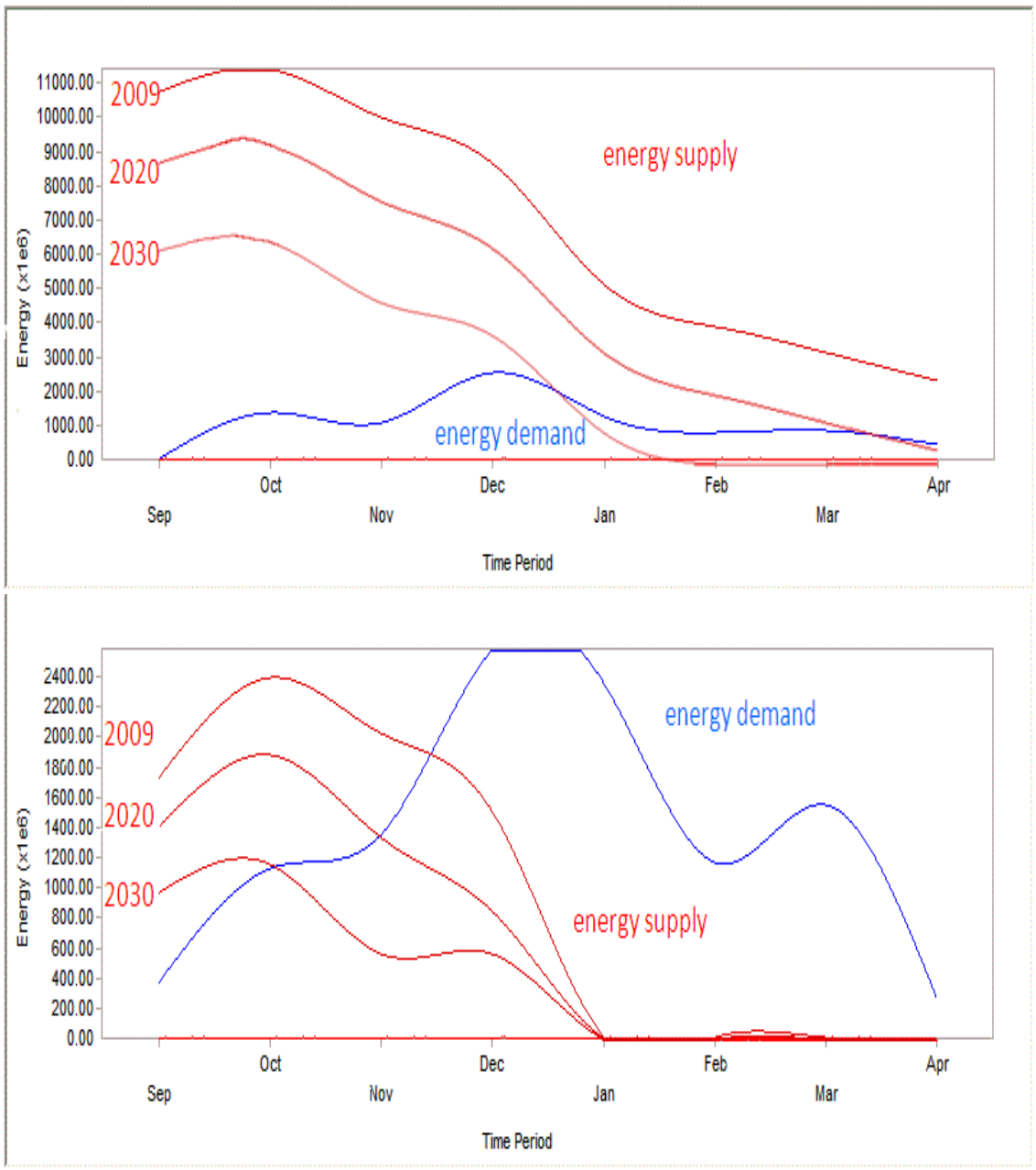


Figure 10: Energy state for grazer guild (top) and dabbler guild (bottom) under 2009 conditions and projected future energy supply scenarios (2020 and 2030)

Implications for Bird Populations

Under current conditions, TRUEMET indicated that the energetic demands of dabbler waterfowl on the Fraser River Delta significantly exceeds energetic supplies by midwinter. Grazers currently experience an excess of energy through the winter, but this is predicted to change to a deficit by midwinter within 20 years under most likely scenarios.

The situation for dabblers is somewhat supported by the FDNPS study, which found that about 50% of Northern Pintail moved to Puget Sound by midwinter, possibly due to depleted food sources in the Fraser River Delta. However, many dabblers remain in the Fraser River Delta throughout winter, and it is therefore apparent that information is lacking to model dabbler energetics sufficiently. Regardless, the model is generally correct in suggesting that dabblers are stressed by winter's end under current conditions. The FDNPS study indicated that potatoes were essentially depleted in the Fraser River Delta by March. This conclusion is supported in work done by DUI in the North Puget Sound, as their TRUEMET results suggested that dabbler foods were also mostly depleted by the end of the winter season.

While results of the TRUEMET model contain some inaccuracies, 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. As a result of JV partner activities, significant areas of farmland in the Fraser River Delta and on the east coast of Vancouver Island have been secured and will continue to produce waterfowl-compatible crops.

In addition to outright loss of beneficial crops, continued development adjacent to or within farmlands will fragment existing agricultural habitats and effectively exclude waterfowl from even more habitat. 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. This information will assist PBHJV partners in identifying high priority lands for conservation and actions for best practices or policy changes.

Ongoing incremental losses of freshwater wetlands and estuarine/intertidal habitats to development also limit the capacity of the area to support waterfowl, though to date we do not have the species-habitat models to forecast carrying capacities for habitats other than agricultural lands, or for waterfowl other than dabblers and grazers (e.g. Brant, sea ducks). Loss of habitat, be it via development, climate change, or increased disturbance, will also

undoubtedly have negative impacts on other non-waterfowl wetland and estuarine-dependent bird species.

Incentive programs and conservation land use agreements (e.g., cover crop and farm planning programs) can influence a large area, though on a shorter-term basis compared to land securement. Partners have also secured the remaining large wetland complexes in and near the Fraser River Delta (Burns Bog, Alaksen National Wildlife Area [NWA], Serpentine Fen Wildlife Management Area [WMA], Pitt-Addington WMA). With the establishment of Robert's Bank WMA in 2012,in conjunction with Boundary Bay and Sturgeon Banks WMAs and other partner conservation projects, protection of remaining intertidal habitats on the Fraser River Delta is nearly 100%. Partners have also made significant strides in securing agricultural land, estuaries, and shallow intertidal habitats on the east coast of Vancouver Island. It is imperative that this work continue.

Assessing the Conservation Estate

The high biological value and increasing vulnerability of the PBHJV has long been recognized. Many organizations, working alone and in partnerships, have invested significant resources and energies in conservation efforts in the region. 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 communication and outreach programs.

Conservation Areas Database

To track and coordinate their land securement efforts, PBHJV partners, in coordination with the Canadian Intermountain Joint Venture, have developed a province-wide database consisting of spatial boundaries and attributes to complement existing datasets for provincial and federal parks and protected areas. This BC nongovernment organization Conservation Areas Database (CAD) improves the precision and accuracy of tracking conservation lands and improves the efficiency of data management. In British Columbia, there is now a more comprehensive picture of the conservation estate at a fine scale.

The conservation estate (Table 8) includes lands from nongovernment organizations (for full list, see Appendix 5), National Wildlife Areas, provincial protected areas (e.g., Provincial Parks, Conservancies, Wildlife Management Areas), and National Parks. There are still a few minor gaps to address, including regional and municipal parks with a primary objective of conservation, marine protected areas, habitat compensation areas, and First Nations lands set aside for conservation. Because the boundaries have been mapped at a fine scale (cadastral), this allows for very detailed habitat inventories. This often involves assessing collaborative land management activities on adjacent properties owned by different organizations, identifying

property encroachment violations, and developing accurate summaries of the entire conservation estate by designation type or by owner.

Conservation areas were mapped and described at a very fine scale (cadastral, e.g. Figure 11), and the CAD was web-enabled in 2009. The team has also mapped habitat types within these conservation lands, as shown in Table 9. The total area in the PBHJV (BC) set aside for conservation purposes is nearly 4.2 million hectares; this equates to 18.4% of the land (3.7 million ha) and 1.0% of the ocean (0.5 million ha). The largest portion is in various provincial protected designations such as Conservancies and Provincial Parks. National Parks, provincial Ecological Reserves, provincial Protected Areas, and provincial Wildlife Management Areas are also significant components of the total conservation area. The remaining area consists of NGO-protected lands (which consist of numerous small properties protecting some very significant features), National Wildlife Areas, and various other lands under provincial administration and managed for conservation purposes.

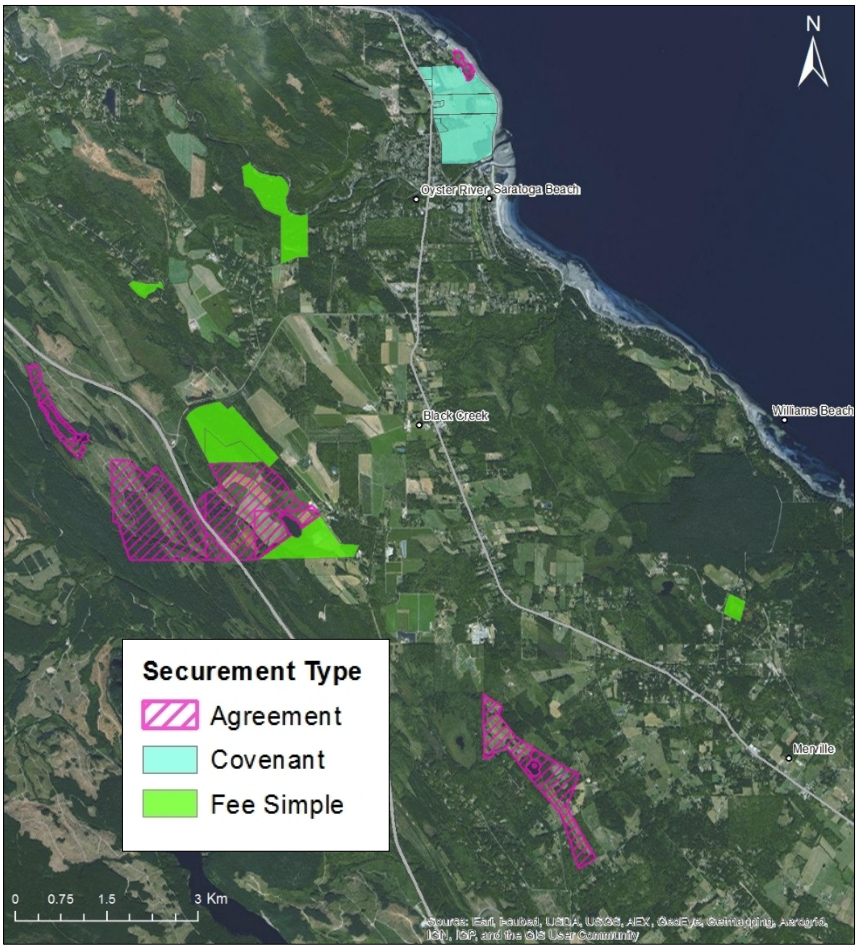


Figure 11: Example of CAD on Vancouver Island

Table 8: Conservation lands in PBHJV by Planning Area (up to November 2014)

Tenure[1]	Entire PBHJV		PBHJV Planning Area				
			Southwestern BC	Northern & Western Vancouver Isl.	Northern & Central Mainland	Queen Charlotte Islands	Pacific Offshore
	Area Conserved (ha)	*% Landbase Protected*	*Area Conserved (ha)*				
Federal							
National Parks	201,365	0.32	5,245	49,997	115	146,008	-
National Wildlife Areas	739	0.00	739	-	-	-	-
Provincial							
Provincial Parks	1,481,124	2.39	610,624	273,196	528,150	69,154	-
Ecological Reserves	85,670	0.14	6,651	38,861	29,076	10,712	370
Protected Areas	43,867	0.07	878	4,071	38,918	-	-
Conservancies	2,311,674	3.73	41,371	-	1,837,217	427,426	5,659
WMAs	37,755	0.06	35,894	1,692	170	-	-
Other conservation lands	4,541	0.01	3,308	12	1,168	53	-
NGOs							
Fee simple acquisition	8,425	0.01	6,749	170	1,537	84	-
Conservation encumbrance[2]	5,854	0.01	6,881	41	26	-	-
Conservation land use agreement[3]	6,119	0.01	5,575	-	108	1,043	-
Total[4]	**4,183,235**	6.75	***(18.4 % of the total land area, 1.0% of the total marine area)***				

[1] Federal and provincial totals are as of February 2014, and the NGO land values are as of November 30 2014. Full details are in Appendix 5.
[2] The boundaries of some conservation encumbrances (covenants) have not yet been quality controlled by their securement agencies.
[3] Values were sourced directly from DUC.
[4] As there can be more than one type of protection or more than one interest in a given area, summing the area of all conservation tenures leads to an overestimation of the secured areas. The total area reported removes the overestimation (overlap) and reflects the true conservation area.

Table 9: Area of cover types within conservation lands in PBHJV (up to March 2014)

Cover Type [1]	Total Area (ha)	Area Conserved [2] (ha)	Area Conserved (%)
Water	14,845,613	553,508	3.7%
Coniferous Forest	9,950,262	1,830,455	18.4%
Ice/Snow	2,683,979	414,374	15.4%
Shrubs / Sparse Trees	1,706,977	340,439	19.9%
Alpine [3]	1,488,052	343,836	23.1%
Barren Land	889,759	166,603	18.7%
Broadleaf	861,698	130,388	15.1%
Herbs	470,867	48,911	10.4%
Rock/Rubble	324,728	75,225	23.2%
Mixedwood	293,274	55,135	18.8%
Wetlands / Lakes [4]	240,663	64,900	27.0%
Urban	131,931	520	0.4%
Agriculture [3]	117,457	3,027	2.6%
Estuarine Intertidal [5]	74,585	33,601	45.1%
Grassland [3]	1,313	128	9.7%
No Data (Marine)	27,936,854	128,251	0.5%
Grand Total	**62,018,013**	**4,183,235** [6]	**6.8%**

[1] Data for most cover types is from the EOSDmod dataset, and is current as of 2000. The forest classes were retained as-is, while several of the non-forest classes were augmented with other datasets.
[2] Derived from the BC NGO Conservation Areas Database (current to Dec 2013).
[3] Identified using BC Government 1:250,000 Baseline Thematic Mapping (BTM).
[4] Derived from the BC Government 1:20,000 Corporate Watershed Base (CWB).
[5] Derived from mapping conducted by the Pacific Estuary Conservation Program (PECP).
[6] As there can be more than one type of protection or more than one interest in a given area, summing the area of all conservation tenures leads to an overestimation of the secured areas. The total area reported removes the overestimation (overlap) and reflects the true conservation area.

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 (acquisitions, encumbrances and land use agreements). For the NGO lands, for example, approximately 20% were secured prior to NAWMP in 1986, 10% was secured between 1986 and 1991, when the PBHJV was established, and 70% was secured between 1991 and 2014.

MULTIPLE PARTNERS INVOLVED IN A RESTORATION PROJECT AT NANAIMO RIVER ESTUARY (PHOTO K. BARRY)

Decision Support Tools

PBHJV partners use several decision support tools (Table 10) to direct management actions and address the limiting factors affecting waterfowl and other wildlife species. Some tools have been developed by an individual organization and shared with the partners, while other tools have been developed cooperatively.

Table 10: Decision Support Tools currently or soon to be available for the PBHJV (BC)

Decision Tool	Purpose
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.
PBHJV Strategic Plan Target Areas	Identifies geographical target areas for conservation attention in each Planning Unit.
PECP Estuary Ranking	Prioritizes estuaries for securement of waterfowl foraging habitat (agricultural and tidal habitat).
NCC Conservation Planning System	A three phase conservation planning system used by NCC to identify the highest-priority areas for conservation and to guide conservation actions.

CWS Coastal Lowlands Regional Conservation Plan	Identifies and prioritizes areas for conservation, based on a combination of the best available habitat and wildlife data, with a focus on migratory birds, species at risk, and federal lands.
PBHJV Sea Duck Models (in progress)	Will identify shallow marine and estuarine areas of high sea duck use to target conservation action.
CWS 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.
CWS Pelagic Seabird Model (in progress)	Will identify areas of high seabird use, based on remotely sensed variables.
Bird Studies Canada Coastal Waterbird Abundance Mapping	Identifies coastal areas with high winter use by waterfowl and other waterbirds.
Provincial Conservation Framework	Developed by the BC Ministry of Environment to rank species and ecosystems under three broad conservation goals, for optimal allocation of conservation resources.
Other Tools: • BC Marine Planning Partnership (MaPP) Planning Portal • BC Marine Conservation Analysis • Living Oceans Society Maps • BC Parks Shoreline Sensitivity Model	Used to identify and overlay a wide variety of marine (human) uses, values, and ecological indicators.

DUC 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 (Figure 12). Within the PBHJV, the highest priority is the Fraser Delta, followed by the east coast Vancouver Island. For each Priority Area, DUC has prepared comprehensive landscape plans to identify habitat threats, set habitat objectives, and outline a conservation program for meeting objectives[88,89].

[88] Ducks Unlimited Canada 2004
[89] Ducks Unlimited Canada 2012

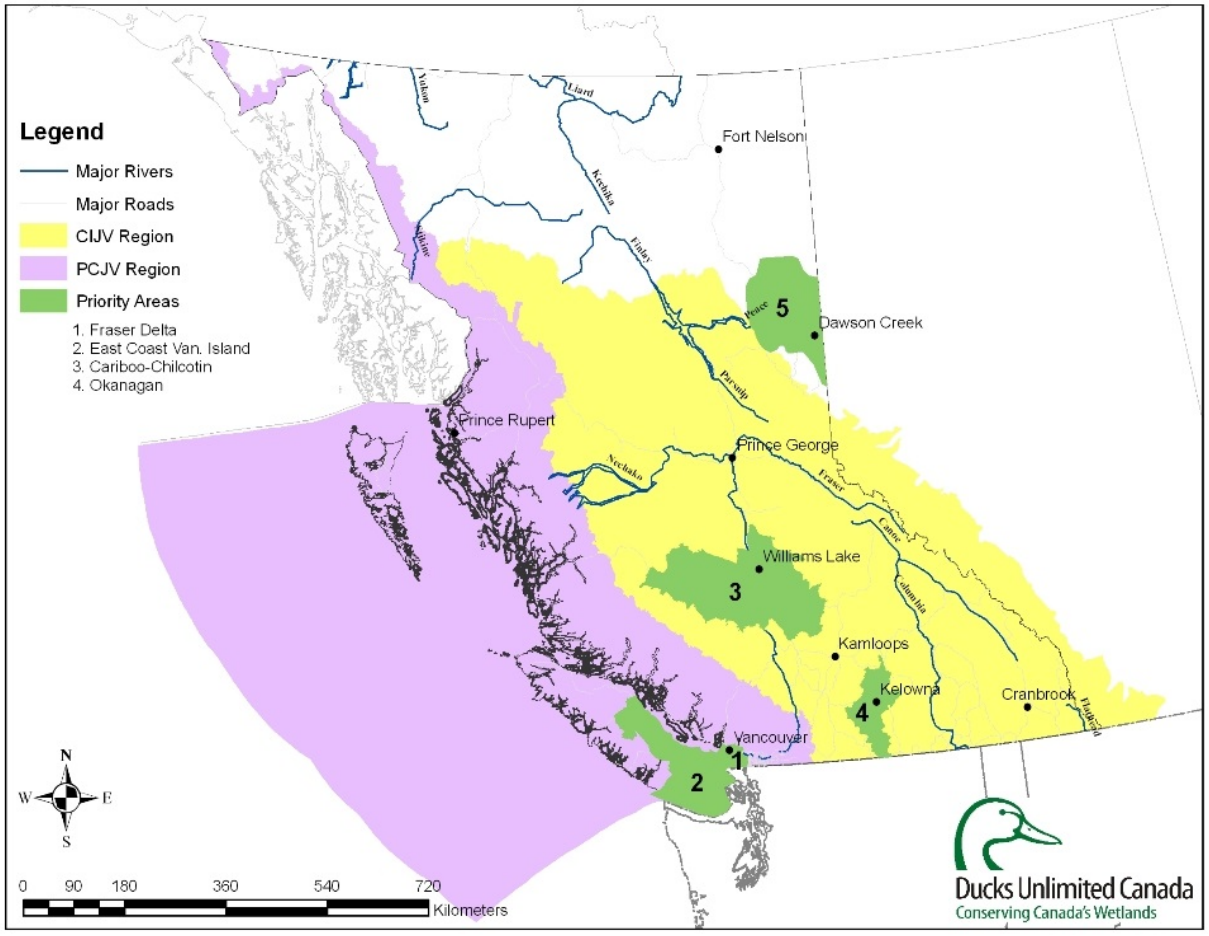


Figure 12: DUC Waterfowl Priority Areas in BC

PBHJV Strategic Plan Target Areas

A number of general target areas (Figure 13) were identified in the 2005 PCJV (BC) Strategic Plan. Further population monitoring work will be required to generate spatial boundaries for the targets. Many of these overlap with locations identified by the Canadian Important Bird Areas Program[90].

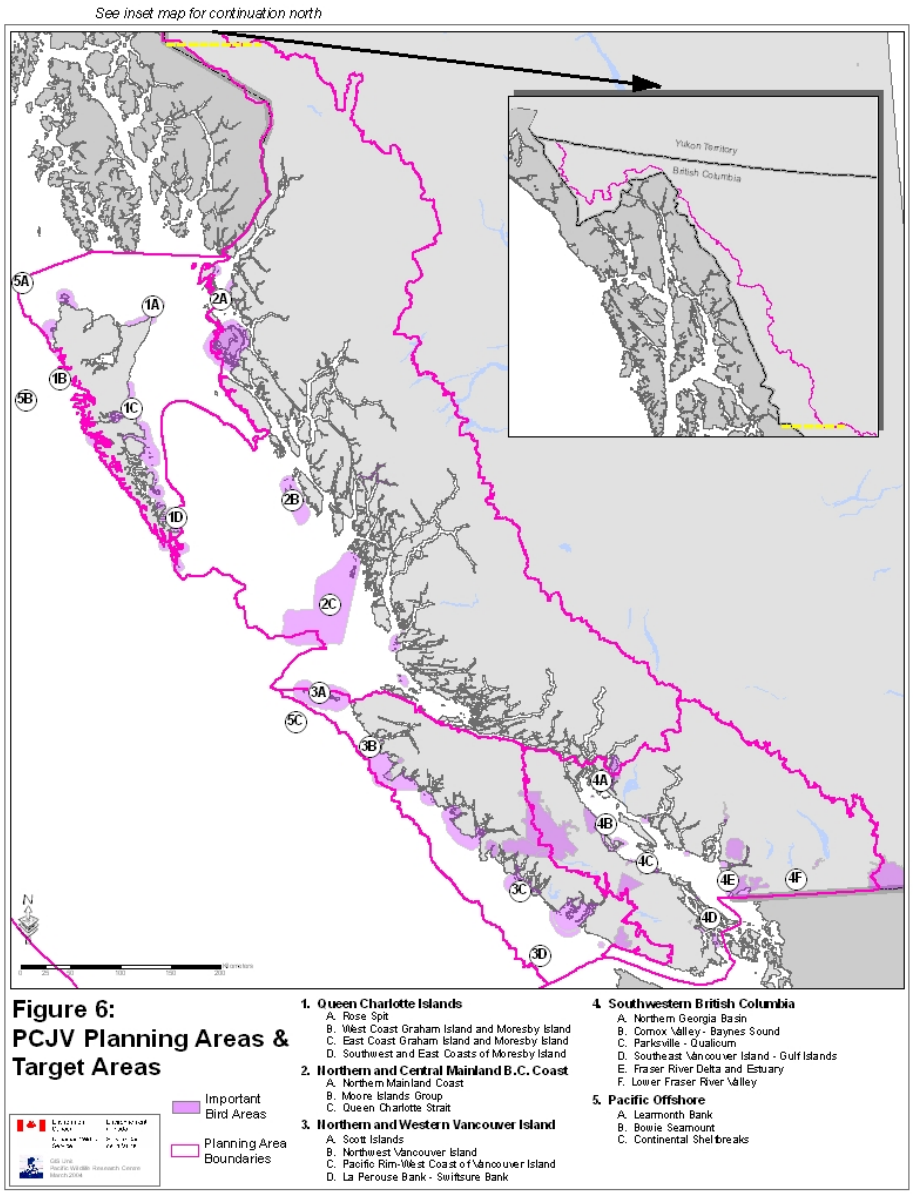


Figure 13: PCJV 2005 Strategic Plan target areas (numbered) by Planning Area

[90] http://www.ibacanada.ca/

PECP Estuary Ranking Project

This project identified and mapped 442 of B.C.'s estuaries using standardized criteria and Geographic Information System (GIS) tools. The project provided a quantifiable regional overview of estuary habitats that links existing biophysical data and attributes to assist conservation planning.

In the first iteration (2007), individual estuaries were ranked for their biological importance to waterbirds (ducks, geese, swans, loons, and grebes) using data and metrics of estuary size, herring spawn occurrence, intertidal biodiversity, habitat rarity, and waterbird use. In the second iteration (2014), estuaries were ranked using a slightly different formula which included mean fish escapement and excluded habitat rarity. Herring spawn and waterbird inventory data sources were also updated and reanalyzed.

Each of the 442 estuaries was placed in one of five Importance Classes (Figure 14) where Importance Class 1 contains the highest ranked estuaries with relative rankings of 80-100% of the maximum scoring estuary. The lower mainland, the east coast of Vancouver Island, and the northwest coast of Vancouver Island have estuaries ranked in the top two classes, while other top ranking estuaries are distributed across the central coast and Haida Gwaii.

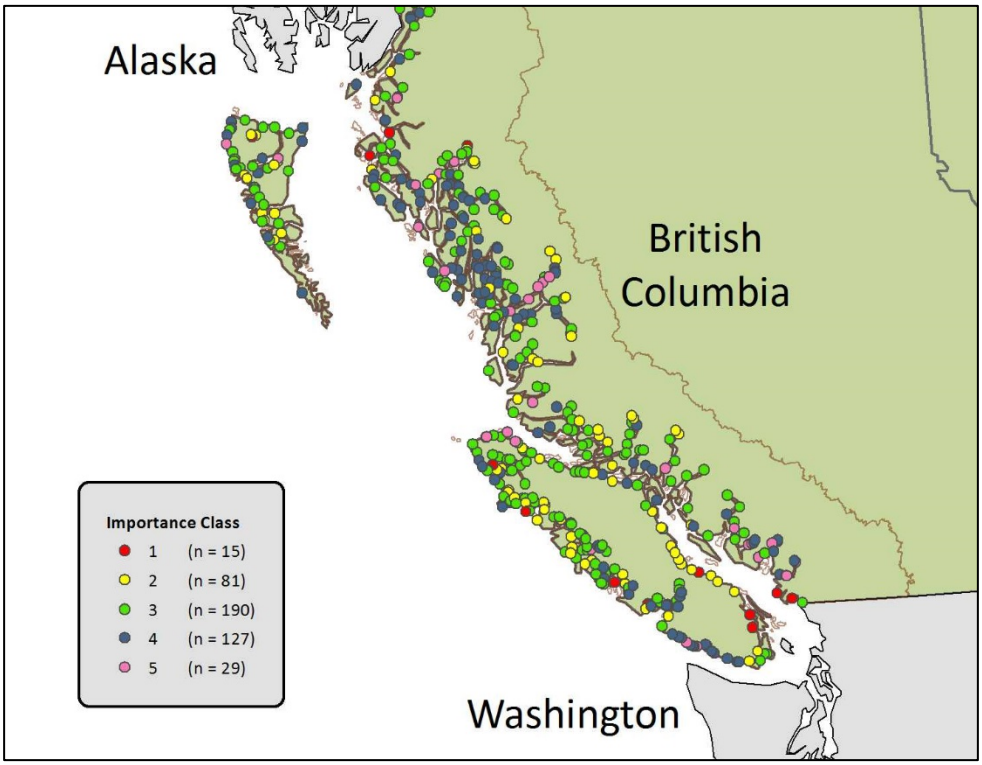


Figure 14: Results of the estuary ranking project (2014 version)

Nature Conservancy of Canada Conservation Planning System

NCC's conservation planning has a long history, from adopting a systematic Conservation Framework based on adaptive management principles in 2002, the development of Ecoregional Assessments in 2005, the 2007 development of Natural Area Conservation Plans, and the adoption of International Union for Conservation of Nature (IUCN) classifications in 2009. In 2011, NCC developed the Land Information System (LIS).

Guided by the best available conservation science, NCC seeks to protect areas of natural diversity for their intrinsic value and for the benefit of future generations. Work is focused on specific landscapes throughout Canada that have been identified as important for biodiversity conservation, 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*[91]. One of the outcomes is a spatial matrix of biodiversity value versus threats/urgency for conservation action. Ecoregional plans cross political boundaries, and are now in place for the whole of the PBHJV.

The result of the ERA is the identification of specific focal areas, known as Natural Areas. NCC developed Natural Area Conservation Planning in 2007; the process for developing Natural Area Conservation Plans (NACPs) was updated in 2014. A NACP is a 10-year conservation plan that guides conservation implementation and supports decision making at inception and throughout the implementation period, so that limited conservation resources are used most efficiently. Through these plans, NCC identifies desired conservation results, then develops, prioritizes, and implements activities that will lead to these results, tracks their progress, and adapts based on what was learned. The scope of each plan encompasses the long-term conservation of all biodiversity in each Natural Area. Conservation planning requires recognition of the shifting nature of landscapes and our knowlegde of them. NCC staff members and partners try to view the planning process as iterative and ongoing, rather than a once-a-decade exercise. At the Natural Area scale, conservation actions are selected and implememented based on priority. Actions may include securement, stewardship, education, communication, and policy development. At least 80% of NCC's conservation is delivered within a Natural Area. NCC has three Natural Areas within the PBHJV:1) the Salish Sea, 2) Central Coast Rainforest, and 3) Haida Gwaii (Figure 15).

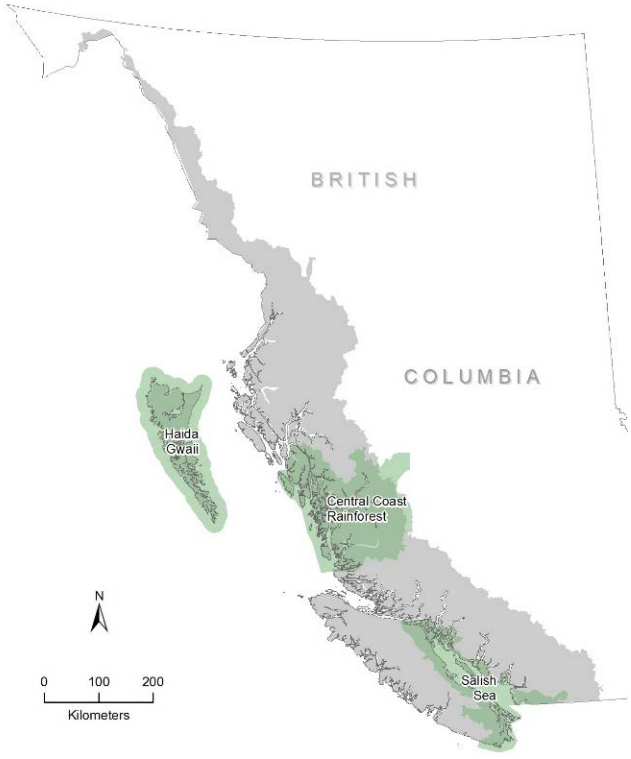


Figure 15: NCC's 'Natural Areas' in the PBHJV

NCC's most significant conservation action is the acquisition of key properties that capture conservation (biodiversity) targets and help

[91] Groves et al 2000

alleviate defined threats (e.g., acquisition of lakefront wetlands to remove the threat of inappropriate residential or agricultural development). Examples within the PBHJV include the James Island and Ocean Blue projects. For each property secured, NCC creates a Management Plan that links goals, a smaller set of targets (usually a subset of the NACP targets), threat analysis, 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 IUCN, and 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.

Canadian Wildlife Service Coastal Lowlands Regional Conservation Plan

In 2014, CWS developed a regional plan for the BC Coastal Lowlands region to identify conservation priorities in the area. The plan focuses on federal responsibilities, namely migratory birds and species at risk. Priority lands have been identified through a combination of habitat and wildlife ratings. Habitat ratings have been developed from an integrated land cover dataset which presents the best-available habitat data. Wildlife data was amalgamated from a variety of data sources, such as the BC Breeding Bird Atlas, Coastal Waterbird Survey, eBird data, and identified critical habitats for species at risk. The plan ranks Priority Areas for conservation within the plan boundaries, and the next steps are to identify initial actions for top-priority locations. The plan focuses on federally owned or administered lands, but also addresses provincial Crown and private lands.

CONDUCTING SURVEYS FOR THE BC BREEDING BIRD ATLAS AT A REMOTE FRESHWATER WETLAND (PHOTO E. DEMERS)

PBHJV Sea Duck Models

The sea duck models currently under development by JV partners use the provincial ShoreZone dataset and Bird Studies Canada's Coastal Waterbird Survey data to investigate relationships between coastal habitat and sea duck abundance to predict habitat use of sea ducks and other waterbirds along the BC coast. Four explanatory models have been developed thus far, and models for another six sea duck species are underway. Work is continuing to express the models spatially in a GIS, with the eventual goal of using them to help identify areas associated with large numbers of birds, which can then be prioritized for conservation action. The PBHJV has approached the Sea Duck Joint Venture about future collaboration on this model.

BLACK SCOTER (L) AND LONG-TAILED DUCK (R), TWO OF THE SPECIES TO BE MODELED

CWS Bird Studies Canada Coastal Waterbird Distribution Models

These models were used to identify over 150 sites having high species richness and site uniqueness (Figure 16). Another 250 sites were identified through a combined diversity index which considered both richness and uniqueness.

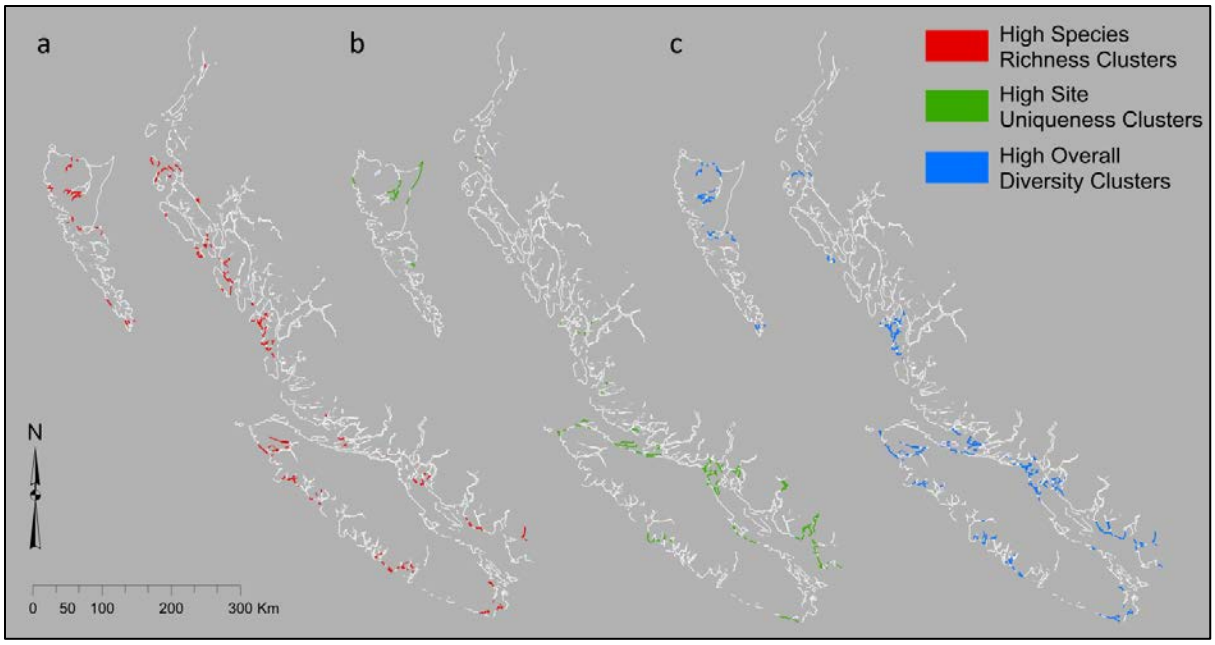


Figure 16: Maps of high clusters of species richness (a), site uniqueness (b), and overall diversity (c), from Rickbeil et al 2014

Canadian Wildlife Service Pelagic Seabird Model

CWS, in conjunction with the University of Victoria, is developing a pelagic seabird model to predict occurrence in non-surveyed marine areas. Because seabirds are highly variable in space and time, and surveys are often conducted opportunistically, accurate models that can predict distributions or abundances based on habitat variables (such as season, ocean topography, sea surface temperature, distance to land or breeding colonies, etc.) are required to fill in survey gaps and identify geographic areas of importance. CWS is currently developing various forms of decision tree machine-learning algorithms to model distributions of seabirds based on at-sea data.

Bird Studies Canada Coastal Waterbird Survey Abundance Mapping

The BC Coastal Waterbird Survey (BCCWS) is a long-term monitoring program involving mainly volunteer-collected data during the winter months. BCCWS data has been used to identify areas with high winter use by waterfowl (e.g., Figure 17) and other waterbirds, and highlight differences in the spatial distributions of various bird groups/guilds particularly in non-estuarine areas.

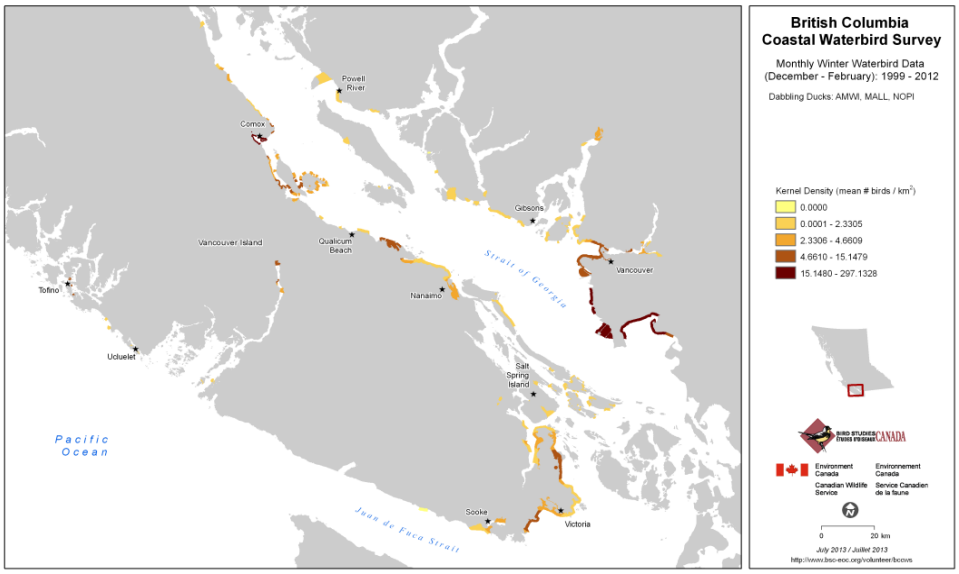


Figure 17: Mean waterfowl density in Southwestern BC Planning area during BC Coastal Waterbird Surveys (1999-2012), for select PBHJV priority dabbling ducks

Provincial Conservation Framework

The Conservation Framework (CF), developed by the BC Ministry of Environment, is a series of decision-support tools that prioritize species and ecosystems for conservation, with the overarching aim of improving collaboration and optimizing the allocation of resources for conservation activities within the province.

In the CF, species and ecosystems are ranked under three overarching conservation goals:

- Goal 1: To contribute to global efforts for species and ecosystem conservation
- Goal 2: To prevent species and ecosystems from becoming at risk
- Goal 3: To maintain the full diversity of native species and ecosystems

Species and ecosystems are ranked based on global and regional risk status, trends, threats, feasibility of recovery, and stewardship responsibility. Rankings are updated as new information becomes available.

Other Tools

1. The Marine Planning Partnership for the North Pacific Coast (MaPP), a partnership between the Province and 18 First Nations formalized in 2011, has produced a marine planning portal[92] which allows users to overlay many different data layers, including administrative boundaries, species, habitats, and marine uses. The partnership has also used the portal to create draft zones with different recommended activity themes (e.g., economic, recreational/tourism) for North Vancouver Island, and to run a Marxan analysis to identify potential conservation target areas.

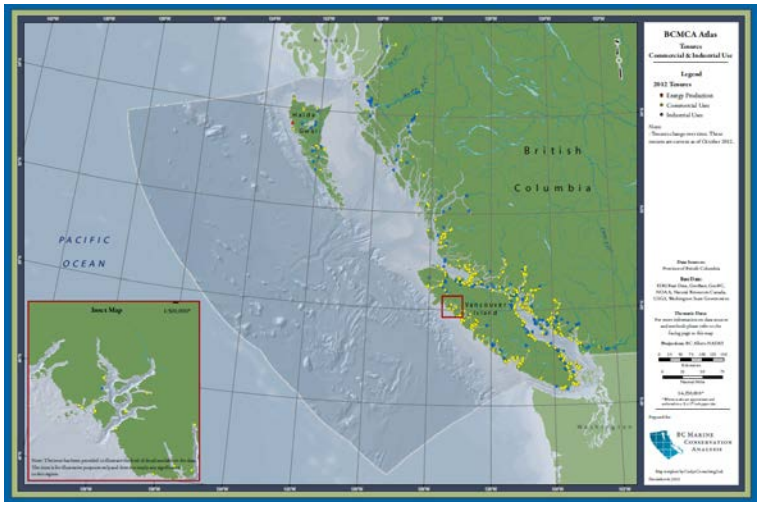


Figure 18: Commercial and industrial tenures on the BC Coast, BC Marine Conservation Analysis

2. The BC Marine Conservation Analysis (BCMCA) project[93] (2006-2013) provides resource managers and decision-makers with resources to inform marine planning and management initiatives. It was comprised of representatives from various government

[92] http://mappocean.org/science-and-planning-tools/marine-planning-portal/
[93] http://bcmca.ca/

agencies, nongovernment organizations, academia, and industries with an interest in marine planning or use of ocean resources. The project produced a series of maps depicting ecological resources and human uses such as commercial and industrial tenures (Figure 18). The BCMCA also developed an interactive online atlas which allows public users to overlay over 300 maps of various marine features.

3. One of the major contributors to the BC Marine Conservation Analysis, the Living Oceans Society[94], has created their own series of maps depicting such features as marine bird diversity (Figure 19) and areas of high conservation value.

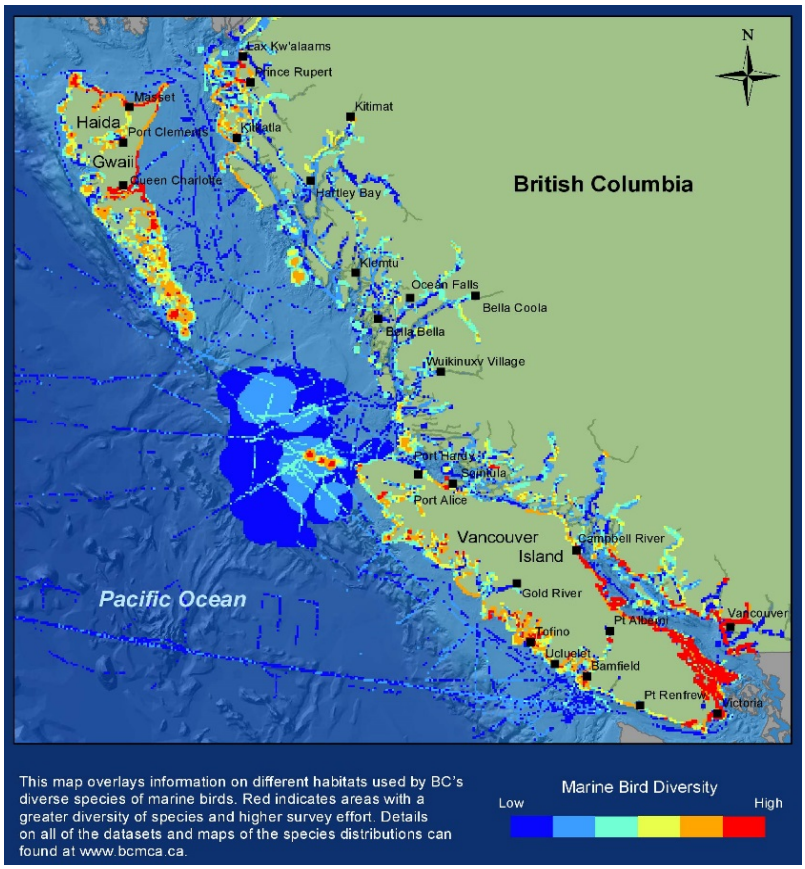


Figure 19: Living Oceans Society projection of marine bird diversity on the BC Coast, May 2013

4. At the provincial level, the BC Ministry of Environment (or BC Parks?)has developed a Shoreline Sensitivity Model (Figure 20), which independently rates marine and terrestrial coastline segments according to their sensitivity to sea level rise, then spatially builds a

[94] http://www.livingoceans.org/maps

map of relative shoreline sensitivity using the provincial Broad Ecosystem Inventory and ShoreZone datasets.

Figure 20: BC Parks Shoreline Sensitivity Model in the Denman Island Area of Vancouver Island

Habitat Goals and Objectives

In 1993, the PCJV Strategic Plan[95] developed 5-year habitat securement and stewardship objectives based on previous work[96] which used 1970s Canada Land Inventory mapping, ground surveys, and expert knowledge to estimate wetland areas capable of maintaining waterfowl

[95] PCJV Strategic Plan 1993
[96] BC Waterfowl Technical Committee 1989

numbers at about 70% of 1970s levels without enhancement. It was assumed that the remaining 30% of the population could be supported on non-critical, non-threatened wetlands.

Subsequently, in 2003 the PBHJV Science and Technical Committee reviewed the 1993 goals and conducted additional analysis, to update habitat objectives[97] to account for sea ducks and include some restoration activities. Estimates were not linked through models to population objectives. Rather, they were developed using conceptual models and relative ranking of habitat types. See Appendix 6 for a breakdown of habitat objectives by PBHJV Planning Area.

FRESHWATER LAKE HABITAT ON VANCOUVER ISLAND (PHOTO K. BARRY)

In 2014, PBHJV updated its habitat objectives to guide conservation actions (Tables 11, 12). Similar to the objectives set out in 1993 and 2003, these objectives are based on inventories of available habitats, although inventory data have improved and our approaches have become more inclusive, leading to dramatic increases in freshwater wetland objectives, for example. In both prior iterations, programs were broadly defined under the goals of securement, stewardship, and restoration. Habitat programs described in this IP use newer terminology involving Initiatives and Initiative Programs[98], but for clarity the former terms will be used in this section to describe broad goal categories.

[97] PCJV (BC) Technical Committee 2003

[98] Securement corresponds to the Habitat Retention – Permanent and Habitat Retention – Medium-term Initiatives.
Stewardship corresponds to the Habitat Retention – Short-term Initiative.
Restoration corresponds to the Wetland Restoration and Upland Restoration Initiatives.

In the next five years, these habitat objectives will be reviewed and refined using various species-habitat or energetics models that explicitly identify how much habitat (and of what type) is required to maintain a desired waterfowl population level. Currently, several such models are in development (see Habitat-Species Relationships, page 25, and Decision Support Tools, page 57). One model, the TRUEMET energetics model for agricultural land in the Fraser River Delta, is already complete (see page 25). Table 12 presents the 2014 objectives in more detail, and outlines the approaches that were taken to refine them for this iteration.

Table 11: Historic (1993 and 2003) and current (2014) PBHJV habitat objectives. Refer to Table 12 for more details on approaches taken to generate 2014 objectives.

Habitat Type	Habitat Objectives (ha)								
	1993			2003[1]			2014		
	Secur	Stewd	Restor	Secue	Stewd	Restor[2]	Secur	Stewd	Restor
Agricultural Land	1,800	26,700	-	4,100	138,780	2,050	3,120	1,640[3]	1,980
Freshwater Wetland	500	-	-	8,076	47,045	4,038	249,450[4]		24,945[5]
Estuarine	53,500	-	-	72,934	-	36,467	74,585[6]		7,460[5]
Shallow Marine	-	-	-	73,000	-	-	155,500[7]		-
Totals	**55,800**	**26,700**	**26,710[8]**	**158,110**	**185.825**	**42,555**	**484,310**		**34,385**

[1] Similar methodologies were used in 2003 as 1993. Increases in area over that timeframe are primarily attributable to improved mapping and increased knowledge of the habitat inventory in BC.
[2] Restoration objectives were set equal to 50% of the securement objective.
[3] Objective was reduced from 2003 based on a more targeted approach for specific field types based on results from energetics model. It includes only one Waterfowl Priority Area at present.
[4] Objective was increased significantly from 2003 based on an improved wetland inventory and a more inclusive approach (e.g., wetlands were not screened for inclusion based on topography and distance from coastline).
[5] Restoration objective were set equal to 10% of the securement objective, based on recent partner experience with restoration projects.
[6] From the PECP technical report (CWS tech report #476) published in 2007.
[7] Objective was increased from 2003 based on an improved habitat (herring spawn area) inventory.
[8] Objective was not broken down by habitat type.

Objectives for each Habitat Type:

Agricultural lands*:* Objectives for agricultural lands were developed for two waterfowl Priority Areas within Southwest BC: the Fraser River Delta and the east coast of Vancouver Island. For the Fraser River Delta, a final habitat objective was developed using the TRUEMET energetics model to calculate how much agricultural land (a combination of potatoes, grain, and pasture/hayfield) would be required to supply 50% of the energy needs of current populations

of dabblers and grazers[99]. For the east coast of Vancouver Island, habitat inventory data was used to set an objective, primarily based on the availability of productive agricultural land within 1 km of the coastline[100]. Migrating/wintering waterfowl use of agricultural lands in other Planning Units is considered negligible, therefore no habitat objective was developed for agricultural lands outside Southwest BC. Agricultural objectives will be met via a combination of securement and stewardship activities. Securement will occur through a combination of fee simple acquisition, conservation encumbrances (covenants), and medium- to long-term conservation land-use agreements. Stewardship activities include agriculture policy actions, incentive programs, short-term land-use agreements, best management plan (BMP) implementation, and other extension/outreach activities.

MALLARDS ON A HARVESTED FIELD, ALAKSEN NATIONAL WILDLIFE AREA (PHOTO: AMY THEDE)

[99] Ducks Unlimited Canada 2012
[100] Ducks Unlimited Canada 2004

Table 12: 2014 PBHJV habitat objectives, including remaining areas to be secured, and approaches taken to update past objectives

Habitat Type / Priority Area		Habitat Objectives (ha)			Already Secured[1]		Still to Secure	Update/Refinement Methods		
		Secur	Stewd	Restor	Area (ha)	% of objective	Area (ha)	Model/Approach	Status	Lead Partner
Agricultural Land (SWBC only)	Fraser River Delta	920	1,640	380	560	61%	360	**TRUEMET Energetic Model:** Used crop energy supply and waterfowl energy demand to identify the amount of farmland needed in waterfowl friendly crops to sustain current populations.	Complete	DUC
	ECVI	2,200[2]		1,600	789	36%	1,411	**Habitat Inventory:** From DUC's 2004 Landscape Plan. Calculated based on availability + distance to estuary + slope + soil fertility.	Complete but needs updating	DUC
Freshwater Wetland		249,450[2]		24,945	61,781	25%	187,699	**Habitat Inventory:** Calculated based on BC Freshwater Atlas and SEI mapping, then applied a temperature cutoff (minus 1 deg Celsius).	Complete	DUC/EC
Estuarine		74,585[2]		7,460	33,601	45%	40,984	**Estuary Ranking Model:** Mapped and ranked key estuaries using five data sources (size, waterbird presence, herring spawn, salmon escapement, species rarity). Currently all estuaries are included in securement objective.	Complete	DUC/EC
								Sea Duck Model: Working to identify all coastline areas important to sea ducks, to improve prioritization of where to act.	Partially complete	DUC/EC
								Sea Level Rise Model: Will identify impacts of various sea level rise scenarios on estuarine habitats, to improve prioritization of where to act.	Early stages	DUC/EC
Shallow Marine		155,500[2]		-	18,100	12%	137,400	**Herring Spawn Data:** Used updated information from DFO to identify the most important sites (e.g. "major" or "vital" events), then applied at 2 km buffer.	Complete	DUC/EC
								Sea Duck Model: Working to identify all coastline areas important to sea ducks to improve prioritization of where to act and improve quantification of additional habitat is required to maintain populations.	Partially complete	DUC/EC

[1] This value includes only areas that have been secured with a long-term agreement, and does not include areas influenced by stewardship programs.
[2] These objectives have not yet been split into "securement" vs. "stewardship" goals.

Freshwater wetlands: The BC Freshwater Atlas (PBHJV-wide) and Sensitive Ecosystems Inventory (available in Southwest BC only, for Metro Vancouver, the Sunshine Coast and the east coast of Vancouver Island) were used to identify existing freshwater wetland habitat across the PBHJV (BC). Mean January temperatures were used to exclude wetlands that typically freeze over in winter[101], and thus provide little habitat value to wintering waterfowl. Due to the high magnitude of historic losses of this habitat type, particularly in Southwest BC, the objective was then set at 100% of the remaining wetlands. A restoration goal was set at 10% of the overall habitat objective. Approximately 92% of unsecured wetlands are on Crown land. Securement will occur through a combination of Crown designations, fee simple acquisitions, conservation covenants, and land-use agreements. Stewardship activities include wetland policy actions, BMP implementation, and other extension/outreach activities. Restoration will occur via compensatory habitat mitigation programs, as well as more traditional engineered wetland programs.

Estuarine habitat: An inventory of intertidal estuarine habitat throughout the PBHJV (BC) was derived from the previously completed Estuary Ranking Model. In alignment with federal no not loss policy that existed pre-2012 for fish habitat, the habitat objective was set at 100% of extant habitat. Securing intertidal estuarine habitat will occur almost entirely through Crown designations, though a limited portion may occur via fee simple acquisitions. Wetland and coastal water policy activities will form the bulk of stewardship activities in this habitat type. A restoration goal was set at 10% of the overall habitat objective, and will be obtained primarily via compensatory mitigation (habitat mitigation) programs.

Shallow marine waters: Similar to the 2003 exercise, herring spawn sites were used as a proxy for sea duck habitat, as herring spawn sites critically important for a wide variety of species, including many waterbirds and sea ducks. As in 2003, the habitat objective for shallow marine waters is set at 100% of known herring spawn sites. Herring spawn sites have been updated using the most recent DFO herring spawn mapping data[102]. Protection of marine sites will necessarily occur almost entirely through coastal water policy changes and best management practices for coastal industries, though some sites may also be secured by Crown designations. Restoration works in this habitat type

SEA DUCK AGGREGATION AT A HERRING SPAWN SITE

[101] Wetlands in areas with mean January temperatures of -1°C or lower were removed from the dataset. Temperature data available from the UBC Forestry Department, at http://www.genetics.forestry.ubc.ca/cfcg/ClimateBC40/Default.aspx.
[102] Hay and McCarter 2013

have not been deemed feasible at this time, but promising work has been happening along the Salish Sea.

Integration of Avian Decision-Support Tools

PBHJV partners have a variety of decision support tools for planning wetland and waterfowl conservation (Table 10). However, many of these tool have been developed for specific areas within the PBHJV, or are applicable to only one habitat type. For example, Ducks Unlimited Canada and Environment and Climate Change Canada previously collaborated on a Waterfowl Decision Support System (DSS) specific to waterfowl values. While this model is useful for identifying potential targets for waterfowl-focused conservation, it is limited to the CIJV, and includes only three main data inputs (waterfowl breeding density, Canada Land Inventory Capability for Waterfowl, and freshwater wetland occurrence). Also, Priority Area objectives were developed primarily in consideration of waterfowl habitat needs, and although other water-associated birds use the same habitats the needs of certain species may not be sufficiently captured via waterfowl habitat conservation actions.

The PBHJV Science and Technical Committee is currently working to bring together a number of models into a single comprehensive tool which explicitly incorporates multiple habitats, ecological values, threats, land tenure, program type, and conservation opportunity. This Joint Venture Securement and Restoration DSS tool (JVDSS) will be used not just for typical JV programmatic purposes, but also to guide wetland and estuary mitigation efforts related to industrial activities and impacts.

The JVDSS will include a range of habitats. Habitat types of interest are in line with JV priorities and include:

1. Freshwater wetlands, including lakes and rivers
2. Estuaries
3. Agricultural lands
4. Grasslands
5. Riparian areas
6. Shallow marine habitats.

The JV has broadened its approach to measuring ecological value for these habitats (beyond relying solely on breeding waterfowl densities)For a given habitat type, several relevant datasets will be compiled and assigned an ecological value score based on various combinations of parameters (Table 13 represents this approach for freshwater wetlands). ESRI's ArcGIS Model Builder is then used to generate ecological value scores for each habitat. Some models are still unfinished, but as new models become available, they will represent additive information and be used to supplement core layers, making the tool incrementally better.

Table 13: JVDSS datasets used to produce ecological value scores for freshwater wetlands

Habitat Type	Landcover Datasets						Biological Models/Designations [1]								Species Occurrence		Combination of Parameters	Ecological Value Score
	Sensitive Ecosystems Inventory	Freshwater Atlas (waterbodies <50ha)	EOSD mod (Habitat=wetland)	PECP estuaries	Hectares BC valley bottoms	GCC grassland Layer	CLI waterfowl capability (class1-3s)	Important Bird Areas (Habitat=wetland)	Essential Waterfowl Habitat	Coastal Waterbird Survey "hotspots"	Essential Habitat Polygons	Drever Waterbird model high richness zone	Estuary Ranking Model class 1 or 2	DUC CIJV DSS (class 2-5)	Breeding Bird Atlas point count	Conservation Data Centre EO point + 50 buffer		
Fresh-Water wetland		X												X			SEI/FWA + DUC DSS (Classes -10)	High
	X	X					X										SEI/FWA + CLI (Classes 1-3S)	High
	X	X						X									SEI/FWA + IBAs (Wetland Habitats)	High
	X	X				X											SEI/FWA + Grasslands	High
	X	X			X												SEI/FWA + Valley Bottoms (primary)	High
	X	X							X								SEI/FWA +Essential Waterfowl Habitats	Mod
	X	X				X											SEI/FWA + Grassland-Assoc Ecosystems	Mod
	X	X			X												SEI/FWA + Valley Bottoms (secondary)	Mod
	X																All other Wetlands (SEI)	Mod
		X															All other Wetlands (FWA)	Low

x denotes that a dataset will be used in a particular combination to assign value for that habitat type.

1 Some of these key bird tools are not fully completed at present.

2 Acronyms: SEI – Sensitive Ecosystems Inventory; FWA – Freshwater Atlas; CLI – Canada Land Inventory Capability for Waterfowl; IBA – Important Bird Areas; EO – Element Occurrence; DSS – Decision Support System; PECP – Pacific Estuary Conservation Program; EOSD – Earth Observation for Sustainable Development; GCC – Grasslands Conservation Council.

The JVDSS will explicitly incorporate site- and landscape-level disturbances and threats to the various habitats of interest, as well as select other factors relevant to decision making, including conservation status and land tenure.

Not all information sources will apply to (or be collectable at) all scales. Therefore, the team is using a two-stage approach, wherein stage 1 involves using a decision tree to analyze mainly GIS datasets at a small scale, and stage 2 will involve more expert opinion and data which may not be available in a GIS at larger scales.

The stage 1 decision tree (Figure 21) is intended to mimic other informal project evaluation processes followed by several of the BC conservation partners, wherein threats to a property are among several aspects considered when evaluating potential conservation actions. Each terminus of the decision tree is assigned a conservation action, such as :

- maintain current level of management,
- encourage use of BMPs on unsecured Crown land or stewardship on unsecured private land,
- secure high value Crown lands through designation or private lands through acquisition/covenant,
- undertake habitat restoration on secured lands.

High-value sites which are flagged for secure or restore conservation actions will be extracted into a subset for further consideration in stage 2, which is still under development.

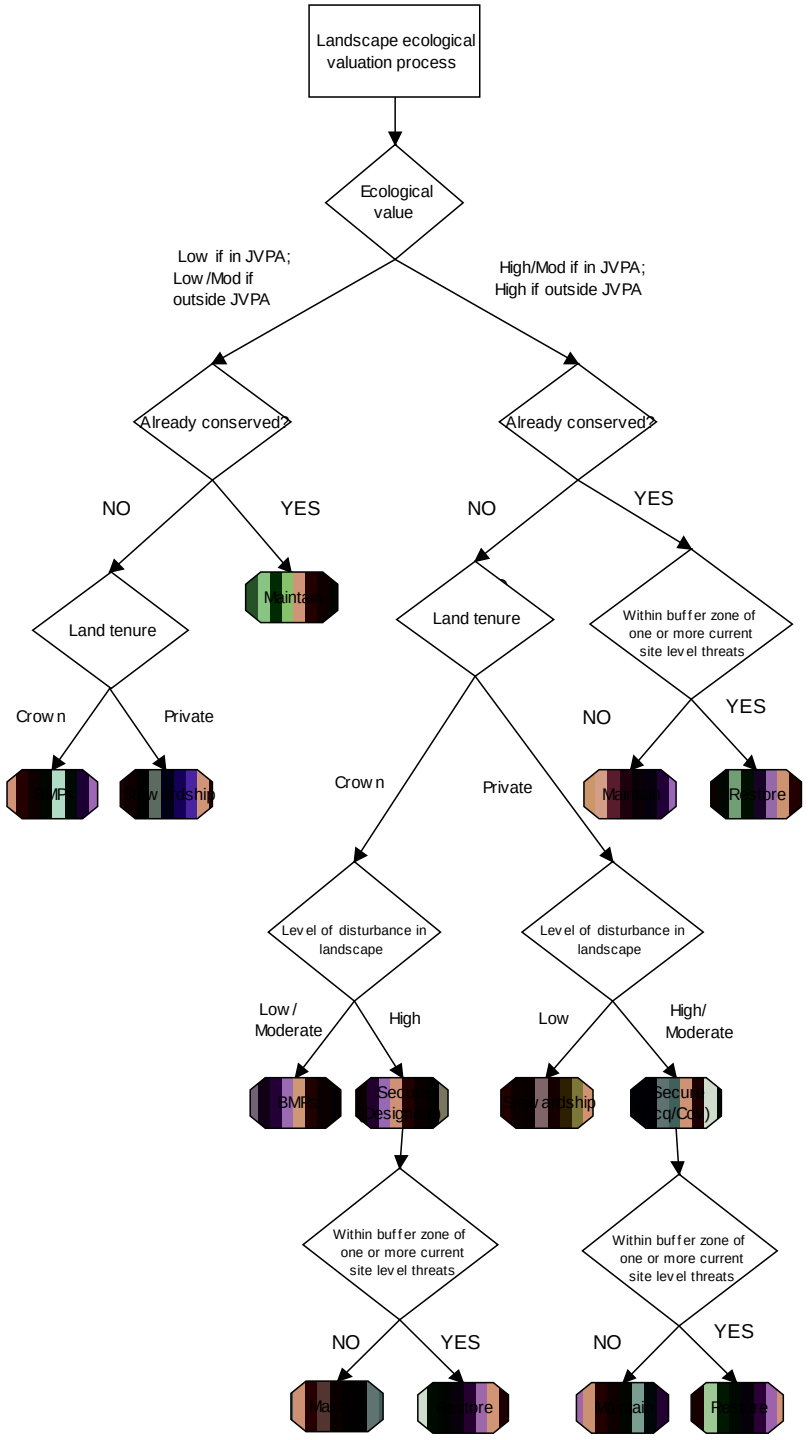


Figure 21: Stage 1 decision tree used in JVDSS project

4: Habitat Delivery

Conservation Programs and Initiatives

PBHJV partners utilize a wide variety of tools and activities to: i) conserve, enhance, restore and manage habitat for waterfowl and other wildlife; ii) ensure actions are targeted where they will have the greatest benefit; and iii) assess the effectiveness and efficiency of these activities. PBHJV partners work across varying land tenures, habitats, and scales. For waterfowl, conservation actions are aimed at protecting staging and wintering habitat, preventing conversion of suitable habitat to non-suitable habitat types (e.g., waterfowl-friendly to non-compatible crop types on agricultural land), and the retention and restoration of water on the landscape, both as wetlands and seasonally-flooded agricultural fields.

Over time, each Canadian JV has developed their own terminology to describe their activities. To standardize tracking and reporting on JV activities across Canada, common terminology is now used [103] to describe the activities that Canadian JVs and their partners undertake to achieve their objectives. This IP strives to use this newly defined standardized terminology wherever possible.

The new terminology is largely hierarchical, with each partner activity supporting ten key Initiatives. These ten Initiatives are discussed below (Table 14), and the component Programs and individual activities used by various JV partners in support of each Initiative are highlighted. Some partner activities support multiple Initiatives; these are discussed under their most closely related Initiative.

[103] A Common Language for Canadian NAWMP Habitat Joint Ventures, 2013

Table 14: Initiatives and Programs undertaken by JV partners, and example Activities within each Program

Initiative	Initiative Program	NAWCA Terminology	Example Activities	Participating Organizations[1]
Habitat Retention - Permanent	Fee Simple Acquisition – Paid	Securement	Purchase of lands for conservation	Land-owning NGOs
	Fee Simple Acquisition - Donated		Receipt of donated lands for conservation	
	Conservation Encumbrance - Paid		Purchase of restrictive covenants for conservation	
	Conservation Encumbrance - Donated		Receipt of donated restrictive covenants for conservation	
	Crown Designation		Designation of WMAs, Ecological Reserves, NWAs, MPAs, etc.	EC-CWS, MFLNRO
Habitat Retention - Medium-term	Conservation/Cooperative Land Use Agreement	Securement	30-year Conservation Agreements for wetland creation/enhancement	DUC
			On-Farm Program	
	Crown Agreements		Crown Land Agreements	
Habitat Retention - Short-term	Conservation/Cooperative Land Use Agreement	Stewardship	Cover Crop Programs	DUC, DFWT
			Grassland Set-asides, Grass Margin and Hedgerow Stewardship Programs	DFWT
Wetland Restoration	Hydrological Restoration	Enhancement	Engineered Wetland Program - installation of water controls to restore or enhance wetland habitat	DUC, DFO
	Ecological Restoration	Management	Invasive species removal (e.g., purple loosestrife, yellow flag iris, etc.)	Land-owning NGOs/agencies
		Enhancement	Spartina program	DUC, Surrey, Delta, TFN, MFLNRO,VICLMP, Spartina Working Group
		Management	Vegetation control (e.g., control of willow, hardhack, cattail to maintain marsh conditions)	DUC
	Compensatory Mitigation/Habitat Compensation	Enhancement	Restoration/enhancement of wetlands or estuaries under DFO fish habitat compensation programs	
Upland Restoration	Ecological Restoration	Management	Invasive species removals (e.g., Himalayan blackberry, scotch broom, knotweed, English ivy)	Land-owning NGOs/Govt agencies
			Vegetation control (e.g., mowing)	

Initiative	Initiative Program	NAWCA Terminology	Example Activities	Participating Organizations[1]
			Native vegetation plantings	
	Incentive	Stewardship	Cover Crop Programs	DUC, DFWT
			Grassland Set-asides, Grass Margin and Hedgerow Stewardship Programs	DFWT
Land and Water Policy	Agriculture Policy	Government Relations	Development & promotion of Wetland Ways guidelines	WSP /SCCP
	Wetland Policy			
	Integrated Land Use Planning		Development & promotion of Green Bylaws Toolkit	
Management of Habitat Assets	Natural Wetlands	Management	Project operation and maintenance	Land-owning NGOs/agencies
	Engineered Wetlands			DUC
	Upland and Associated Wetlands			Land-owning NGOs/agencies
	Wetland Rebuild	Securement	Major repairs/project rebuilds (water controls)	DUC
Conservation Planning	Program Coordination	Coordination	JV coordination, Implementation Plans, etc.	EC-CWS, DUC
	Planning Tools	Reconnaissance and Design	Development of planning tools such as the TRUEMET energetics model, sea duck model, estuary ranking project, pelagic seabird model, coastal waterbird distribution model, and BC Coastal Waterbird Survey mapping	EC-CWS, DUC, BSC, academic partners (e.g. SFU)
Science	Habitat Program Evaluation	Evaluation	Assessment of the effectiveness of partner conservation activities, such as analyses of cover crop programs	DUC, DFWT, EC-CWS
	Physical Science	Reconnaissance and Design	Sea level rise modeling	DUC/EC-CWS
	Habitat/Landscape Inventory		Mapping, inventory (use of existing habitat inventory information; GIS support, etc).	
	Waterfowl/Wildlife Science	Evaluation	FRDNPS study	
			Buffers/disturbance study	DUC/SFU
		Monitoring	BC Coastal Waterbird Survey, Beached Bird Survey, Christmas Bird Count, Breeding Bird Survey	BSC, EC-CWS
Communication	Communication & Education	Communications	Project Webfoot	DUC

Initiative	Initiative Program	NAWCA Terminology	Example Activities	Participating Organizations[1]
and Education	Outreach of Conservation Successes	Communications	General communications & marketing – social media, websites, project signage, press releases, etc.	All partners

[1] BSC – Bird Studies Canada; DFO – (Federal) Department of Fisheries and Oceans; DUC – Ducks Unlimited Canada; DFWT – Delta Farm and Wildlife Trust; EC-CWS – Environment and Climate Change Canada Canadian Wildlife Service; MFLNRO – (BC) Ministry of Forests, Lands and Natural Resources; SCCP – South Coast Conservation Program; SFU – Simon Fraser University; TFN – Tsawwassen First Nation; WSP – Wetland Stewardship Partnership

Habitat Retention (Permanent, Medium- and Short-Term)

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.

In the PBHJV (BC), habitat retention programs focus on securing high-value habitats that are at high risk of loss or degradation. Permanent methods of securing privately held land include fee simple acquisition (either by donation, purchase, or combination thereof), or by obtaining and registering conservation encumbrances (called covenants in BC) on title, either by donation, purchase or a combination. On Crown lands, permanent securement is obtained by various Crown designations, such as the creation of National Wildlife Areas, National Marine Conservation Areas, Provincial Wildlife Management Areas (WMAs), or Provincial Ecological Reserves.

In the most sensitive and threatened habitats, JV partners attempt to concentrate permanent securement efforts in large blocks of habitat. For example, at the east end of Boundary Bay (also known as Mud Bay), the Serpentine and Nicomekl Rivers empty into the Boundary Bay WMA. Serpentine Fen WMA provides additional protected habitat just upstream along the Serpentine River. DUC has bridged these two WMAs to create a large block of contiguous, protected habitat by securing adjacent agricultural lands via conservation covenants which maintain the grasses and grains of a dairy farm (Figure 22). Together, this provides an integrated habitat complex of tidal wetlands, freshwater wetlands, and agricultural land which provides forage and safe roosting sites for thousands of migrating and wintering waterfowl.

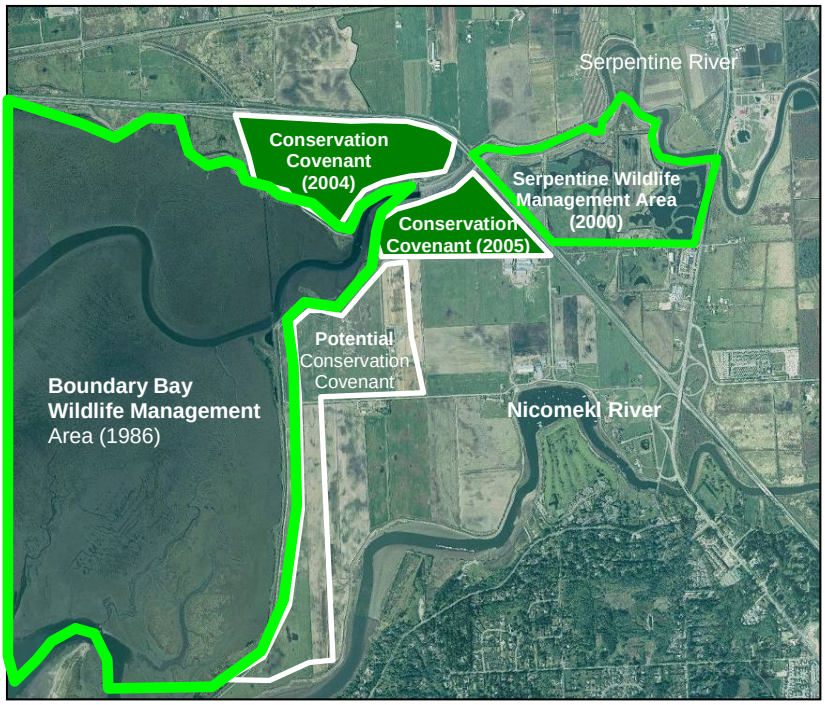


Figure 22: The complex of secured habitats in the Mud Bay area

Non-permanent methods of securement may be for medium-term (10-99 years) or short-term (<10 years) timeframes. These methods of securement typically utilize various conservation land use agreements. For example, DUC frequently uses standard 30-year conservation agreements,

whereby DUC will restore or enhance wetland habitats on privately held lands. More recently, DUC has explored 20-year cooperative agreements (On-Farm Plans) which assist farmers with managing their lands for wildlife as well as agricultural values. Another partner, The Nature Trust of BC, is responsible for overseeing the grazing management of 47,000 hectares under long-term lease or license on its South Okanagan Biodiversity Ranches.

Other programs use annual agreements to obtain short-term habitat protection. Encouraging cover crops, grassland set-asides, best practices for soil conservation, and agreements with farmers to retain wildlife habitat has proven to be very effective in the PBHJV. The Vancouver Island Conservation Lands Management Program (VICLMP), DUC, and Delta Farmland and Wildlife Trust have been writing plans and administering agreements with landowners in the PBHJV for decades, and this is expected to continue

TRUMPETER SWANS REST IN A FIELD WHERE A COVER CROP IS ESTABLISHING AMONG THE STUBBLE OF A HARVESTED CROP

In general, the level of securement declines with its cost, and use of these securement tools is typically balanced according to biological value of the habitat, available resources, and landowner willingness. In the PBHJV (BC), securement in perpetuity via fee-simple purchase or conservation encumbrance (covenant) is reserved for exceptionally significant habitats, as high land prices can make these tools very expensive, particularly in southwest BC where land can vary from $60,000 to $1,000,000 per acre. Such acquisitions are often undertaken as collaborations between multiple organizations with shared objectives.

Habitat Restoration (Wetland and Upland)

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

Some partners restore very high-value wetlands by installing engineered structures to control the hydrologic regime of a basin for the benefit of waterfowl and other wildlife. JV partners also engage in ecological restoration of habitats. On previously secured habitats, these programs typically involve the periodic removal of invasive species such as purple loosestrife, yellow-flag iris and scotch broom to maintain the ecological integrity of high-value habitat; the control of vegetation ingrowth to maintain hemi-marsh conditions (e.g., cattail, hardhack and willow control); or planting of native species to restore degraded upland or wetland areas. One ongoing ecological restoration project is the control of the invasive cordgrass, *Spartina* spp., to ensure that tidal estuaries continue to provide habitat and food for migrating waterfowl and other birds. A control program was initiated in 2004 by DUC to raise awareness of the issue, demonstrate the logistics and costs required for control, and build partnerships for control efforts. Since then, the *Spartina* program has expanded to include the Province of BC, Environment and Climate Change Canada, Washington State, VICLMP, local municipalities and First Nations, and local naturalists groups.

HOLDEN CREEK PROJECT ON VANCOUVER ISLAND. EXISTING DIKES IN THE NANAIMO ESTUARY WERE BREACHED AND A NEW DIKE WAS CONSTRUCTED TO RESTORE INTERTIDAL HABITAT

JV partners also work to restore habitat under compensatory mitigation (habitat compensation) programs. For instance, DUC has partnered with the federal Department of Fisheries and Oceans to deliver three major habitat restoration and enhancement projects as part of the Deltaport Third Berth offsite mitigation program.

DUC has restored tidal marsh habitat using a combination of dike breaches and new water control installation, to enhance newly created and existing salt marsh by creating channels and pools, and enhancing native vegetation.

Since 2000, DUC has piloted On-Farm Plans, which are co-operative agreements with landowners that help farmers with long-term planning and investment into their land. The goal is to promote soil conservation and sustainable farming practices in conjunction with waterfowl-friendly farming. In addition, JV partners deliver cover crop programs in the Comox Valley region of Vancouver Island and in the municipality of Delta. These cover crop programs are short-term (annual) incentive programs which encourage farmers to plant cover or relay crops for the benefit of soils and wintering waterfowl. Delta Farmland and Wildlife Trust also operates grassland set-side, grass margin, and hedgerow programs to encourage provision of old-field and native shrub habitats within the agricultural landscape.

Land and Water Policy

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[104]. The WSP has used a variety of strategies, including influencing government legislation, developing and promoting Best Management Practices[105] (BMPs), and developing draft municipal green bylaws[106] and other resources for local governments[107]. Policy activities are collaborative and informed by science. Activities focus on encouraging governments to favour wetlands, estuaries and other sensitive ecosystems by implementing a variety of strategies.

The partners have identified three priority policy activities:

1. Encouraging the BC provincial government to incorporate the identification, recognition and protection of wetlands and estuaries in its new water legislation (the BC Water Stewardship Act).
2. Working with the province to develop a mitigation strategy for development-related impacts to wetlands and estuaries, supported by tools such as the PECP estuary ranking.
3. Working with the BC Ministry of Agriculture and Lands and the BC Ministry of Forests, Lands and Natural Resource Operations to designate priority Crown Lands for conservation, maintain existing protected wetlands and tidal lands as WMAs, or give

[104] Wetland Stewardship Partnership 2010b
[105] Wetland Stewardship Partnership 2009
[106] Wetland Stewardship Partnership 2007
[107] Wetland Stewardship Partnership 2010a

conservation groups first right of refusal for land purchases or conservation covenants.

Other policy initiatives include:

- Promoting sector-specific wetland BMPs for various industries and other sector groups to avoid and minimize impacts on wetlands.
- Promoting the use of the *Green Bylaws Toolkit* to provide options for local governments to maintain wetlands, estuaries and associated agricultural habitats in their Official Community Plans, Regional Growth Strategies, and Economic Development Plans.
- Developing a framework for working with government at all levels (federal, provincial and municipal) to increase protection for shallow marine habitats.
- Promoting the value of ecological goods and services provided by functioning wetlands and estuaries.

Management of Habitat Assets

INSTALLATION OF REPLACEMENT WATER CONTROL AT FANNY BAY PROJECT ON VANCOUVER ISLAND

Once secured, conservation lands must be managed to ensure they continue to provide the habitat values and productive capacity for waterfowl and other wildlife they were originally secured for. On engineered (constructed) wetlands, such management typically involves inspection, operation and maintenance of water control structures. As an engineered wetland approaches the end of its life, the responsible conservation organization assesses the effectiveness of each project (long-term costs and liabilities vs. biological benefits) and, where appropriate, such projects are rebuilt. When projects are rebuilt, project design is reviewed to determine approaches to reduce rebuild and operational costs. When projects are renegotiated with landowners, operation and management is turned over to the landowner whenever possible to minimize future obligations.

It is not only engineered wetlands that require management; natural wetlands and uplands must also be managed. Management efforts on such lands can include control of vegetation to maintain a desired ecological state (e.g., mowing to maintain grassland, removing cattail to keep open water in marshes), the removal or control of invasive species that threaten the ecological integrity and functioning of the habitat, or planting native vegetation to improve habitat conditions. These activities also support the wetland and upland restoration Initiatives.

Management of public access (trails, signage, etc.) on conservation lands is also included under this Initiative.

JV partners continue to look for new ways of operating and managing existing habitat projects in a cost efficient manner. Costs are balanced against habitat function to derive the most benefit for the least expense, consistent with the concept of minimal ecological management.

Conservation Planning

PBHJV (BC) activities are coordinated by a Steering Committee which includes representatives from its major active partners. The PBHJV (BC) Steering Committee is currently chaired by a representative from Environment and Climate Change Canada, which also supports the partnership by providing a PBHJV (BC) Coordinator to assist in optimizing partner activities.

PBHJV 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 by JV partners, and those under development, are discussed more fully under Decision Support Tools (page 57).
JV partners all contribute to the overall conservation mandate of the PBHJV (BC), but each partner does so according to their own mandate and resources. Some partners have mandates that are wider in scope than just waterfowl and wetlands, and consequently they operate on broader landscapes. Other partners focus on specific types of conservation activity, such as land securement, or monitoring and research, and thus their contributions are concentrated in certain areas. Nonetheless, the PBHJV (BC) provides an important forum for the various partners to communicate, coordinate their activities, and work together on particular projects, allowing partners to realize greater efficiency in use of staff, funding, expertise and other resources.

The PBHJV (BC) Steering Committee also forms part of the PBHJV Board, which is chaired by a Canadian and a US board member. The PBHJV Board oversees the international activities of the PBHJV and ensures the various PBHJV Steering Committees are working together toward a larger, PBHJV-wide vision.

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, species-habitat relationships, and landscape trends in habitat availability and condition.

- 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.

The PBHJV Science and Technical Committee, with representatives from government and NGO partners, is responsible for designing, implementing, and evaluating individual and collaborative science programs. For example, recently completed studies[108] have helped quantify the impacts of various types of disturbance and fragmentation on waterfowl use of agricultural lands, allowing JV partners to more accurately assess the current availability of agricultural habitat and assess fine scale impacts of future development. In addition, a pilot program is underway to model the impacts of sea level rise on estuarine habitat. If it proves feasible, the final model will allow JV partners to predict changes in availability (gains or losses) of several estuarine habitat types under various sea level rise scenarios, which will in turn inform long-term planning help identify restoration opportunities (e.g., dike breach). A future research priority is expansion of the TRUEMET model to model energetics of intertidal areas as well as agricultural lands, which will further expand the utility of the TRUEMET model.

The concept of evaluation is a consistent theme within the PBHJV (BC) science program. Evaluation of program activities at different spatial and temporal scales is critical to assess program success. At the project level, the team conducts long-term habitat and population monitoring to determine the response to conservation actions, and researches basic assumptions to improve performance. At the Joint Venture level, the team monitors populations and habitats to help evaluate the overall program, and provides information to assist larger bird conservation initiatives to assess the status of birds at the continental and global levels.

Communication, Education and Outreach

Communication, education, and public outreach are generally undertaken by each of the PBHJV (BC) partners according to the individual mandates their organizations. An exception is the WSP, which undertakes joint communication tasks under the direction of the WSP coordinator. The JV Coordinator is currently working to develop a JV-wide communications plan.

In general, partners communicate to: 1) inform and educate the public (and the various PBHJV partners), 2) to provide guidance and/or advice on issues which relate to government or industry policies, 3) to encourage new partnerships and funding opportunities, and 4) to maintain and increase public support for conservation activities. Partners use multiple formats to ensure the appropriate information reaches the target audience. Tools include websites and social media, mass media publications, technical reports, conference presentations, peer reviewed journal articles.

[108] Middleton 2014

BIOLOGISTS TEACH THE PUBLIC ABOUT THE IMPORTANCE OF ALL ASPECTS OF A WETLAND

Some partners run targeted programs for children. For example, DUC has a directed education program, Project Webfoot, which targets schoolchildren from Grades 4 to 6. The program provides teacher resources and field trips to select local wetlands. DUC also produces curriculum-linked resources and teacher guides for Grades 4-12.

Integrating communication/outreach and education with conservation programs will be critical to achieving objectives, particularly Land and Water Policy objectives. In addition to engaging priority audiences, the PBHJV communication plan will prioritize messaging for bird habitat conservation objectives to help determine where increases in audience awareness and behaviors can help achieve objectives. This is particularly relevant to government and industry audiences. However, it is important to recognize the need to motivate the general public and raise awareness about impacts of habitat loss so they are inspired to support this work either financially or through other means, such as advocacy or volunteering. Increasing connections with the urban demographic in the Lower Mainland will be key to building stronger public support for wetland and waterfowl conservation activities.

Certain partners periodically conduct formal assessments of priority audiences to measure changes in awareness, attitudes, and behaviors over time. Assessments may be in the form of focus groups, surveys, interviews or other systematic means of gathering audience data.

Communication within the PBHJV (BC) between partners is mainly facilitated by the PBHJV Coordinator and includes both digital and print communications (e.g., Habitat Matters). The PBHJV Coordinator also communicates with other Canadian JVs at regular Coordinator meetings and meetings of the US and Canadian NAWCC Councils. All partners endeavour to share their activities within the broader scientific community as well, via presentations at conferences, publications, and other media.

Program Objectives / Expenditure Forecast

Table 5 provides an estimated 5-year expenditure forecast based on current and anticipated funding levels in conservation programs. This would bring the total securement within 5 years (Table 16) to 143,576 ha (29.7% of overall habitat objectives) if securement includes both permanent and medium-term tools as well as Land and Water Policy. At this rate of securement, it would take approximately 20 more years to reach 50% of habitat securement objectives, assuming habitat objectives will not change and securement can be successfully provided through Land and Water Policy. Securement through Land and Water Policy will be an important component to achieve habitat objectives in the long-term, however this tool is still relatively new and unproven within this JV. Furthermore, the loss of agricultural lands may decline below what can support the current waterfowl population within 20 years, therefore habitat objectives will need to be completely achieved within the next 20 years.

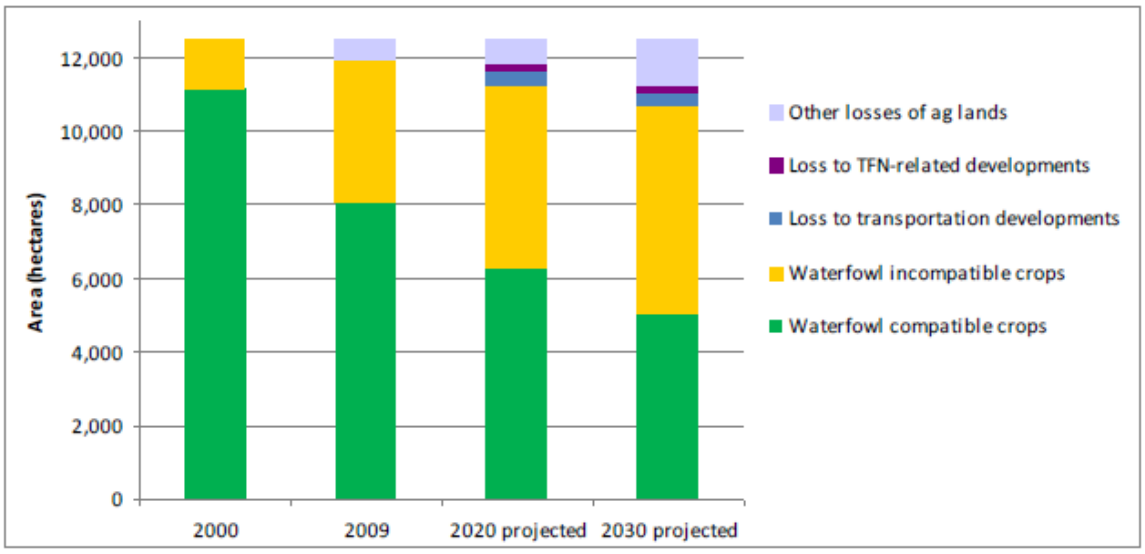


Figure 23: Trends (actual and projected) in broad crop types on agricultural land in the Fraser River Delta

Table 15: Expected amount and cost of Priority Activities within each Initiative Program

Initiative		Program/Activity	Area (ha) by habitat				5-Year Costs		
			Ag Land	F/water Wetland	Estuary	Shallow Marine	Direct	Staff time	Total
Habitat Retention	Permanent	Acquisitions	50	20	250		$15,400,000	$ 600,000	$16,000,00
		Covenants (Encumbrances)	100				$ 5,000,000	$ 300,000	$ 5,300,000
		Crown Designations		5,000	10,000	5,000	$ 500,000	$ 900,000	$ 1,400,000
	Medium-term	Conservation Agreements	200		125		$ 1,625,000	$ 60,000	$ 1,685,000
		Crown (Protocol) Agreements							
	Short-term	Stewardship / Incentives	1,300			1,000	$ 750,000	$ 660,000	$ 1,410,000
Habitat Restoration	Wetland	Hydrologic Restoration					$ 4,125,000	$1,200,000	$ 5,325,000
		Ecologic Restoration		1,000			$ 500,000	$ 360,000	$ 860,000
		Mitigation			70		$ 1,890,000	$ 330,000	$ 2,220,000
	Upland	Ecologic Restoration	325				$ 350,000	$ 60,000	$ 410,000
		Mitigation							
Land and Water Policy		Agricultural Policy							
		Wetland Policy						$ 900,000	$ 900,000
		Integrated Land Use Planning	1,000	1,000	5,000	1,000	$ 50,000	$ 360,000	$ 410,000
Management of Habitat Assets		Engineered Wetlands					$ 930,000	$1,170,000	$ 2,100,000
		Natural Wetland					$ 505,000	$ 810,000	$ 1,315,000
		Upland Management					$ 190,000	$ 150,000	$ 340,000
		Wetland Engineered Rebuilds					$ 250,000	$ 300,000	$ 550,000
Conservation Planning/Science		Coordination						$ 750,000	$ 750,000
		Planning Tools/Science						$ 600,000	$ 750,000
		Project/Program Evaluation					$ 150,000	$ 600,000	$ 900,000
		Inventory/Monitoring					$ 300,000	$1,200,000	$ 1,800,000
Communication and Education		Various					$ 600,000	$ 300,000	$ 325,000
		TOTALS	**2,975**	**7,020**	**15,445**	**7,000**	**$33,140,000**	**$11,610,000**	**$44,750,000**

Table 26: Contribution of proposed 5-year securement expectations toward overall objectives

Habitat Type	Overall Securement Objectives	Secured To date		Proposed 5-Year Securement	Total Secured after 5 Years	
	ha	ha	%	ha	ha	%
Agricultural Land	3,120	1,349	43.2%	1350	2,699	86.5%
Freshwater Wetland	249,450	61,781	24.8%	6020	67,801	27.2%
Estuarine	74,585	33,601	45.1%	15375	48,976	65.7%
Shallow Marine	155,500	18,100	11.6%	6000	24,100	15.5%
Total	**482,655**	**114,831**	**23.8%**	**28,745**	**143,576**	**29.7%**

Delivery Capacity

Partnerships are inherent to PBHJV operations in British Columbia, and activities are often dependent on funding from partners or other external sources. With the PBHJV as a forum for effective coordination of activities, partnerships between members build on the strengths of each agency and enable cost-effective approaches for the best use of staff, capabilities, and financial resources. However, capacity continues to be a barrier to achieving JV goals, particularly since most partners are not focused exclusively on Joint Venture activities.

Currently, two of the partners (DUC and NCC) are the recipients of grants under the North American Wetlands Conservation Act (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.

The Steering Committee and Science and Technical Committee work with their counterparts in the PBHJV (US) to align programs and priorities as much as possible. Several Steering Committee and Technical Committee members also serve similar functions with the Canadian Intermountain JV in the Interior of BC, and various partners share information with the (international) Sea Duck JV. The Science Committee is also working on partnership opportunities with the North Pacific Landscape Conservation Cooperative (NPLCC), and the PBHJV Coordinator sits on the NPLCC Board.

The PBHJV (BC) recognizes a need for new types of partnerships to improve program delivery and meet objectives. Since industries have large impacts on the land base, forming partnerships to work cooperatively has the potential for widespread benefits. Partnerships on a project-by-project basis with First Nations, communities, and land managers could also create opportunities to work on land which partners would not otherwise be able to access or influence at a meaningful scale. These partnerships should be framed in the context of working together to address problems of mutual concern, including conservation, social and economic needs. The PBHJV would also benefit from an expansion of research partnerships, which would

improve the JV's capacity to engage in science and answer pressing questions. For example, a partnership with Simon Fraser University (see Disturbance, page 48) has started to fill in select research gaps.

5: Monitoring

Conservation Tracking System

The PBHJV partnership has been tracking conservation actions via the Canadian National Tracking System (NTS). However, because the NTS is very coarse-scale and not spatially explicit, it cannot be used to inform conservation decisions and planning[109]. The BC ENGO Conservation Areas Database (CAD) is more useful in making the link between conservation actions and progress toward objectives. Currently, the CAD is administered by two PBHJV partners (The Nature Trust of BC and DUC), with all JV partners contributing information to update it on a yearly basis. Funding from CWS resulted in the CAD being web-enabled in 2009. This single database has increased spatial precision and accuracy while reducing multiple inter-organization requests for project accomplishments. Currently the focus is on improving the CAD's availability to the public, and coordinating with non-partner land trusts.

The CAD is still in its relative infancy, but as models are developed the linkage between conservation tracking and biological accomplishments (habitat and population gains) will improve. For instance,

- TRUEMET (energetic) modeling can be used to quantify the contribution of several habitat types toward winter and migration forage for waterfowl. Therefore, we are able to place an ecological value on securement (through purchase or covenants) of at-risk lands and/or restoration of degraded habitats via compatible agriculture.
- Existing habitat-species models can be used to quantify the benefits of water control-type projects for waterfowl pair and brood abundance.
- The newly-revised PECP Estuary Model will be used to set values to estuaries in terms of waterfowl and waterbird use, and confirm that high-value estuaries are being conserved. The still-developing Sea Duck, Shorebird and Pelagic Seabird Models should provide similar guidance with regard to offshore or non-tidal habitats.

For many securement projects in the PBHJV planning area, conservation benefits derive from preventing future losses. These outcomes must be tracked separately from projects which provide additive benefits based on habitat improvements. Section 6 discusses treatment assumptions and related priorities for research.

Projects and programs that do not involve long-term securement, such as short-term cooperative land use agreements and incentive programs, are not currently captured by the

[109] The NTS will still be used to track partner financial contribution and expenditures. DUC maintains the NTS and regularly enters its own data into the NTS. Other JV partner accomplishments will be added concurrently with an annual request for updating of the CAD.

CAD, but work is underway to digitize some cover crop and habitat set aside projects. In addition, though policy activities are tracked internally by individual partners, the impacts of policy activities (e.g., as hectares positively influenced) are not yet in the CAD.

Habitat Inventory & Monitoring Programs

MONITORING THE OCCURRENCE OF INVASIVE SPARTINA CORDGRASS

One of the PBHJV's main objective 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 will focus on those habitats relating to the limiting factors that are of greatest concern (Table 17), and work to address the habitat drivers and information needs identified in previous sections. For example, monitoring land cover enables the JV partnership to estimate the types and amounts of habitat secured over time in a spatially explicit approach. Monitoring estuaries and wetlands improves the accuracy and applicability of habitat-species models in estimating population sizes and distributions. And monitoring the occurrence of invasives, such as Spartina, can help to assess the effectiveness of intertidal restoration programs.

Many of the habitat mapping datasets are static and lack specific plans for updates. Trend statistics are only available at a broad scale for forests and agricultural land, and that information can be related to some bird population trends. However, for estuaries and wetlands, which occupy a relatively small percentage of the PBHJV area, there is no such systematic reporting. In addition, these habitats often experience changes that can only be detected at a fine scale, and finer scale datasets, such as those found in the Canadian Wetland Inventory, are mostly limited to the southwest coast (Figure 23).

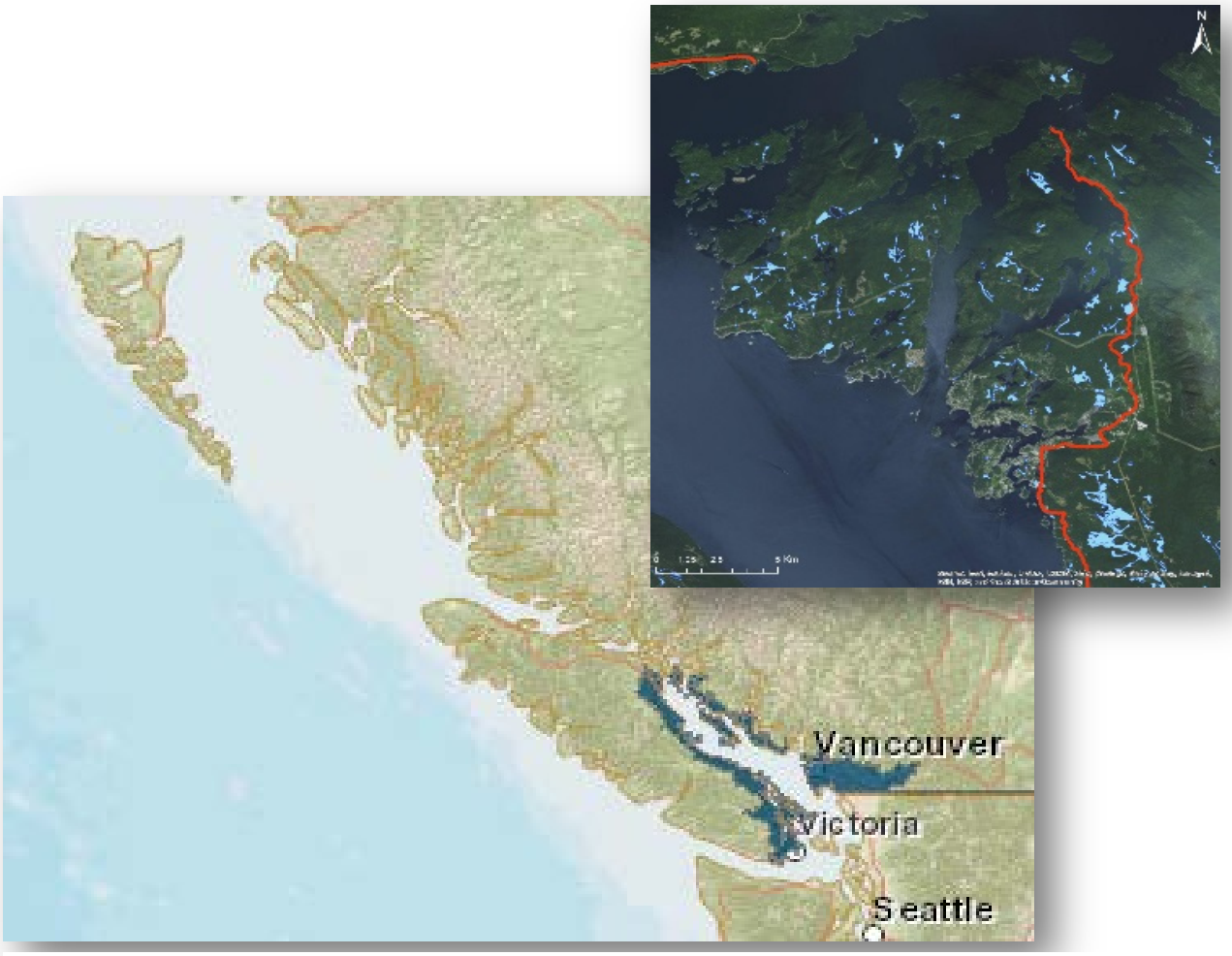


Figure 24: Canadian Wetland Inventory coverage in the PBHJV (BC), which consists of primarily of Sensitive Ecosystem Inventory data (inset)

Table 17: Habitat inventory/monitoring programs in the PBHJV, by habitat category

Habitat Type	Monitoring Program	Lead Partner/ Agency	Description of Habitat Parameters Monitored	Use in Decision-Making
Agricultural Land	Census of Agriculture	Statistics Canada	Agricultural operation and land use information collected nationally every 4 years at regional district scale.	To provide general agricultural trends.
	Fraser River Delta Cropland	Ducks Unlimited Canada	JV partners have inventoried land cover on individual fields every 2-3 years since 2004 (a larger set of fields in the Fraser Valley has been surveyed every ten years).	To provide accurate, local agricultural trends (particularly crop types), and to feed TRUEMET models and update agricultural habitat objectives.
Freshwater Wetland	BC Freshwater Atlas	Province of BC	Digital mapping of wetlands, lakes and rivers at 1:20,000 scale, collected in 1980s and 1990s but not regularly updated.	To delineate the extent of wetlands (PBHJV-wide) for use in habitat-species models.
	Sensitive Ecosystem Inventories	Province of BC	Wetlands and estuaries mapped at 1:20,000 scale on the east coast of Vancouver Island and Gulf Islands (1993-95) and the Sunshine Coast (1994-99).	To delineate the extent of wetlands (in SWBC) for use in habitat-species models; feeds into identification of unprotected sites; to help populate the Canadian Wetland Inventory.
	Metro Vancouver Important Wetland Mapping	Metro Vancouver	Wetlands identified at 1:5,000 to 1:20,000 scale in Metro Vancouver and Abbotsford from Sensitive Ecosystem Inventories 2007-09.	To help identify remaining unprotected sites, and provide a detailed baseline for the Metro Vancouver area.
	Miscellaneous	EC-CWS, Metro Vancouver	Coastal wetland inventories (1989, 1999, 2009).	To support various planning tools.
Estuarine	PECP estuary polygons and leases/licenses	EC-CWS	Outlines boundary of intertidal area, protected areas and threats (e.g., aquaculture) of 442 estuaries along BC Coast. Done at 1:10,000 scale in 2004.	To determine the extent of intertidal wetland zone in estuaries, and to support estuary habitat-species models.
	Spartina monitoring	Province of BC, DUC, VICLMP, SWG	Mapping of shorelines along Fraser River Delta, Baynes Sound and east coast of Vancouver Island to determine abundance/density of invasive Spartina cordgrass.	To determine extent of infestations which are targeted for removal or treatment.
Shallow Marine	Biological ShoreZone Mapping	Province of BC	Physical and biological 1:10,000 scale mapping of the BC shoreline, formalized in 1995. Collected via interpretation of oblique low-tide aerial imagery.	To provide physical shoreline characteristics for use in the Sea Duck Model.

To help address this, in 2010 a subset of PBHJV partners (including DUC and CWS) began a project to track fine-scale trends in freshwater wetland distribution and spatial attributes in BC. A trial was established within the Canadian Intermountain Joint Venture (CIJV)[110], but it is expected that a similar exercise will be conducted in the PBHJV, incorporating lessons learned during the CIJV project. Also, as mentioned previously, the PBHJV partners have mapped habitat types within all lands captured in the CAD, and will continue to update these as new areas are added.

INSTALLATION OF A DATA-LOGGER AT SITE OF GRAUER INTERTIDAL RESTORATION

The partners also undertake monitoring of habitat restoration work (e.g., Grauer project) and other conservation actions to ensure proper evaluation and to support adaptive management.

Population Monitoring Programs

The main objective for PBHJV is to quantify bird numbers and assess population status, in order to monitor trends and to support habitat-species models which, in turn, drive Decision Support Tools. PBHJV population monitoring integrates results from various regional, national and international monitoring programs. These programs (Table 18) are mainly run by Canadian Wildlife Service and Bird Studies Canada, although the Washington State government has monitored populations of sea ducks in partnership with the US Fish and Wildlife Service and Sea Duck Joint Venture and Lesser Snow Goose. Due to the lack of demographic information for almost all species, the PBHJV will work through university and other research partnerships to address these gaps.

[110] Harrison and Moore 2013. SPOT satellite imagery was used to assess whether wetland occurrence in the South Okanagan valley bottom changed between 1988-2010. A significant percentage of valley-bottom wetlands were lost or converted to other habitat types, and that wetlands under 5 hectares in area were disproportionately affected.

Table 38: Population inventory/monitoring programs in the PBHJV

Monitoring Program	Lead Partner / Agency	Description of Population Parameters Monitored	Use in Decision-Making	Geographic Area
BC Coastal Waterbird Survey (BCCWS)	Bird Studies Canada	Ongoing monthly winter volunteer shoreline survey of waterbirds in discrete zones.	To provide regional population size and distribution trends; to identify areas with high winter use by waterfowl and other waterbirds; linked with Shore-Zone habitat data to generate habitat-use models.	Much of the Lower Mainland, and areas of the Sunshine Coast and Vancouver Island.
BC Sea Duck Surveys	Washington Dept Fish and Wildlife	Habitat-based aerial surveys of nearshore wintering waterfowl have been undertaken on an opportunistic basis for parts of the BC Coast.	To express waterfowl in linear densities (birds/km of shoreline) for species and groups; surveys use the BC Marine Ecological Unit habitat classes.	PBHJV
PBHJV Coastal Waterbird Inventory	EC-CWS	An aerial monitoring plan for wintering waterfowl, using a rotating panel design, implemented on a pilot basis in winter 2008-2009 and coast-wide in winter 2009-2010.	To provide the bird abundance and density information used to revise the PECP Estuary Model in 2014.	PBHJV
BC Breeding Bird Atlas	Bird Studies Canada	A seven year project (2008 to 2014) to determine the distribution and relative abundance of birds across BC. Will not be repeated for 20 years.	To provide baseline distribution data for many waterbird species.	Province
Species-specific winter surveys of Lesser Snow Goose, Trumpeter Swan and Pacific Brant	EC-CWS and Washington Dept Fish and Wildlife	Snow Goose surveys are conducted annually by Washington State staff in mid-winter to track the Fraser-Skagit sub-population of the Wrangel Island Lesser Snow Goose; involves interpreting aerial photos of flocks. Swan surveys are run by volunteers throughout the winter. Brant have been counted in midwinter by students and CWS staff since 1992.	To track population sizes and distributions of wintering waterfowl of local significance; also used to estimate age ratios for Brant.	Snow Goose – Georgia Basin/Puget Sound Trumpeter Swan - Comox Valley Brant – Roberts Bank and Boundary Bay
BC Beached Bird Survey	Bird Studies Canada	A volunteer-based shoreline survey to collects baseline information on the causes and rates of seabird mortality (est 1986).	To determine which seabirds are most affected by oiling, and tracks oiling rates over time; helps identify which species are vulnerable to food supplies or bycatch.	Mostly in Georgia Strait
Pelagic Bird Monitoring	EC-CWS	Observers on “ships-of-opportunity” (usually DFO vessels) monitor and record birds encountered using standardized transect methods, opportunistically since the early 1980s.	To inform on species distribution and relative abundance; results were analyzed and published in 2009.	PBHJV

Breeding Bird Survey (BBS)	EC-CWS, Patuxent Wildlife Res. Centre	BBS volunteers collect point-count data along pre-determined, 40-km routes in the first two weeks of June of each year. Designed more for landbirds, but data is collected for other groups when encountered.	To collect long-term data on the population status and trends of breeding birds in North America; also used by Partners in Flight to assess population trends at continental, national, and BCR scales.	North America
Rocky Point and Iona Bird Monitoring Stations	Rocky Pt Bird Observatory / WildResearch	Follow standardized protocols to net and band birds during the peak of migration. Iona Island operates during both the spring and fall migration periods. Rocky Point targets fall migrants.	To assess survival, productivity and population trends of neotropical migrant landbirds that breed in the boreal forest are not well captured by surveys such as the BBS.	Iona Island Bird Observatory (Fraser River Delta) Rocky Pt Bird Observatory (Vancouver Isl.)

6: Research

The PBHJV Science and Technical Committee leads and coordinates research activities among the partners with relevance to JV priorities (e.g., conservation of waterfowl and waterbirds and their habitats). Partnerships are actively sought with universities and other research partners to increase effectiveness and available resources. Research is broadly categorized under the headings of Habitat/Species Models and Conservation Actions.

Habitat/Species Models

TRUEMET Energetic Model

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 for agricultural lands but not yet intertidal. 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.

Research to Address Key Uncertainties

Use of TRUEMET still only applies to the major dabbling and grazing duck species, as well as Lesser Snow Goose. It was not possible to address estuarine-dependent species such as sea ducks and Brant due to a lack of information about energetic resources available in intertidal habitats. Therefore another strategy is needed to develop habitat objectives which more explicitly address the needs of species that feed in estuaries and the intertidal zone. The energy supply/demand relationship of intertidal habitats was mostly excluded from TRUEMET energy supply calculations because current research and analysis is incomplete from these habitats. To address this gap, DUC has initiated research to quantify the energy supply available to sea ducks from various vegetative and aquatic invertebrate food sources.

PECP Estuary Model

Assumptions

- All waterfowl using estuaries are observable via fixed wing aircraft.
- One-time observations of bird density in mid- to late winter are representative of the habitat value of the intertidal zone and freshwater wetlands to waterfowl and other waterbirds.
- Surveys generate an unbiased estimate of population abundance, species distribution, diversity, and habitat use for the entire PBHJV area.
- The distribution of mapped estuaries in available GIS datasets is representative of the habitats that are available for bird use in an average year. This model does not currently address environmental stochasticity or the potential effects of climate change.

Research to Address Key Uncertainties

A pilot project was initiated to predict impacts of climate change related sea level rise (SLR) on important estuaries. The project will model impacts of SLR on vegetative communities in the intertidal and supratidal zones to predict gains and losses of various estuarine habitat types under different SLR scenarios. This will assist the PBHJV in quantifying expected habitat trends and in targeting mitigation. In the US portion of the PBHJV, there has been considerable effort to model SLR effects on estuaries using SLAMM (Sea Level Affecting Marshes Model). SLAMM[111] is a mathematical model which uses digital elevation data and vegetation information to produce GIS simulations of estuary zone changes associated with various SLR scenarios. In Canada, there has been limited use of this model so far due to a lack of suitable imagery.

Sea Duck Models

Assumptions

- Current explanatory-type models explain a satisfactory level of variance in the BCCWS data. (Because the mixed-effects compound Poisson approach is relatively recent, there is no accepted method for determining the percent of variance explained by the model.)
- Current explanatory-type models can be used to predict areas of high sea duck use.

Research to Address 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

[111] Clough et al 2010

abundance for areas that were not included in the model. The PBHJV plans to test the predictive capacity of these models by expressing them spatially and comparing the outputs to another georeferenced dataset which covers a greater portion of the PBHJV (e.g., Figure 24) and which was not included in the model development.

Conservation Actions

Assumptions

- As in other wintering JVs, waterfowl productivity in the PBHJV is better served by focusing on activities that result in increased survival rates (e.g., hen survival) in priority habitats, rather than activities that influence reproductive rates (e.g., nest success).
- Conserving and restoring priority waterfowl habitats via PBHJV programs will have a positive effect on survival rates for most waterfowl and other water-associated birds, and on carrying capacity at the landscape scale, at a measureable level. For example, On-Farm Planning projects which provide extra forage for waterfowl will increase non-breeding (winter) survival.
- The most effective programs are those which target estuaries (especially those with a high proportion of agricultural land), agricultural habitats, and freshwater wetlands.
- The partners are able to accurately identify estuaries with high restoration potential.
- Designating large areas of Provincially owned Crown land as Conservancies and Wildlife Management Areas is an effective means of conserving large areas for the long term. Intertidal habitats secured within provincial Wildlife Management Areas are relatively secure, but may require targeted restoration (e.g., where *Spartina* cordgrass is invading intertidal zones).

Research to Address Key Uncertainties

There is a lack of baseline knowledge of vital rates specific to the PBHJV for most species. Knowledge of population dynamics and resource utilization through the annual cycle is mostly derived from information collected outside the PBHJV. The JV currently lacks the capacity to address inadequate information on demographic parameters.

The sea duck habitat-species models currently under development (p. 81) should help indicate whether there are critical habitats outside existing program delivery areas, as well as enabling insight into sea duck limiting factors. DUC's planned research on intertidal food sources (p. 80) may also shed light on the relative contribution of intertidal habitats to overall waterfowl non-breeding forage needs, particularly for Brant and sea ducks.

The ongoing Joint Venture Decision Support System (JVDSS) will help improve selection of degraded or at-risk habitat areas where the likelihood of successful restoration is high.

In the CIJV, partners have been exploring ways to use survey datasets and project files to compare the value of conserved lands versus non-conserved lands. The process is still developing, but if successful, this information may also be used in the PBHJV to help quantify the value of conservation.

Sensitivity Analyses

Statistical analysis of key parameters (to examine their influence on model results) is a longer-term priority for the JV that will be addressed once habitat-species models are better defined, and improved confidence estimates for key parameters are created. 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.

Spatial Data Analyses

The PBHJV believes its 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 (e.g., SEI mapping) for most of the Joint Venture.
3. Predictive capability for modeling the effects of sea level rise on estuary intertidal zones is still developing.
4. The condition of habitats on conservation lands is not well known due to limitations in capacity to monitor site-specific conditions.
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).

As discussed in Section 5: Monitoring, the PBHJV partners are actively working to address these limitations.

7: Human Dimensions

2012 NAWMP Revision

The NAWMP Revision in 2012[112] included, for the first time, the role of people in the conservation of waterfowl. Goal 3 aims for: "growing numbers of waterfowl hunters, other conservationists and citizens who enjoy and actively support waterfowl and wetlands conservation." 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.

Many PBHJV partners have already embarked on activities that help to achieve Goal 3; however, it has never been explicitly included in reporting of JV activities, nor have these activities always been focused on the specific outcome of waterfowl conservation, though arguably they have that outcome. The PBHJV partners in British Columbia will refine these activities in the upcoming five years, and work with the Human Dimensions Working Group (HDWG) and Public Engagement Team (PET) to implement strategies appropriate for British Columbia.

Human Dimensions Working Group

The Human Dimensions Working Group (HDWG), formed in response to the NAWMP Revision 2012, is developing the scientific and technical foundations to define objectives for hunters, birders, and other potential supporters. The PBHJV Coordinator sits on this committee. With support and input from the PBHJV, the HDWG is finalizing a survey of waterfowl hunters and viewers to understand motivations for wildlife conservation, and factors influencing recruitment and retention of waterfowl hunters and viewers. The PBHJV recruited Dr. Howie Harshaw from the University of Alberta to be the Canadian Joint Venture representative for this activity, to ensure that the Canadian public is actively engaged in Human Dimension studies for NAWMP.

Public Engagement Team

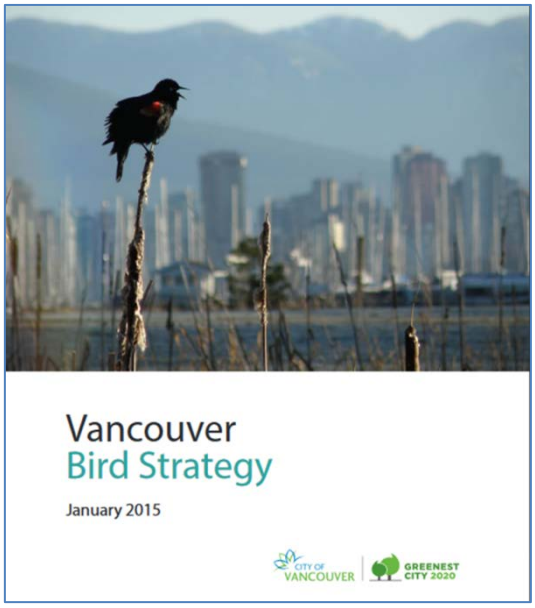
The HDWG survey results will play a significant role in determining how the strategies developed by the Public Engagement Team (PET) will be rolled out to each Joint Venture. The PBHJV Coordinator is actively involved in the PET, and is working with the team to develop and

[112] http://www.nawmprevision.org/sites/default/files/NAWMP-Plan-EN-may23.pdf

coordinate strategies to promote participation in hunting, viewing, and other waterfowl-related recreation. The PET aims to: 1) increase support for waterfowl and wetland conservation, 2) create and maintain communication networks, 3) facilitate development and dissemination of tools to help NAWMP partners engage with broader groups of people interested in waterfowl and habitat conservation.

To identify actions that will meet Goal 3, the PBHJV will be guided by the final strategies and action plan developed by PET. Suitable activities for British Columbia will be identified based on input from the PBHJV Board.

Connecting People to Nature



CONNECTING HUMANS TO NATURE IS HAPPENING AT THE LOCAL GOVERNMENT LEVEL

There are numerous opportunities to connect the public with nature and waterfowl. The Georgia Basin area is home to roughly 3.3 million people–95% of the human population of the PBHJV (BC)–and 75% of all people in British Columbia[113]. Hundreds of thousands of waterfowl also migrate through or winter in the area. At the heart of the area lies the Fraser River Delta, where both waterfowl and people occur in maximum densities and in very close proximity.

Consequently, efforts to secure and enhance habitat for waterfowl within the PBHJV (BC) oftenoccur very near or within population centers. For example, JV partners have frequently worked with local governments to create and secure wetlands within public parks. These parks provide breeding, migration, and wintering habitat for waterfowl, while also encouraging public uses such as hiking, waterfowl viewing, and photography. Environment and Climate Change Canada has announced a National Conservation Plan with the goal of Connecting People To Nature. Some resources have been allocated to achieve this goal, both for EC and for other Joint Venture partners.

Outreach and Public Awareness

Currently, each JV partner conducts outreach or public education according to their own mandate; there is no coordinated strategy for public engagement. Over the next five years, the

[113] Statistics Canada 2012

PBHJV will assess if a more coordinated approach is needed. There is little information about this topic, such as public knowledge about conservation, support for bird (and waterfowl) conservation, numbers of people using JV partner project sites, and types of recreational activities supported. Collecting such information is needed to inform the JV whether a coordinated communication strategy is needed, and if so, to identify target audiences and key messages.

The PBHJV will collect baseline information on current trends in public use of natural wetland spaces. For example, recreational users of local parks that are JV partner project sites will be surveyed. In addition, information from local governments on numbers of park users and recreational activities supported will be collated.

GUIDED BIRDWATCHING EVENT DURING THE TOFINO SHOREBIRD FESTIVAL (PHOTO K. BARRY)

Many PBHJV partners already have extensive outreach networks. For example, Bird Studies Canada runs several citizen 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. All of these programs engage volunteers in various ways to support bird conservation, often by collecting data on bird distributions and population trends.

The PBHJV will make use of this and similar networks to gather and disseminate information, and support the existing networks to ensure they can continue engaging the public. A key challenge will be to ensure that information gathered and messages distributed go beyond current JV partner spheres of influence. Supporters of current partners (e.g., members of DUC, BSC volunteers) are typically already engaged and supportive of bird conservation, and are not representative of the general public.

The PBHJV Board will determine if it needs to reach out to a broader audience, including birdwatchers, nature photographers, outdoor recreationists of all types, First Nations, and those concerned about other environmental issues (e.g., climate change, sustainability). If so, the PBHJV (BC) will need to actively engage and work with additional partners who have connections with these broader groups, and who have experience in public outreach and education.

PUBLIC SIGNS AT SOMENOS MARSH INCLUDE THE FIRST NATIONS NAME OF SEVERAL WATERFOWL AND OTHER SPECIES FOUND IN THE AREA (PHOTO K. BARRY)

Providing and Growing Opportunities for Hunters

Providing opportunity for waterfowl hunters is a challenge in the PBHJV (BC). On the central and north coasts and Haida Gwaii, access is the major limitation. . There are few human settlements, and the people in these communities have limited ability to access all available areas with ducks (due to weather, distances, and boat requirements). First Nations land rights also often limit where non-indigenous people can hunt. The situation is very 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 actively object to 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.

PBHJV partners who are already doing so will continue to work to maintain currently available hunting opportunities. Both provincial and federal wildlife agencies are supportive of continued waterfowl hunting in the Georgia Basin. In the Lower Fraser Valley, a special licensing system

which addresses some concerns (e.g., providing suitable insurance for hunters 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.

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 ha) of the remaining estuarine habitat.

ENCOURAGING PEOPLE TO ENGAGE IN WATERFOWL HUNTING WILL INCREASE CONSERVATION DOLLARS AND AWARENESS OF WATERFOWL CONSERVATION

Another increasing challenge in the Georgia Basin is the conflict between expanding populations of urban resident Canada Geese and wintering Lesser Snow Geese and aviation safety, agricultural interests, recreational users, and land owners/managers. Grazing by these abundant 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 coming under increasing pressure from the public to do something about these geese. The problem geese issue presents an opportunity for PBHJV partners to engage local governments and the public on issues around waterfowl conservation, management, and hunting. Hunting remains one of the best tools to control waterfowl populations and manage their distribution, and these discussions provide a unique opportunity for PBHJV partners to engage local governments on the need to maintain areas open to firearm use. Similarly, they may also serve as a forum for outreach to the public about the role hunting plays in both conservation and management.

When important waterfowl areas overlap with a highly populated urban area, there are opportunities to build stronger relationships between waterfowl, agricultural, hunting, and urban audiences. For example, the Locavore movement (which favours locally-produced foods) would encourage stronger support for local agriculture and waterfowl compatible crops. As well, the emergence of the "urban hunter" who is interested in consuming wild, ethically harvested meat is gaining ground in the Fraser Valley. PBHJV partners will work with these

groups, and others with overlapping interests, such as EatWild.ca and the BC Wildlife Federation to support these efforts.

The PBHJV will also continue to support programs that encourage and support local farmers to grow bird-friendly crops, such as the Delta Farmland and Wildlife Trust (DFWT) and Ducks Unlimited Canada. The increased desire for local food means more opportunity to combine food production and habitat conservation, particularly winter forage for waterfowl.

8: Plan Forward

During development of this IP and reflecting upon past activities, the JV partners identified a number of successes, information gaps, and ongoing challenges (learning opportunities) that will shape both the short and medium term priorities of the PBHJV.

1. **Successes:**
    a. Securement of approximately 23.8% of PBHJV (BC) habitat objectives to date;
    b. PECP Estuary Ranking Model (2007) and subsequent revision (2014);
    c. TRUEMET modelling for Fraser River Delta 2000) and revision (2012);
    d. NGO Conservation Areas Database (2010), the first spatially explicit database of Government and Nongovernment conservation lands in Canada, which has enabled JV partners to quantify degree of conservation over space and time;
    e. 2005 Strategy focusing more resources towards a stronger biological foundation (spatial Planning Units, identifying priority species);
    f. Studies providing insight into disturbance impacts on species such as American Wigeon, Brant, shorebirds;
    g. Development of several models and pilot projects: Sea duck model, Coastal Waterbird Distribution Model, CWS Pelagic Seabird model. While these models are in progress, they are expected to be completed in the short term (1-3 years);
    h. New partnerships with industry and governments to restore wetlands and form partnerships such as the Wetland Stewardship Partnership;
    i. Diversity of partner and partnership planning models that target general habitat conservation and confirm importance of areas:
        i. CWS Coastal Lowlands Regional Conservation Plan,
        ii. Provincial Conservation Framework,
        iii. BC Marine Planning Partnership,
        iv. BC Parks Shoreline Sensitivity Model,
        v. DUC Waterfowl Priority Areas,
        vi. NCC Conservation Planning System,
        vii. BC Marine Conservation Analysis,
        viii. Bird Studies Canada Coastal Waterbirds Abundance Mapping.

2. **Program Challenges:**
    a. Habitat loss is continual in areas such as the Fraser River Delta, where conversion of agricultural land, freshwater wetlands, and estuarine habitat is high. Increasing human population in areas such as Fraser River Delta and east coast of Vancouver Island will intensify habitat loss and degradation;
    b. Sea level rise will increase wetland loss in diked (and typically urbanized) areas of the BC Coast;

c. Concurrently with climate change and urbanization, invasive species continue to spread to key habitats;
d. While much key habitat remains to be secured on private lands (e.g., acquisition of agricultural land and some wetlands), the majority of the habitat objectives are on Crown land. This will require a stronger focus on securement under Crown Designations and Crown Agreements, and increased effectiveness of partner-led Land and Water Policy activities;
e. There is a lack of capacity to deliver the priority program elements of the plan, both in terms of financial and human resources. The JV needs to increase the number and diversity of partnerships to help address program gaps.

3. Data Gaps:

a. The NGO Conservation Areas Database must include appropriate local government and First Nation conservation areas;
b. Trend information must be improved. Finer scale freshwater and tidal wetland trends in time (e.g., 5-10 years) and space are mostly limited to southwest coast. Invasive species (e.g., *Spartina*) that can significantly impact key habitats must also be tracked;
c. Lidar data is necessary to support sea level rise models;
d. Habitat objectives must be further refined spatially, particularly for shallow marine habitats;
e. The TRUEMET model must be run for the east coast of Vancouver Island, including integration of energetic values for natural foods in marine and intertidal areas;
f. There is a lack of demographic information of most waterfowl species (e.g., key population vital rates);
g. Sensitivity analyses should be incorporated into species-habitat models;
h. Partners need to better understand whether conservation programs are making a difference at the landscape and Joint Venture levels (for habitats) and addressing limiting factors at the population and vital rate levels (for species);
i. Partners must also address how to better track habitat condition and incorporate this into conservation design.

Addressing challenges needs to be done within the context of the 2012 NAWMP Revision and its three main objectives[114]: population, habitat and supporters. The overall population objective does not explicitly include the PBHJV because wintering and migrating areas are not major contributors to the population objective. The overall habitat objective to: "conserve a system with capacity to maintain long-term average waterfowl population levels that periodically supports 40 million or more breeding ducks, and consistently supports resource

[114] http://nawmprevision.org/sites/default/files/NAWMP_Revised_Objectives_North_American_Waterfowl_Management_Plan_Final_9-22-14.pdf

users at objective levels" will be supported by the PBHJV's approach to conservation. The integrity of continental breeding populations cannot be maintained without equal consideration of the needs of birds during wintering and migrant periods. The supporter objective to: "increase waterfowl conservation support among various constituencies to at least the levels experienced during the last two decades" will be addressed via our still-developing Human Dimensions programs and projects.

4. Priorities

IP Section	Component/Action	Priority	Time Period
Biological Planning	All-bird Implementation Plan	1	L
Conservation Design	Models in progress: TRUEMET, Sea duck model, Coastal Waterbird Distribution Model , CWS Pelagic Seabird model	1	S
	Initial functioning Joint Venture Securement and Restoration DSS tool	2	S
	Refine the securement, stewardship and restoration objectives for all four habitat types	2	M
	Better quantify restoration objectives based on models or inventory	3	M
	NGO Conservation Database		
Habitat Delivery	Maintain current securement, restoration and management progress and current funding levels	1	S,M,L
	Expand to undertake program delivery through additional partners, e.g., industry funding through habitat mitigation	1	S,M,L
	Develop programs to reduce the high abundance species	2	M
	Incorporate the identification, recognition and protection of wetlands and estuaries into appropriate government legislation	1	L
	Increase Crown Designation of Crown wetlands and estuaries	1	S,M,L
	Complete JV Communications plan which would integrate conservation programs to facilitate achieving JV objectives.	1	S
Monitoring	Wetland trends (broad scale)	2	M
	Wetland trends (fine scale outside Priority Areas)	3	L
	Continue population monitoring programs	1	S,M,L
	Baseline demographic parameters	2	L
Research	Further investigate conservation program effectiveness / address limiting factors	2	M
	Sea Level rise modeling	2	M
Human Dimensions	Incorporate human dimensions into other aspects of conservation design and delivery through Working Group and Public Engagement Team	1	S,M,L

The entire PBHJV is currently undergoing a process to increase the coordination of activities between the Canadian and US portions. To date, the overall direction of the JV has been coordinated by an international Management Board, but specific activities were determined and led by regional steering committees, including the BC Steering Committee. Partners have expressed a desire for greater information-sharing and joint cross-regional projects, and are working to make this a reality.

Partners are 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 waterfowl and waterbirds in the PBHJV, the JV is exploring the use of Miradi software[115]. This software was developed to assist with conservation planning, and it utilizes Open Standards for the practice of conservation[116] developed by the Conservation Measures Partnership (CMP). These Open Standards are organized into a number of steps which formalize the concept of an adaptive management planning and delivery cycle (Figure 24). It is anticipated that the Open Standards approach can help break this Implementation Plan down into a workplan that can better direct and engage partners when it comes to implementing NAWMP in the BC PBHJV. Another goal is to work with the PBHJV as a whole to create an international Implementation Plan to guide activities across the entire coastline, from Alaska to Northern California and Hawaii.

Figure 25: Open Standards for the Practice of Conservation

[115] https://miradi.org
[116] http://cmp-openstandards.org

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Appendix 1: Breakdown of PBHJV (BC) Planning Areas

Planning Area	Sub-planning Area	Base Unit Name	Base Unit Type
Southwestern British Columbia	Lowland & Intertidal Marine	Fraser Lowland	Ecosection
		Nanaimo Lowland	
		Georgia Lowland	
		Shallow Marine (high tide to 20m depth)	Ecounit
	Mountains	Leeward Island Mountains	Ecosection
		Eastern Pacific Ranges	
		Southern Pacific Ranges	
		Northwestern Cascade Ranges	
	Deep Marine	Photic Marine (20 – 50m depth)	Ecounit
		Mid-depth Marine (50 – 200m depth)	
		Deep Marine (200 – 1000m depth)	
Northern and Western Vancouver Island	Lowland & Intertidal Marine	Nahwitti Lowland	Ecosection
		Shallow Marine (high tide to 20m depth)	Ecounit
	Mountains	Northern Island Mountains	Ecosection
		Windward Island Mountains	
	Deep Marine	Photic Marine (20 – 50m depth)	Ecounit
		Mid-depth Marine (50 – 200m depth)	
		Deep Marine (200 – 1000m depth)	
Northern and Central Mainland	Lowland & Intertidal Marine	Hecate Lowland	Ecosection
		Outer Fiordland	
		Shallow Marine (high tide to 20m depth)	Ecounit
	Mountains	Central Boundary Ranges	Ecosection
		Central Pacific Ranges	
		Cranberry Upland	
		Kimsquit Mountains	
		Kitimat Ranges	
		Meziadin Mountains	
		Nass Basin	
		Nass Mountains	
		Northern Boundary Ranges	
		Northern Pacific Ranges	
		Southern Boundary Ranges	
	Deep Marine	Photic Marine (20 – 50m depth)	Ecounit
		Mid-depth Marine (50 – 200m depth)	
		Deep Marine (200 – 1000m depth)	
Queen Charlotte Islands	Lowland & Intertidal Marine	Queen Charlotte Lowland	Ecosection
		Shallow Marine (high tide to 20m depth)	Ecounit
	Mountains	Queen Charlotte Ranges	Ecosection
		Skidegate Plateau	
	Deep Marine	Photic Marine (20 – 50m depth)	Ecounit
		Mid-depth Marine (50 – 200m depth)	
		Deep Marine (200 – 1000m depth)	
Pacific Offshore		Continental Slope	Ecosection
		Sub-Arctic Pacific	
		Transitional Pacific	
		Deep Marine (200 – 1000m depth)	Ecounit
		Abyssal Marine (> 1000m depth)	

Appendix 2: PBHJV (BC) Waterfowl Species Rankings

Priority Waterfowl Species	PCJV Strategic Plan[1]			BC Conservation Framework[2]			NAWMP Implementation Framework[3]		
Species – Regional Population	*Continental Concern*	*Regional Concern*	*Steward -ship*	*Goal 1*	*Goal 2*	*Goal 3*	*Continental Priority*	*NonBreed Import*	*NonBreed Need*
Lesser Snow Goose - Wrangel Isl. popn.	√						Mod H	High	High
Pacific Brant	√			6	2	3	High	High	Highest
Cackling Goose			M	6	6	4	High	High	Highest
Canada Goose - resident urban geese			M	6	6	6	Mod	Mod H	Mod H
Canada Goose - Lesser (*parvipes ssp*)							High	High	Highest
Canada Goose - Dusky (*occidentalis ssp)*	√			3	6	2	High	High	Highest
Canada Goose - Vancouver (*fulva ssp)*		√					Mod	High	High
Trumpeter Swan - Pacific Coast popn.			√	5	6	5	Mod L	High	High
Wood Duck			M	6	1	3	Mod	Mod L	Mod L
American Wigeon	√			6	6	6	Mod H	High	High
Mallard			M	6	6	5	High	Mod H	High
Northern Pintail	√			6	2	4	High	Mod H	High
Greater Scaup		√		6	2	4	Mod	High	High
Lesser Scaup		M		6	2	4	High	Mod H	High
Harlequin Duck		√		4	1	3	Mod	High	High
Surf Scoter	√			6	4	4	Mod H	High	High
White-winged Scoter	√			6	6	5	Mod H	High	High
Black Scoter	√			6	2	4	Mod H	Mod H	Mod H
Long-tailed Duck		M		6	6	2			
Bufflehead		√		6	6	6	Mod	High	High
Barrow's Goldeneye			√	4	1	3	Mod	High	High

Non-Priority Waterfowl Species	PCJV Strategic Plan[1]			BC Conservation Framework[2]			NAWMP Implementation Framework[3]		
Species – Regional Population	*Continental Concern*	*Regional Concern*	*Steward -ship*	*Goal 1*	*Goal 2*	*Goal 3*	*Continental Priority*	*NonBreed Import*	*NonBreed Need*
Greater White-fronted Goose				5	4	5	Mod L	High	High
Mute Swan				6	6	6			
Tundra Swan – Western popn.				6	6	4	Mod L	High	High
Gadwall				6	6	6	Mod	Mod L	Mod L
Eurasian Wigeon									
Blue-winged Teal				6	2	4	Mod H		
Cinnamon Teal				6	4	5	Mod H		
Northern Shoveler				6	6	6	Mod	Mod H	Mod H
Green-winged Teal				6	6	5	Mod	Mod H	Mod H
Canvasback				6	2	4	Mod H	Mod H	Mod H
Ring-necked Duck				6	6	6	Mod	Mod L	Mod L
Common Goldeneye				6	3	4	Mod H	Mod H	Mod H
Hooded Merganser				6	6	6			
Common Merganser				6	6	5			
Red-breasted Merganser				6	4	5	Mod L	Mod H	Mod
Ruddy Duck				6	6	6	Mod L	Mod H	Mod

1 √ denotes species fits category during wintering and migration periods; M denotes migration period only.

2 The BC Conservation Framework ranks the conservation needs of species and/or ecosystems under three different goals: Goal 1: Contribute to global efforts for species and ecosystem conservation; Goal 2: Prevent species and ecosystems from becoming at risk; Goal 3: Maintain the diversity of native species and ecosystems. 1 is highest priority, 6 is lowest. Scores are current as of August 2014.

3 Species rankings from the North American Waterfowl Management Plan[117], for Waterfowl Conservation Region 5, which encompasses the PBHJV (BC) area.

[117] North American Waterfowl Management Plan 2004

Appendix 3: PBHJV (BC) Non-Waterfowl Priority Species in All Habitats

Priority species[1]	Pillar group	Population objective	COSEWIC[2]	SARA[3]	British Columbia provincial listing
White-tailed Ptarmigan (*saxatilis*)	Landbird	Assess / Maintain			Blue (*saxatilis*)
Sooty Grouse	Landbird	Increase 100%			Blue
Common Loon	Waterbird	Assess / Maintain			
Yellow-billed Loon	Waterbird	Assess / Maintain			Blue
Horned Grebe	Waterbird	Assess / Maintain	SC		
Western Grebe	Waterbird	Increase 100%			Red
Laysan Albatross	Waterbird	Assess / Maintain			Blue
Black-footed Albatross	Waterbird	Assess / Maintain	SC	SC	Blue
Short-tailed Albatross	Waterbird	Recovery objective	T	T	Red
Northern Fulmar	Waterbird	Assess / Maintain			Red
Pink-footed Shearwater	Waterbird	Recovery objective	T	T	Blue
Flesh-footed Shearwater	Waterbird	Assess / Maintain			Blue
Buller's Shearwater	Waterbird	Assess / Maintain			Blue
Manx Shearwater	Waterbird	Assess / Maintain			
Leach's Storm-Petrel	Waterbird	Assess / Maintain			
Brandt's Cormorant	Waterbird	Assess / Maintain			Red
Double-crested Cormorant	Waterbird	Assess / Maintain			Blue
Pelagic Cormorant	Waterbird	Assess / Maintain			Red (*pelagicus*)
American Bittern	Waterbird	Assess / Maintain			Blue
Great Blue Heron (*fannini*)	Waterbird	Assess / Maintain	SC (*fannini*)	SC (*fannini*)	Blue (*fannini*)
Green Heron	Waterbird	Assess / Maintain			Blue
Black-crowned Night-Heron	Waterbird	Assess / Maintain			Red
Bald Eagle	Landbird	Assess / Maintain			
Northern Harrier	Landbird	Assess / Maintain			
Cooper’s Hawk	Landbird	Increase 100%			
Northern Goshawk (*laingi*)	Landbird	Recovery objective	T (*laingi*)	T (*laingi*)	Red (*laingi*)
Rough-legged Hawk	Landbird	Assess / Maintain			Blue

Priority species[1]	Pillar group	Population objective	COSEWIC[2]	SARA[3]	British Columbia provincial listing
Black-bellied Plover	Shorebird	Assess / Maintain			
American Golden-Plover	Shorebird	Migrant (no population objective)			Blue
Black Oystercatcher	Shorebird	Assess / Maintain			
Wandering Tattler	Shorebird	Migrant (no population objective)			Blue
Whimbrel	Shorebird	Migrant (no population objective)			
Long-billed Curlew	Shorebird	Recovery objective	SC	SC	Blue
Marbled Godwit	Shorebird	Assess / Maintain			
Ruddy Turnstone	Shorebird	Assess / Maintain			
Black Turnstone	Shorebird	Assess / Maintain			
Surfbird	Shorebird	Assess / Maintain			
Red Knot	Shorebird	Migrant (no population objective)	T (*roselaari*)	T (*roselaari*)	Red
Sanderling	Shorebird	Assess / Maintain			
Western Sandpiper	Shorebird	Assess / Maintain			
Rock Sandpiper	Shorebird	Assess / Maintain			
Dunlin	Shorebird	Assess / Maintain			
Short-billed Dowitcher	Shorebird	Assess / Maintain			Blue
Wilson's Phalarope	Shorebird	Assess / Maintain			
Red-necked Phalarope	Shorebird	Assess / Maintain			Blue
Heermann's Gull	Waterbird	Assess / Maintain			
Western Gull	Waterbird	Assess / Maintain			
California Gull	Waterbird	Assess / Maintain			Blue
Thayer's Gull	Waterbird	Assess / Maintain			
Glaucous-winged Gull	Waterbird	Assess / Maintain			
Caspian Tern	Waterbird	Assess / Maintain			Blue
Black Tern	Waterbird	Increase 50%			
Common Tern	Waterbird	Migrant (no population objective)			
Common Murre	Waterbird	Assess / Maintain			Red
Thick-billed Murre	Waterbird	Assess / Maintain			Red

Priority species[1]	Pillar group	Population objective	COSEWIC[2]	SARA[3]	British Columbia provincial listing
Pigeon Guillemot	Waterbird	Assess / Maintain			
Marbled Murrelet	Waterbird	Recovery objective	T	T	Red
Xantus's Murrelet	Waterbird	Assess / Maintain			
Ancient Murrelet	Waterbird	Assess / Maintain	SC	SC	Blue
Cassin's Auklet	Waterbird	Assess / Maintain			Blue
Rhinoceros Auklet	Waterbird	Assess / Maintain			
Horned Puffin	Waterbird	Assess / Maintain			Red
Tufted Puffin	Waterbird	Assess / Maintain			Blue
Band-tailed Pigeon	Landbird	Increase 50%	SC	SC	Blue
Barn Owl	Landbird	Assess / Maintain	T	SC	Blue
Western Screech-Owl (*kennicottii*)	Landbird	Assess / Maintain	SC (*kennicottii*)	SC (*kennicottii*)	Blue (*kennicottii*)
Snowy Owl	Landbird	Assess / Maintain			Blue
Northern Pygmy-Owl	Landbird	Assess / Maintain			Blue (*swarthi*)
Spotted Owl	Landbird	Recovery objective	E	E	Red
Short-eared Owl	Landbird	Assess / Maintain	SC		Blue
Northern Saw-whet Owl (*acadicus)*	Landbird	Assess / Maintain			
Northern Saw-whet Owl (*brooksi*)	Landbird	Assess / Maintain	T (*brooksi*)	T (*brooksi*)	Blue (*brooksi*)
Common Nighthawk	Landbird	Assess / Maintain	T	T	
Black Swift	Landbird	Increase 100%			
Vaux's Swift	Landbird	Assess / Maintain			
Rufous Hummingbird	Landbird	Increase 100%			
Belted Kingfisher	Landbird	Assess / Maintain			
Lewis’s Woodpecker	Landbird	Increase	T	SC	Red
Red-breasted Sapsucker	Landbird	Increase 50%			
Hairy Woodpecker	Landbird	Assess / Maintain			Blue (*picoideus*)
Gyrfalcon	Landbird	Assess / Maintain			Blue
Peregrine Falcon (*anatum*)	Landbird	Assess / Maintain	T (*anatum*)	T (*anatum*)	Red (*anatum*)
Peregrine Falcon (*pealei*)	Landbird	Assess / Maintain	SC (*pealei*)	SC (*pealei*)	Blue (*pealei*)
Olive-sided Flycatcher	Landbird	Increase 100%	T	T	Blue
Western Wood-Pewee	Landbird	Increase 100%			

Priority species[1]	Pillar group	Population objective	COSEWIC[2]	SARA[3]	British Columbia provincial listing
Willow Flycatcher	Landbird	Increase 100%			
Pacific-slope Flycatcher	Landbird	Assess / Maintain			
Cassin's Vireo	Landbird	Increase 50%			
Hutton's Vireo	Landbird	Maintain current			
Steller's Jay	Landbird	Assess / Maintain			Blue (*carlottae*)
Northwestern Crow	Landbird	Assess / Maintain			
Horned Lark (*strigata*)	Landbird	Recovery objective	E	E	Red
Purple Martin	Landbird	Assess / Maintain			Blue
Violet-green Swallow	Landbird	Assess / Maintain			
Barn Swallow	Landbird	Increase 100%	T		Blue
Chestnut-backed Chickadee	Landbird	Assess / Maintain			
Pacific Wren	Landbird	Assess / Maintain			
Golden-crowned Kinglet	Landbird	Increase 100%			
Western Bluebird	Landbird	Increase			Red
Varied Thrush	Landbird	Assess / Maintain			
Orange-crowned Warbler	Landbird	Increase 100%			
MacGillivray's Warbler	Landbird	Increase 50%			
Black-throated Gray Warbler	Landbird	Assess / Maintain			
Townsend's Warbler	Landbird	Assess / Maintain			
Spotted Towhee	Landbird	Assess / Maintain			
Vesper Sparrow (*affinis*)	Landbird	Recovery objective	E (*affinis*)	E (*affinis*)	Red (*affinis*)
Western Meadowlark	Landbird	Increase			Red
Rusty Blackbird	Landbird	Assess / Maintain	SC	SC	Blue
Bullock's Oriole	Landbird	Increase 100%			
Pine Grosbeak (*carlottae*)	Landbird	Assess / Maintain			Blue (*carlottae*)
Purple Finch	Landbird	Increase 50%			
Red Crossbill	Landbird	Increase 50%			
Pine Siskin	Landbird	Increase 100%			

[1] All non-waterfowl priority species were taken from Environment and Climate Change Canada's BCR 5 Conservation Strategy[118]. Details of the priority species selection process, as well as the derivation of population objectives, are outlined in that document.
[2] Species' assessment status by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC); SC – Special Concern; T – Threatened; E – Endangered.
[3] Species status under the federal *Species at Risk Act* (SARA).

[118] Environment Canada 2013

Appendix 4: Estimated Waterfowl Populations in the PBHJV (BC)

Priority Species	PBHJV Midwinter Population Estimate[1]	Data Confidence	Habitats Used					
			Shallow	Estuary	Freshwater Wetland	Commercial Agricultural Land	Agricultural-Residential Mix	Urban
Greater White-fronted Goose	500	Medium		100		100	300	
Lesser Snow Goose (Wrangel Isl population)	67,000	High		30,000		37,000		
Pacific Brant	2,500	High	2,500					
Canada Goose	30,000	Medium	1,000	12,000	3,000	6,000	3,000	5,000
Cackling Goose (*Branta hutchinsii*)								
Canada Goose – resident urban population								
Canada Goose – Lesser (*parvipes ssp*)								
Canada Goose – Dusky (*occidentalis ssp*)								
Canada Goose – Vancouver (*fulva ssp*)								
Mute Swan	250	Medium		125	50		50	25
Trumpeter Swan (Pacific Coast population)	8,000	High	200	2,000	300	5,500		
Tundra Swan (Western population)	150	Medium		30		120		
Wood Duck	4,000	Low		500	2,000	500	700	300
Gadwall	2,000	Low		500	1,500			
American Wigeon	135,000	Medium	10,000	100,000	1,000	20,000	1,000	3,000
Eurasian Wigeon	500	Medium		300		100		100
Mallard	104,000	Medium	10,000	65,000	10,000	15,000	2,000	2,000
Blue-winged Teal	100	Medium		50	50			
Cinnamon Teal	100	Medium		50	50			
Northern Shoveler	2,000	Medium		1,000	1,000			
Northern Pintail	59,000	Medium	5,000	44,000		10,000		
Green-winged Teal	20,000	Medium	2,000	10,000	3,000	2,500	2,000	500
Canvasback	600	Low		500	100			
Ring-necked Duck	4,000	Low	2,000	1,000	1,000			

Priority Species	PBHJV Midwinter Population Estimate[1]	Data Confidence	Habitats Used					
			Shallow	Estuary	Freshwater Wetland	Commercial Agricultural Land	Agricultural-Residential Mix	Urban
Scaup spp.	32,000	Medium	10,000	20,000	1,000			1,000
Harlequin Duck	25,000	low	25,000					
Surf Scoter	270,000	Low	250,000	20,000				
White-winged Scoter	34,000	Low	30,000	4,000				
Black Scoter	10,500	Low	10,000	500				
Long-tailed Duck	15,000	Low	14,500	500				
Bufflehead	45,000	Medium	25,000	15,000	4,000			1,000
Common Goldeneye	32,000	Medium	30,000	2,000				
Barrow's Goldeneye	70,000	Medium	60,000	10,000				
Hooded Merganser	6,700	Low	5,000	1,000	500			200
Common Merganser	35,000	Medium	25,000	7,500	2,500			
Red-breasted Merganser	3,500	Medium	3,000	500				
Ruddy Duck	500	Low		500				
ALL	**1,018,900**		**520,200**	**348,655**	**31,050**	**96,820**	**9,050**	**13,125**

[1] Waterfowl population objectives are based on "no net loss"; therefore population objectives are set to equal to current mid-winter population estimates.

Appendix 5: ENGO Securement Organizations and Areas

Securement Organization	Main Securement Type			
	Fee Simple (ha)	Covenants & Other Registered Interests [2] (ha)	Agreements & Other Unregistered Interests [3] (ha)	Total (ha)
Abbotsford Land Trust Society		0.6		0.6
American Friends of Canadian Land Trusts		5.8		5.8
Bowen Island Conservancy		1.7		1.7
Bowen Island Local Trust Committee		9.4		9.4
Brown Property Preservation Society		18.9		18.9
Canadian Wildlife Service		28.0		28.0
Comox Strathcona Natural History Society		4.3		4.3
Comox Valley Land Trust		110.5		110.5
Conservancy Hornby Island		23.5		23.5
Cowichan Land Trust		98.6		98.6
Denman Conservancy Association	124.2	196.2		320.4
Ducks Unlimited Canada	2,815.7	307.1	6,119.2	9,242.0
Gabriola Historical and Museum Society		0.2		0.2
Gabriola Island Local Trust Committee		15.7		15.7
Gabriola Land and Trails		131.9		131.9
Galiano Conservancy Association	177.8	216.7		394.5
Galiano Island Local Trust Committee		43.4		43.4
Galiano Local Trust Committee		10.9		10.9
Gambier Island Conservancy		149.1		149.1
Garry Oak Meadow Preservation Society		1.5		1.5
Habitat Acquisition Trust	1.0	1,631.9		1,632.9
Islands Trust Fund Board	657.8	640.5		1,298.3
Lasqueti Island Nature Conservancy		57.6		57.6
Mayne Island Conservancy Society		0.5		0.5
Mayne Island Trust Committee		0.5		0.5
Nanaimo & Area Land Trust		260.3		260.3
Nature Conservancy of Canada	1,008.1	451.5		1,459.6
North Pender Island Local Trust Committee		53.3		53.3
Pender Islands Conservancy Association		25.1		25.1
Quadra Island Conservancy &Stewardship Society	23.0	127.3		150.3
Rosewall-Bonnel Land Trust Society		1.0		1.0
Salt Spring Island Conservancy	235.4	310.1		545.5
Salt Spring Island Local Trust Committee		268.9		268.9
Salt Spring Island Water Preservation	210.7	43.5		254.2
Sunshine Coast Conservation Association		149.1		149.1
The Galiano Club	345.4			345.4
The Land Conservancy of BC	440.8	4,849.6		5,290.4
The Nature Trust of BC	4,428.8	361.8		4,790.6
Wild Bird Trust	5.1	0.3		5.4
Total Area (ha) [1]	**10,473.8**	**10,606.8**	**6,119.2**	**27,199.8**

[1] Total areas may not equal values in Table 8 due to overlapping tenures.
[2] The area value is calculated for the entire parcel, which may overestimate the actual interest.
[3] The area value was not calculated using GIS. It was sourced from Ducks Unlimited Canada's project database.

Appendix 6: Habitat Objectives by Planning Area

Habitat Type	Program	PBHJV (BC)	Southwest BC	Northwest Vancouver Island	Northern and Central Mountains	Queen Charlotte Islands	Pacific Offshore
		Area (ha)	*Area (ha)*				
Agricultural Land	Securement	**3,120**	3,120	-	-	-	-
	Stewardship	**1,640**	1,640	-	-	-	-
	Restoration	**1,980**	1,980	-	-	-	-
Freshwater Wetland	Securement / Stewardship	**249,450**	64,056	27,119	97,420	60,855	-
	Restoration	**24,945**	6,405	2,712	9,742	6,085	-
Estuarine	Securement / Stewardship	**74,585**	34,536	4,871	31,923	3,255	
	Restoration	**7,460**	3,455	485	3,195	325	
Shallow Marine	Securement / Stewardship	**155,500**	66,700	26,000	43,500	19,300	-
	Restoration	**-**	-	-	-	-	-
ALL	**Securement / Stewardship**	**484,310**	**169,541**	**57,244**	**173,910**	**83,380**	**35**
	Restoration	**34,385**	**11,787**	**3,124**	**13,041**	**6,408**	**4**

Appendix 7: Acronyms & Abbreviations

Abbreviation	Translation
ALC	Agricultural Land Commission
ALR	Agricultural Land Reserve
AOU	American Ornithologists' Union
BBS	Breeding Bird Survey
BC	British Columbia
BCBBA	British Columbia Breeding Bird Atlas
BCCWS	British Columbia Coastal Waterbirds Survey
BCMCA	BC Marine Conservation Analysis
BCR	Bird Conservation Region
BMP	Best Management Practices
BSC	Bird Studies Canada
BTM	Baseline Thematic Mapping
CAD	BC ENGO Conservation Areas Database
CB	Conservation Blueprint
CBC	Christmas Bird Count
CF	Conservation Framework
CIJV	Canadian Intermountain Joint Venture
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DFWT	Delta Farmland and Wildlife Trust
DUC	Ducks Unlimited Canada
DUI	Ducks Unlimited International
EC	Environment and Climate Change Canada
ECVI	East Coast of Vancouver Island
ENGO	Environmental Non-Governmental Organization
EOSD	Earth Observation for Sustainable Development
ERA	Ecoregional Assessment
EEZ	Exclusive Economic Zone
FDNPS	Fraser Delta-North Puget Sound
GIS	Geographic Information System
HS models	Habitat-Species Models
IP	Implementation Plan
JV	Joint Venture
JVDSS	Joint Venture Decision Support System
LIS	Land Information System
MFLNRO	BC Ministry of Forests, Lands and Natural Resource Operations
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

Abbreviation	Translation
NCC	Nature Conservancy Canada
NPLCC	North Pacific Landscape Conservation Cooperative
NTS	National Tracking System
NWA	National Wildlife Area
PCJV	Pacific Coast Joint Venture
PBHJV	Pacific Birds Habitat Joint Venture
PBHJV (BC)	British Columbia Pacific Birds Habitat Joint Venture
PECP	Pacific Estuary Conservation Program
PIF	Partners in Flight
PT	Population Trend
SARA	Species at Risk Act
SFU	Simon Fraser University
SLR	Sea level rise
SLAMM	Sea Level Affecting Marshes Model
SWBC	Southwest British Columbia
TFN	Tsawwassen First Nation
TNT	The Nature Trust of British Columbia
USFWS	United States Fish and Wildlife Service
VICLMP	Vancouver Island Conservation Land Management Program
WMA	Wildlife Management Area
WSP	Wetland Stewardship Partnership