Status and Distribution of Marine Birds and Mammals in Burrard Inlet and Indian Arm, British Columbia 2011-13

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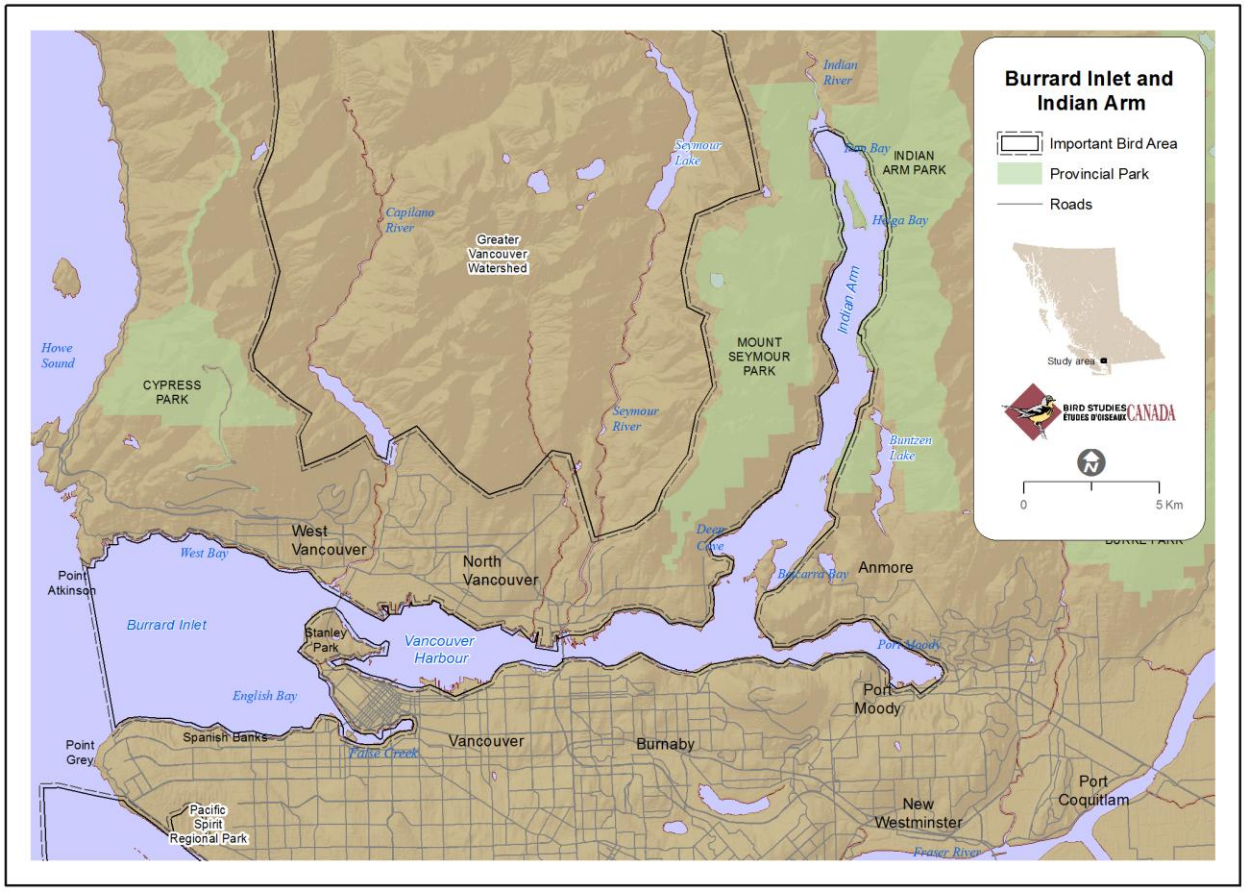

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The data from this survey are publicly available for download at www.naturecounts.ca

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Executive Summary

Burrard Inlet and Indian Arm is the site of the largest port in Canada, Port Metro Vancouver. On Vancouver's doorstep, the area is subject to numerous uses and pressures, including shipping, industry, urban development, and recreation. The area is very important for waterbirds. In fact, the presence of large numbers of waterfowl, gulls, and herons of conservation significance using Burrard Inlet and Indian Arm led to its designation as an Important Bird Area in the late 1990s. There are 16 regularly occurring species of birds and mammals that are federally designated as Endangered, Threatened, or Special Concern, or provincially Red- or Blue-listed by the government of British Columbia in Burrard Inlet and Indian Arm.

We report on a systematic, boat-based survey made about each month between 31 December 2011 and July 25, 2013 of all marine birds (48) and mammals (2) observed on the marine waters of Burrard Inlet and Indian Arm. Our purpose was to document the seasonal abundance and distribution of birds and mammals through a year. We compare the results with existing information on the distribution, abundance and conservation of marine birds and mammals in the wider surrounding region. Our key findings indicate:

- Several designated Species at Risk were present in parts of Burrard Inlet and Indian Arm including Harbour Porpoise, Marbled Murrelet, Peregrine Falcon, and Great Blue Heron.
- The shoreline was used by important numbers of diving ducks and gulls, in particular the Surf Scoter, Barrow's Goldeneye and Glaucous-winged Gull.
- Large declines among Western Grebes and Marbled Murrelets, and possibly several other species, reflect changes noted in the region.
- Bridges across First and Second Narrows, and False Creek are used by important numbers of nesting Pelagic and Double-crested Cormorants.

Many marine bird and mammal species of conservation concern occur as seasonal visitors in the Burrard Inlet and Indian Arm. Natural and anthropogenic drivers of their population trends are region-wide, requiring broad action and collaboration with other agencies. Key linkages to be made are with Fisheries and Oceans Canada to better understand regional trends in forage and predator fish populations, and linkages between these and marine birds and mammals; NGOs and academic groups conducting monitoring and science-based research, including Simon Fraser University, University of British Columbia, Bird Studies Canada, and the BC Cetacean Sightings and Orca Networks; and Recovery Teams for SARA-listed Species at Risk. A broader marine atlas is needed to improve understanding of bird distribution, abundance, and movements within this dynamic environment.

1. Introduction

1.1 Background and context

Burrard Inlet and Indian Arm is the site of the largest port in Canada (Port Metro Vancouver 2015) and the backdrop to the most photographed and picturesque views of the city of Vancouver. The region is culturally important to indigenous people who have a centuries-old record of the presence of birds in their archeological record (Trost 2005, Morin 2015) and to birdwatchers seeking species characteristic to the west coast of Canada and the Pacific Northwest (Kautesk 1977). The City of Vancouver passed a Bird Friendly Strategy in 2015 with goals to enhance habitats and to provide bird-appreciation opportunities to city residents and visitors.

Burrard Inlet and Indian Arm is an extension of the Salish Sea ecosystem that holds several globally and internationally important numbers of birds (Butler and Vermeer 1989, Butler 2009). Less well known is that the abundance and diversity of several species of birds in Burrard Inlet and Indian Arm are globally and nationally important (Bird Studies Canada 2000-2015).

Despite the abundance of birds in the Salish Sea, several surveys suggest the region is witnessing a significant decline of some species (Bower 2009, Anderson et al. 2009, Crewe et al. 2012). Vilchis et al. (2015) found long term declines most pronounced among some seabirds (alcids) and grebes that specialize on small fish for prey. They posited that the changes in bird numbers might signal large ecological changes to the food web. Brown and Gaydos's (2007) review of the potential threats to wildlife in the Salish Sea included human disturbance, underwater acoustics and oil spills from increased shipping to and from ports in Vancouver and Washington, and a variety of ecological changes.

The purpose of this report is to present results of a year-round census from 2011-13, and compare with historical information on the distribution and abundance of marine birds and mammals in Burrard Inlet and Indian Arm, and the Salish Sea. The project builds on similar work conducted within the Southern Gulf Islands of British Columbia (Davidson et al. 2010).

Table 1. Regularly occurring marine bird and mammal species of conservation priority in Burrard Inlet and Indian Arm.

Scientific Name	Common Name	COSEWIC Status[1]	BC CDC Status[2]	SARA Status[3]
Podiceps auritus	Horned Grebe	SC	Yellow	No status
Aechmophorus occidentalis	Western Grebe	SC	Red	No status
Phalacrocorax auritus	Double-crested Cormorant – Pacific Coast subspecies	Not at risk	Blue	No status
Phalacrocorax penicillatus	Brandt's Cormorant	N	Red	
Ardea herodias fannini	Great Blue Heron – Pacific Coast subspecies	SC	Blue	SC
Clangula hyemalis	Long-tailed Duck	N	Blue	
Melanitta perspicilliata	Surf Scoter	N	Blue	
Melanitta americana	Black Scoter	N	Blue	
Falco peregrinus pealei	Peregrine Falcon – Pacific subspecies	SC	Blue	SC
Larus californicus	California Gull	N	Blue	
Uria aalge	Common Murre	N	Red	
Brachyramphus marmoratus	Marbled Murrelet	T	Blue	T
Orcinus orca Pop. 5	Killer Whale – Southern Resident Population	E	Red	E
Orcinus orca Pop. 3	Killer Whale – Transient Population	T	Red	T
Eschrichtius robustus	Gray Whale	SC	Blue	SC
Phocoena phocoena	Harbor Porpoise	SC	Blue	SC
Mirounga angustirostris	Elephant Seal	Not at risk	Red	

[1] Committee on Species of Endangered Wildlife in Canada listing (www.cosewic.gc.ca): E =Endangered; T = Threatened; SC = Special Concern; N = not assessed

[2] BC Conservation Data Centre listing (www.env.gov.bc.ca/cdc/): Red is the provincial equivalent of the federal Endangered and Threatened categories; Blue is equivalent to Special Concern; Yellow indicates not at risk.

[3] Species at Risk Act assessment (http://www.registrelep-sararegistry.gc.ca/species/schedules_e.cfm?id=1)

Sources: Birds (this study); Killer Whales (CBC 2013), Elephant Seal (R.W. Butler pers. comm.).

1.2 Previous studies

The earliest records of birds come from the archeological literature; these indicate long term presence of many species of birds seen in the inlet today (Trost 2005, Morin 2015). Campbell et al. (1972a) summarized records for all species of birds seen in the Vancouver region in 1970, including Burrard Inlet and Indian Arm. Kautesk (1977) described the birds using the waters of Stanley Park mostly to direct visiting birdwatchers to viewing opportunities. Hanrahan (1994) summarized the seasonal abundance of birds seen in Port Moody Inlet in 1992. The Vancouver Natural History Society (1995) provided the first anecdotal summary of the birds for the entirety of Burrard Inlet and Indian Arm. This report was followed by a summary of shore and boat-based counts by Breault and Watts (1996) of birds in Burrard Inlet and Indian Arm between September and June, which provided a comparison. The Stanley Park Ecology Society conducted several studies of bird distributions and abundance in the waters around Stanley Park and compared results between 2001-02 and 2010-11 (Worcester 2013); Straker (2014) tallied heron and eagle nests.

There have been many studies of the biology, behaviour and numbers of several species within the study area. Savard (1998) investigated territorial behaviour of Barrow's Goldeneyes in Stanley Park, Plath (1994, 1997) documented breeding by Purple Martins in Burrard Inlet, and Boyd and Esler (2011) tracked movements of Barrow's Goldeneye fitted with satellite transmitters between the study area and their breeding grounds and moulting lakes in the interior of BC. Cook (2008) summarized the location of eagle nests on the North Shore. Information on the trends of various species in the region includes waterbird population trends in Padilla Bay, Washington (Anderson et al. 2009), the Salish Sea (Vilchis et al. 2015), the Strait of Georgia (Crewe et al. 2012), and Puget Sound (Nysewander et al. 2001; Bower 2009).

2. Study Area and Methods

2.1 Study Area

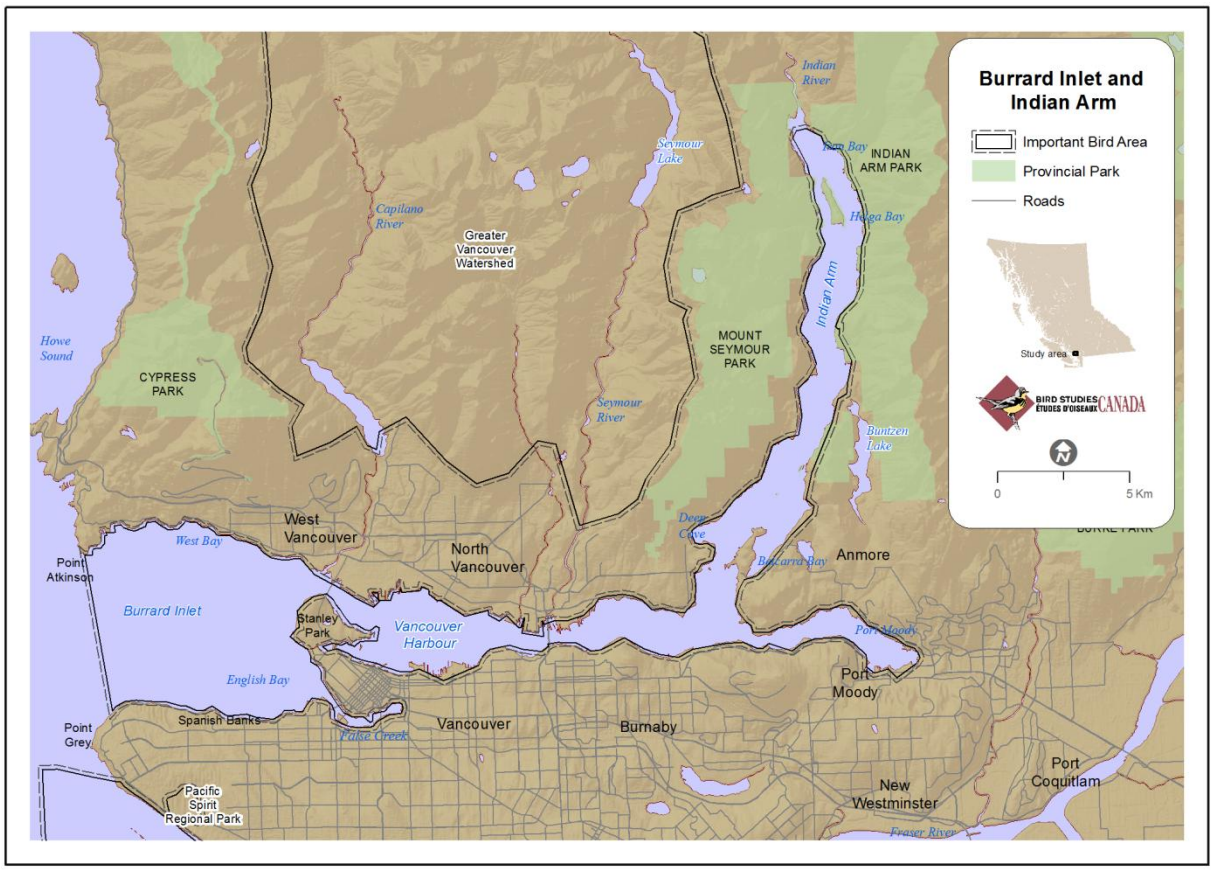

Fig. 1 Burrard Inlet and Indian Arm study area

The study area includes all the tidal waters of Indian Arm and Burrard Inlet including Port Moody Arm and English Bay, west to Point Atkinson and the Point Grey bell buoy (49.29N, 123.265W). Burrard Inlet - Indian Arm is estuarine with relatively fresh surface waters flowing out of the inlet over saline waters originating from the Strait of Georgia (Davidson 1979). Most of the freshwater input comes from the Indian River and Buntzen power station (Dunbar 1965). Turbulent mixing occurs in the constrictions at First and Second Narrows. Relatively clean and pollution-free waters of Vancouver Harbour described by Stockner and Cliff (1979) are the result of reduced discharges, strong tidal mixing and seaward flushing.

Burrard Inlet, Port Moody Arm and the entrance to Indian Arm are rimmed with urban and industrial development interspersed with parks within the city of Vancouver and surrounding cities, municipalities and districts. Waterfront cottages dot the shoreline of Indian Arm where the land is largely undeveloped crown land, Provincial Park and Indian Reserve.

2.2 Transect Route and Field Protocol

Survey methods designed to estimate population size and distribution of seabirds in large open waters use a sampling method based on a fixed transect width (Tasker et al. 1984). The aim of our study was to derive an estimate of the total number of birds present and record their distribution in mostly narrow waterways, which required us to use a wider transect.

We surveyed the entire perimeter of English Bay, Vancouver Harbour and Indian Arm approximately each month. Counts of birds were made from either a 5.2 m long rigid hull boat or a 7 m long aluminum boat moving at 12 knots along a 500 m wide transect of the shoreline. In the relatively narrow inlets we were able to see much of the shore and water so our estimates closely approximate the total number of birds present. The exceptions were some distant birds in shallow water where our boat could not travel in Port Moody Inlet, Maplewood Mudflats, and Spanish Banks, and the deep water in central English Bay. Our estimates in these areas were likely slightly lower than the total number of birds present. We occasionally saw birds far from the transect off Spanish Banks although few birds were seen far from shore on the transect route between Point Atkinson and Point Grey. The region of English Bay that is far from shore needs to be addressed in future work.

Two observers watched for birds on either side of the boat. One observer called out waypoints approximately every 500 meters while the other observer recorded the data. Binoculars were used to assist in counting and identifying distant birds. In most situations, birds were counted individually. Flocks of more than about 1000 individuals were estimated by summing the number of groups of 10 or 100 individuals. On two occasions we compared our estimates against the number counted from a photograph of the same flock. We estimated 1500 and 350 birds were present compared to 1357 and 323 from photos of the same flocks, a precision similar to other studies (Prater 1979). Rappolt et al (1984) concluded that over and underestimates canceled each other out.

2.3 Kernel and Cluster Mapping Techniques

Kernel analysis is used to estimate population density and is also used to visualize distribution patterns. Kernel applications are widely used in wildlife research. Kernel analysis creates a smooth surface in which the estimated surface value is highest at the location of the known data points and diminishes with increasing distance from the point, reaching zero at the predefined search radius distance from this point (ArcGIS 9.3, ESRI 2009).

2.3.1 Kernel Analysis

We applied a kernel estimator to determine the spatial distribution pattern of each species of interest using effort-corrected counts. A cell size of 50 metres (resolution) and a search radius of 1,500 metres were used to define the kernel settings. Next, we normalized each raster layer into groups using a “natural breaks” classification method. This method creates classes by identifying naturally occurring breaks in the distribution of data values. It attempts to reduce variance within groups and maximize the variance among groups. To allow comparison among species, we labeled highest values as *primary* area, the second highest values as *secondary* area, and the

third highest as *tertiary* area. One further tier of (lowest) values was excluded from visual representation on the species maps to minimize distraction from areas of higher importance.

2.3.2 Clustering Analysis

In order to determine the distribution of groups of interest (e.g. SARA-COSEWIC species), the respective species rasters needed to be combined. In order to make the rasters comparable, it was important to use a common measurement scale and weights that allow us to make calculations of standardized criteria among several kernel rasters. To do this, we assigned numerical weights to the categories described above. Primary areas, secondary areas, and tertiary areas were assigned weights of 10, 6 and 2 respectively. After scaling the kernel raster datasets, the selected species were overlapped and summed together. The resulting rasters were displayed using "equal interval" classification which divides a dataset into groups at regular intervals containing equal ranges of values. In this way, a clustering degree was identified where primary, secondary and tertiary areas represent the species abundance and spatial distribution (and the lowest tier of values was excluded as before).

It is important to note that the maps in this report show the results of applying kernel analysis within 1,500 m of the waypoints along the survey transect route only; the analysis does not extrapolate beyond 1,500 m either side of the transect line. There are shortcomings of applying this technique to waypoints along a transect line, including spatial autocorrelation not being accounted for. The maps represent only the data collected during this survey, and do not reflect an absence of birds or mammals >1.5 km away from the transect line.

2.4 Other Observations

We included observations of birds and marine mammals seen in the inlet within a few years of our surveys but missed by us. The observations of these species listed in the Discussion, help to fill out the species list for the region.

3. Results

3.1 Summary of Records

Eleven surveys were conducted between 31 December 2011 and 25 July 2013, tallying approximately 3,952 records (waypoint-encounters) of 100,175 individuals of 48 marine bird and two marine mammal species, summarized in Table 2. Surf Scoter and Glaucous-Winged Gull were the most abundant species, comprising more than 50% of all individuals. Harbour Seal was the most numerous marine mammal recorded.

Table 2. Number of marine birds and mammals counted during 11 line transect surveys (within 500 meters either side of survey vessel) in Burrard Inlet and Indian Arm, British Columbia, 2012-2013. Annual total is the sum of August 2012 to July 2013 (shaded) columns.

Species	Survey Dates (number of survey points)											Annual Total (Aug 2012-Jul 2013)
	2012					2013						
	Dec/Jan	Mar	Aug	Sept	Nov	Dec/Jan	Feb	Mar	Apr/May	Jun	Jul	
	(288)	(288)	(288)	(288)	(288)	(288)	(288)	(288)	(288)	(288)	(288)	
Red-throated Loon	2	0	0	0	5	182	3	0	0	0	0	190
Pacific Loon	0	0	0	0	2	0	0	0	0	0	0	2
Common Loon	7	7	0	13	10	17	8	3	1	0	0	52
Red-necked Grebe	0	0	0	3	9	1	0	0	0	0	0	13
Horned Grebe	24	9	0	1	19	23	25	12	0	0	0	80
Western Grebe	36	40	0	1	9	23	25	20	3	0	0	81
Double-crested Cormorant	101	23	88	98	102	78	77	49	195	23	64	774
Brandt's Cormorant	36	0	1	0	13	7	21	11	3	0	0	56
Pelagic Cormorant	341	140	205	203	249	128	231	278	137	152	181	1764
Great Blue Heron	3	21	19	8	3	4	6	2	17	54	13	126
Canada Goose	167	48	351	359	176	69	103	106	94	939	833	3030
Trumpeter Swan	0	6	0	0	0	0	0	0	0	0	0	0
American Wigeon	16	6	0	20	102	4	0	24	145	0	0	295
Mallard	77	490	12	30	80	60	51	64	4	40	0	341
Northern Pintail	0	0	0	0	15	0	0	3	30	0	0	48
Green-winged Teal	0	0	0	5	70	38	0	2	0	0	0	115
Greater Scaup	1400	4505	0	0	17	1627	1489	21	7	0	0	3161
Harlequin Duck	17	0	0	0	18	7	0	7	27	7	0	66
Surf Scoter	9720	8971	0	0	1739	7557	3998	131	0	0	0	13425
White-winged Scoter	341	7	0	0	190	142	58	2502	2102	5	1	5000
Black Scoter	0	0	0	0	2	0	1	0	0	0	0	3
Long-tailed Duck	16	5	0	0	1	2	1	2	0	0	0	6
Bufflehead	122	64	0	0	424	190	211	252	209	0	0	1286
Common Goldeneye	156	91	0	0	33	273	232	218	0	0	0	756
Barrow's Goldeneye	3672	2023	0	0	1555	2003	2162	1628	85	0	0	7433
Hooded Merganser	1	3	0	0	0	10	1	5	0	0	0	16
Common Merganser	6	3	31	22	2	8	5	31	18	11	5	133
Red-breasted Merganser	11	0	0	0	1	14	24	0	0	0	0	39
Bald Eagle	29	11	2	1	10	12	16	6	10	11	8	76
Merlin	0	0	0	1	0	0	0	0	0	0	0	1
Osprey	0	0	0	0	0	0	0	0	1	3	5	9
Peregrine Falcon	2	0	0	1	0	0	1	0	0	0	0	2
Black Oystercatcher	22	0	0	0	0	9	0	0	0	0	0	9
Black Turnstone	2	0	0	5	0	0	3	0	0	0	0	8
Sanderling	63	0	0	0	0	0	0	0	0	0	0	0
Dunlin	0	0	0	0	0	270	0	0	0	0	0	270
Spotted Sandpiper	1	0	3	8	0	0	0	0	1	0	0	12
Western Sandpiper	0	0	3	0	0	0	0	0	0	0	0	3
Bonaparte's Gull	0	0	0	0	6	1	0	0	0	0	30	37
Mew Gull	840	943	122	185	1077	1074	842	250	241	0	0	3791
Ring-billed Gull	0	0	2	2	0	0	0	0	0	0	8	12

Species	Survey Dates (number of survey points)											Annual Total (Aug 2012-Jul 2013)
	2012					2013						
	Dec/Jan (288)	Mar (288)	Aug (288)	Sept (288)	Nov (288)	Dec/Jan (288)	Feb (288)	Mar (288)	Apr/May (288)	Jun (288)	Jul (288)	
California Gull	7	0	13	30	2	2	0	0	0	0	4	51
Glaucous-winged Gull	1798	1882	1325	4114	2258	3321	2233	718	1082	1391	2238	18680
Herring Gull	0	0	0	0	0	0	0	1	0	0	0	1
Common Murre	1	0	0	0	0	24	1	0	0	0	0	25
Pigeon Guillemot	0	9	4	0	1	4	6	21	10	4	20	70
Marbled Murrelet	0	0	0	0	4	0	0	0	0	5	0	9
Belted Kingfisher	0	1	1	6	1	0	0	0	1	0	0	9
Harbour Seal	33	8	36	72	75	16	58	18	61	13	70	419
Harbour Porpoise	0	0	0	0	0	1	0	0	3	0	0	4
Total birds	19037	19308	2182	5116	8205	17184	11834	6367	4423	2645	3410	61366
Total mammals	33	8	36	72	75	17	58	18	64	13	70	423
All Species	19070	19316	2218	5188	8280	17201	11892	6385	4487	2658	3480	61789

3.2 Historical Comparisons in abundance and distribution

Our findings concur with the conclusion made by Breault and Watts (1995) two decades ago that large numbers of birds used the inner harbour between Lions Gate and Iron Workers Memorial bridges (at the first and second narrows), and waterfowl and gulls were the most numerous birds. However, the number of birds reported by Breault and Watts (1995) was greater than in our study. The maximum number of birds counted in their study area in 1993 was 25,000 compared to 17,000 and 19,000 in our 2012 and 2013 surveys, respectively (Table 2). However, Breault and Watts' (1995) peak number of 16,812 diving ducks in December 1993 was very similar to our tally of 15,462 for December 2011 and slightly more than the 11,833 we counted in December 2012 (Table 2). Some of the largest differences were our tally of about half the number of Barrows' Goldeneye reported by Breault and Watts (1995). A gradual decline for over a decade was detected for goldeneye in the Strait of Georgia (Crewe et al. 2012). We also have witnessed the near disappearance of the Western Grebe and Marbled Murrelet from the inlet, and possible declines to Black Scoter, Red-throated Loon, Common Loon, Red-necked Grebe and Bonaparte's Gull. Although some of these declines might be attributed to different methodologies, coverage and effort used by Breault and Watts (1995) and us, declines for many species have also been detected in the Strait of Georgia (Crewe et al. 2010). Whether the declines in Burrard Inlet and Indian Arm reflect region-wide ecological change or are more site specific needs to be assessed.

Species that have increased in number include the Great Blue Heron, Double-crested Cormorant and Bald Eagle. The increase of nesting herons in Stanley Park can be attributed to the arrival of many herons following the abandonment of a large colony in Pacific Spirit Park. Cormorants increased after they began to nest beneath bridges perhaps to find safety from eagles. Bald Eagles are undergoing a recovery in numbers across North America following years of persecution and poisoning. The eagle has taken well to the urban and suburban environment including the abundance of bird and fish prey in Burrard Inlet and Indian Arm.

3.3 General finding for SARA species and conservation concerns

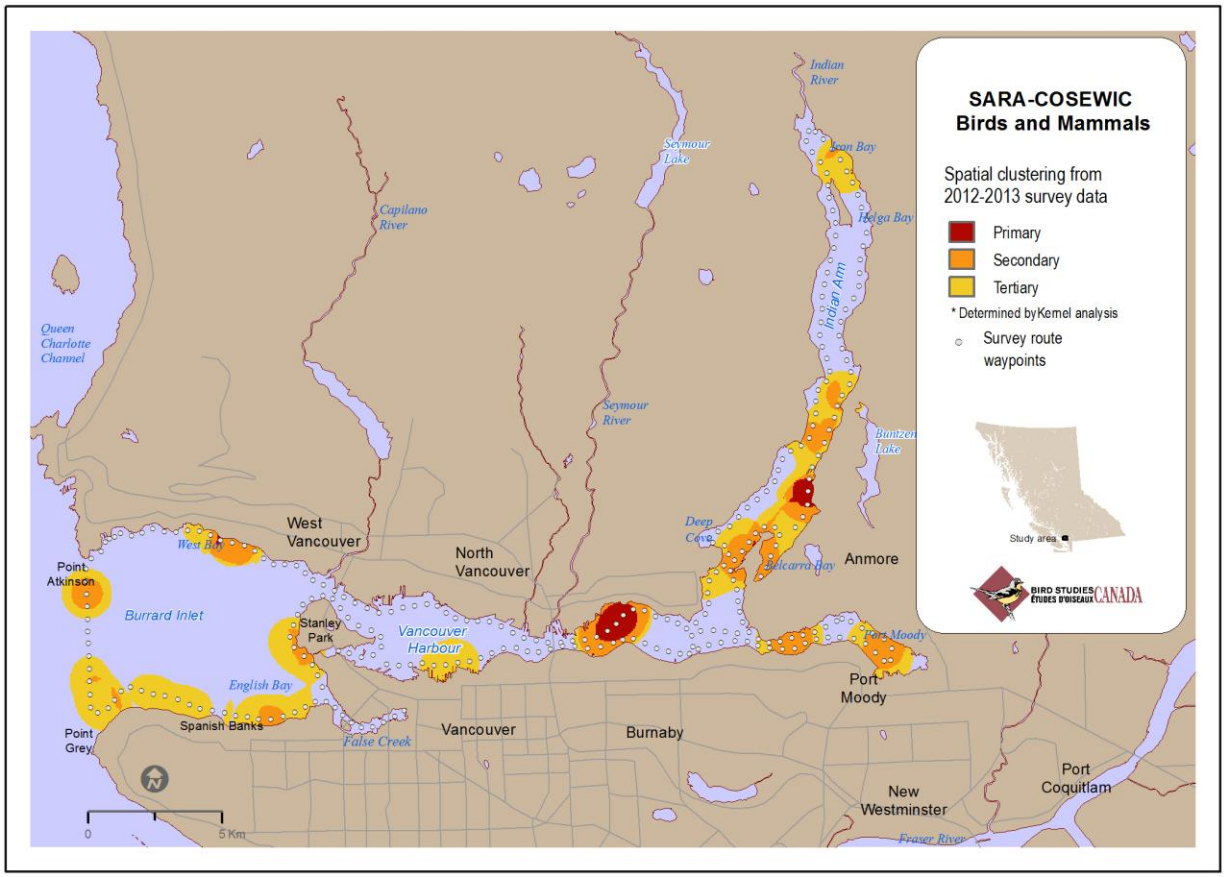

Fig. 2 Primary, secondary and tertiary areas for all federal Species at Risk along the transect route in Burrard Inlet and Indian Arm, based on spatial clustering analysis of all survey records of SARA-COSEWIC listed marine bird and mammal species.

Of special interest for conservation are 16 species that have been given designations for concern (Table 1). Among the six SARA species, the most troubling is the Marbled Murrelet that was plentiful in the 1970s. The murrelet has become scarce in Burrard Inlet and Indian Arm. Critical nesting habitat for the species has been identified in the Burrard Inlet watershed (Environment Canada 2014). The Great Blue Heron is designated a Species of Special Concern and identified in the Important Bird Area designation. There was a large heron colony in Stanley Park and a few small colonies around the inlet during our survey. Many herons from Stanley Park flew to the Fraser River delta to forage but some herons foraged for fish along the shores of Burrard Inlet and Indian Arm. We saw Peregrine Falcons on a few occasions and it possibly nests in the area. Nest locations need to be identified and protected. Transient and resident populations of Killer Whales periodically enter Burrard Inlet and Indian Arm but these areas lie outside the defined 'critical habitat' (Government of Canada 2015). Gray Whales periodically surface in English Bay and enter Indian Arm. Harbour Porpoises were seen at the entrance to English Bay where RWB has frequently encountered them.

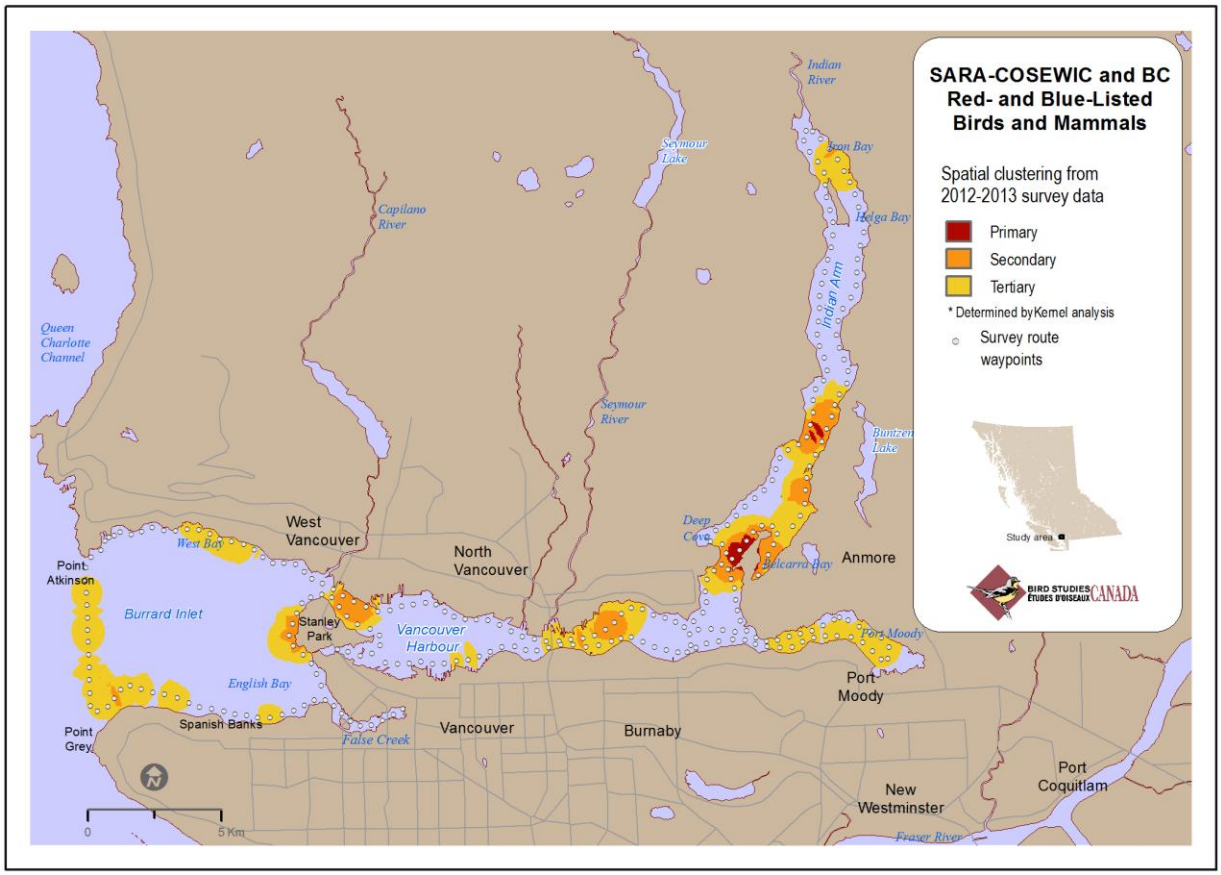

Fig. 3 Primary, secondary and tertiary areas for all federal and provincial marine bird and mammal Species at Risk along the transect route in Burrard Inlet and Indian Arm, based on spatial clustering analysis of all survey records of SARA-COSEWIC and Ministry of Environment Red- and Blue-listed marine bird and mammal species.

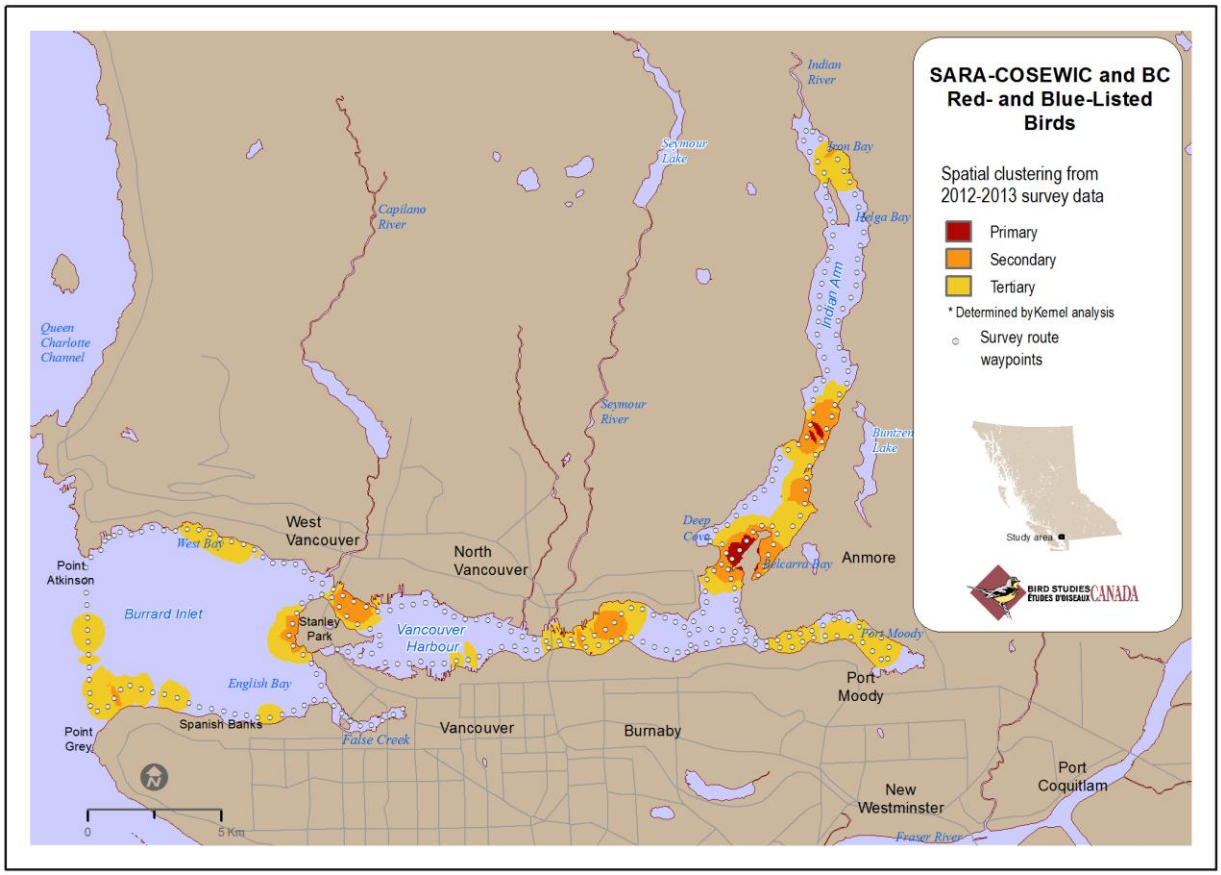

Fig. 4 Primary, secondary and tertiary areas for all federal and provincial marine bird Species at Risk along the transect route in Burrard Inlet and Indian Arm, based on spatial clustering analysis of all survey records of SARA-COSEWIC and BC Ministry of Environment Red- and Blue-listed marine bird species. Note this differs from Fig. 3 only in the exclusion of Harbour Porpoise.

Ten species on either the COSEWIC or Provincial Red/Blue list include the Horned Grebe, Western Grebe, Double-crested Cormorant, Brandt's Cormorant, Long-tailed Duck, Surf Scoter, Black Scoter, California Gull, Common Murre, and Elephant Seal. The causes of decline are not always known and warrant specific studies to understand what can be done.

3.4 Food Specialists

A goal to sustain birds and mammals regardless of their designations requires a functioning ecosystem that can supply them with food, shelter, nest sites and resting locations. Restoring and sustaining habitats while minimizing pollution will be required.

Important food sources for birds are marine vegetation, small fish and marine invertebrates. Some of the large flocks of diving ducks appear to be attracted by mussels and barnacles as food along wharves and piers and by spilled grain from terminals in the harbour. Seabirds, grebes and herons depend on small schooling and inshore species of fish. Restoration and maintenance of

eelgrass beds, estuaries, salt marshes, mudflats, and salmon bearing streams is an important component for all species of birds.

A number of species in this report that have declined forage largely on small forage fish. These forage fish specialists include Brandt's and Pelagic Cormorant, Common Murre, California Gull, Great Blue Heron, Harbour Porpoise, Horned and Western Grebe, Marbled Murrelet, Pacific Loon, and Pigeon Guillemot. The trends on forage fish populations in the inlet are not well understood but anecdotally, there seems to be fewer than in the recent past. We combined the forage fish specialist species together in the accompanying map to show areas where those species were most numerous. Their presence might reflect fish abundance. The six major areas were: Central and south English Bay including Stanly Park and Spanish Banks; the Inner Harbour; Second Narrows east to and including Maplewood Mudflats; the entrance to Indian Arm; the head of Port Moody Inlet; and the head of Indian Arm.

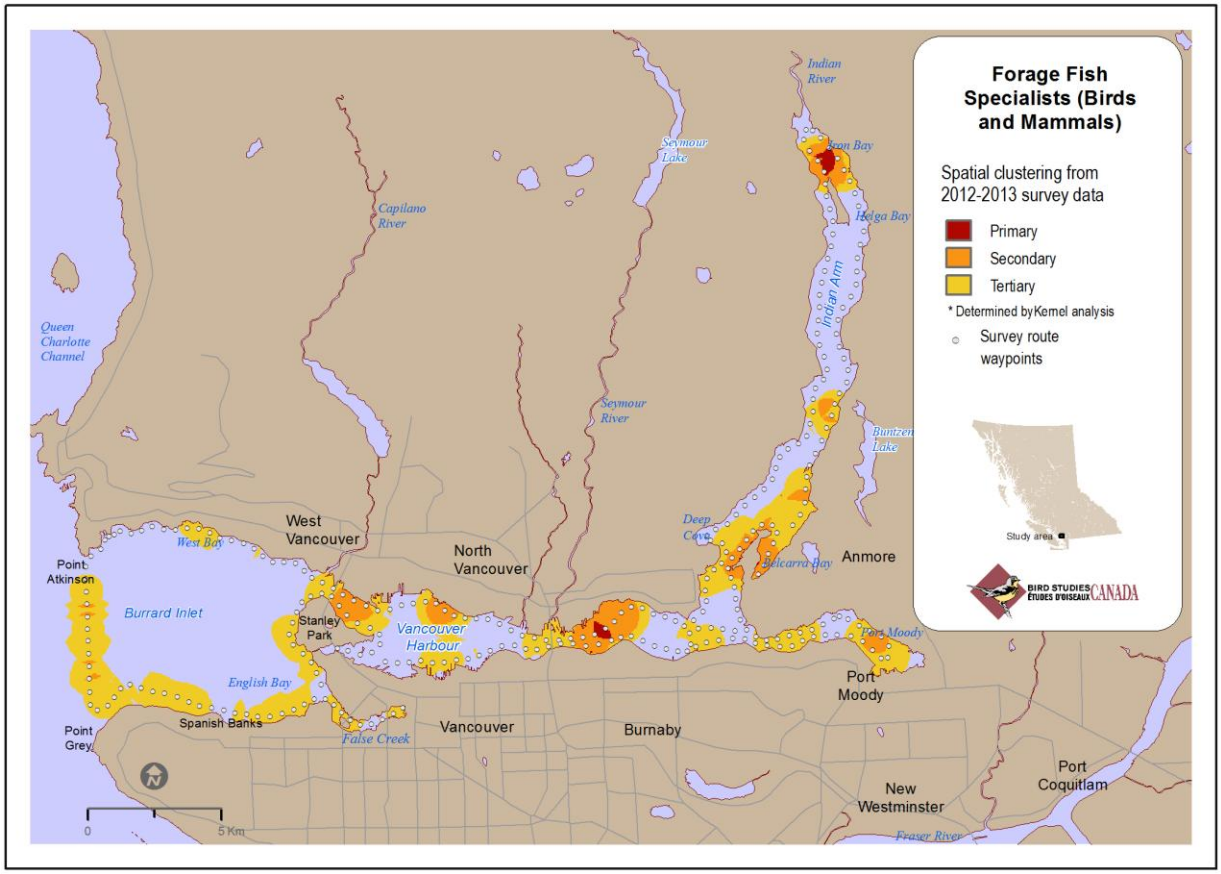

Fig. 5 Primary, secondary and tertiary areas for forage fish specialists (birds and mammals) along the transect route in Burrard Inlet and Indian Arm, based on spatial clustering analysis of all survey records of forage fish specialists.

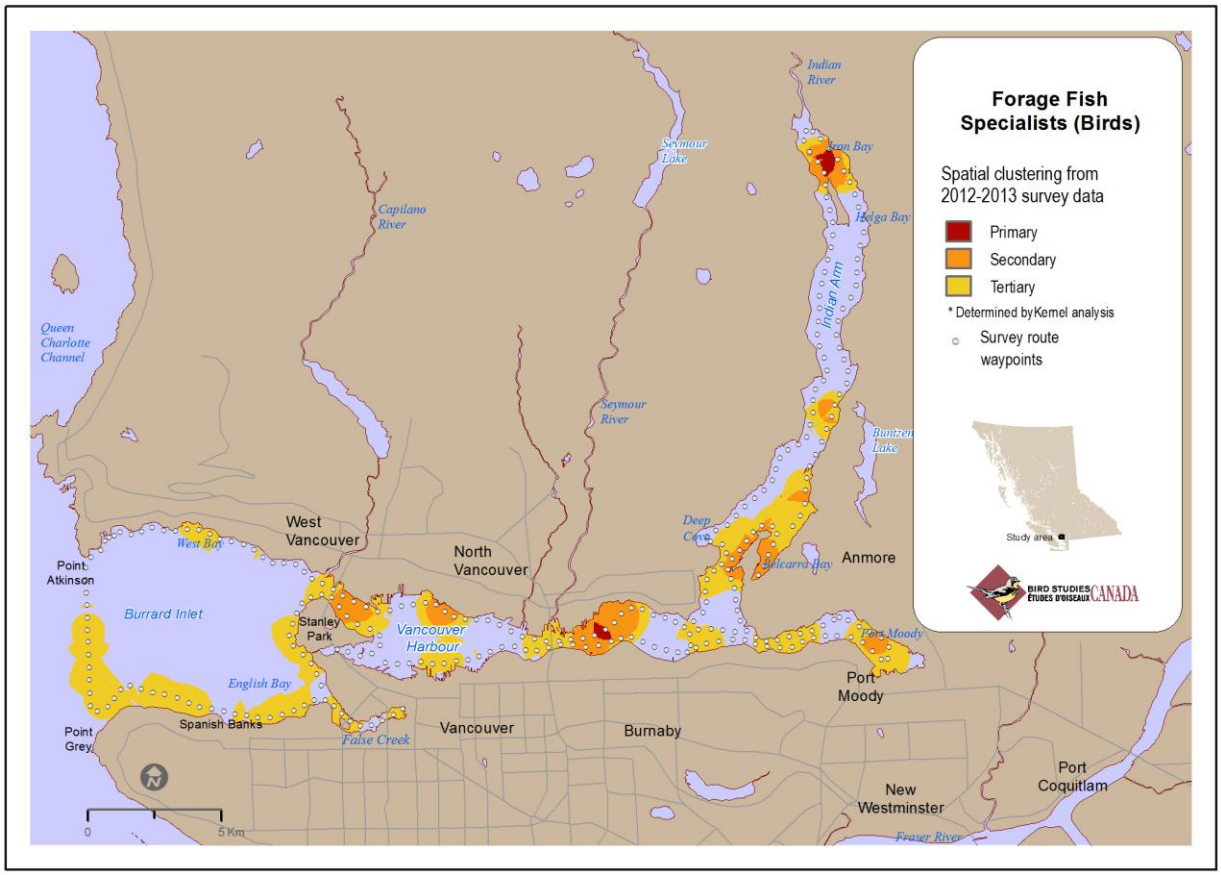

Fig. 6 Primary, secondary and tertiary areas for forage fish specialists (birds) along the transect route in Burrard Inlet and Indian Arm, based on spatial clustering analysis of all survey records of forage fish specialists. Note this differs from Fig. 5 only in the exclusion of Harbour Porpoise.

The second group was the rocky shore specialists that specialize on eating mussels, and other marine invertebrates including seaducks and shorebirds. These species include Barrow's Goldeneye, Black Turnstone, Glaucous-winged Gull, Harlequin Duck, and Surf Scoter. They were especially numerous at Cypress Creek where large numbers of birds bathed and rested; a large flock of scoters seen off Point Grey; Stanley Park and adjacent North Shore; the inner harbour where flocks of scoters assembled; the entrance to Indian Arm; Port Moody Inlet; Twin Islands; and the head of Indian Arm.

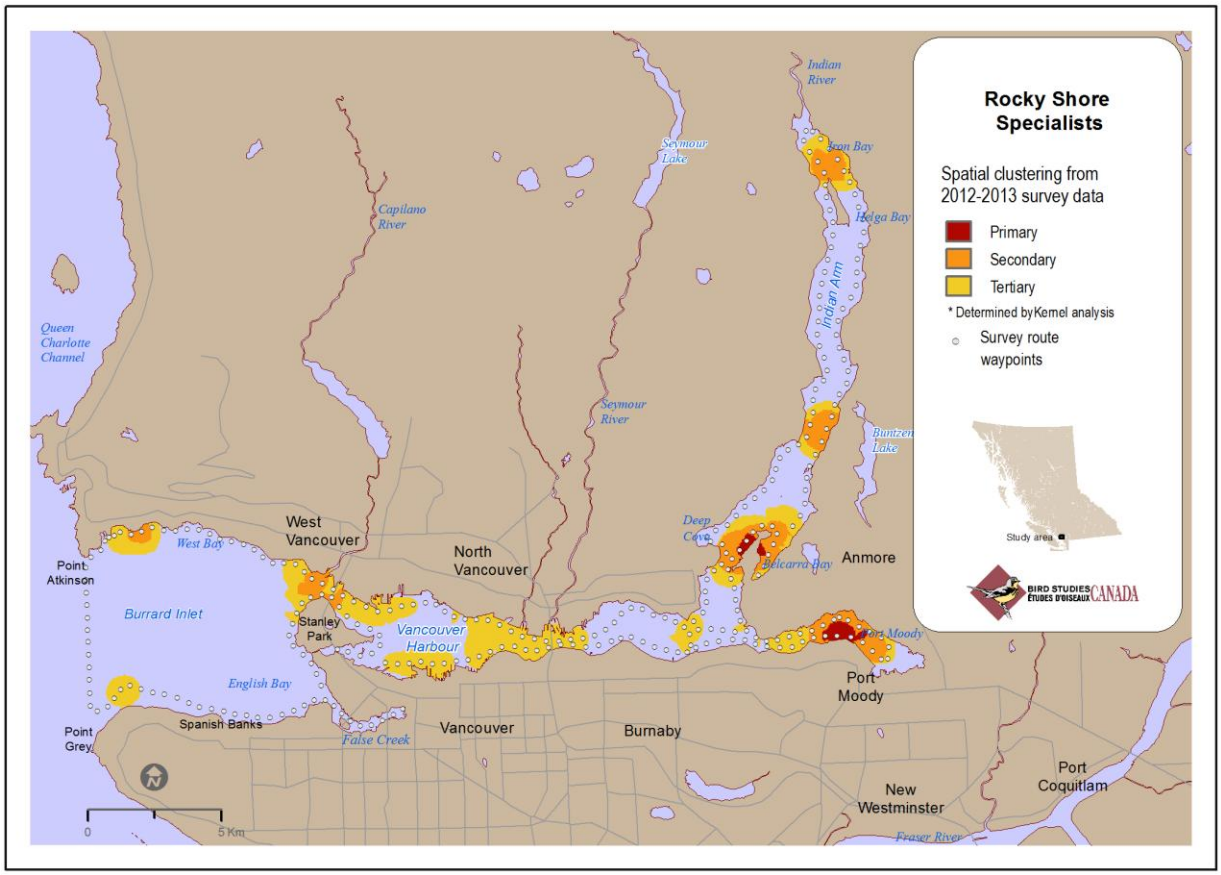

Fig. 7 Primary, secondary and tertiary areas for rocky shore specialists along the transect route in Burrard Inlet and Indian Arm, based on spatial clustering analysis of all survey records of rocky shore specialists.

4. Discussion

4.1 Precision of Estimates

We assumed that we could see and count most birds present on the water during our surveys. The exceptions were on extensive intertidal shallows in Port Moody Inlet, Maplewood Mudflats, and Spanish Banks, and in the open water of central English Bay. In those locations, we could see birds that were too distant to identify or count. The intertidal areas are included in the BC Coastal Waterbird Survey in which observers on land tally all the birds within one kilometer of shore. Our surveys done during the day would have missed tallying a large gull and seaduck night roost reported in English Bay (Worcester 2010).

We also assumed that a single survey each month would represent the abundance of waterbirds. This assumption is likely valid for the majority of species that remain for the winter but less so for migrants such as the Bonaparte's Gull and California Gull that might move through in a short period of time. Our assumption that a monthly snapshot would represent the distribution of birds likely under represented the overall distribution. For example, satellite

tracking of Barrow's Goldeneye captured in Indian Arm indicated that the birds moved regularly about the inlet.

Several species of birds that were not seen by us that would likely be recorded with more surveys include Semipalmated Plover, Killdeer, Greater Yellowlegs, Lesser Yellowlegs, Least Sandpiper, Long-billed Dowitcher, Short-billed Dowitcher, Thayer's Gull, Common Tern, Caspian Tern, and Rhinoceros Auklet. Among the marine mammals were a few species that were present shortly before, during or after our surveys. Although none were recorded on the survey, we include them here for completeness of the list of marine mammals for the harbour. An Elephant Seal (*Mirounga angustirostris*) underwent a pelage molt while hauled out on Ambleside Beach 1-20 May 2013. There were unconfirmed reports of a few Steller Sea Lions (*Eumatopias jubatus*) in Port Moody Inlet. A Grey Whale (*Eschrichtius robustus*) was observed near Stanley Park 3 September 2010 and again on 12 August 2015. Killer Whales (*Orcinus orca*) traveling in one or possibly two pods entered Vancouver Harbour on 14 June 2013 (CBC News 2013) and a pod of Pacific White-sided Dolphins (*Lagenorhynchus obliquidens*) entered English Bay and False Creek on 17 March 2014 (CBC News 2014). We did not see a Northern River Otter (*Lutra canadensis*) despite it being a widespread, year-round resident that frequents docks and shorelines around Burrard Inlet and Indian Arm.

4.2 Historical Changes

The archeological record indicates that large numbers of ducks, loons and gulls were present in the inlet in the past (Trost 2005). Our study revealed large numbers of ducks and gulls were present but the number of loons and grebes were small. There was an abundance of herring, northern anchovy and surf smelt in the archeological record that would have been prey for loons and grebes in the past that were absent or occurred in low abundance in the inlet during our study. In June 2014, herring was seen at the head of Indian River (RWB), and in March 2015, herring spawned on the shores of Indian Arm. Large schools of small fish assumed to be this species were present in August (R. MacVicar and R. Foster, pers. comm.). We show that the numbers of birds and the species for the most part, in the study area have not changed substantially since 1995. The exceptions include the Marbled Murrelet, Western Grebe, Black Scoter, Red-throated Loon, Common Loon, Red-necked Grebe, Horned Grebe, and Bonaparte's Gull. The decline of these species has also been detected at a regional level. The reason for the decline is unclear but might be related to a decline in their fish prey in the Salish Sea (Vilchis et al. 2015).

The 48 species of birds and two marine mammals we reported on in Burrard Inlet and Indian Arm are part of complex ecological community dependent on the interaction of ocean currents and tides, freshwater runoff, marine and terrestrial plants, and marine life to provide them with food, water to drink, places for nesting and for rest. Our understanding of the distribution and abundance of many species and their ecological interactions is nonexistent or in its infancy. Targeted research to fill these gaps would assist in efforts to restore and enhance existing habitats, and measure change to the Burrard Inlet and Indian Arm ecosystem.

4.3 SARA-COSEWIC Species, Forage Fish Specialists and Rocky Shore Specialists Habitat Delineation

The three summary maps - species of conservation concern, forage fish specialists, and rock shore specialists – are the beginnings of priority areas for the ongoing maintenance of species in Burrard Inlet and Indian Arm. However, the mobile nature of the thousands of scoters and goldeneye using the inlet make these flocks vulnerable to oil spills which can have serious long-term consequences for the recovery of their populations (Day et al.1997, Peterson 2003). Our surveys were a snapshot of how these birds use the harbour. An important consideration is to use satellite tracking techniques on Surf Scoters in the harbour to define their daily use patterns.

Seaducks appeared to contend with most human activity such as walking the seawall, traveling in boats, paddleboarding and kayaking, but it is unclear how much the ducks will tolerate.

5. Habitat Recommendations

Our study has established a baseline against which change including recovery, can now be measured. We also identified species of conservation priority that will require specific actions. At a broader level, the maintenance of the abundant species will require sustaining their habitats. Specifically, mussel beds and barnacle encrusted shores that support the suite of rocky shores specialists need to be mapped, and spawning locations for forage fish need to be located and protected. Opportunities to consider are the enhancement of habitats for forage fish such as marshes, seagrass meadows, removal or wrapping of creosote pilings, and restoration of riparian edges, and hard surfaces for mussels and barnacle attachment.

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References

Afton, A.D. and M.G. Anderson. 2001. Declining scaup populations: a retrospective analysis of long-term population and harvest survey data. The Journal of Wildlife Management 65:781-796

Ainley, D. G., D. N. Nettleship, H. R. Carter and A. E. Storey. 2002. Common Murre (*Uria aalge*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/666

Alaska Department of Fish and Game 2006. *Our wealth maintained: a strategy for conserving Alaska's diverse wildlife and fish resources.* Alaska Department of Fish and Game, Juneau, Alaska. xviii+824 p. http://www.adfg.alaska.gov/static/species/wildlife_action_plan/appendix4_waterbirds.pdf

Andres, B.A.. 1999. Effects of persistent shoreline oil on breeding success and chick growth in Black Oystercatchers. Auk 116:640-650.

Anderson, E.M., J.L. Bower, D.R. Nysewander, J.R. Evenson and J.R. Lovvorn. 2009. Changes in avifaunal abundance in a heavily used wintering and migration site in Puget Sound, Washington, during 1966-2007. Marine Ornithology 37:19-27.

Anderson, E.M, D. Esler, W.S. Boyd, J.R. Evenson, D.R. Nysewander, D.H. Ward, R.D. Dickson, B.D. Uher-Koch, C.S. VanStratt and J.W. Hupp. 2012. Predation rates, timing, and predator composition for Scoters (*Melanitta* spp.) in marine habitats. Canadian Journal of Zoology 90:42-50.

Anderson, E.M., R.D. Dickson, E.K. Lok, E.C. Palm, J.P. Savard, D. Bordage and A. Reed. 2015. Surf Scoter (*Melanitta perspicillata*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. doi:10.2173/bna.363

Andres, B. A., P. A. Smith, R. I. G. Morrison, C. L. Gratto-Trevor, S. C. Brown and C. A. Friis 2012. Population estimates of North American shorebirds, 2012. Wader Study Group Bulletin 119: 178-194

Anonymous. 1995. The birds of Burrard Inlet. Vancouver Natural History Society, Vancouver, Canada. ISBN 0-9695974-3-6

Anonymous. 2014. Bald Eagle Breeding Report 2014. Stanley Park Ecology Society, Vancouver, BC. On line at http://stanleyparkecology.ca/wp-content/uploads/downloads/2015/01/Eagle-Report-2014-Final.pdf

Barr, J. F., C. Eberl and J. W. Mcintyre 2000. Red-throated Loon (*Gavia stellata*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology.

B.C. Conservation Data Centre. 2015. BC Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Aug 13, 2015).

BC Coastal Waterbird Survey (no date). Web site. http://www.birdscanada.org/volunteer/bccws/index.jsp?targetpg=bccwsmaps

Best, R.J. and P. Arcese. 2009. Exotic herbivores directly facilitate the exotic grasses they graze: mechanisms for an unexpected positive feedback between invaders. Oecologia 159:139–150.

Binford, L. C. B.G. Elliot and S.W. Singer. 1975. Discovery of a nest and the downy young of the Marbled Murrelet. Wilson Bull. 87:303- 319.

Bird Studies Canada. 2000-2015. Important Bird Areas of Canada Database. Port Rowan, Ontario: Bird Studies Canada. http://www.ibacanada.org

Blight LK . 2011. Egg Production in a Coastal Seabird, the Glaucous-Winged Gull (*Larus glaucescens*), Declines during the Last Century. PLoS ONE 6(7): e22027. doi:10.1371/journal.pone.0022027

Blight, L. K. 2012. Glaucous-winged gulls *Larus glaucescens* as sentinels for a century of ecosystem change : long-term trends in population, diet, and egg production in North America's Salish Sea. Unpubl. PhD thesis, UBC.

Bower, J. L. 2009. Changes in marine bird abundance in the Salish Sea: 1975-2007. Marine Ornithology 37:9-17.

Boyd, W.S. and D. Esler. 2011. Barrows Goldeneye Migration. web site. http://www.sfu.ca/biology/wildberg/CWESeaducksfolder/BAGOwebpage/BAGOMigrationHome.html

Breault, A. and P. Watts. 1996. Bird survey project: seasonal and spatial trends in distribution and abundance of waterbirds in Burrard Inlet, November 1996. Burrard Inlet Environmental Action Program, North Vancouver, B.C.

Burger, A.E. 2015a. Surf Scoter *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C. http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=SUSC&lang=en [24 Jul 2015]

Burger, A.E. 2015b. Killdeer *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C. http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=KILL&lang=en [20 Aug 2015]

Butler, R.W. 1997. The great blue heron. UBC Press, Vancouver, BC.

Butler, R.W. and R.W. Campbell. 1987. The birds of the Fraser River delta: populations, ecology and international significance. Canadian Wildlife Service Occasional Paper 65, Ottawa.

Butler, RW and RS MacVicar. 2013. Field Observations of Gray Whales in Boundary Bay, British Columbia 1991-2012. Pacific WildLife Foundation Technical Report Number 2.

Butler, R.W., R. MacVicar and R. Foster. 2011. Attempts to Restore Eelgrass (*Zostera marina*) in Port Moody Inlet, British Columbia. Pacific WildLife Foundation Technical Report Number 1. Pacific WildLife Foundation, Port Moody, British Columbia. Online at http://www.pwlf.org/eelgrassreport.pdf

Butler R. and R. Vennesland. 2015. Great Blue Heron *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C. http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=GBHE&lang=en [16 Jul 2015]

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, C. W Kaiser, and M. C. E. McNall 1990. The birds of British Columbia. Vol. 1. Nonpasserines: introduction and loons through waterfowl. Royal British Columbia Museum, Victoria, B.C. 514 p.

Campbell, R.W., M. G. Shepard and R. H. Drent. 1972a. Status of birds in the Vancouver area in 1970. Syesis 5: 138-167.

Campbell, R.W., M. G. Shepard and W.C. Weber (eds.) 1972b. Vancouver Birds in 1971. Vancouver Natural History Society, Vancouver, B.C.

Canadian Wildlife Service Waterfowl Committee. 2013. *Population Status of Migratory Game Birds in Canada: November 2013*. CWS Migratory Birds Regulatory Report Number 40.

CBC News. 2013. Killer whales spotted near Vancouver's Stanley Park. On line at http://www.cbc.ca/news/canada/british-columbia/killer-whales-spotted-near-vancouver-s-stanley-park-1.1330156

CBC News. 2014. Dolphins, orcas delight watchers in Vancouver, Squamish. http://www.cbc.ca/news/canada/british-columbia/dolphins-orcas-delight-watchers-in-vancouver-squamish-1.2574894

Chatwin, T.A, M.H. Mather and T.D. Giesbrecht. 2002. Changes in Pelagic and Double-Crested Cormorant nesting populations in the Strait of Georgia, British Columbia. Northwestern Naturalist 83(3):109-117.

Chatwin, T. M. Mather and T. Giesbrecht. 2001. Double-crested Cormorant and Pelagic Cormorant inventory in the Strait of Georgia in 2000. Ministry of Environment, Nanaimo. On line at http://www.env.gov.bc.ca/bcparks/eco_reserve/oakbay_er/cormorant-inventory.pdf

Chutter, M. 2015. Peregrine Falcon *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C. http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=PEFA&lang=en [28 Jul 2015]

Cook, D.L. 2008. Past, present and future Bald Eagles nests sites on the north shore of Burrard Inlet. Discovery 37: 27-33.

COSEWIC. 2009. COSEWIC assessment and status report on the Horned Grebe *Podiceps auritus*, Western population and Magdalen Islands population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 42 pp.

Cresswell, G., Walker, D. and Pusser, T. 2007. Whales and Dolphins of the North American Pacific including Seals and other Marine Mammals. Harbour Publishing, British Columbia, Canada.

Crewe, Tara, Karen Barry, Pete Davidson, and Denis Lepage. 2012. Coastal waterbird population trends in the Strait of Georgia 1999–2011: Results from the first 12 years of the British Columbia Coastal Waterbird Survey. British Columbia Birds 22:8-35.

Davidson, P., R.W. Butler, A. Couturier, S. Marquez and D. Lepage. 2010. Status and Distribution of Birds and Mammals in the Southern Gulf Islands, British Columbia. Bird Studies Canada & Pacific Wildlife Foundation unpublished report to Parks Canada.

Davidson, L. W. 1979. On the physical oceanography of Burrard Inlet and Indian Arm, British Columbia. MSc thesis, University of British Columbia.

Davis, J. (n.d.). Status of the Wood Duck. Retrieved August 14, 2015, from http://www.ducks.org/conservation/waterfowl-biology/status-of-the-wood-duck

Dawe, N.K. and A.C. Stewart. 2010. The Canada Goose (*Branta canadensis*) on Vancouver Island, British Columbia. *British Columbia Birds* 20:24-40.

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

Dawe, N.K., W. S. Boyd, T. Martin, S. Anderson, M. Wright. 2015. Significant marsh primary production is being lost from the Campbell River estuary: another case of too many resident Canada Geese (*Branta canadensis*)? *British Columbia Birds* 25:2–12.

Day, R.H., S.M. Murphy, J.A. Wiens, G.D. Hayward, E.J. Harner and L.N. Smith 1997. Effects of the *Exxon Valdez* oil spill on habitat use by birds in Prince William Sound, Alaska. Ecological Applications 7:593–613. http://dx.doi.org/10.1890/1051-0761(1997)007[0593:EOTEVO]2.0.CO;2

Donaldson, G. M., C. Hyslop, R. I. G. Morrison, H. L. Dickson and I. Davidson 2000. Canadian shorebird conservation plan. Environment Canada, Ottawa, Canada: Canadian Wildlife Service.

Drever, M.C., M.J.F. Lemon, R.W. Butler and R.L. Millikin. 2014. Monitoring populations of Western Sandpipers and Pacific Dunlins during northward migration on the Fraser River Delta, British Columbia, 1991–2013. Journal of field Ornithology 85: 10-22.

Ducks Unlimited Canada (n.d.). Gadwall. Retrieved August 13, 2015, from http://www.ducks.ca/learn-about-wetlands/wildlife/gadwall/.

Ducks Unlimited (n.d.) Gadwall. Retrieved August 13, 2015, from http://www.ducks.org/hunting/waterfowl-id/gadwall#ad-image-0

Dunbar, D.S. 1985. A numerical model of stratified circulation in a shallow-silled inlet. Ph.D. Thesis, University of British Columbia, Vancouver, British Columbia, 273 pp.

Elliott, J. E., and K. H. Elliott 2013. Tracking marine pollution. Science 340.6132: 556-558.

Environment Canada 2011. Status of birds in Canada. http://www.ec.gc.ca/soc-sbc/index-eng.aspx?sY=2011&sL=e Accessed 24 August 2015.

Environment Canada. 2013. Bird Conservation Strategy for Bird Conservation Region 5: Northern Pacific Rainforest. Canadian Wildlife Service, Environment Canada. Delta, British Columbia. 128pp. + appendices.

Environment Canada, 2014. North American Breeding Bird Survey - Canadian Trends Website, Data-version 2012. Environment Canada, Gatineau, Quebec, K1A 0H3. http://www.ec.gc.ca/ron-bbs/P005/A001/?lang=e&m=b&r=5&p=L&t=18153

Environment Canada. 2014. Recovery Strategy for the Marbled Murrelet (*Brachyramphus marmoratus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. v + 49 pp.

Ford, J. K.B. 2014. Marine mammals of British Columbia. Royal British Columbia Museum Handbook, Volume 6, Victoria, B.C.

Frasier, T.R., S. M. Koroscil, B.N. White, and J. D. Darling. 2011. Assessment of population substructure in relation to summer feeding ground use in the eastern North Pacific gray whale. Endangered Species Research 14: 39-48.

Gauthier, G. 2014. Bufflehead (*Bucephala albeola*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/067 doi:10.2173/bna.67

Goulet, R. 2009. Aspects of the Ecology of Urban-nesting Bald Eagles (*Haliaeeus leucocephalus*) in South-Coastal British Columbia. Masters of Science Thesis: McGill University p. 98.

Government of Canada 2015. Recovery strategy for Northern and Southern resident killer whales (*Orcinus orca*) in Canada. 2015-08-14.

Gratto-Trevor, C., Morrison, R.I.G., Collins, B., Rausch, J., Drever, M. and V. Johnston 2011. Trends in Canadian shorebirds. Canadian Biodiversity: Ecosystem Status and Trends 2010, Technical Thematic Report No. 13. Canadian Councils of Resource Ministers. Ottawa, ON. iv + 32 p.

Hamel, N. J., A. E. Burger, K. Charleton, P. Davidson, S. Lee, D. Bertram and J. Parrish 2009. Bycatch and beached birds: assessing mortality impacts in coastal net fisheries using marine bird strandings. Marine Ornithology 37: 41-60.

Hanrahan, C. 1994. Wildlife inventory of the Shoreline Park system, Port Moody, B.C.. Burke Mountain Naturalists. On line http://www.bmn.bc.ca/assets/bmn/doc/inventy.pdf.

Hayward, J. L. and N. A. Verbeek. 2008. Glaucous-winged Gull (*Larus glaucescens*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/059

Hepp, G. R. and F. C. Bellrose. 2013. Wood Duck (*Aix sponsa*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/169

Hipfner, J. M. 2005. Population status of the common murre *Uria aalge* in British Columbia, Canada. Marine Ornithology 33: 67-69.

Hipfner, M. 2015a. Common Murre *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=COMU&lang=en [20 Aug 2015]

Hipfner, M. 2015b. Pigeon Guillemot *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=PIGU&lang=en [20 Aug 2015]

Hipfner, M. 2015c. Rhinoceros Auklet *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=RHAU&lang=en [20 Aug 2015]

Hipfner, M. 2015a. Pelagic Cormorant *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=PECO&lang=en [28 Jul 2015]

Hipfner, M. 2015b. Black Oystercatcher *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=BLOY&lang=en [28 Jul 2015]

Hogan, D., J. Thompson, D. Esler and W.S. Boyd. 2011. Discovery of Important Postbreeding Sites for Barrow's Goldeneye in the Boreal Transition Zone of Alberta. Waterbirds 34: 261-386.

Howie, R. 2015a. Red-necked Grebe *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=RNGR&lang=en [09 Sep 2015]

Howie, R. 2015b. Western Grebe *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=WEGR&lang=en [24 Jul 2015]

Jackson, B. J. and J. A. Jackson. 2000. Killdeer (*Charadrius vociferus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/517

Jardine CB, Bond AL, Davidson PJA, Butler RW, Kuwae T. 2015. Biofilm consumption and variable diet composition of Western Sandpipers (*Calidris mauri*) during migratory stopover. Public Library of Science 10: doi:10.1371/journal.pone.0124164

Kautesk, B. M. 1977. The site guide: Stanley Park, Vancouver, British Columbia. American Birds 31: 287-291.

Kelly, J. F., E. S. Bridge and M. J. Hamas. 2009. Belted Kingfisher (*Megaceryle alcyon*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/084 doi:10.2173/bna.84

Kuwae, T., P.G. Beninger, P. Decottignies, K.J. Mathot, D.R. Lund, and R.W. Elner. 2008. Biofilm grazing in a higher vertebrate: the Western Sandpiper, *Calidris mauri*. Ecology 89:599–606.

Lacroix, D. 2001. Foraging impacts *and* patterns of wintering surf scoters feeding on bay mussels in coastal Strait of Georgia, British Columbia. MSc thesis,Simon Fraser University, B.C.

Lance, B.K., D.B. Irons, S.J. Kendall and L.L. McDonald. 2001. An evaluation of marine bird population trends following the Exxon Valdez oil spill, Prince William Sound, Alaska. Marine Pollution Bulletin 42: 298-309.

Leschack, C. R., S. K. Mckinght and G. R. Hepp. 1997. Gadwall (*Anas strepera*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/283

Lok, E., M Kirk, D. Esler and W.S. Boyd. 2008. Movements of pre-migratory Surf and White-winged Scoters in response to Pacific Herring spawn. Waterbirds 31: 385-393.

Martell, A. 2015a. Canada Goose *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=CAGO&lang=en [15 Jul 2015]

Martell, A. 2015b. Hooded Merganser *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=HOME&lang=en [09 Sep 2015]

Middleton, H.A. 2014. The influence of intensive land use types on the foraging distribution of ducks wintering in the Fraser River Delta, British Columbia. PhD thesis, Simon Fraser University, Burnaby, B.C.

Morgan, K. H., Vermeer, K. and K. W. McKelvey 1991. Atlas of pelagic birds of western Canada. Canadian Wildlife Service Occasional Paper No. 72, Ottawa.

Morin, J. 2015. Tsleil-Waututh Nation's History, Culture and Aboriginal Interests in Eastern Burrard Inlet (Redacted Version). Prepared for Gowling Lafleur Henderson Toronto, Ontario M5X 1G5 http://twnsacredtrust.ca/wp-content/uploads/2015/05/Morin-Expert-Report-PUBLIC-VERSION-sm.pdf

Morrison, R. I. G. 1994. Shorebird population status and trends in Canada. Bird Trends 3: 3-5.

Moskoff, William and Louis R. Bevier. 2002. Mew Gull (*Larus canus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/687

Murphy, S.M. and T.J. Mabee. 2000. Status of Black Oystercatchers in Prince William Sound, Alaska, Nine Years After the Exxon Valdez Oil Spill. Waterbirds 23: 204-213.

Noble, D. G. and J. E. Elliott 1986. Environmental contaminants in Canadian seabirds, 1968-1985: Trends and effects. Canadian Wildlife Service, Ottawa.

Norris, D. R., P. Arcese, D. Preikshot, D.F. Bertram and T. K. Kyser. Diet reconstruction and historic population dynamics in a threatened seabird. Journal of Applied Ecology 44: 875-884.

North American Bird Conservation Initiative. 2012. The State of Canada's Birds. Environment Canada, Ottawa. http://www.stateofcanadasbirds.org/

North American Bird Conservation Initiative, U.S. Committee. 2014. The State of the Birds 2014 Report. U.S. Department of Interior, Washington, D.C. 16 pages.

North American Waterfowl Management Plan, Plan Committee. 2012. North American Waterfowl Management Plan 2012. People conserving waterfowl and wetlands.Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales, 70 pp.

Nysewander, D. R., J.R. Evenson, B.L. Murphie and T.A. Cyra. 2001. Report of marine bird and marine mammal component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 period. Washington Department of Fish and Wildlife, Olympia, Wash. 161p.

Olesiuk, P. 1999. An assessment of the status of harbour seals (*Phoca vitulina*) in British Columbia. Canadian Stock Assessment Secretariat Research Document 1999/33.

Peterson, C.H., S.D. Rice, J.W. Short, D. Esler, J. L.Bodkin, B. E.Ballachey, D. B. Irons. 2003. Long-term ecosystem response to the Exxon Valdez Oil Spill. Science 302: 2082-2086.

Plath, T. 1994. Purple Martin (*Progne subis*) nest box program first recorded nesting in 22 years for B.C. mainland. Discovery 23: 143-146.

Plath, T. 1997. Purple Martin nest box program: 1966 update. Discovery 26: 109-111.

Pollet, I. L., D. Shutler, J. Chardine and J. P. Ryder. 2012. Ring-billed Gull (*Larus delawarensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/033

Port Metro Vancouver. 2015. Web site. On line at http://www.portmetrovancouver.com/about-us/

Prater, A.J. 1979. Trends in accuracy of counting birds. Bird Study 26: 198–200.

Rappoldt, C., Kersten, M. and Smit, C. 1985. Errors in large-scale shorebird counts. Ardea 73:13–24.

Reed, J. M., L. W. Oring and E. M. Gray. 2013. Spotted Sandpiper (*Actitis macularius*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/289

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The breeding bird survey: its first fifteen years 1965-1979. U.S. Fish Wildl. Serv. Resour. Publ. 157.

Robertson, G., F. Cooke, I. Goudie and W. S. Boyd. 1997. The timing of arrival and moult chronology of Harlequin Ducks *Histrionicus histrionicus.* Wildfowl 48: 147-155.

Sauer, J. R., S. Schwartz and B. Hoover 1996. *The Christmas Bird Count Home Page. Version 95.1.* Patuxent Wildlife Research Centre, Laurel, Md. http://www.mbr-pwrc.usgs.gov/bbs/bbs2010.html

Savard, Jean-Pierre L. 1988, Winter, Spring and Summer Territoriality in Barrow's Goldeneye: Characteristics and Benefits. Ornis Scandinavica
19: 119-128.

Siddle, C.R. 2015a. Mew Gull *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=MEGU&lang=en [20 Aug 2015]

Siddle, C.R. 2015b. Ring-billed Gull *in* Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). *The Atlas of the Breeding Birds of British Columbia, 2008-2012*. Bird Studies Canada. Delta, B.C.
http://www.birdatlas.bc.ca/accounts/speciesaccount.jsp?sp=RBGU&lang=en [20 Aug 2015]

Simons, T.R. 1980. Discovery of a ground-nesting Marbled Murrelet. Condor 82:1-9.

Smith, C.M., F. Cooke, G.J. Robertson, R.I. Goudie, and W.S. Boyd. 2000.
Population Dynamics of Harlequin Ducks in British Columbia and Alberta *in*
L. M. Darling, editor. Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., 15 - 19 Feb.,1999. Volume One. B.C. Ministry of

Environment, Lands and Parks, Victoria, B.C. and University College of the Cariboo, Kamloops, B.C. 490pp.

Smith, J. and K. Morgan 2005. An assessment of seabird bycatch in longline and net fisheries in British Columbia. Canadian Wildlife Service Technical Report Series No. 401. Delta, British Columbia.

Species at Risk Public Registry. 2015. Wildlife species at risk. On line at http://www.registrelep-sararegistry.gc.ca

Stanley Park Ecology Society 2013. No title. On line eagle survey of Vancouver. http://stanleyparkecology.ca/wp-content/uploads/downloads/2013/12/SPES-Bald-Eagle-Final-Report-2013.pdf

Stockner, J. G and D. Cliff. 1979. Phytoplankton Ecology of Vancouver Harbor. Journal of the Fisheries Research Board of Canada 36: 1-10

Stout, B. E. and G. L. Nuechterlein 1999. Red-necked Grebe (*Podiceps grisegena*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/465 doi:10.2173/bna.465

Straker, D. 2014. Pacific Great Blue Heron Annual Report. Stanley Park Ecology Society, Vancouver, B.C. On line at http://stanleyparkecology.ca/wp-content/uploads/downloads/2014/09/Stanley-Park-Heron-Report-2014.pdf

Sullivan, T.M., R.W. Butler and W.S. Boyd. 2002a. Seasonal distribution of waterbirds in relation to spawning Pacific Herring, *Clupea pallasi*, in the Strait of Georgia, British Columbia. Canadian Field-Naturalist 116: 366-370.

Sullivan, T. M., S. L. Hazlitt and M. J. F. Lemon 2002b. Population trends of nesting Glaucous-winged Gulls, *Larus glaucescens*, in the southern Strait of Georgia, British Columbia. Canadian Field-Naturalist 116: 603-606.

Tasker, M. L., P. Jones, T. Dixon and B.F. Blake. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. Auk 101:567-577.

Thompson, C. W., M. L. Wilson, D. J. Pierce and D. DeGhetto 1998. Population characteristics of Common Murres and Rhinoceros Auklets entangled in gillnets in Puget Sound, Washington, from 1993 to 1994. Northwestern Naturalist 79: 77-91.

Trost, T. 2005. Forgotten waters: A zooarcheological analysis of the Cove Cliff Site (DhRr18), Indian Arm, British Columbia. MA thesis, Simon Fraser University, Burnaby.

Vancouver Natural History Society 1995. The birds of Burrard Inlet. Vancouver Natural History Society, Vancouver, BC (ISBN 0-9695974-3-6)

Varty, A. 2010. Marine mammals return to the Strait of Georgia. Georgia Straight on line. http://www.straight.com/article-345025/vancouver/marine-mammals-return-strait-georgia

Vermeer, K. 1977. Some observations on Arctic Loons, Brandt's Cormorants and Bonaparte's Gulls in Active Pass. Murrelet 58:45-57.

Vermeer, K. 1982. Food and distribution of three *Bucephaia* species in British Columbia waters. Wildfowl 33: 22-30.

Vermeer, K. and K. Devito 1989. Population trend of nesting Glaucous-winged Gulls in the Strait of Georgia. p. 88-93 *in* K. Vermeer and R. W. Butler (eds.) The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Special Publication, Canadian Wildlife Service, Ottawa. 186p.

Vermeer, K., I. Szabo and P. Greisman 1987. The relationship between plankton feeding Bonaparte's and Mew Gulls and tidal upwelling at Active Pass, British Columbia. Journal of Plankton Research 9: 483-501.

Vermeer, K., R. W. Butler and K. H. Morgan 1994. Comparison of seasonal shorebird and waterbird densities within Fraser River delta intertidal regions. Occasional paper. Canadian Wildlife Service, Delta, British Columbia.

Vilchis, L. I., C. K. Johnson, J. R. Evenson, S. F. Pearson, K. L. Barry, P. Davidson, M.G. Raphael and J. K. Gaydos. 2015. Assessing ecological correlates of marine bird declines to inform marine conservation. Conservation Biology 29: 154-163

Wilson S, Anderson EM, Wilson ASG, Bertram DF, and P. Arcese. 2013. Citizen science reveals an extensive shift in the winter distribution of migratory Western Grebes. PLoS ONE 8: 65408. doi:10.1371/journal.pone.0065408

Winkler, D. W. 1996. California Gull (*Larus californicus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.proxy.lib.sfu.ca/bna/species/259

Worcester, R. 2010. State of the Park Report for the Ecological Integrity of Stanley Park. Stanley Park Ecology Society. http://stanleyparkecology.ca/wp-content/uploads/downloads/2012/03/State-of-the-Park-Report-for-the-Ecological-Integrity-of-Stanley-Park-full-report.pdf

Worcester, R. 2011. Trends in the abundance of wintering waterbirds along the Stanley Park shoreline between 2001/2002 and 2010/2011. Stanley Park Ecology Society, Vancouver. BC On line at http://stanleyparkecology.ca/wp-content/uploads/downloads/2012/02/SPES_-Winter-Waterbird-Trend-Report-6-Dec-2011.pdf

Ydenberg, R.C., R.W. Butler, D.B. Lank, B.D. Smith and J. Ireland. 2004. Western sandpipers have altered migration tactics as peregrine falcon populations have recovered. Proceedings of the Royal Society of London B 271: 1263–1267.

Appendix 1. Species Accounts

Each account begins with a summary of the Conservation Status in Canada and British Columbia. *Conservation Status* in the following accounts is derived from: 1) the Committee on Species of Endangered Wildlife in Canada listing (www.cosewic.gc.ca) for Endangered, Threatened, and Special Concern; and 2) BC Conservation Data Centre listing (www.env.gov.bc.ca/cdc/) where Red is the provincial equivalent of the federal Endangered and Threatened categories; Blue is equivalent to Special Concern, and Yellow indicates not at risk. Next is a summary of what is known about the species local ecology and regional trends. A summary of the status of the species in the Salish Sea provides regional context to its abundance and distribution, and the *Survey Records* pertain to our survey of Burrard Inlet and Indian Arm. Although a map is provided for every species, there are cases where the map does not adequately describe the distribution and abundance of the species, e.g., for very rare species; for species that are highly mobile and where the timing of the survey might miss them. In such cases, the limitations of the map are noted. We close with *Conservation Issues* and *Recommendation* sections.

BIRDS

Canada Goose *Branta canadensis*

Conservation Status Conservation Data Centre: BC Yellow List

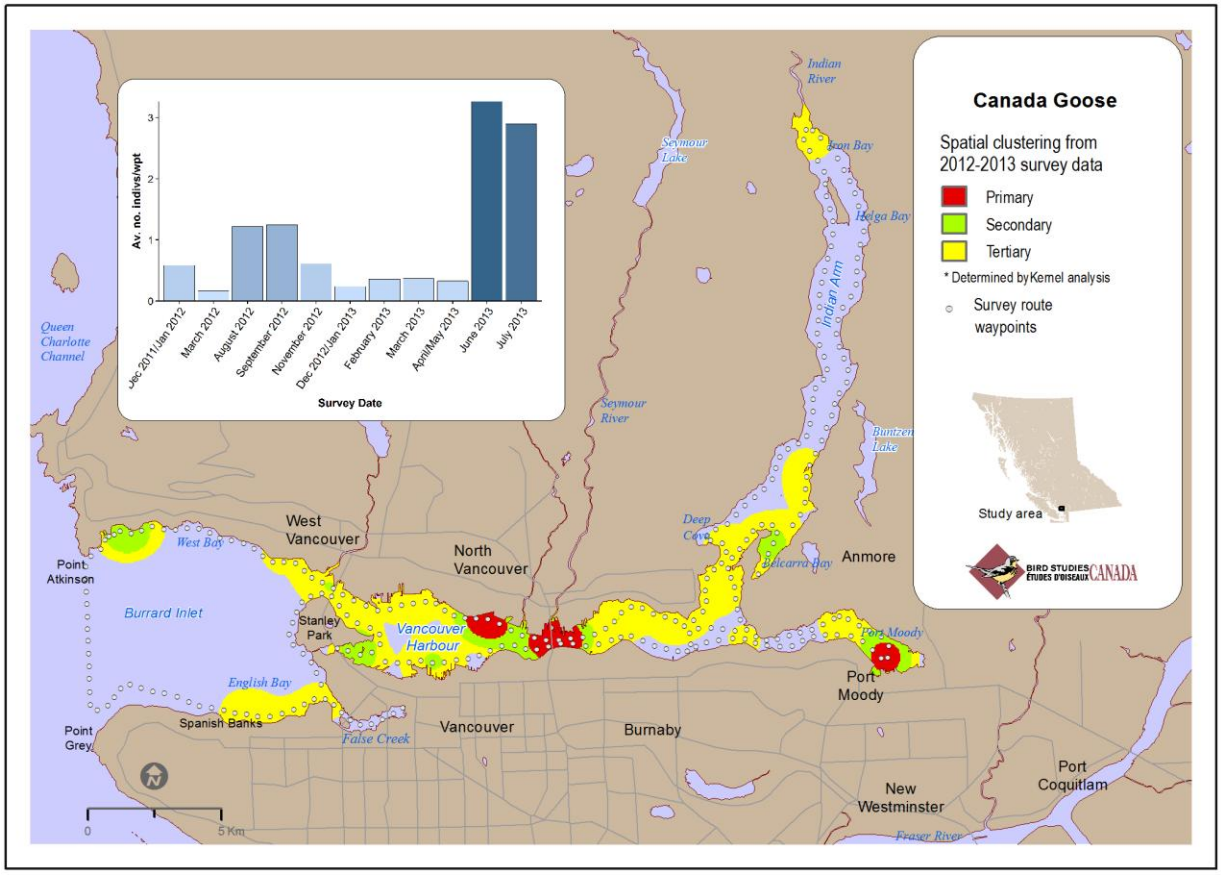

Fig. 8 Spatial distribution and seasonal abundance of Canada Goose in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The number of resident exotic Canada Geese tallied during the BC Coastal Waterbird Survey increased significantly averaging annually 3.8% between 1999 and 2011 (Crewe et al. 2012). This upward trend was mirrored in Puget Sound (Crewe et al. 2012). A native subspecies of Canada Geese, referred to as the Dusky Canada Goose (*B. c. occidentalis*), transits the region between winter quarters in the Willamette Valley, Oregon and breeding grounds in the Copper River, Alaska (Campbell et al. 1990).

Salish Sea Status The Canada Goose in the lower mainland was largely migratory and a summer visitor until the 1970s (Campbell et al. 1990, Dawe and Stewart 2010, Martell 2015a). Small resident flocks were reported to breed in 1970 but most geese seen were in transit (Campbell et al. 1972b). The migratory native Canada Geese pass through the region in spring and autumn, often at

high elevation. Starting in the 1970s, Canada Geese of several subspecies from other parts of Canada and the USA were shipped to the lower mainland by fish and game organizations from which arose the burgeoning resident exotic population in the Salish Sea, including Burrard Inlet and Indian Arm (Campbell et al. 1990). By the 1990s, the Canada Goose had become a regular fixture in Burrard Inlet and Indian Arm. Hanrahan (1994) reported more than 100 were present in Port Moody Inlet in summer and 350 in winter of 1992.

Survey Records 2011-13

Canada Geese were present year-round exceeding more than 900 individuals in June (Table 2). Several hundred geese used the fields and waters of Port Moody Arm during our surveys during the non-breeding season and while moulting their feathers in summer. The species was also numerous oat Maplewood Mudflats and around grain terminals in the harbour. Small flocks moulted feathers in the Indian River estuary. Canada Geese dispersed around Burrard Inlet and Indian Arm to nest and raise goslings.

Conservation Issues

The resident exotic Canada Goose has had a negative effect on vegetation in several estuaries on the eastern shore of Vancouver Island (Dawe et al 2011, 2015) and there were signs of heavy grazing by geese at the head of Port Moody Inlet during our study. Nesting exotic Canada Geese have also impacted floral vegetation on small islands (Best and Arcese 2009). Geese were present in the Indian River estuary but their impact has not been assessed.

Recommendations

Estuarine vegetation is an important source of food energy for the ecosystem to function. Several creeks and rivers support naturally spawning salmon that might be impacted by the loss of vegetation. Dawe et al (2015) recommended actions to reduce the number of geese on Vancouver Island. A review of the impact of geese in Burrard Inlet and Indian Arm should be undertaken.

Trumpeter Swan *Cygnus buccinator*

Conservation Status COSEWIC (1996): Not at risk; Conservation Data Centre: BC Yellow List

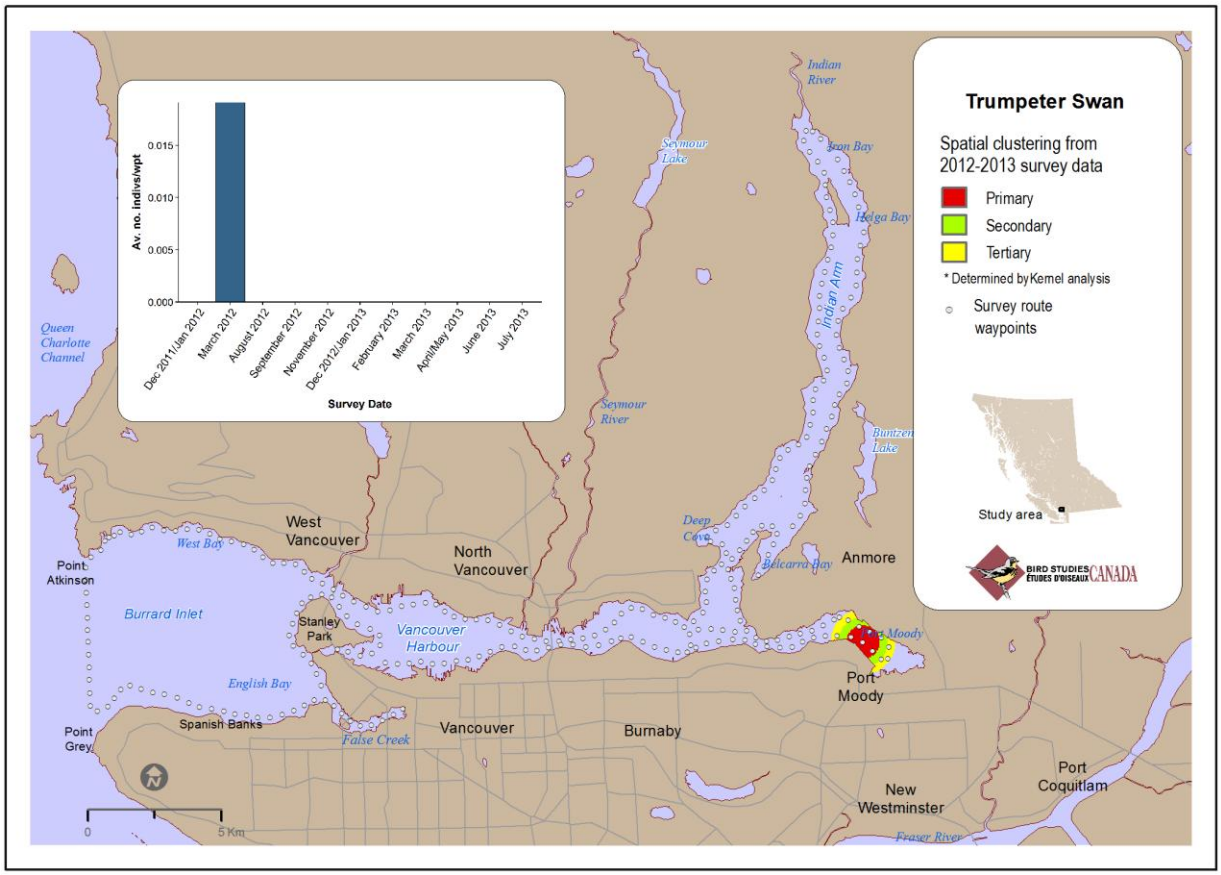

Fig. 9 Spatial distribution and seasonal abundance of Trumpeter Swan in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends In winter, Trumpeter Swans rely on freshwater and coastal estuarine wetlands and adjacent agricultural areas such as those found in the Comox Valley and lower Fraser River Valley. After reaching near-extinction from over-hunting in the early twentieth century, Trumpeter Swan numbers increased steadily throughout their North American range. The BC breeding population, in the northern interior, is small but steadily increasing (BC Conservation Data Centre 2015). The winter population has rebounded and is now widespread. At the continental level, the species has reached the management goal (North American Waterfowl Management Plan 2012).

Salish Sea Status Monitoring by the Canadian Wildlife Service showed an increase of over 11% from 2001-2006 in the Fraser Valley and Vancouver Island (Canadian Wildlife Service Waterfowl Committee 2013) but there was no significant trend in the Fraser delta using the BC Coastal Waterbird Survey data from 1999-2011 (Crewe et al.

2012).

Survey Records 2011-13 The Trumpeter Swan was rarely seen in the study area. We saw swans only in Port Moody Inlet during our survey and a few swans were present at the mouth of the Indian River during a visit within the survey period.

Conservation Issues The major conservation issues facing the Trumpeter Swan in the Strait of Georgia are loss of winter farmland habitat to development, loss of suitable crop types to agricultural intensification, human disturbance, lead shot poisoning and losses of coastal marsh habitat due to climate change (Environment Canada 2013).

Recommendations No measures are proposed

American Wigeon *Anas americana*

Conservation Status Conservation Data Centre: BC Yellow list

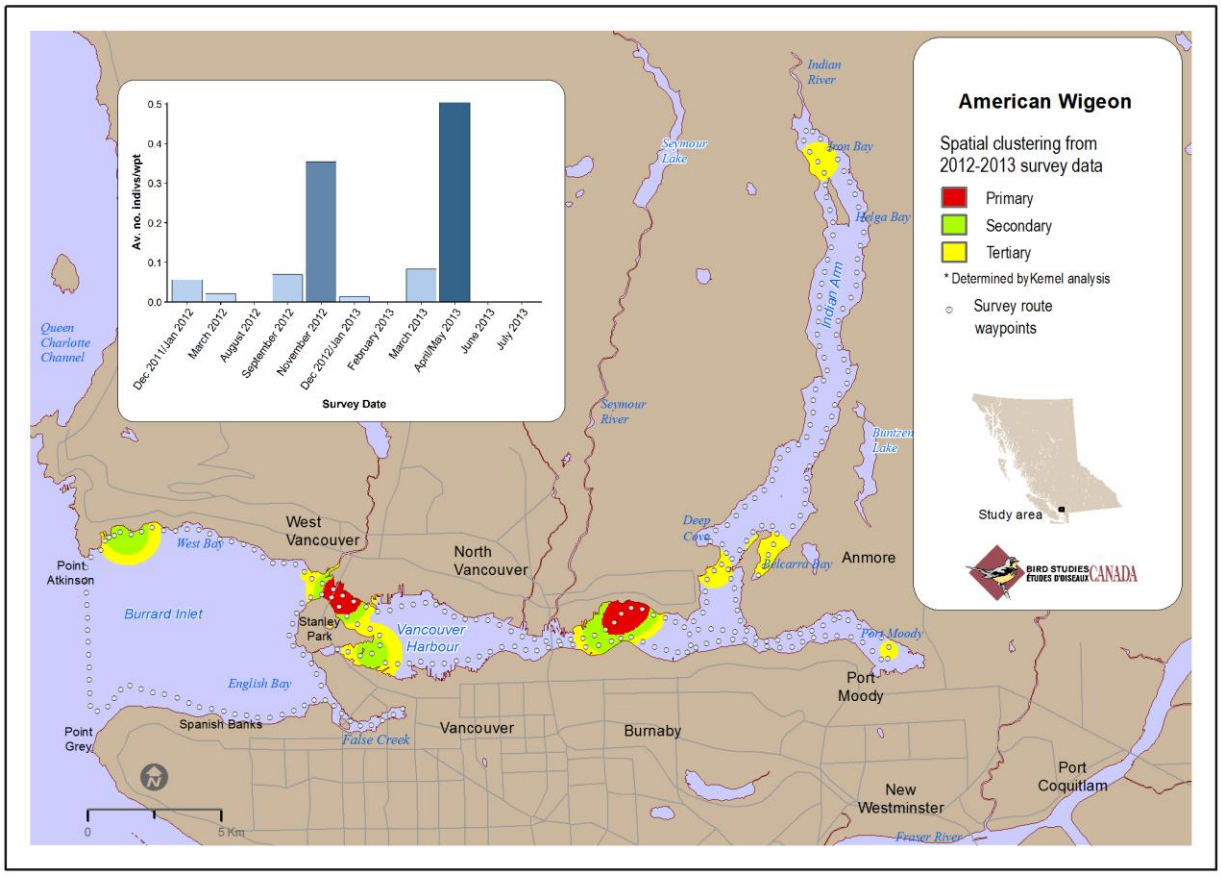

Fig. 10 Spatial distribution and seasonal abundance of American Wigeon in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Fraser River Delta is the centre of the wintering distribution in the Strait of Georgia for this numerous and widespread

	species (Crewe et al. 2012). Flocks of many tens of thousands graze on farmland and rest in Boundary Bay in winter (Crewe et al. 2012, Middleton 2014). The American Wigeon forages on grasses on lawns and in fallow fields, on marsh plants and marine eelgrass and algae.
Salish Sea Status	The BC Coastal Waterbird Survey showed no significant trend for American Wigeon between 1999 and 2011 (Crewe et al. 2012). The BC Christmas Bird Count data from the period 1959–1988 showed no discernible trend (Sauer et al. 1996). However, a significant increase since the mid-1970s was reported from Padilla Bay, Washington (Anderson et al. 2009).
Survey Records 2011-13	American Wigeon tendency to hug the shoreline and forage on lawns and fields made them difficult to see from a boat. Our surveys indicated two areas of high use at Maplewood and Stanley Park. We saw fewer than 25 on most surveys with the exception being April/May and November when over 100 were present during migration (Table 2).
Conservation Issues	Although the population appears stable, steady losses of agricultural land to urban development and transportation corridors, and changes in agricultural land cover stand to threaten wintering habitat (Environment Canada 2013). There were few wigeon in the study area and no pressing conservation issues.
Recommendations	No measures are proposed

Mallard *Anas platyrhynchos*

Conservation Status Conservation Data Centre: BC Yellow list

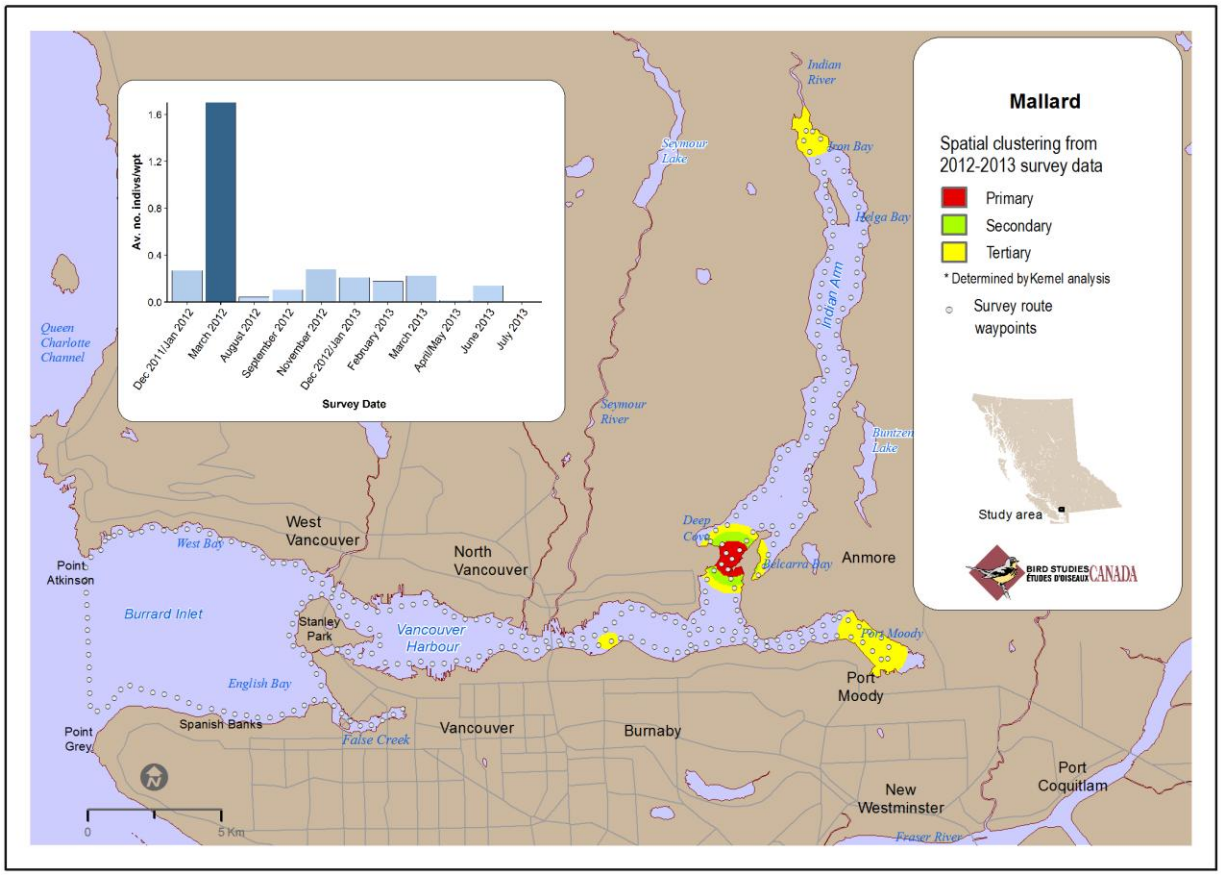

Fig. 11 Spatial distribution and seasonal abundance of Mallard in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Mallard is an herbivorous duck that forages on the blades, seeds and roots of grasses and sedges in both estuarine marshes and agricultural fields. Mallard are widespread throughout the Salish Sea and have a clear centre of abundance in the Fraser delta where many thousands graze on farmland and rest in Boundary Bay in winter (Crewe et al. 2012, Middleton 2014).

Salish Sea Status No significant regional trend apparent in BC Coastal Waterbird Survey data from 1999-2011 (Crewe et al. 2012). No significant change in the wintering population in BC from Christmas Bird Count data from 1959-1988 (Sauer et al. 1996). Although there was no significant trend in winter numbers in Puget Sound from 1978-80 to 2003-06 (Bower 2009), Mallard numbers have been increasing in Padilla Bay, Washington, since the mid-1970s (Anderson et al. 2009). The highest number tallied for Port Moody Inlet in 1992 was 120 birds (Hanrahan 1994).

Survey Records 2011-13 The Mallard was not numerous on our survey of the marine

waters of the study area although it was abundant in nearby lakes, ponds and parks. The Mallard was more widespread than our surveys indicated. One reason was that the Mallard tended to stay close to shore where it was difficult to see from our boat. For example, Mallards use Maplewood Mudflats, Stanley Park, Capilano River mouth and many other locations (RWB pers. obs.). We saw 80 or fewer on every survey except March 2012 when 490 were present (Table 2). The following March we only saw 64 ducks. Mallards were seen near Deep Cove, Port Moody Inlet, the south shore near Second Narrows where they were likely eating spilled grain, and the Indian River during our survey.

Conservation Issues Although the population is stable, steady losses of agricultural land to urban development and transportation corridors and changes in agricultural land cover stand to threaten wintering habitat (Environment Canada 2013).

Recommendations No measures are proposed

Northern Pintail *Anas acuta*

Conservation Status Conservation Data Centre: BC Yellow list

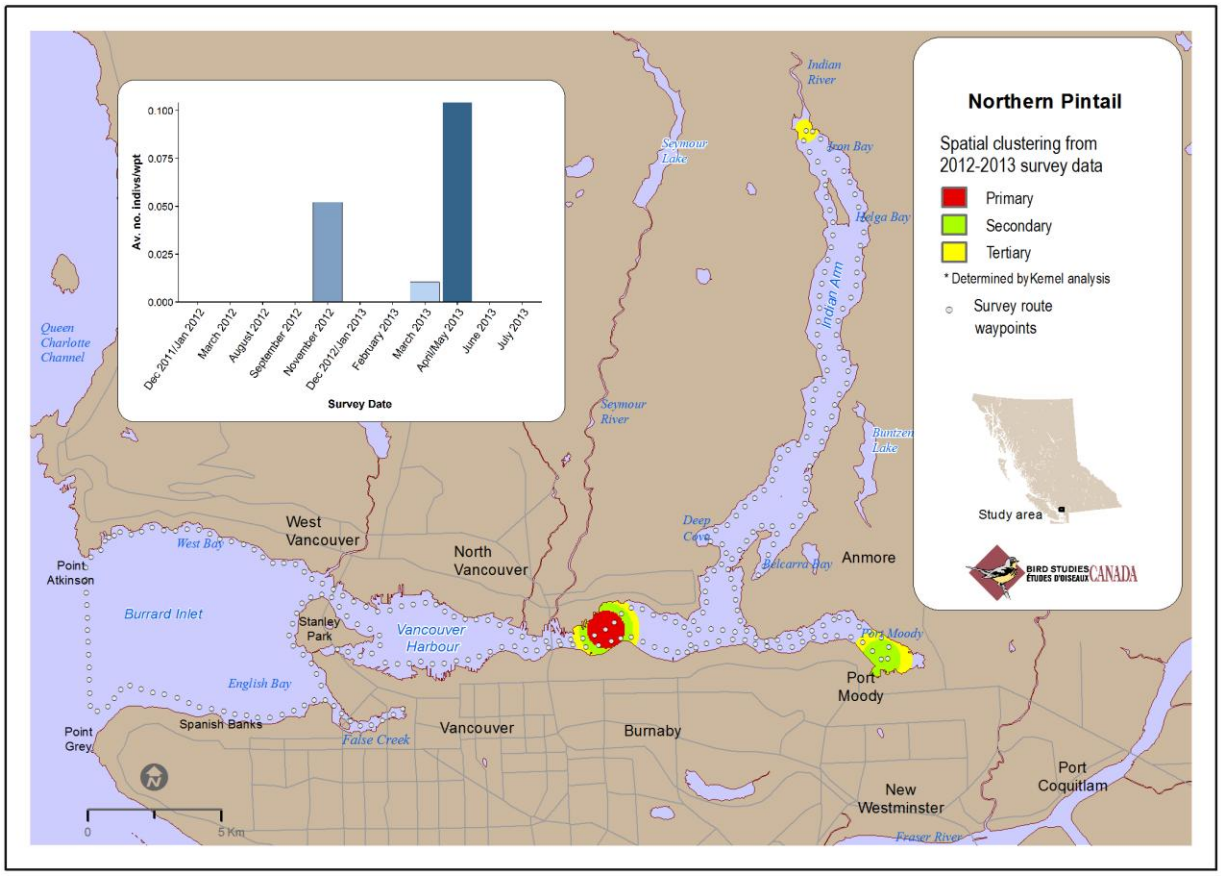

Fig. 12 Spatial distribution and seasonal abundance of Northern Pintail in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends	Northern Pintails are herbivorous ducks that eat blades, seeds and roots of grasses and sedges in both estuarine marshes and agricultural fields. It is the third-most abundant of the duck species wintering in the region. Northern Pintail are common and widespread throughout the Strait of Georgia with a strong centre of abundance around the Fraser delta (Crewe et al. 2012). Flocks of many thousands graze on farmland and rest in Boundary Bay in winter (Crewe et al. 2012, Middleton 2014). Nationally and continentally, Northern Pintails were declining until the mid-1990s (North American Bird Conservation Initiative 2014).
Salish Sea Status	The BC Coastal Waterbird Survey found no significant change in numbers from 1999-2011 (Crewe et al. 2012). Christmas Bird Count data from BC showed no significant change in numbers between 1959 and 1988 (Sauer et al. 1996). Anderson and colleagues (2009) found no significant change in Northern Pintail numbers in Padilla Bay, Washington, between the mid-1970s and mid-2000s. No significant trend in Northern Pintail numbers was found in Puget Sound between 1978-80 and 2003-06 (Bower 2009).
Survey Records 2011-13	The Northern Pintail was not numerous in the marine waters of the study area during our surveys, and like the Mallard and American Wigeon, it was difficult to see where it remained close to shore. The few pintails we saw were at Maplewood Mudflats, Port Moody Inlet and the Indian River on our survey during spring and fall migration in March, April/May and September (Table 2).
Conservation Issues	Although the population is stable, losses of nearby agricultural land to developments and transportation corridors, and changes in agricultural land cover are considered important issues for maintenance of wintering habitat (Environment Canada 2013). Monitoring needs include the development of a marsh monitoring program and targeted winter surveys (Environment Canada 2013.)
Recommendations	No measures are proposed

Green-winged Teal *Anas carolinensis*

Conservation Status Conservation Data Centre: BC Yellow list

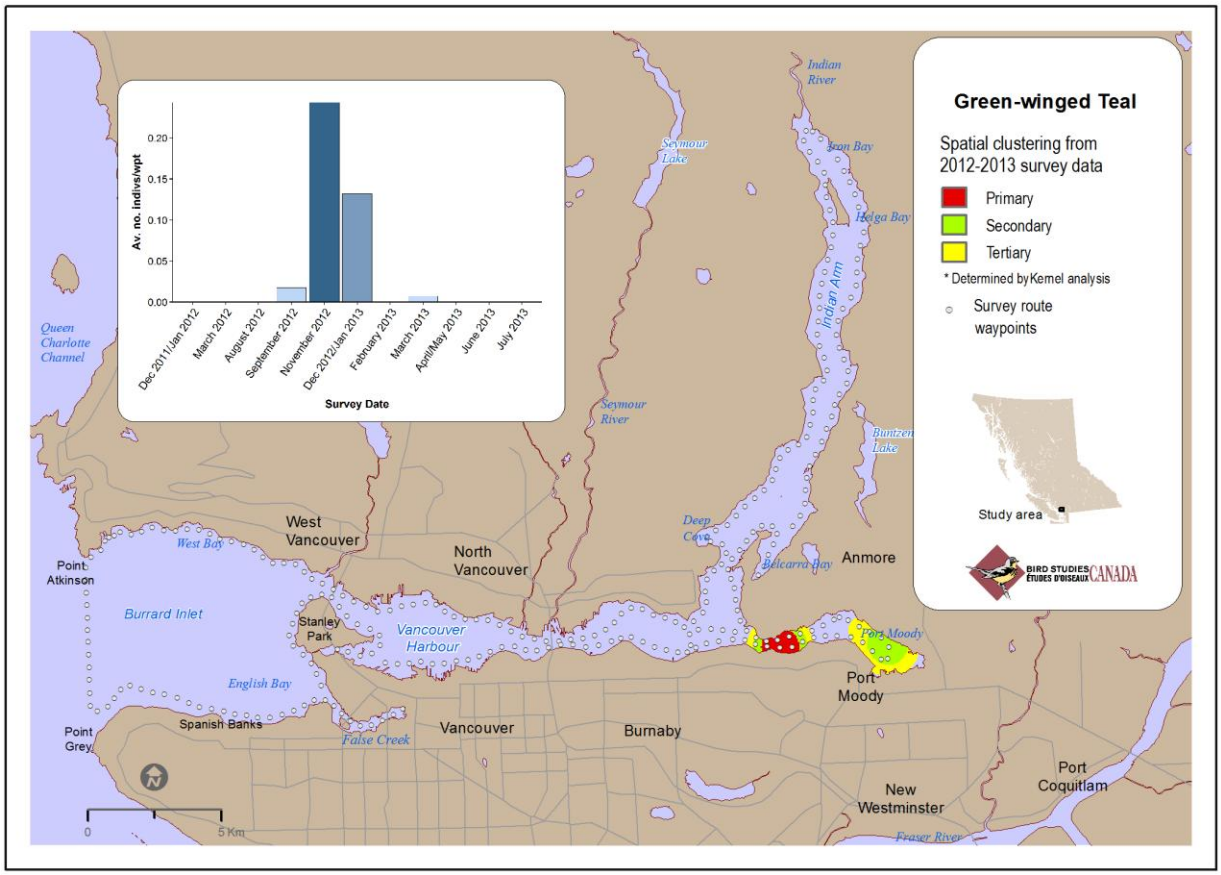

Fig. 13 Spatial distribution and seasonal abundance of Green-winged Teal in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Green-winged Teal is associated with freshwater and brackish wetlands on the coast of British Columbia where it is an abundant migrant and winter species (Campbell et al. 1990). The species is especially numerous in the Fraser River Delta and estuaries around the Salish Sea (Butler an Campbell 1987). The Coastal Waterbird Survey reported that the teal was declining significantly between 1999 and 2011, although the survey was not the best method to monitor the species (Crewe et al. 2012). The Christmas Bird Count from B.C. from the period 1959–1988 showed no significant trend (Sauer et al. 1996).

Salish Sea Status Campbell et al. (1972a) considered the species to be common in winter, and a situation that continues today. Over 400 were tallied in Port Moody Inlet in 1992 (Hanrahan 1994).

Survey Records 2011-13 The Green-winged Teal was not numerous in the marine waters of the study area although it is an abundant species in the region. Like the Mallard, Northern Pintail and American Wigeon, the Green-winged Teal tends to stay close to shore making

them difficult to see from a boat. A small number of teal use Port Moody Inlet each winter (RWB pers. obs.). Teal were seen feeding along the mudflats and shoreline in Port Moody Inlet on our survey. The greatest number was 70 birds seen in November (Table 2).

Conservation Issues Crewe et al. (2012) highlighted this species to watch because of declining trends on the Coastal Waterbird Survey.

Recommendations The Green-winged Teal occurs in relatively small numbers in Burrard Inlet and Indian Arm when compared to those in the Fraser River Delta. Providing suitable habitat in the study area for this species is recommended.

Greater Scaup *Aythya marila*

Conservation Status Conservation Data Centre: BC Yellow list

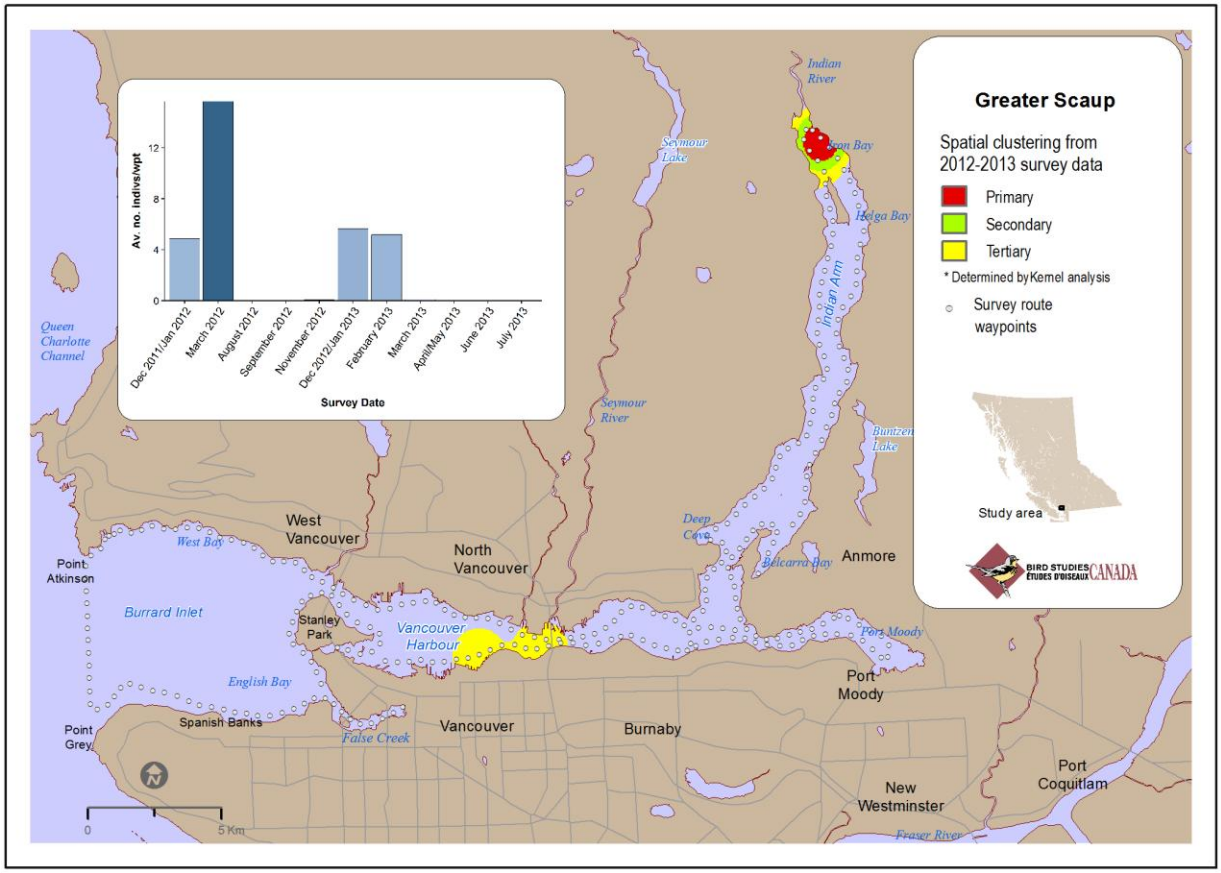

Fig. 14 Spatial distribution and seasonal abundance of Greater Scaup in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Greater Scaup is a migrant and winter resident in the region where it assembles on bays and in estuaries, on lakes and in fields (Campbell et al. 1990). Flocks gather at herring spawning

beaches in the Strait of Georgia in late winter and early spring (Sullivan et al. 2002a). There is heightened conservation concern for the Greater Scaup where declines have been reported at a continental and regional scale (Sauer et al. 1996, Nyeswander et al. 2001, Anderson et al. 2009, Bower 2009).

Salish Sea Status The Coastal Waterbird Survey reported a significant decline on their survey between 1999 and 2011 (Crewe et al. 2012).

Survey Records 2011-13 The Greater Scaup occurred in flocks over 1000 birds in both winters and swelled to over 4500 in March 2012 (Table 2). The following March only 21 were present despite over 1000 being present the previous month. The difference is not clear but might be related to the timing of herring spawn in the Salish Sea that draws large numbers of scaups to eat the eggs (Sullivan et al 2002). Scaups used the Indian River and the inner harbour. We saw hundreds of scaups around the Viterra grain terminal near the Iron Workers Memorial Bridge and among the piers of the central harbour.

Conservation Issues Continental declines on survey of the breeding grounds of the Greater and Lesser Scaup were attributed to a reduction in the recruitment of breeding age scaup in the Canadian western boreal forest (Afton and Anderson, 2001). Vancouver Harbour supports several thousand Greater Scaup during migration where they assemble around grain elevators presumably to eat spilled grains. These numbers exceed those reported by Campbell (1972a) for Vancouver in 1970. Some Greater Scaup might be opportunistically using spilled grain at grain terminals as a food source during migration.

Recommendations Given the continental concern for this species, it is timely to clarify the seasonal use of the harbour by scaup to determine if any conservation action is warranted.

Harlequin Duck *Histrionicus histrionicus*

Conservation Status Conservation Data Centre: BC Yellow list

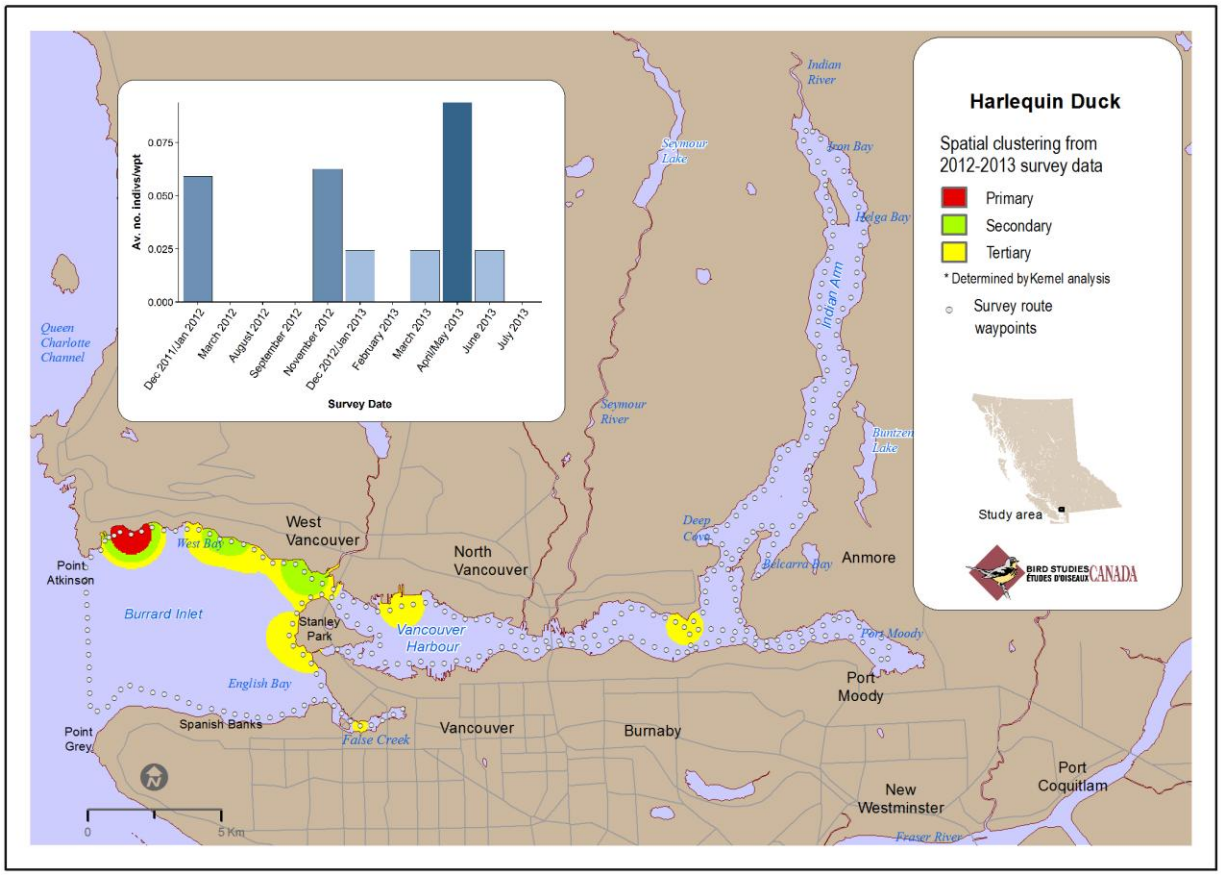

Fig. 15 Spatial distribution and seasonal abundance of Harlequin Duck in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Harlequin Duck in the Salish Sea is a winter resident of rocky shoreline and gravel beaches. The species nests along mountain streams and the males return soon after mating return to the coast to moult feathers and spend the winter. Small numbers occur along many rocky shores in the region until February or March when they fly to the east coast of Vancouver Island to eat Pacific herring eggs (Sullivan et al. 2002a). Surveys of this species in the region show conflicting trends (Crewe et al. 2001).

Salish Sea Status The number of Harlequin Ducks in the Strait of Georgia underwent a slow decline that Crewe et al. (2012) suggested might reflect natural fluctuations. An estimated 11,000 to 15,000 Harlequin Ducks were present in the Strait of Georgia in 2000 (Smith et al. 2000).

Survey Records 2011-13 Small numbers of Harlequin Ducks were seen in the study area with the greatest number reaching 27 birds in April/May (Table 2). Its absence in July and August when they form flocks to

undergo feather moult, suggests that they assemble outside the study area. Harlequin ducks were found mostly in the western end of the study area. The largest numbers gathered at the mouth of Cypress Creek in West Vancouver and pairs or small numbers were scattered along the West Vancouver and Stanley Park shores. A few Harlequin Ducks were present along the shore of Cates Park.

Conservation Issues Burrard Inlet and Indian Arm holds small numbers of Harlequin Ducks in winter that are vulnerable to the effects of oil spills (Lance et al. 2001). Post-breeding ducks begin to return in June to the coast where they undergo a feather moult that renders them flightless from late July through September (Robertson et al. 1997). Moulting ducks are especially vulnerable to disturbance and oiling at this time.

Recommendations Oil spill prevention in the harbour in general and especially in English Bay, should be a priority for this species.

Long-tailed Duck *Clangula hyemalis*

Conservation Status Conservation Data Centre: BC Blue list

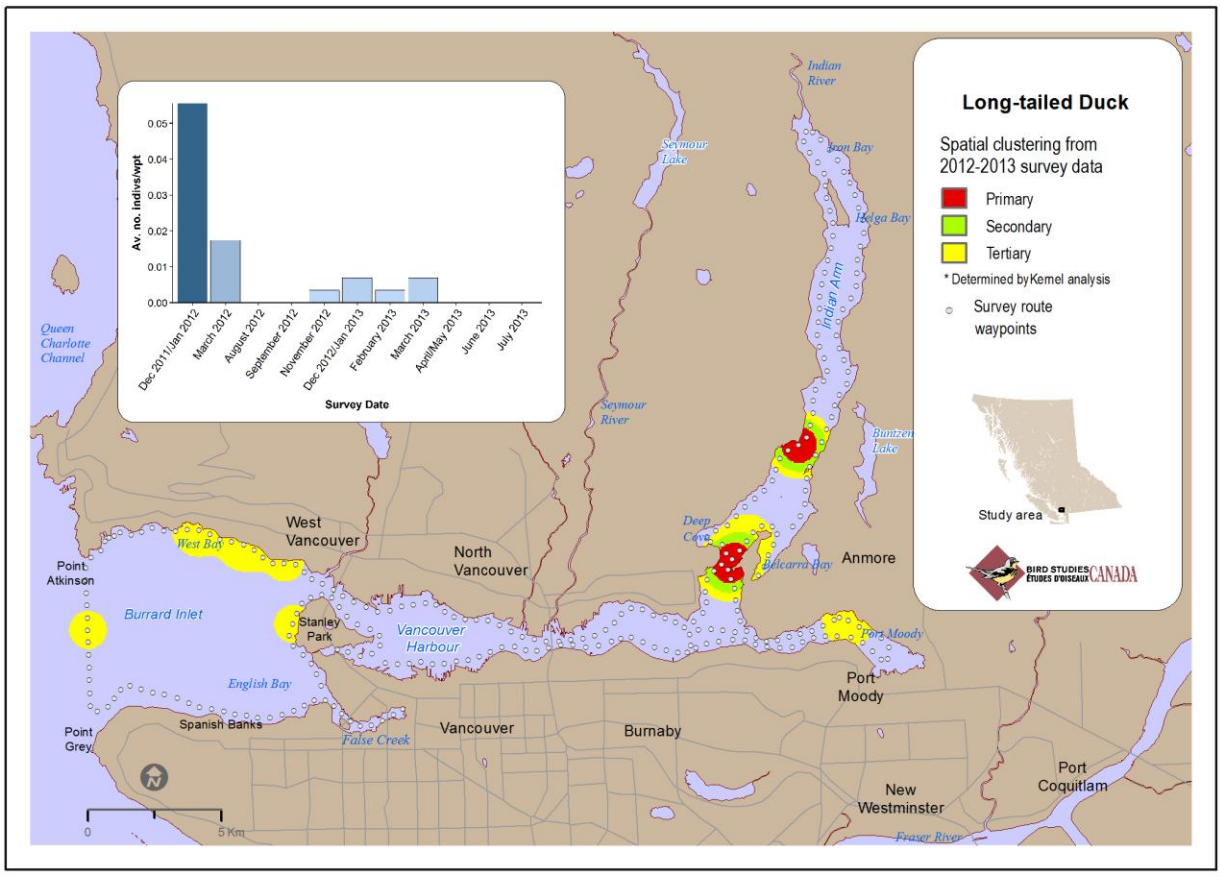

Fig. 16 Spatial distribution and seasonal abundance of Long-tailed Duck in Burrard Inlet and Indian Arm,

British Columbia, December 2011 - July 2013.

Ecology and Regional Trends	The Long-tailed Duck is most often encountered far from shore in deep water where it dives for invertebrates. . The duck spends the winter along the BC Coast and breeds in the Arctic. The Long-tailed Duck has undergone declining trends on regional, continental and global surveys for unknown reasons (reviewed by Crewe et al. 2011).
Salish Sea Status	The Coastal Waterbird Survey indicated a significant declining trend for the period 1999–2011 in the Strait of Georgia (Crewe et al. 2011), and in Puget Sound between the late 1970s and early 2000s (Nyeswander et al. 2001, Bower 2009). Campbell et al. (1972a) reported the species to be frequent in winter. They noted that 20 were present off Stanley Park in March and 53 in November. Long-tailed Ducks spend the winter along the east coast of Vancouver Island where a few thousand have been seen during the spawning season of Pacific Herring (Sullivan et al. 2002a).
Survey Records 2011-13	Few Long-tailed Ducks were present in fall, winter and spring (Table 2). The few birds were present along the West Vancouver and Stanley Park shoreline and in the open water between Point Atkinson and Point Grey. We also saw it at the entrance to Indian Arm, the Indian River and in Port Moody.
Conservation Issues	Only a few Long-tailed Ducks were present in the study area so the level of conservation is possibly low. However, this duck frequents deep water often far from shore and could possibly be more numerous especially in the open water of English Bay, than our surveys indicate.
Recommendations	A survey for this species in the open water of English Bay would confirm the species status there.

Bufflehead *Bucephala albeola*

Conservation Status Conservation Data Centre: BC Yellow list

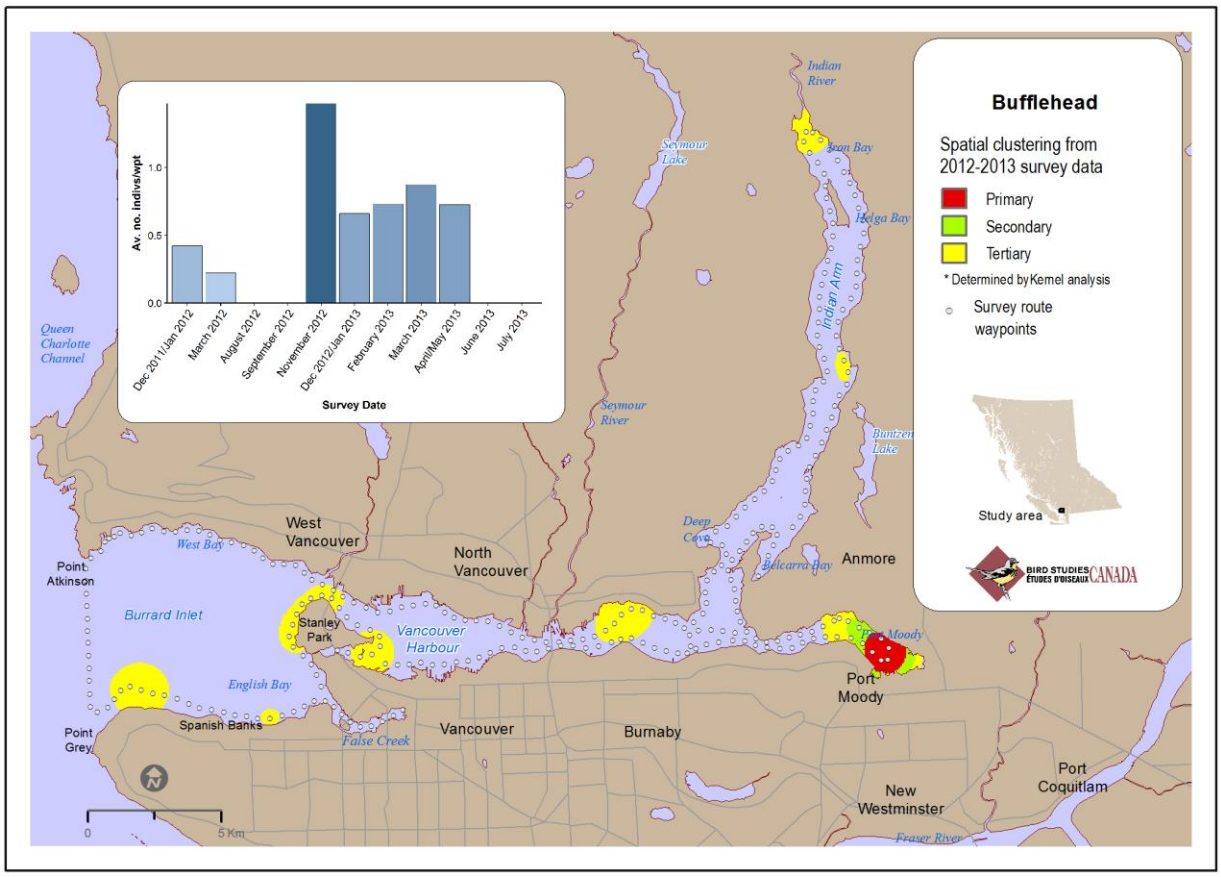

Fig. 17 Spatial distribution and seasonal abundance of Bufflehead in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Bufflehead is a widespread species in nearshore waters throughout the Salish Sea in winter. The Bufflehead nests in holes in tress in the interior of British Columbia and returns to sheltered bays, shallow coves, harbours and estuaries for the winter where it dives mostly for invertebrates (Gauthier 2014). High numbers are found around Comox, Denman Island, between Parksville and Qualicum and in the Squamish Estuary (Crewe et al. 2012). In BC, data from the Christmas Bird Count indicate stable numbers between 1959-1988 (Sauer et al. 1996).

Salish Sea Status No trend was detected from the BC Coastal Waterbird Survey over the period 1999-2011 (Crewe et al. 2012). In Washington State, trends were less clear. Some surveys report declines (Anderson et al. 2009) while those in Puget Sound show increases (Bower 2009).

Survey Records 2011-13 The Bufflehead was widespread on soft bottomed and gravel beaches in the study area such as Spanish Banks, Stanley Park,

Maplewood Mudflats, Port Moody Inlet and Indian River estuary. In those places it was a common species between November and May on our survey (Table 2) but arrived in large numbers a month earlier in October when we did not conduct a survey (RWB, pers. obs.). We recorded over 400 in November and about 200 on each survey from December to April/May (Table 2). An unexplained absence in November 2012 was likely an oversight given its abundance at that time of year.

Conservation Issues

Loss of breeding habitat in the aspen parkland of the BC interior due to logging is a concern (Gauthier 2014, Environment Canada 2013). Mortality due to catastrophic and chronic oil spills on the BC coast is a developing threat according to Environment Canada (2013.) Bufflehead is a priority species under the North American Waterfowl Management Plan.

Recommendations

Improving comprehensive coastal coverage of this widespread diving duck through increasing coverage of marine monitoring programs such as BC Coastal Waterbird Survey and estuarine surveys would be beneficial (Environment Canada (2013))

Surf Scoter *Melanitta perspicillata*

Conservation Status Conservation Data Centre: BC Blue list

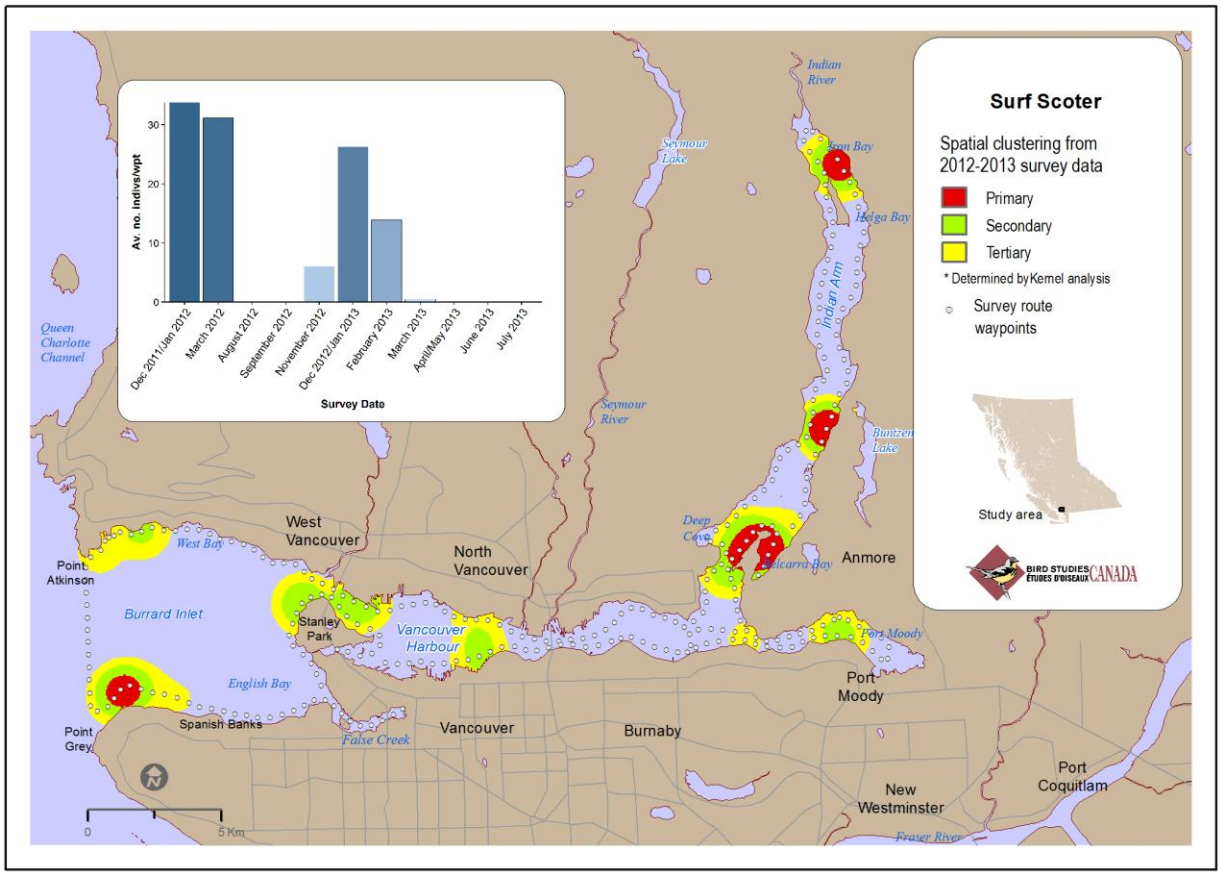

Fig. 18 Spatial distribution and seasonal abundance of Surf Scoter in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends

The coast of British Columbia is a significant winter destination for the Surf Scoter (Burger 2015a) and it is by far the most numerous waterfowl in Burrard Inlet and Indian Arm. Globally important numbers in Burrard Inlet and Indian Arm contributed to its designation as an Important Bird Area (Bird Studies Canada 2000-2015). The Surf Scoter spends its non-breeding season on the coast and migrates to the interior to breed in spring and summer. Small numbers of non-breeding scoters remain in the Salish Sea where they undergo a feather moult in summer. The Surf Scoter can occur in flocks of several thousand birds through the autumn and winter near mussel beds and in late winter and early spring at herring spawning beaches (Sullivan et al. 2002a, Lok et al. 2009). Surf Scoters frequented mussel beds in the study area where they formed into large flocks to dive for mussels that they tear from rocks during dives in shallow water (Lacroix 2001, Worcester 2010). Thousands assemble to eat herring spawn on the east coast of Vancouver

Island in late winter and early spring (Sullivan et al. 2002a, Lok et al. 2009).

Salish Sea Status

The Strait of Georgia is an important winter quarter for this species and where large flocks assemble to eat mussels and clams. Despite concerns about declines of this species in North America (Anderson et al. 2015) the Strait of Georgia Surf Scoters did not show a significant change between 1999 and 2011 (Crewe et al. 2012).

Survey Records 2011-13

The surf scoter was the most numerous waterfowl on our surveys. We tallied 9720 and 7557 scoters in December / January 2012 and 2013, respectively (Table 2). We had highest densities off of scoters off Spanish Banks and in Indian Arm in our surveys with lower densities but important numbers off Stanley Park, in Vancouver Harbour, parts of West Vancouver waterfront, and the entrance to Port Moody (Table 3). This snap shot does not adequately address the mobile nature and overall distribution of this species. Breault and Watts (1995) reported a maximum of 6150 scoters in the study area.

Conservation Issues

Providing food, resting places and preventing pollution are key to the continued presence of this species in the harbour. Burrard Inlet and Indian Arm is a globally important winter habitat for this species. The scoter is vulnerable to the immediate and long term effects of oiled beaches (Day et al.1997, Peterson 2003).

Recommendations

More study of this species is needed to adequately assess its distribution in Burrard Inlet and Indian Arm to assist in locating key foraging and roosting areas in the harbour. In addition, mapping of beds and tracking contaminant loads in mussels would provide information on food quality in the study area. The location and number of seaducks possibly using English Bay as a nighttime roost should be investigated and documented. Oil spill prevention should be a priority for this species.

Black Scoter *Melanitta americana*

Conservation Status Conservation Data Centre: BC Blue list

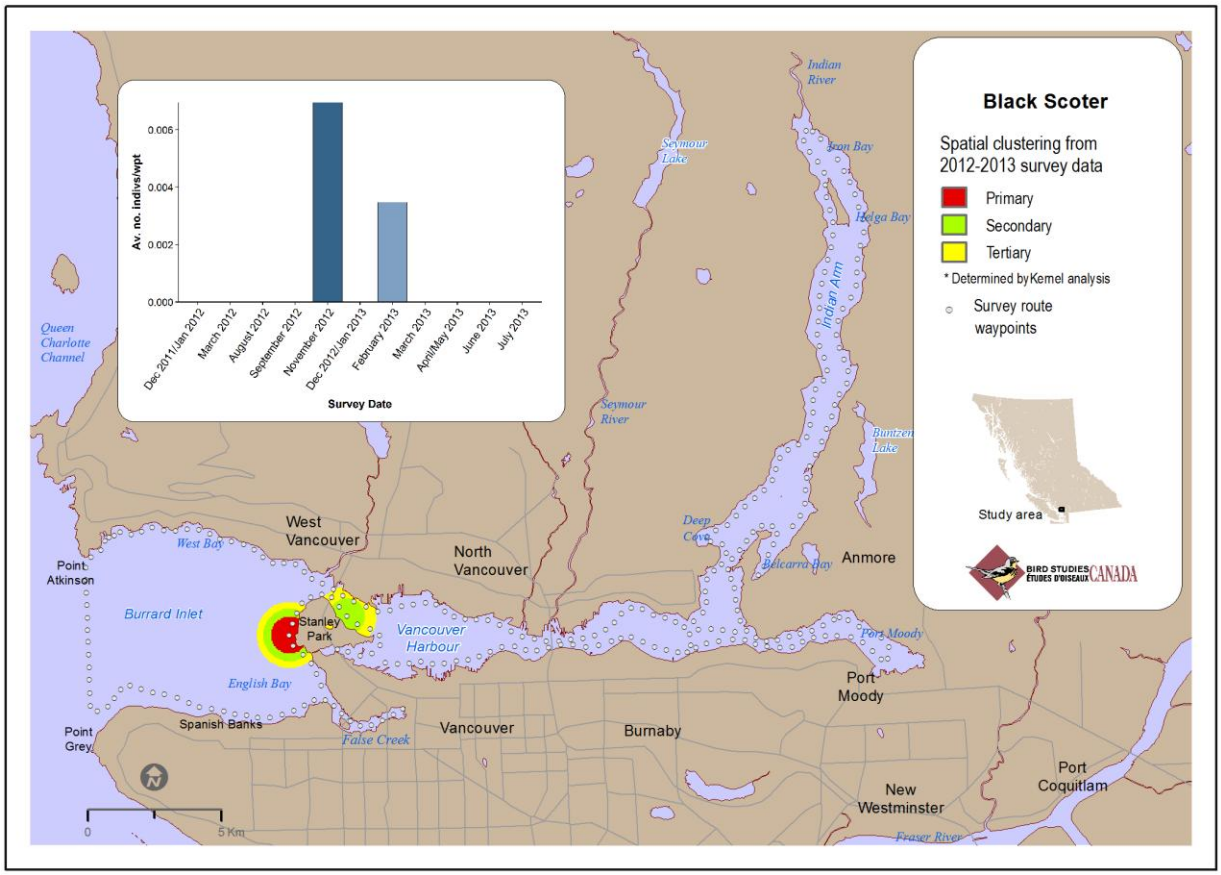

Fig. 19 Spatial distribution and seasonal abundance of Black Scoter in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Black Scoter is a winter resident that departs for breeding grounds for the spring and summer. Crewe et al. (2012) reported this species was undergoing a strong significant decline in the Strait of Georgia from 1999–2011 concurs with several other studies of this species elsewhere in North America. The Black Scoter was frequently seen in winter near Vancouver in 1970 (Campbell et al. 1972a) but it was never very numerous. Sullivan et al. (2002a) tallied 2187 in 23 bays along the east coast of Vancouver Island in 1998.

Survey Records 2011-13 We saw only three Black Scoters (Table 2). The species could easily been overlooked in very large distant flocks of Surf and White-winged scoters.

Conservation Issues Crewe et al. (2012) drew attention to the large decline of this species on surveys and Anderson et al. (2012) suggested that Bald Eagle predation might be a factor. Eagles are important bird predators and were widespread in our survey. The worrying trends suggest that the Black Scoter might soon no longer be

seen in Vancouver Harbour.

Recommendations A careful search for this species in English Bay would be helpful to confirm its status.

White-winged Scoter *Melanitta fusca*

Conservation Status Conservation Data Centre: BC Yellow list

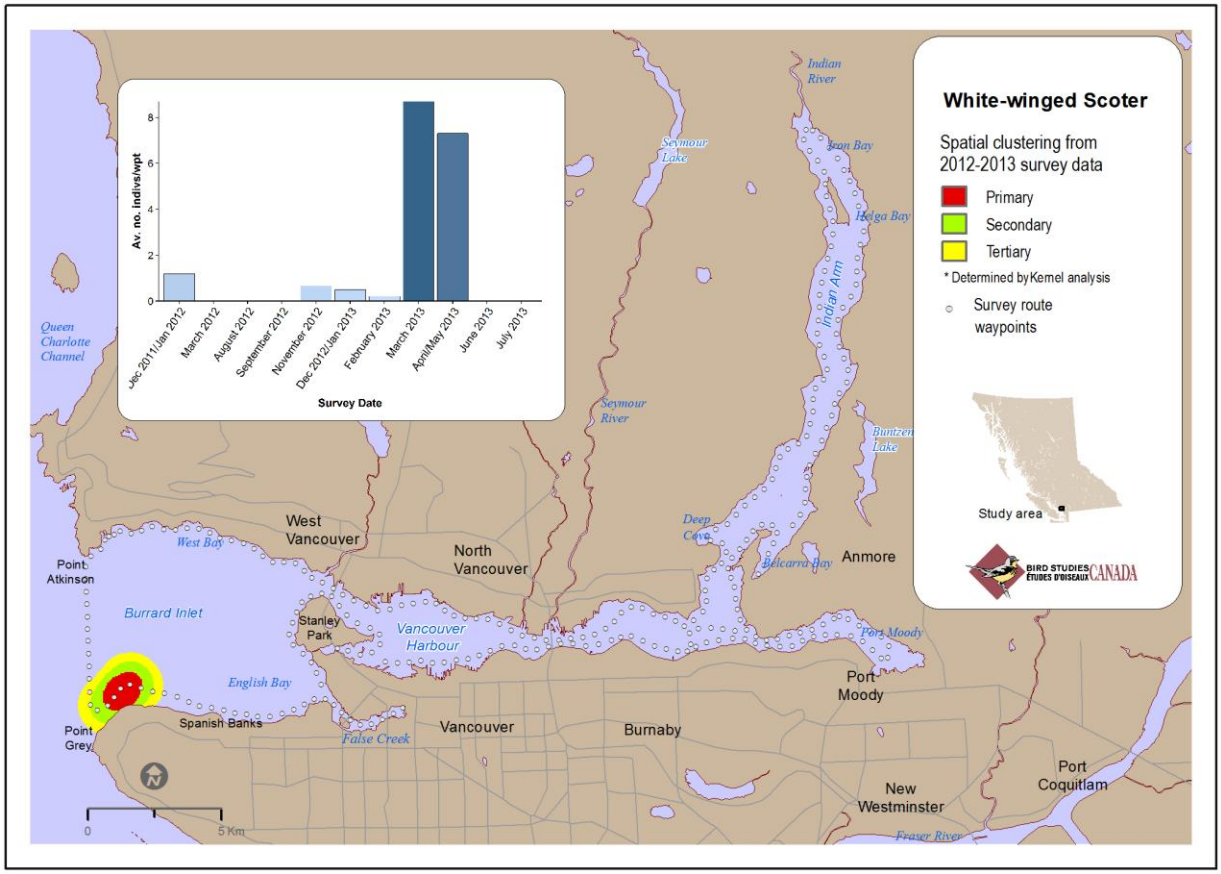

Fig. 20 Spatial distribution and seasonal abundance of White-winged Scoter in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The southern Strait of Georgia and Hecate Strait are centres of winter abundance in British Columbia for this species (Campbell et al. 1990). Many White-winged Scoters spend the autumn, winter and early spring in the Strait of Georgia before migrating to nesting grounds in western Canada. The White-winged Scoter inhabits mostly soft-bottomed substrates where it dives for its food of marine invertebrates. Large numbers assemble along the east coast of Vancouver Island to feed on herring spawn in early spring (Lok et al. 2008).

Salish Sea Status Campbell et al. (1972a) considered the White-winged Scoter to be 'frequent winter' in the Vancouver area in 1970. The BC

Coastal Waterbird Survey showed a significant decline of 7.6% per year over the 1999–2011 period in the Strait of Georgia which contrasts with no significant change between 1978–80 and 2003–06 in Puget Sound (Bower 2009) and a significant increase for all scoters in Padilla Bay (Anderson et al. 2009). These differences perhaps reflect local movements of flocks between bays.

Survey Records 2011-13

A few hundred or fewer White-winged Scoters were present in winter but their numbers swelled to over 2000 in spring migration (Table 2). The large numbers of White-winged Scoter found off Spanish Banks suggests that English Bay might be an important spring staging area for this species. Smaller numbers were also present in English Bay in the company of Surf Scoters in winter.

Conservation Issues

The flocks of over 2000 scoters off Spanish Banks might indicate these waters are important during migration, especially in the light of reported declines. The role of large numbers of eagles that were less numerous in the past, is a possible cause.

Recommendations

The large flocks seen in spring off Spanish Banks requires closer scrutiny to assess the region as a spring staging area for this species. We recommend a study of local eagle diets and behavioural responses of seaducks to the presence of eagles to determine the significance of predation on scoter abundance and distribution.

Barrow's Goldeneye *Bucephala islandica*

Conservation Status Conservation Data Centre: BC Yellow list

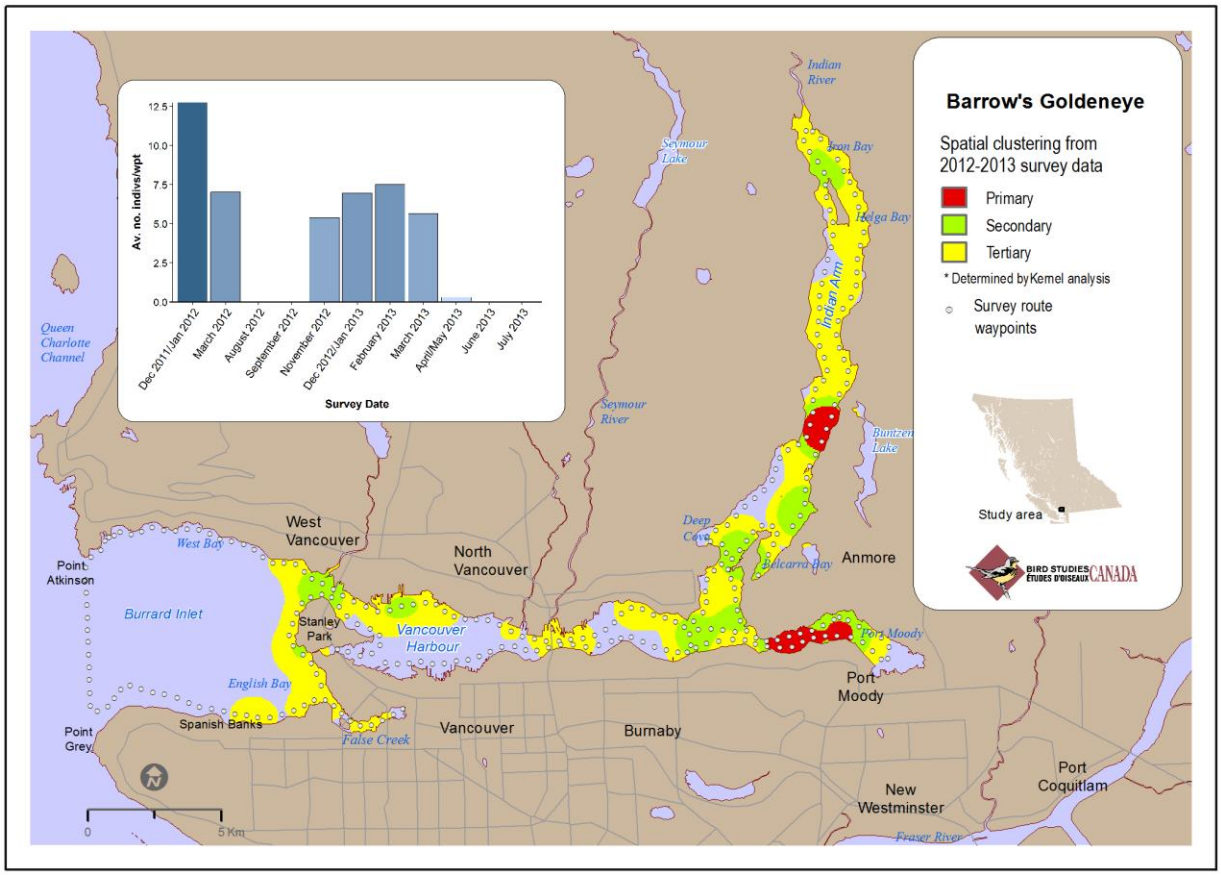

Fig. 21 Spatial distribution and seasonal abundance of Barrow's Goldeneye in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends

The south coast of British Columbia is an important winter quarters for large numbers of the world's Barrow's Goldeneye. Globally important numbers in Burrard Inlet and Indian Arm contributed to its designation as an Important Bird Area (Bird Studies Canada 2000-2015). The goldeneye is a west coast species especially sought by birdwatchers. Burrard Inlet and Indian Arm goldeneye have been the focus of winter territorial behaviour and migration (Savard 1998, Hogan et al. 2011). Barrow's Goldeneye is restricted almost exclusively to sheltered rock shorelines on its winter quarters in the North Pacific. Its winter diet is mostly marine invertebrates such as snails, barnacles and mussels, and herring eggs in spring (Vermeer 1982). Pacific herring spawned on Best Beach in Indian Arm in April 2015 attracting hundreds of goldeneye.

Indian Arm goldeneyes were strongly associated with nest sites in the Cariboo, and Cardinal Lake in Alberta where they moulted

feathers after breeding (Boyd and Esler 2011). Many goldeneye returned to the same winter quarters between years with most females (71%) and some males (29%) relocating to within 5 km of the previous winter location in the subsequent year. Barrow's Goldeneye captured in Indian Arm moved about the inlet and used neighbouring lakes (Boyd and Esler 2011). Worcester (2010) found most goldeneye around Stanley Park frequented the western shore where mussel beds were most prevalent.

Salish Sea Status

Important coastal regions for this species are the southern Sunshine Coast, English Bay and Burrard Inlet area and Howe Sound (Crewe et al. 2012). The BC Coastal Waterbird Survey showed a significant decline of 4.3% annually between 1999–2011 (Crewe et al. 2012). These authors identified Burrard Inlet where numbers had declined significantly over the past two decades.

Survey Records 2011-13

Barrow's Goldeneye was a highly mobile species as reflected in the map and confirmed by satellite tracking (W.S. Boyd, pers. comm.). The greatest number of goldeneyes was in December/January 2012 when we tallied 3672 ducks (Table 2). Two decades earlier, Breault and Watts (1995) tailed nearly double that number at 7126 birds in December. In our study, over a 1000 were present from November to March after which the goldeneye departed for breeding grounds. (Goldeneye arrived in October when we did not conduct a survey, RWB pers. obs). Our surveys showed that the goldeneye was widespread along rocky shores of Burrard Inlet and Indian Arm.

Conservation Issues

Burrard Inlet and Indian Arm is a globally important winter habitat for this species. The goldeneye is vulnerable to the immediate and long term effects of oiled beaches (Day et al.1997, Peterson 2003). The species mobility makes it a potential candidate for oiling and a priority for response. Bird Studies Canada (2000-2015) summary of this species in Burrard Inlet and Indian Arm ranged from 550-3672 birds, the high count being our tally, and representing 1.5% of the global population estimate for this species. There is an historical tally of 7126 goldeneye for Burrard Inlet and Indian Arm reported by (Breault and Watts 1995).

Recommendations

The goldeneye is one of the inlet's iconic birds. Oil spill prevention should be a priority for this species. W.S. Boyd and D. Esler (pers. comm.) have begun to describe local movements of the goldeneye in Burrard Inlet and Indian Arm. We also need to know the features of habitats frequented by goldeneye to ensure continuity.

Common Goldeneye *Bucephala clangula*

Conservation Status Conservation Data Centre: BC Yellow list

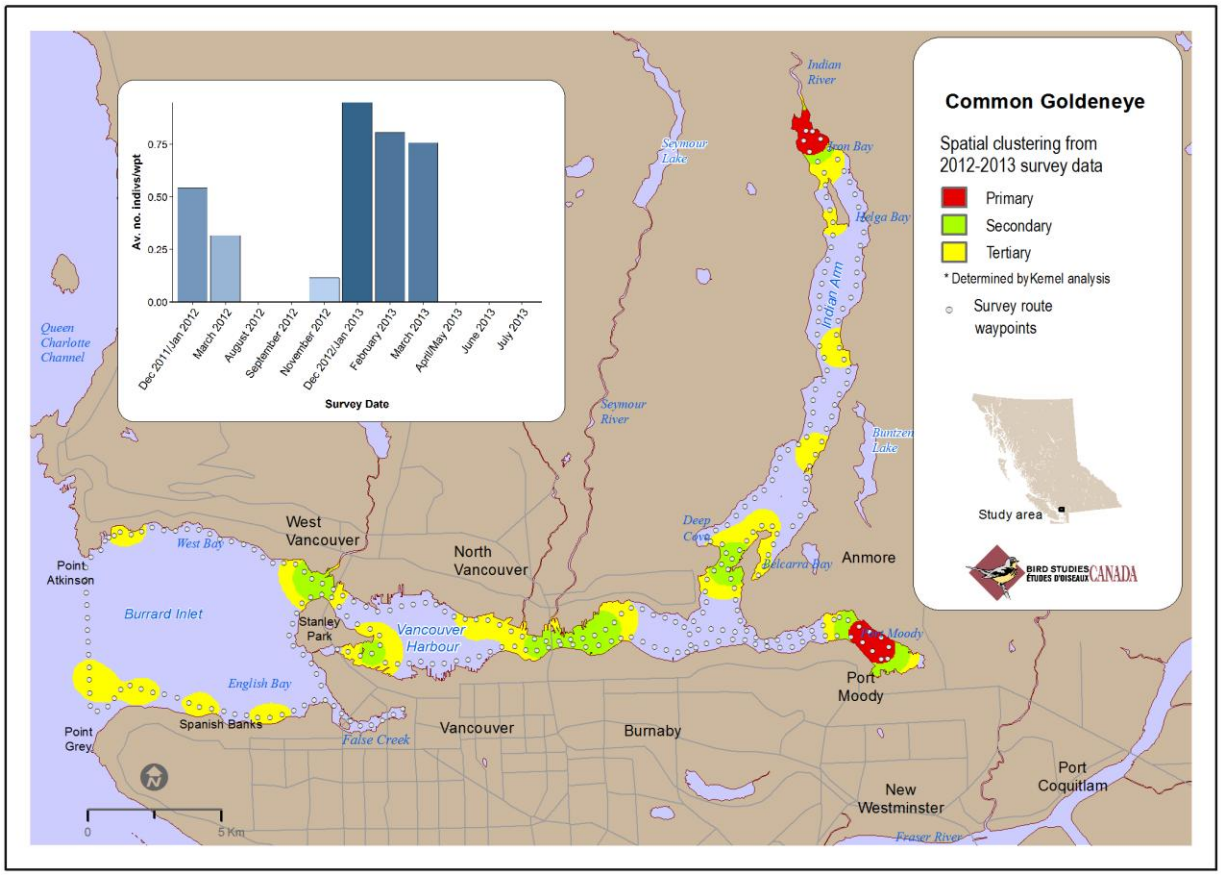

Fig. 22 Spatial distribution and seasonal abundance of Common Goldeneye in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Common Goldeneye is a widespread west coast species in winter often found in soft bottom estuaries and shores (Campbell et al 1990). It eats mostly marine invertebrates and assembles at herring spawning beaches to eat spawn in late winter and early spring (Sullivan et al. 2002a).

Salish Sea Status Crewe et al. (2012) found no significant change in abundance in the Canadian portion of the Salish Sea between 1999 and 2011 whereas both Bower (2009) and Anderson et al. (2009) found large declines on surveys in Puget Sound and Padilla Bay, respectively. Campbell et al. (1972a) reported that the species was common in winter.

Survey Records 2011-13 A few hundred birds were widespread between November and March (Table 2) generally over soft beaches such in Englihs Bay, Maplewood Mudflats, Port Moody Arm and Indian River estuary.

Conservation Issues No conservation issues are proposed.

Recommendations No recommendations are proposed.

Common Merganser *Mergus merganser*

Conservation Status Conservation Data Centre: BC Yellow list

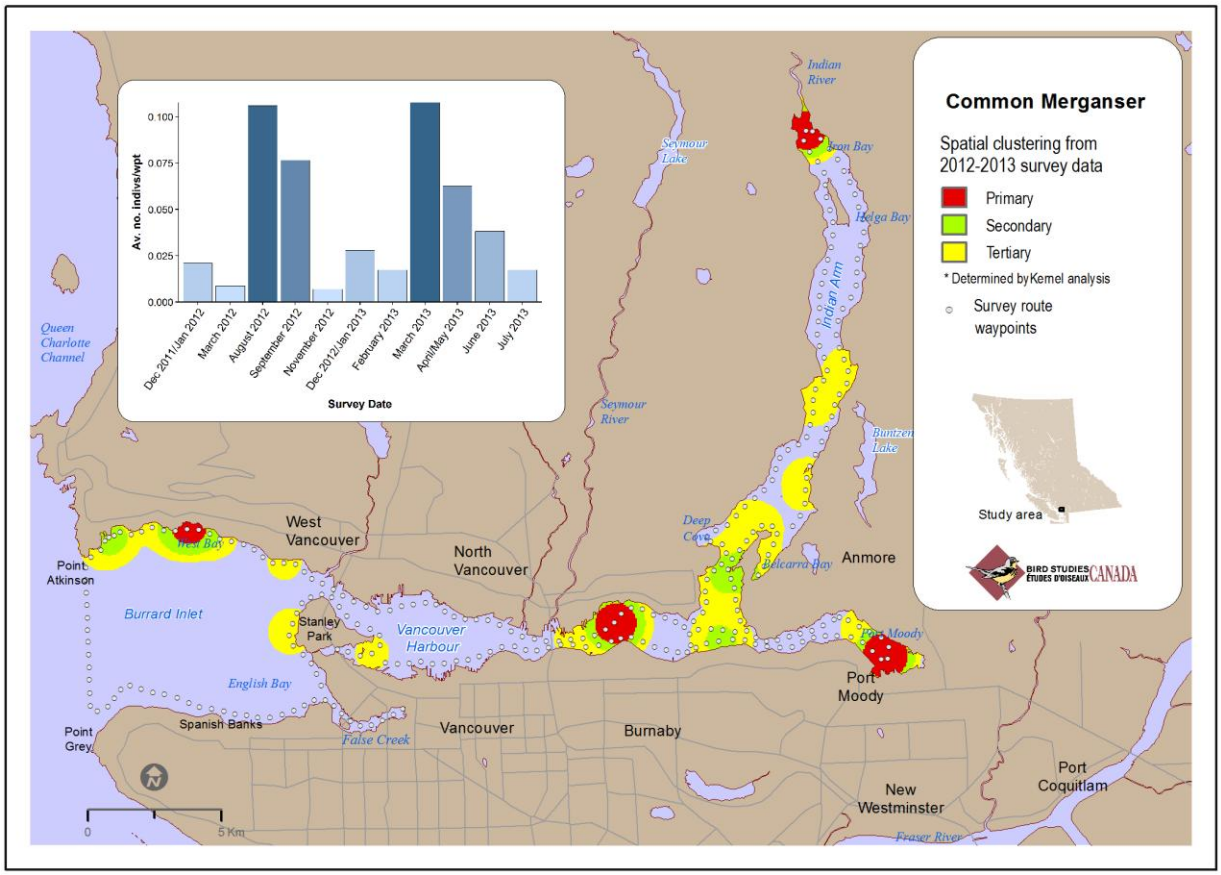

Fig. 23 Spatial distribution and seasonal abundance of Common Merganser in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Common Merganser is a widespread species in small numbers throughout the region. The merganser nests along the shores of local rivers and streams and brings its broods to the sea. Mergansers eat mostly small fish prey.

Salish Sea Status The species abundance appears to be stable in the Salish Sea (Bower 2009, Crewe et al. 2012). The merganser was reported to nest along rivers and streams of the North Shore in 1970 (Campbell et al. 1972a).

Survey Records 2011-13 Small numbers were present year round (Table 2). The Common Merganser occurred in the highest densities near creek and river mouths. Cypress Creek, Maplewood Mudflats, Port Moody Inlet and the Indian River held the highest densities.

Conservation Issues No issues are proposed.

Recommendations Documenting the streams used by mergansers would assist in ensuring the stability of local nesting populations.

Red-breasted Merganser *Mergus serrator*

Conservation Status Conservation Data Centre: BC Yellow list

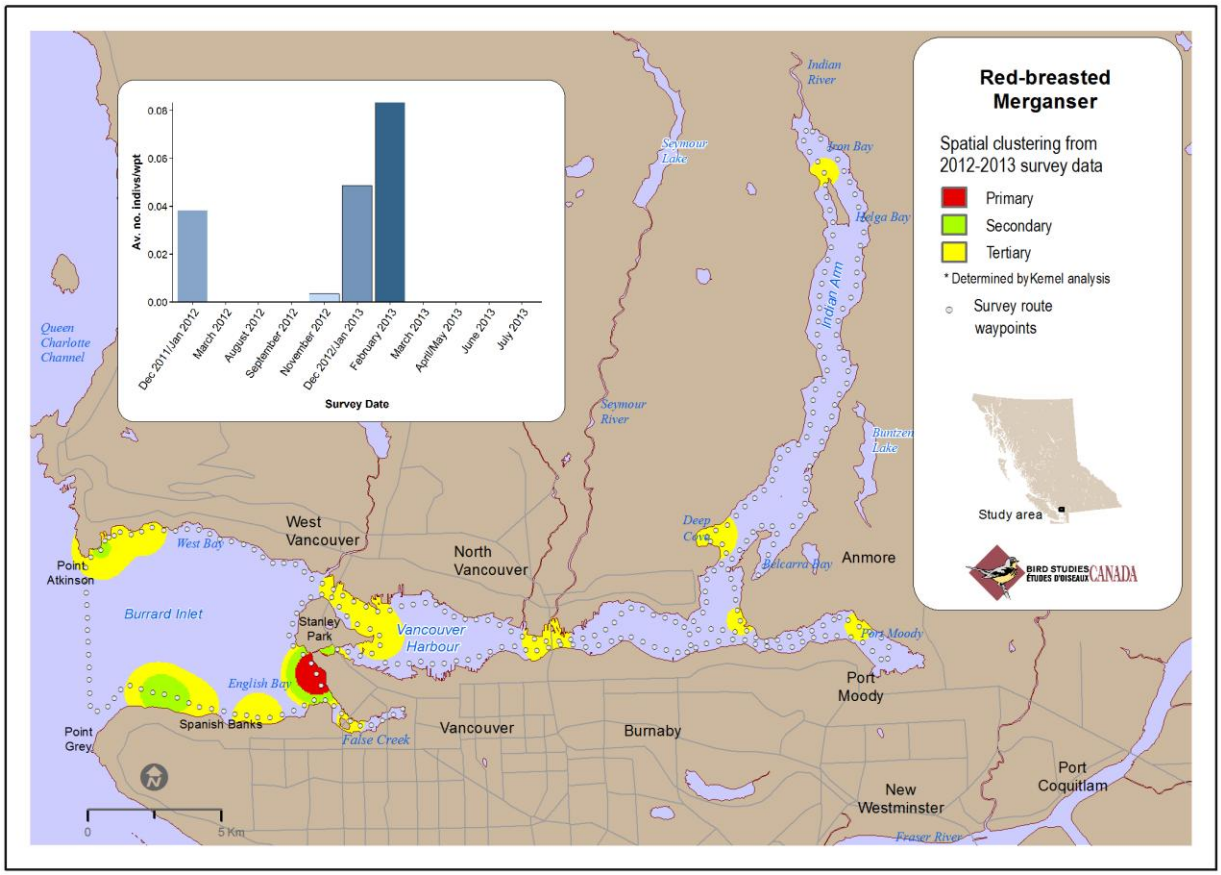

Fig. 24 Spatial distribution and seasonal abundance of Red-breasted Merganser in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Red-breasted Merganser migrates into the region for the winter beginning in September and departs in April (Campbell et al 1972a). Mergansers reside in shallow waters where they dive for small fish along the shores of the south coast. No trend was found in the Christmas Bird Count data from B.C. in 1959–1988 (Sauer et al. 1996).

Salish Sea Status No trend was found for the Coastal Waterbird Survey from 1999-2011 (Crewe et al. 2012) but Bower (2009) reported a decrease 1975–84 and 1998–2007 periods of the Christmas Bird Count data from the Salish Sea.

Survey Records 2011-13 The Red-breasted Merganser occurred as scattered lone individuals or pairs. Nowhere numerous, the few Red-Breasted Mergansers were seen mostly along the west side of Stanley Park.

Conservation Issues No issues are proposed.

Recommendations No measures are proposed.

Hooded Merganser *Lophodytes cucullatus*

Conservation Status Conservation Data Centre: BC Yellow list

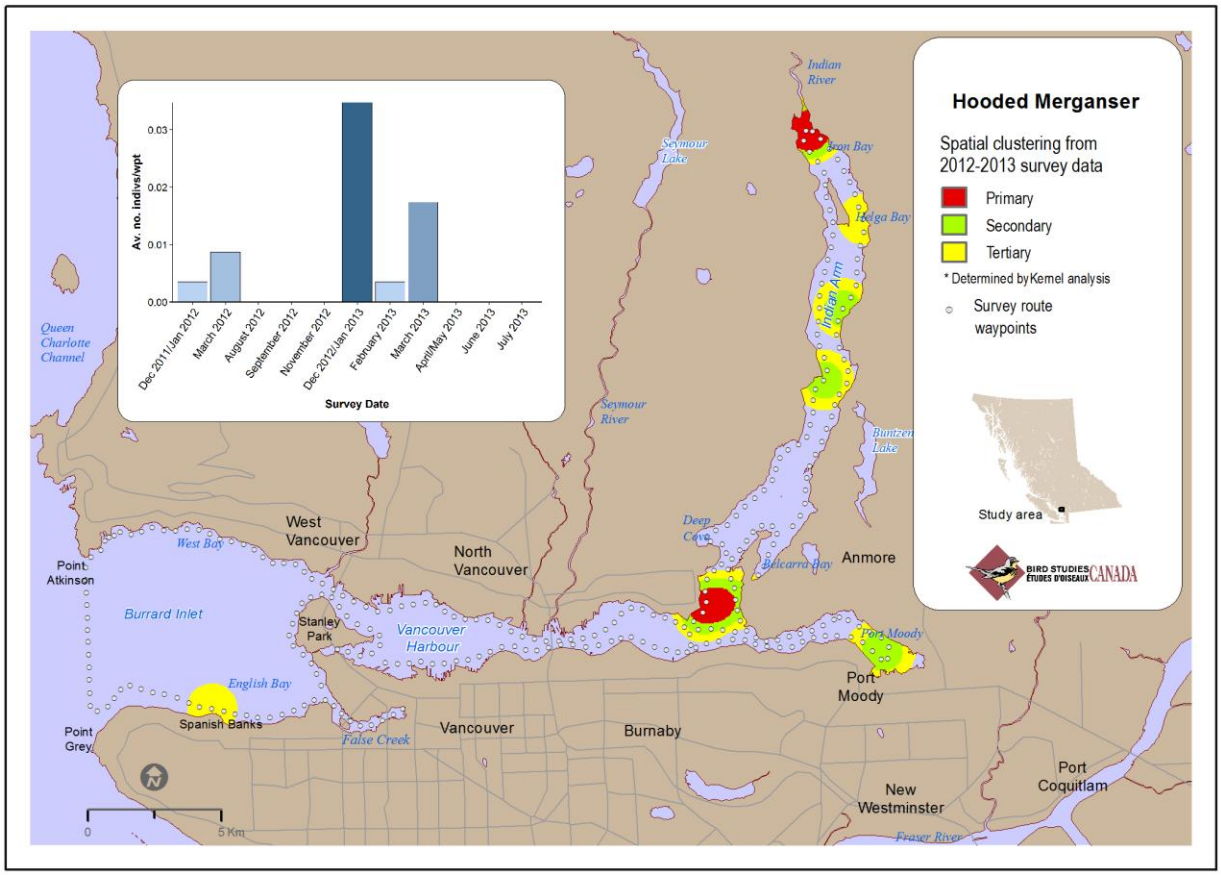

Fig. 25 Spatial distribution and seasonal abundance of Hooded Merganser in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Surveys in the region are not adequate to assess the abundance of Hooded Merganser (Anderson et al. 2009, Crewe et al 2012). Campbell et al. (1990) refer to the species as common in spring, locally very common in autumn, rare to uncommon in summer, and fairly common to locally very common in winter on the south coast of British Columbia. It is most often encountered in bays, inlets and estuaries on the south coast. Coastal and interior populations in British Columbia have more than doubled since 1970 (North American Bird Conservation Initiative 2012).

Salish Sea Status The Hooded Merganser nested in the Lower Mainland in 1970 (Campbell et al. 1972a) and continues to do so. The species is widespread mostly seen in small numbers or as individual birds.

Survey Records 2011-13 The scarcest of the three species of merganser, the Hooded Merganser was seen only in winter and spring (Table 2). The few individuals we saw were scattered around the study area and most often encountered near Cates Park and the Indian River.

Conservation Issues The species is doing well in southern British Columbia and no conservation measures are warranted (Martell 2015b).

Recommendations No measures are proposed.

Pacific Loon *Gavia pacifica*

Conservation Status Conservation data Centre: BC Yellow list

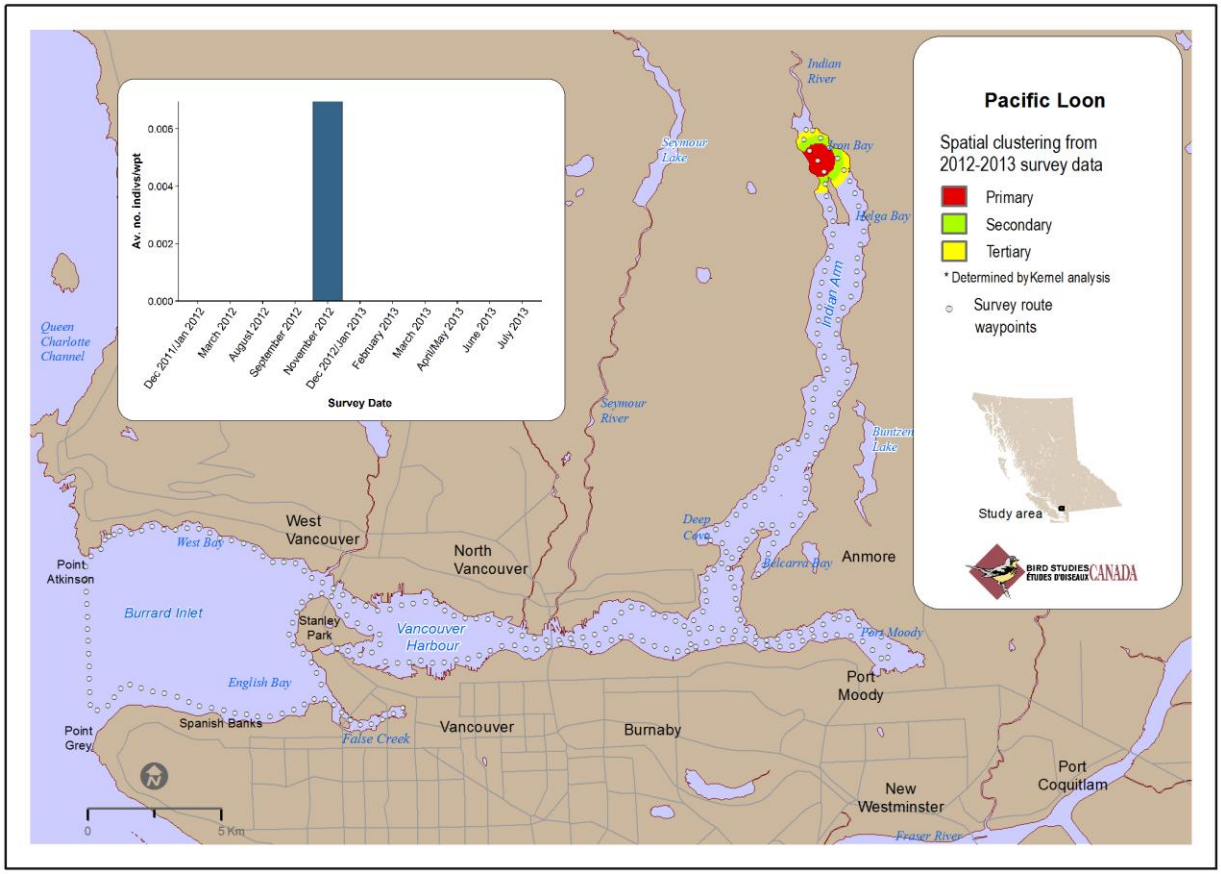

Fig. 26 Spatial distribution and seasonal abundance of Pacific Loon in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Pacific Loon is a flocking species that can occur in large numbers in tidally active areas. Historically, several thousand of this species spent the winter in Active Pass (Vermeer 1977). For example, Davidson et al. (2010) tallied a maximum of 241 loons in 2009 in the eastern entrance to Active Pass. The loon is a winter resident where it dives to pursue its fish prey.

Salish Sea Status Large numbers of loons have historically been reported from Point Roberts, along the east coast of Vancouver Island and in Active Pass (Campbell et al. 1972a, Vermeer 1977, Sullivan et al. 2002a). The censuses around the Salish are confounding (Bower 2009, Anderson et al. 2009, Crewe et al. 2012) and suggest a

complex pattern of local movements likely related to the availability of its prey.

Survey Records 2011-13 Campbell et al. (1972a) did not report the species in Burrard Inlet and Indian Arm. Our only encounter was of two birds near the mouth of the Indian River in November 2012 (Table 2).

Conservation Issues No issues are proposed.

Recommendations No measures are proposed.

Common Loon *Gavia immer*

Conservation Status COSEWIC: not at risk (1997); Conservation Data Centre: BC Yellow list

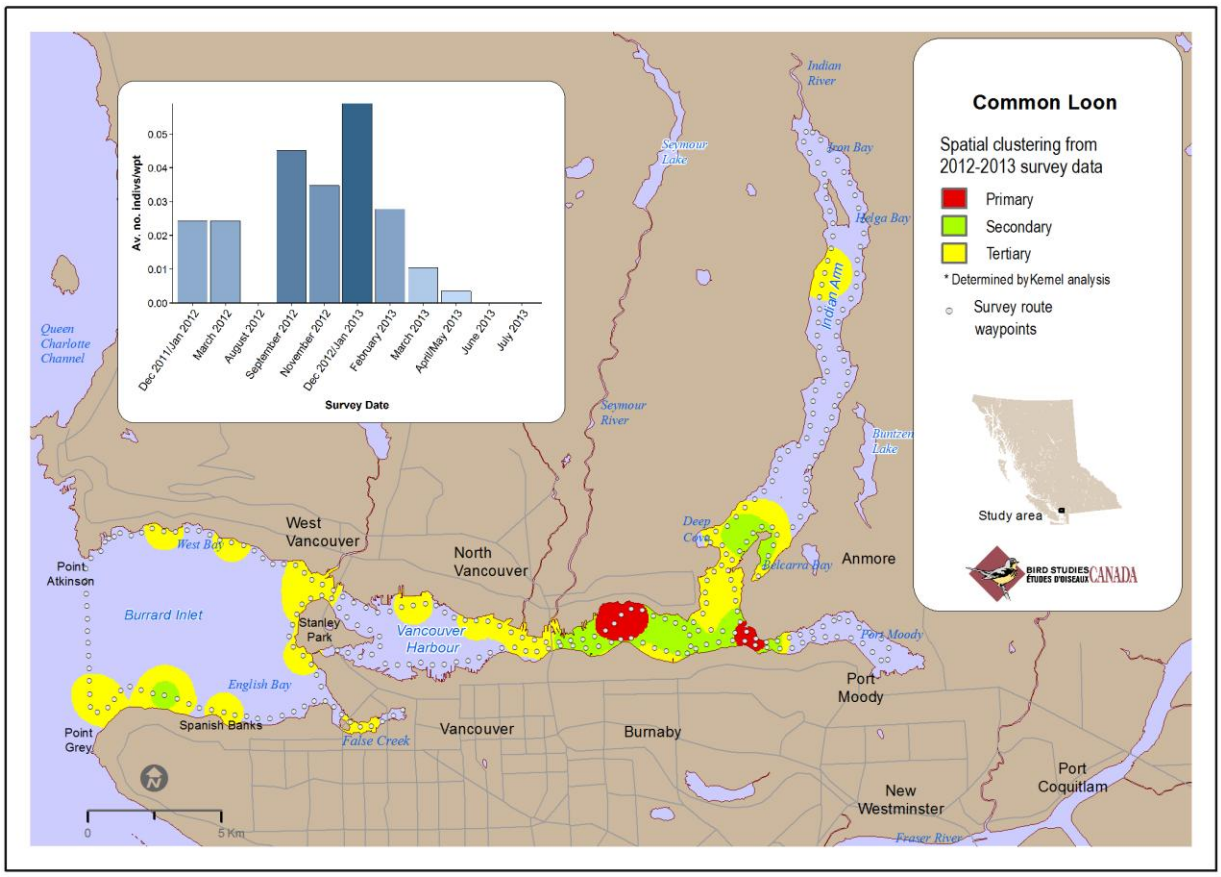

Fig. 27 Spatial distribution and seasonal abundance of Common Loon in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Common Loon is frequently seen in winter along the south coast of British Columbia. The loon departs for breeding lakes in April or May and returns in late August or September (BC Breeding Bird Atlas 2015). A few birds stay on the coast through the summer. The regional trend is confounded by reported increases in Puget Sound (Anderson et al. 2009, Bower 2009)

and decreases in the Strait of Georgia (Crewe et al. 2012).

Salish Sea Status Campbell et al. (1972a) described the status in the Vancouver region as common in winter. Bower et al. (2009) reported a significant increase in 1978-79 and 2003-2006 whereas Crewe et al. (2012) reported a significant decline between 1998 and 2011.

Survey Records 2011-13 We saw as many as 17 Common Loons on our surveys. They were widespread usually as individual birds most often encountered near Maplewood Mudflats and the entrance to Indian Arm.

Conservation Issues The conflicting trends in the abundance of Common Loons in the Salish Sea possibly reflect their distribution in pursuit of mobile fish as prey.

Recommendations Loons join a suite of other species in Burrard Inlet and Indian Arm that eat small fish. Ensuring a supply of small fish as prey for loons and other birds would help maintain their long-term presence in the harbour.

Red-throated Loon *Gavia stellata*

Conservation Status Conservation Data Centre: BC Yellow list

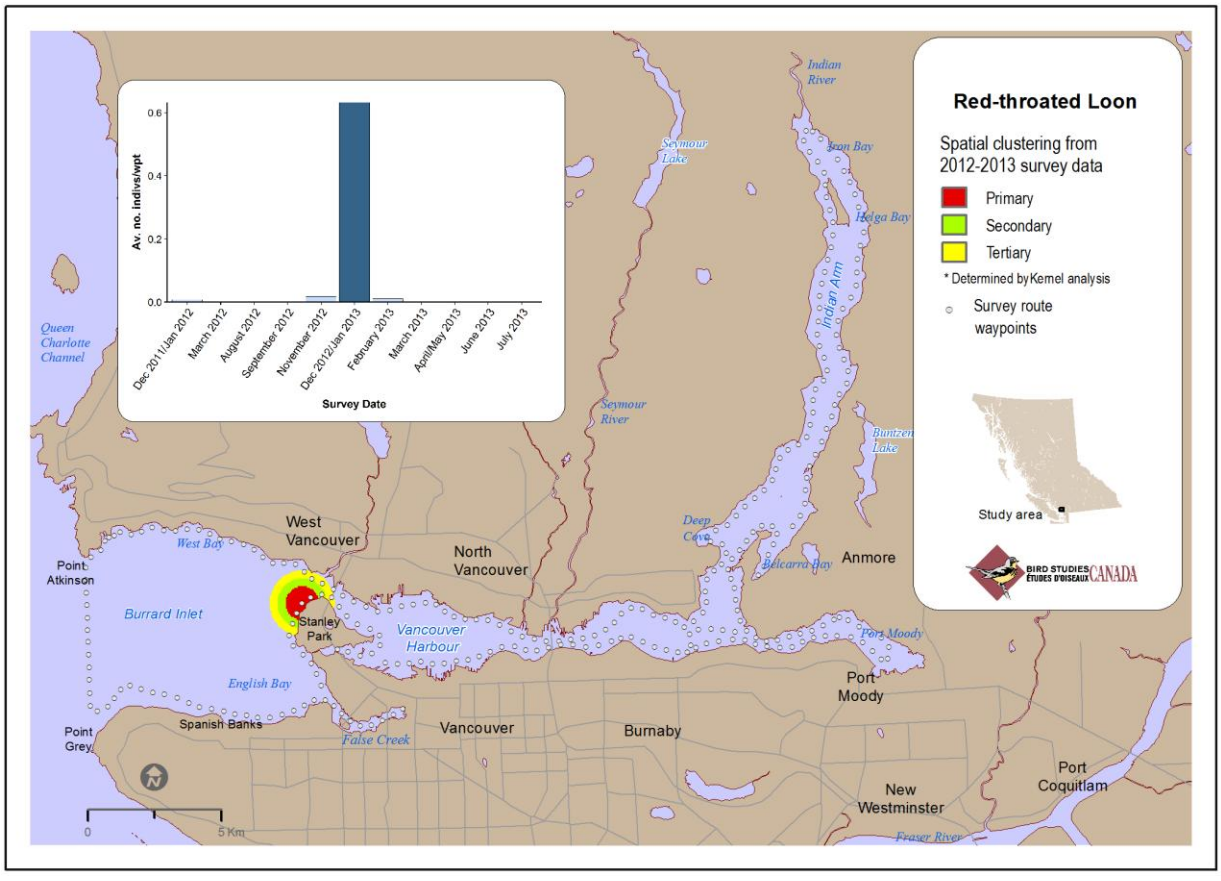

Fig. 28 Spatial distribution and seasonal abundance of Red-throated Loon in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Red-throated Loon nests on small freshwater lakes and ponds near the seashore where it feeds. The number of loons in a region is related to the number of lakes where they can nest but not the water chemistry or fish abundance on the lakes since most food is caught along the seashore (Campbell et al. 1990). Red-throated Loons winter in shallow, sheltered marine waters (Campbell et al 1990) with strong freshwater influence such as the Fraser Delta, Boundary Bay, Mayne Island and the area between Comox and Campbell River (Crewe et al. 2012). In Alaska, a steep 53% population decline was detected between 1977-1993 (Barr et al. 2000).

Salish Sea Status Campbell et al. (1972a) reported that the species frequented the Vancouver region in winter but strong declines were apparent in the Salish Sea in recent years. A significant decline of 9.3% was reported by the BC Coastal Waterbird Survey between 1999-2011 (Crewe et al. 2012). Declines were also apparent in Washington with a 73.9% decline between 1978-80 and 2003-06 in Puget Sound (Bower 2009) and also significant declines in Padilla Bay (Anderson et al. 2009).

Survey Records 2011-13 The Red-throated Loon was generally scarce in the study area, the exception being on December/January 2013 when 182 were seen (Table 2). Only a few Red-throated Loons were seen on our surveys and English Bay was the only place where the species was encountered.

Conservation Issues The decline of this species is worrying especially since the Fraser River estuary historically held large numbers that likely extended into English Bay. The reasons for the declines are not known and might be related to changes in availability of prey. Wintering Red-throated Loons are susceptible to catastrophic and chronic oil spills and being caught in fishing gear (Barr et al. 2000).

Recommendations An assessment of the abundance of this species in English Bay and the mouth of the Fraser River needs to be undertake to determine if and the kinds of actions required for its conservation are warranted.

Red-necked Grebe *Podiceps grisegena*

Conservation Status COSEWIC: not at risk (1982); Conservation Data Centre: BC Yellow list

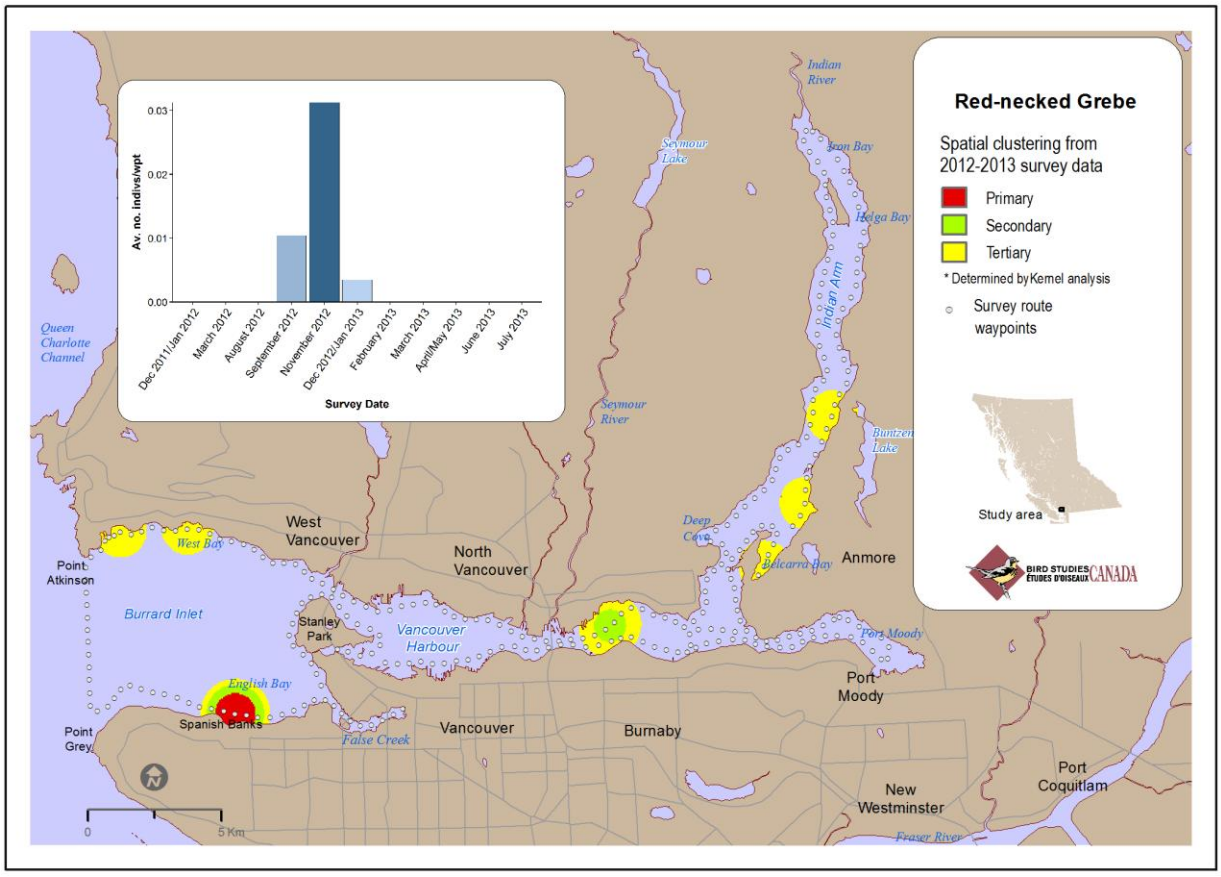

Fig. 29 Spatial distribution and seasonal abundance of Red-necked Grebe in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Red-necked Grebes winter throughout the BC coast with the high numbers showing up in fall (Crewe et al. 2012). They can be found in estuarine and coastal waters in shallow bays and inlets (Stout and Nuechterlein 1999). Regional trend data are scarce (Stout and Nuechterlein 1999). No trend was found in the BC Christmas Bird Count between 1959-1988 (Sauer et al. 1996). Alaska aerial monitoring in Yukon National Wildlife Refuge showed a 10% decline from 1988-1998 (Alaska Department of Fish and Game 2006).

Salish Sea Status No trend was detected in the BC Coastal Waterbird Survey between 1999-2011 (Crewe et al. 2012). To the south in the US portion of the Salish Sea there was a decline of about 35% between 1975-1984 and 1998-2007 (Bower 2009). Aerial surveys in Puget Sound showed an 89% decline between 1978-79 and 1992-99 (Nysewander et al. 2001) and a 33% decline in Padilla Bay between 1978-79 and 2003-06 (Anderson et al.

2009). In October 1971, 55 Red-necked Grebes were counted from Stanley Park where Campbell et al. (1972b) described it to be common.

Survey Records 2011-13 Red-necked Grebes were seen only on a few surveys and in very small numbers (Table 2) notably along Spanish Banks but also along the West Vancouver waterfront, Maplewood Mudflats, Belcarra Bay and in Indian Arm.

Conservation Issues The species is neither a national or regional conservation concern (Howie 2015a). However, in Burrard Inlet and Indian Arm it joins a growing list of species that eat small fish and appear to have declined in abundance.

Recommendations Enhancing small fish populations in the region should benefit this species.

Horned Grebe *Podiceps auritus*

Conservation Status COSEWIC (2009): Special Concern (Western population); Conservation Data Centre: BC Yellow list

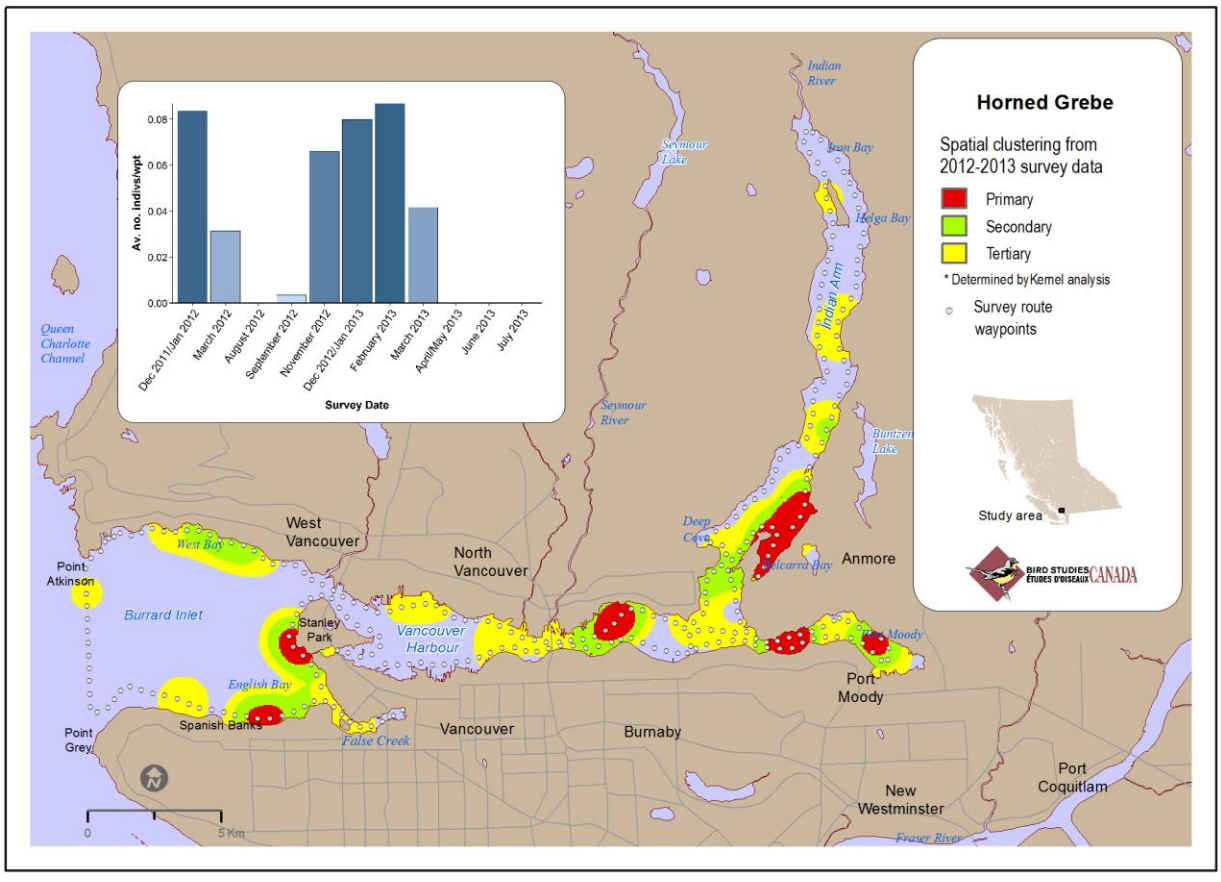

Fig. 30 Spatial distribution and seasonal abundance of Horned Grebe in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends	The Horned Grebe is a frequent winter resident of coastal bays and estuaries in southern British Columbia. The grebe has been undergoing a population decline in numerous surveys in the Salish Sea for several years (Nysewander et al. 2001, Anderson et a;. 2009, Bower 2009, Crewe et al. 2011).
Salish Sea Status	Sullivan et al. (2002a) reported large numbers of Horned Grebes attract to herring spawning along the east coast of Vancouver Island.
Survey Records 2011-13	Present from September to March, small numbers of Horned Grebes were seen scattered throughout much of the study area. The primary locations were western Stanley Park and Spanish Banks, Maplewood Mudflats, Port Moody Inlet and Belcarra.
Conservation Issues	The causes for the plummeting number of Horned Grebe is the most important issue but the threats and causes are not known (COSEWIC 2009). Proposed causes include degradation of wetland nesting areas and predation.
Recommendations	Research to understand the causes of the decline of this once widespread species needs to begin. Several fish-eating species have undergone declines in recent decades suggesting changes in fish abundance would be a good place to start.

Western Grebe *Aechmophorus occidentalis*

Conservation Status COSEWIC (2014): Special Concern; Conservation Data Centre: BC Red list

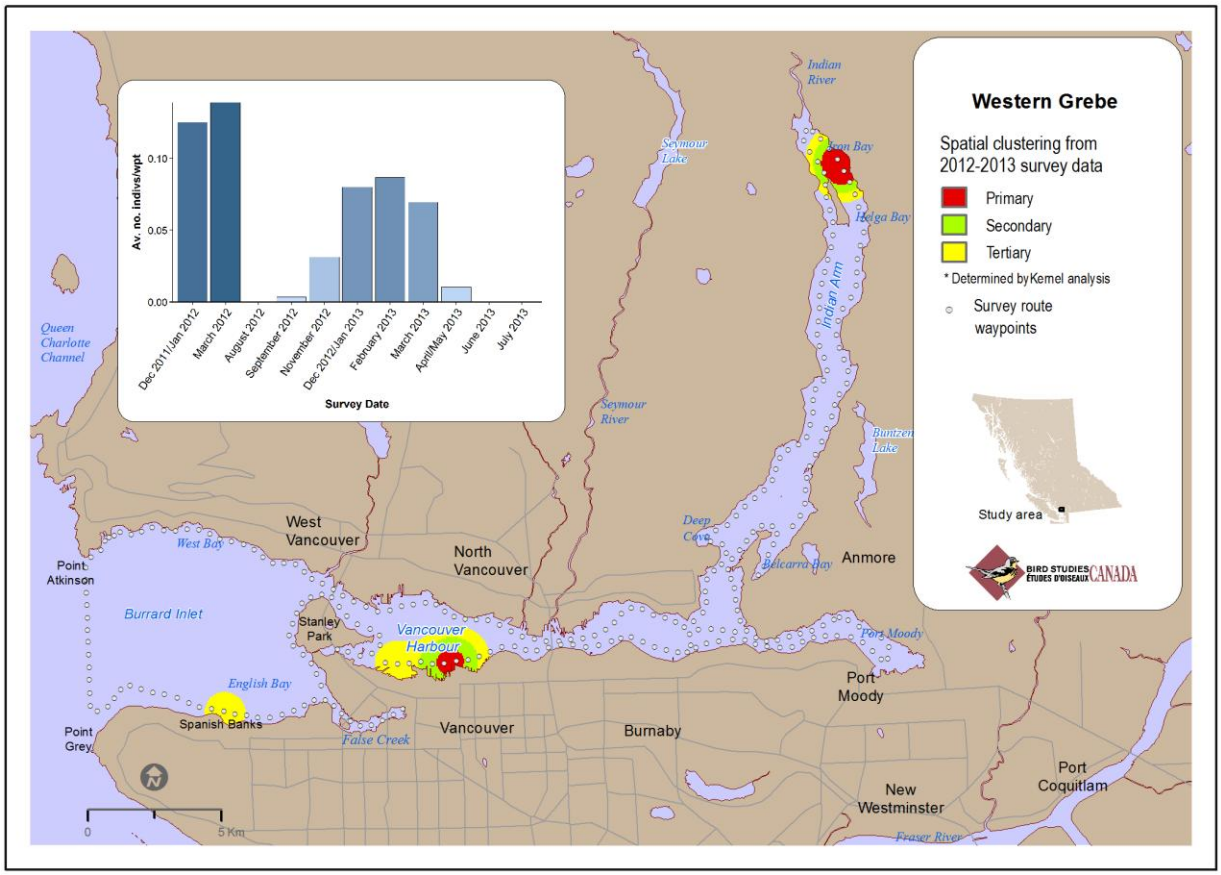

Fig. 31 Spatial distribution and seasonal abundance of Western Grebe in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Western Grebe breeds in western North America and spends the winter along the Pacific Coast (Howie 2015b). Globally important numbers in Burrard Inlet and Indian Arm contributed to its designation as an Important Bird Area (Bird Studies Canada 2000-2015). However, the species has undergone one of the largest declines of waterbirds on surveys in the Salish Sea in recent years (Crewe et al. 2012).

Salish Sea Status In 1970, 2500 grebes were present off Point Grey in May and 150 off Stanley Park in September but the truly remarkable figure of 12,206 on the 1970 Christmas Bird Count was overshadowed by a previous estimate of 15,450 birds (Campbell et al. 1972a). There were 800 in English Bay 1 June 1971 and 4917 were counted on the Christmas Bird Count (Campbell et al. 1972b). The Vancouver Natural History Society (1995) wrote "Sometimes detachments of Western Grebes numbering up to several hundred birds will come inshore from the large offshore

wintering flock of several thousand in the center of the inlet near the moored freighters". About 100-200 grebes roosted at the mouth of the Capilano River in 1979 and foraged on schooling fish in English Bay (RWB unpubl.). Several hundred grebes were present in winter off Deep Cove from 1979 to the early 1980s but by the end of the decade only a few remained (M. DeJong Westman, pers. comm.). Hanrahan (1994) reported that in 1992 between 50-100 grebes were present in winter near Admiralty Point. There were 430 Western Grebes near Dundarave Pier in West Vancouver on 30 December 1997, 400-500 on 11 and 31 January and 211 on 20 March 1998 (RWB, unpubl notes). These observations suggest there was local movement about the study area until the end of the 1990s. The number of Western Grebes in the Salish Sea declined by 95% in recent decades while increasing by 300% in California (Wilson et al. 2012). These authors posit that the shift in abundance of the grebes reflects a distributional shift in their small forage fish prey.

Survey Records 2011-13 Small numbers of Western Grebes were present during our survey. We could count on about 20-40 grebes being present in the inner harbour through the winter (Table 2). A flock was also seen off Iron Bay in Indian Arm perhaps preparing for migration.

Conservation Issues If the grebe shifted its distribution southward in response to small fish prey as proposed by Wilson et al. (2012) then the return of the grebe will depend on the recovery of small forage fish in the inlet. In late summer of 2014 and 2015, large numbers of herring were present in Indian Arm suggesting that a recovery is underway.

Recommendations Ensuring an abundant supply of small fish, in particular Pacific herring would assist in the return of the Western Grebe to the harbour.

Brandt's Cormorant *Phalacrocorax penicillatus*

Conservation Status Conservation Data Centre: BC Red list

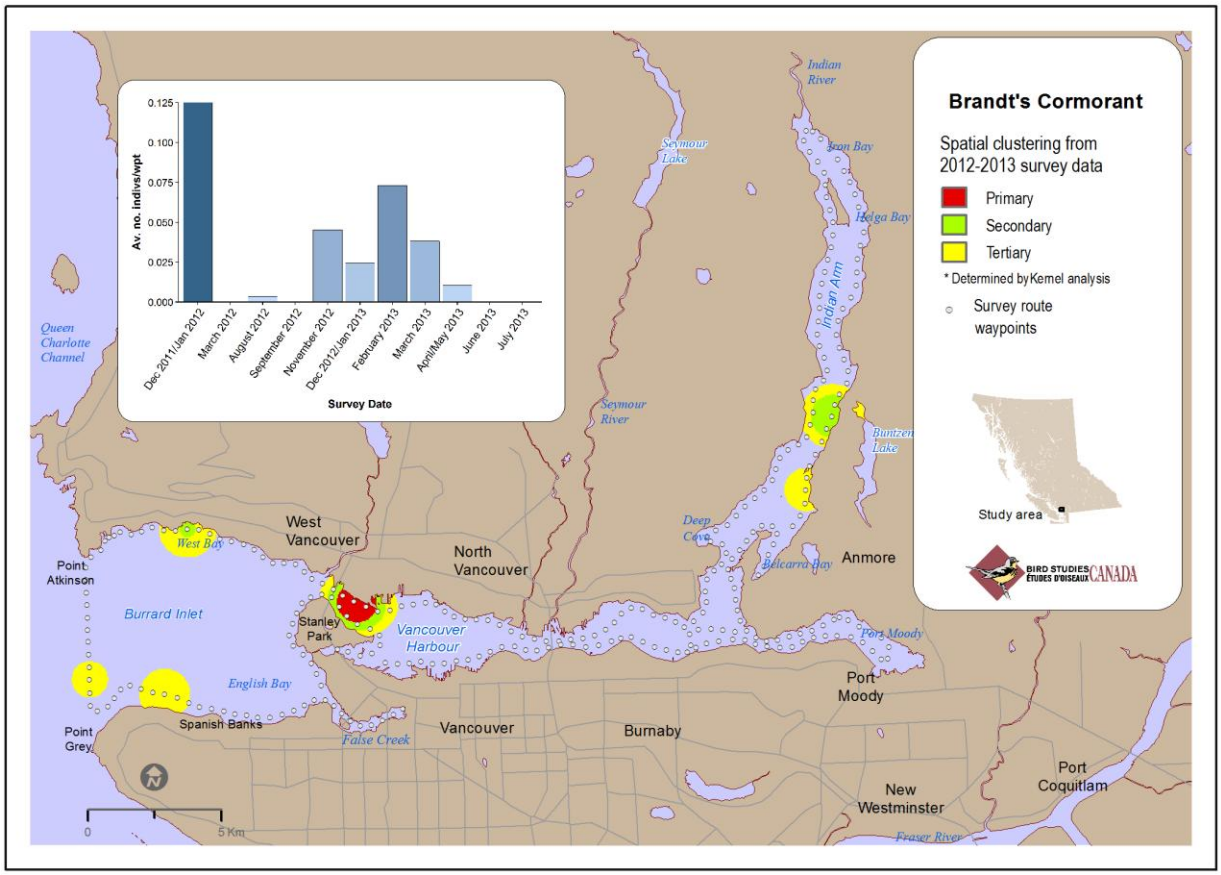

Fig. 32 Spatial distribution and seasonal abundance of Brandt's Cormorant in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Brandt's Cormorant is an endemic species in western North America where it frequents an oceanic, deeper water realm. Large numbers have been reported from Baynes Sound, the Sunshine coast, Victoria and the east coast of Vancouver Island (Crewe et al. 2011). Most Brandt's Cormorant breed outside the province (Campbell et al. 1990).

Salish Sea Status Brandt's Cormorant numbers fluctuate over the years with no significant trend arising in the BC Coastal Waterbird Survey (Crewe et al. 2011).

Survey Records 2011-13 Campbell et al. (1972a) considered the species to be rare in the Vancouver area. A few individuals of this species were seen from November to April/May (Table 2) mostly at the entrance to Burrard Inlet and only occasionally in Indian Arm.

Conservation Issues No conservation issues are proposed.

Recommendations No measures are proposed.

Double-crested Cormorant *Phalacrocorax auritus auritus*

Conservation Status COSEWIC (1978): Not at risk; Conservation Data Centre: BC Blue list

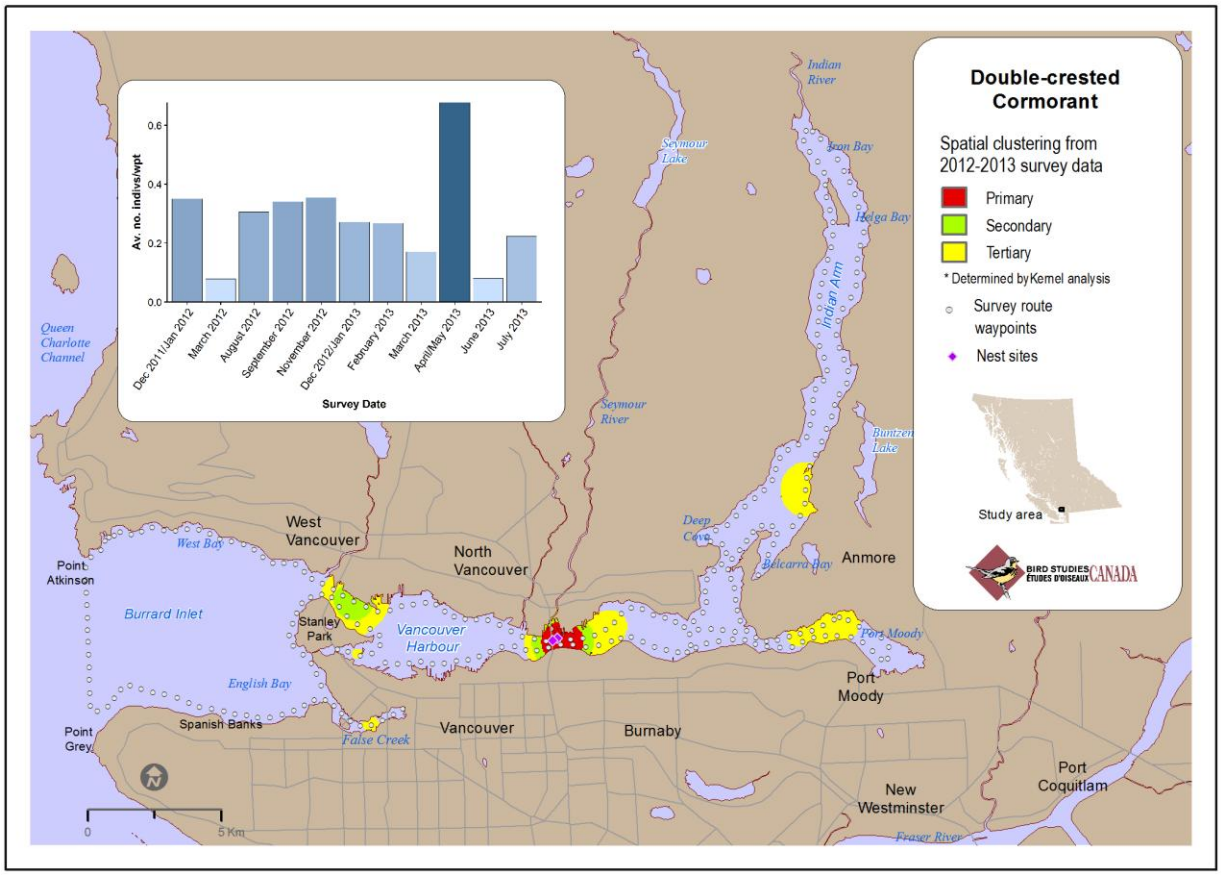

Fig. 33 Spatial distribution and seasonal abundance of Double-crested Cormorant in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

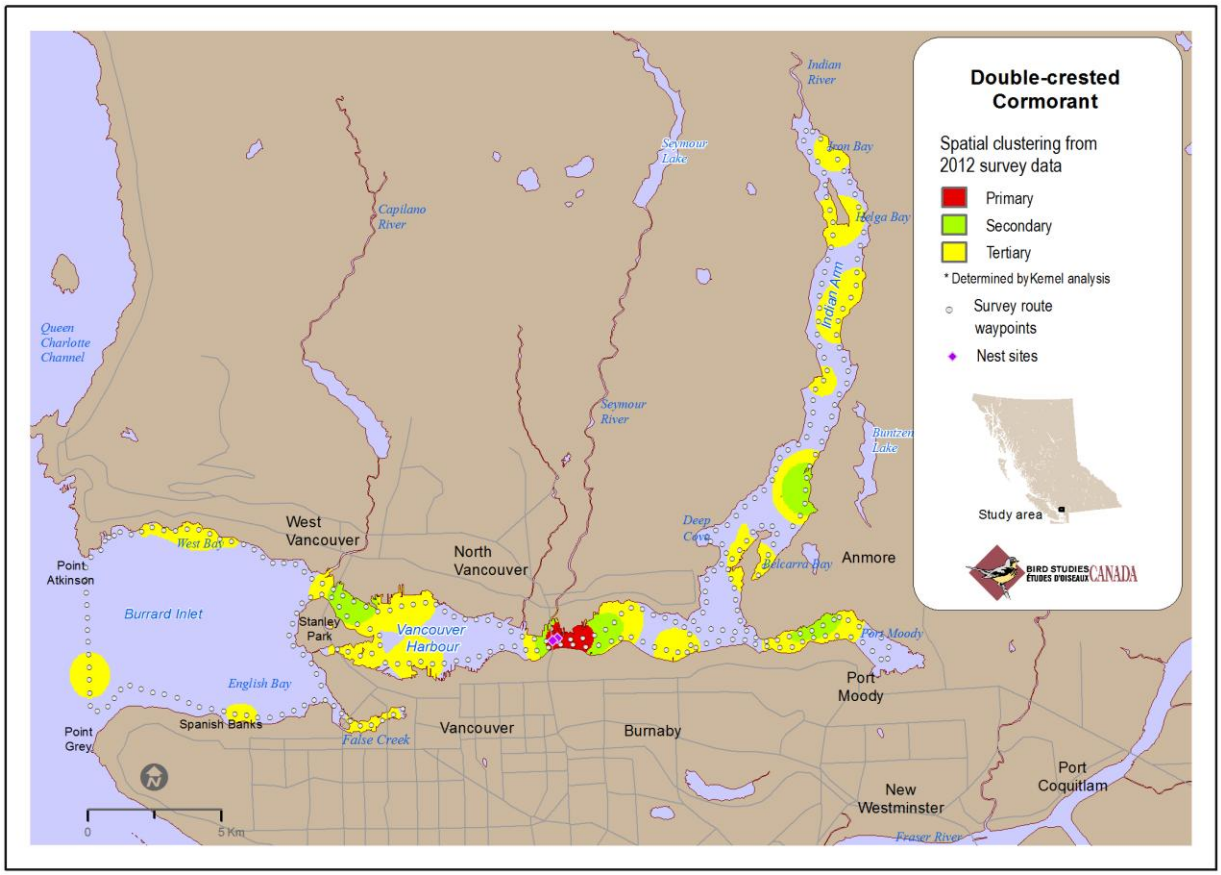

Fig. 34 Spatial distribution and seasonal abundance of Double-crested Cormorant in Burrard Inlet and Indian Arm, British Columbia, December 2011 - November 2012.

Ecology and Regional Trends

The Double-crested Cormorant is a year-round resident that breeds on local islands and human made structures. The number of nesting cormorants at breeding colonies has fluctuated over the years in the region suggesting the region-wide distribution is dynamic perhaps in response to local food resources.

Salish Sea Status

Campbell et al. (1972a) did not report breeding by the Double-crested Cormorant with Burrard Inlet and Indian Arm in 1970. That began to change at least a decade ago and this species began to nest on towers and bridges. Changing distribution seems to be a hallmark of this species in the Salish Sea. Chatwin et al (2002) found colony counts indicating large declines in this species but the number of wintering cormorants did not change significantly in the Salish Sea (Crewe et al. 2011)

Survey Records 2011-13

The Double-crested Cormorant was present year-round and was widespread in the study area. The prime location for Double-crested Cormorant during our survey was the Iron Workers Memorial Bridge where at least 90 pairs nested during our surveys. Other pairs nested beneath the Burrard and Granville Street bridges. The cormorant foraged widely throughout the

study area, as shown by the 2012 map.

Conservation Issues

The Double-crested Cormorant relocates colonies on a regular basis (Chatwin et al. 2002). Conservation of unoccupied but previously used nesting sites would allow for the dynamic nesting distribution to continue. The species nests in the girders beneath the Granville Street Bridge and Iron Workers Bridge perhaps for the safety from eagles the bridges afford. A tower adjacent to the Iron Workers Bridge was used by many Double-crested Cormorants during our survey but subsequently abandoned. We noticed Bald Eagles perched on the tower at this time.

Recommendations

The Double-crested Cormorant is one of the inlet's iconic species. It resides year-round and is widespread where it is often seen diving for fish prey along many beaches or drying its wings on pilings. There are a few suitable nest sites for this species in the supporting structures of bridges around Burrard Inlet. Maintaining access to these places by the cormorants is important to its continuation as a local breeding species.

Pelagic Cormorant *Phalacrocorax pelagicus*

Conservation Status Conservation Data Centre: BC Yellow list

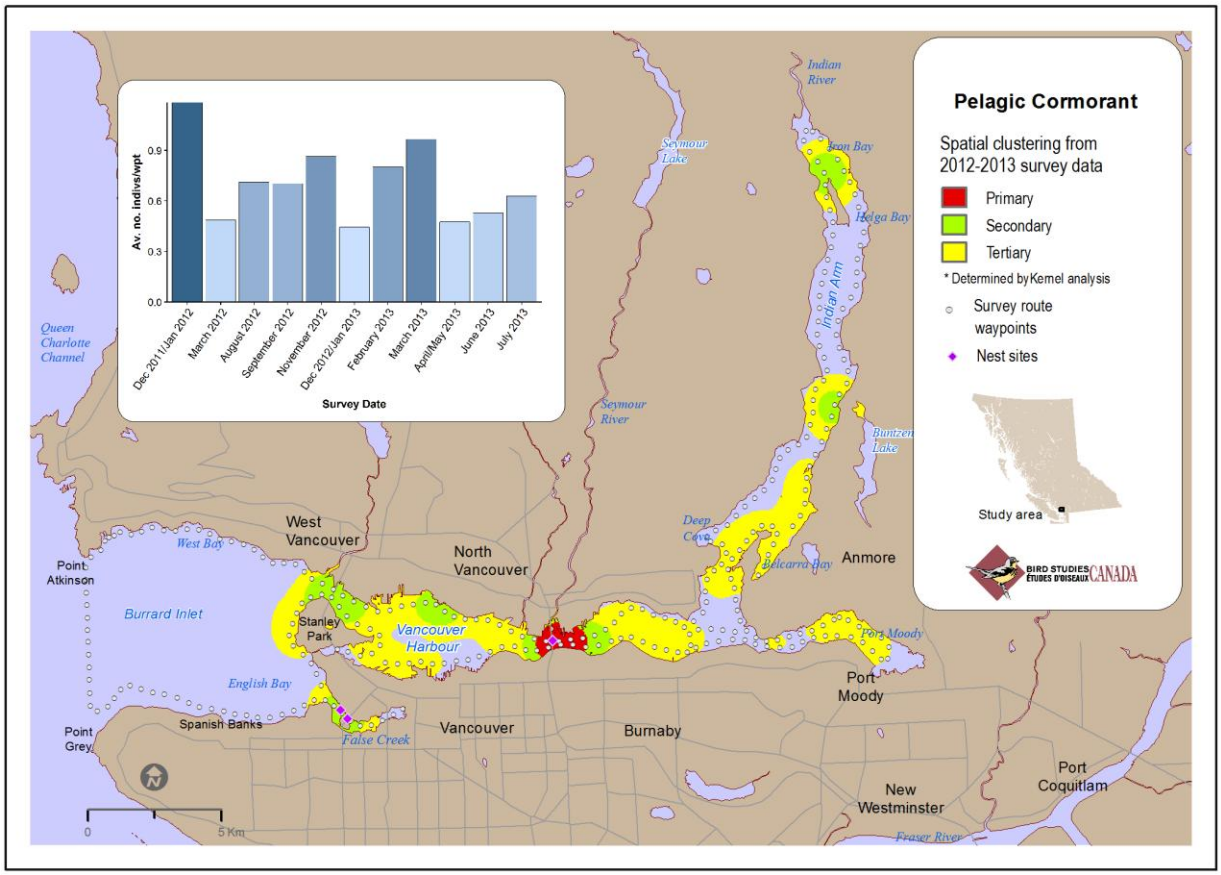

Fig. 35 Spatial distribution and seasonal abundance of Pelagic Cormorant in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Pelagic Cormorant is a resident breeding species on the coast of British Columbia where it dives for fish prey mostly over rocky substrates (Campbell et al. 1990). It is the most widespread species in the province. Analysis of Christmas Bird Count from British Columbia revealed no significant change (Sauer et al. 1996).

Salish Sea Status Two nests were present on Siwash Rock in 1970 (Campbell et al. 1972a). The species also historically nested on cliffs at Prospect Point in Stanley Park (Chatwin 2001). Chatwin et al. (2002) reported widespread declines of this species at nesting sites in the Salish Sea. The Coastal Waterbird Survey showed no significant change in winter populations in the Salish Sea (Crewe et al. 2011), whereas Bower (2009) reported a large increase for Puget Sound.

Survey Records 2011-13 The Pelagic Cormorant was widespread in Burrard Inlet and Indian Arm. Two concentrations of nesting birds were in False Creek and at Second Narrows where large numbers nested

among the bridge structures.

Conservation Issues

The Pelagic Cormorant joins the Double-crested Cormorant in being abundant, widespread, and year-round species of the inlet. The decline of this species as a nesting species in the Salish Sea is possibly the outcome of a recovery of Bald Eagles as bird predators (Chatwin et al. 2002). The apparent conflicting results between surveys are difficult to reconcile but possibly reflects the different time scales of surveys or a difficulty in locating colonies and tallying nesting pairs. The large numbers of cormorants now inhabiting the harbour increases the importance of preventing oil spills.

Recommendations

Maintenance of nesting sites for this species, especially those sheltered from Bald Eagle attacks, is an important step in sustaining local populations. Oil spill prevention will also be important. The Pelagic Cormorant has taken to nesting beneath the Burrard Street, Granville Street and Iron Workers bridges. More than 200 pairs were reported to nest under the Granville Street Bridge making this colony among the largest in the province (Hipfner et al. 2015a).

Great Blue Heron *Ardea herodias fannini*

Conservation Status COSEWIC (2008): Special Concern; SARA Status (2010): Schedule 1, Special Concern; Conservation Data Centre: BC Blue list

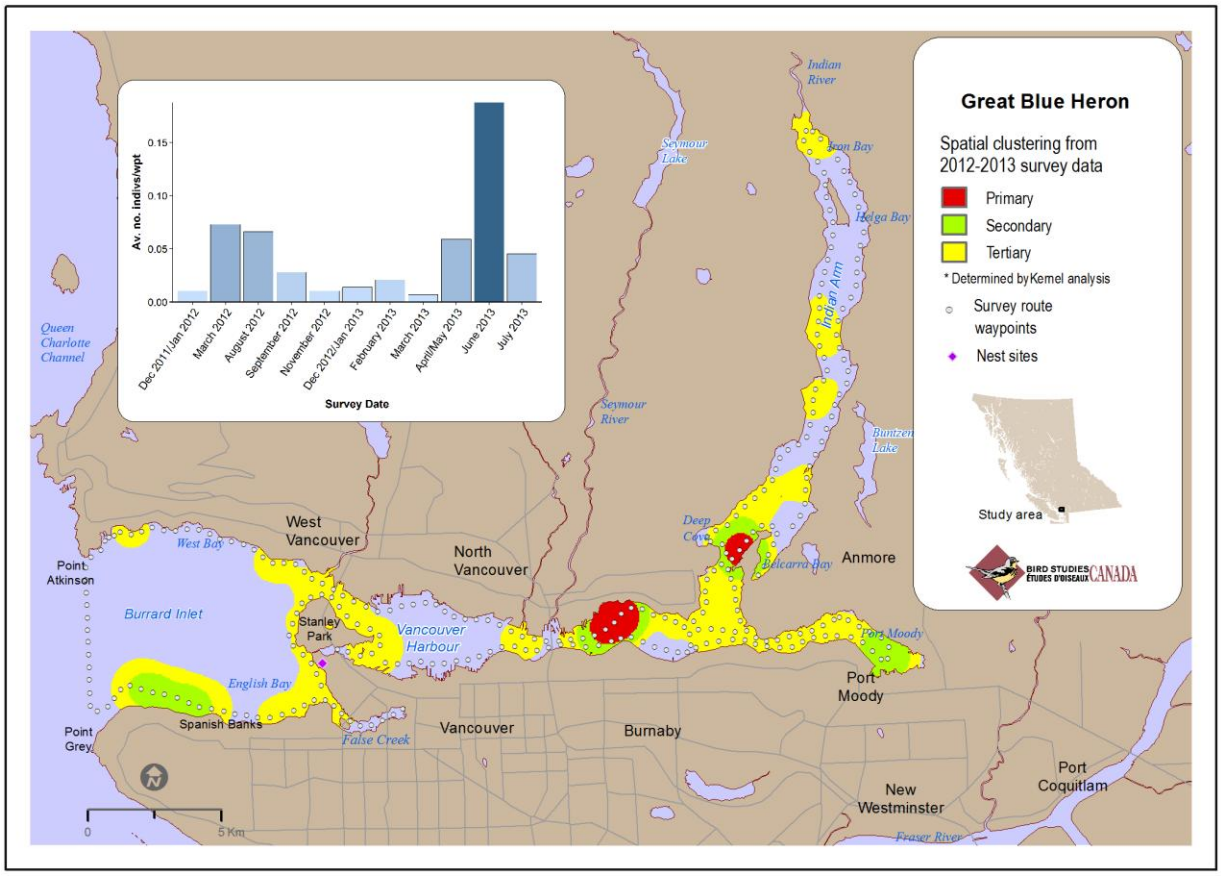

Fig. 36 Spatial distribution and seasonal abundance of Great Blue Heron in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Great Blue Heron is a resident nesting subspecies on the Pacific coast of Washington, British Columbia and southeastern Alaska coastline, including Burrard Inlet and Indian Arm. Herons nest as single pairs across the range and assemble into nesting colonies numbering from between a few to many hundred pairs around the Strait of Georgia and northern Puget Sound. Most breeding herons forage within about 10 kilometers of their nests. Their prey is mostly small fish caught on shallow water beaches in spring and summer augmented with small mammals hunted in fields in autumn and winter (Butler 1997). Nationally important numbers in Burrard Inlet and Indian Arm contributed to its designation as an Important Bird Area (Bird Studies Canada 2000-2015).

Salish Sea Status The Salish Sea, and particularly the lower mainland is the centre of the greatest number of the *fannini* subspecies Pacific Great Blue Herons in Canada (Butler 1997). About 1500 pairs of Great

Blue Herons nested around the Salish Sea in recent decades. The number of nesting pairs has been in slow decline for many years prompting its conservation designation (Butler and Vennesland 2011).

Herons have regularly nested around Burrard Inlet since records began nearly a century ago. A photo by J Matthews in the City of Vancouver Archives of a heron colony in Stanley Park taken in 1921 is the earliest nesting record of herons in the park (Straker 2014). Herons have nested in the park ever since although the location of the colony has changed several times. The current location near the tennis courts and Park Board office at the entrance to Stanley Park was established in 2001 when 14 nests were discovered. The number of nests increased to as many as 173 in 2006. There were 81 nests in 2013 and 94 in 2014 (Straker 2014). The sudden increase in the number of nesting pairs can be attributed to the relocation of a large colony from Pacific Spirit Park to Stanley Park. The only other nesting herons in Burrard Inlet that we were aware of was two nests under construction in Shoreline Park in March 2015 (H. McGuire, pers. comm.). The highest count in 1992 in Port Moody Inlet was 22 herons in July (Hanrahan 1994).

Survey Records 2011-13

The Great Blue Heron occurred on every survey along the shore of Burrard Inlet and Indian Arm, often as single birds and rarely in groups of a few individuals. The most we tallied was 54 herons in June 2013 (Table 2). Primary use areas were shallows where the heron could wade for food such as Spanish Banks and Stanley Park. The herons using Maplewood Mudflats and Port Moody are possibly from another unknown colony location.

Conservation Issues

Eagle predation, habitat loss and human disturbance are the major conservation concerns for this subspecies (Butler and Vennesland 2015). Stanley Park has provided forest habitats for herons to nest for nearly a century. In recent years, herons have also nested in Pacific Spirit Park, near the Shell refinery in Burnaby, and Maplewood Mudflats. Many of the Stanley Park herons flew to the Fraser River delta to forage but a few foraged along the shores of Burrard Inlet. The long-term outlook for these herons will depend on their ability to forage undisturbed along beaches of the harbour where there is an abundance of small fish prey.

Recommendations

Restoration of seagrass beds that were once present in Port Moody Inlet would provide the nursery conditions for fish eaten by breeding herons. Repeated attempts to plant eelgrass there failed when exotic Canada Geese uprooted transplanted shoots (Butler et al. 2011).

Peregrine Falcon *Falco peregrinus pealei*

Conservation Status COSEWIC (2007): Special Concern; SARA Status (2003): Schedule 1, Special Concern; Conservation Data Centre: BC Blue list

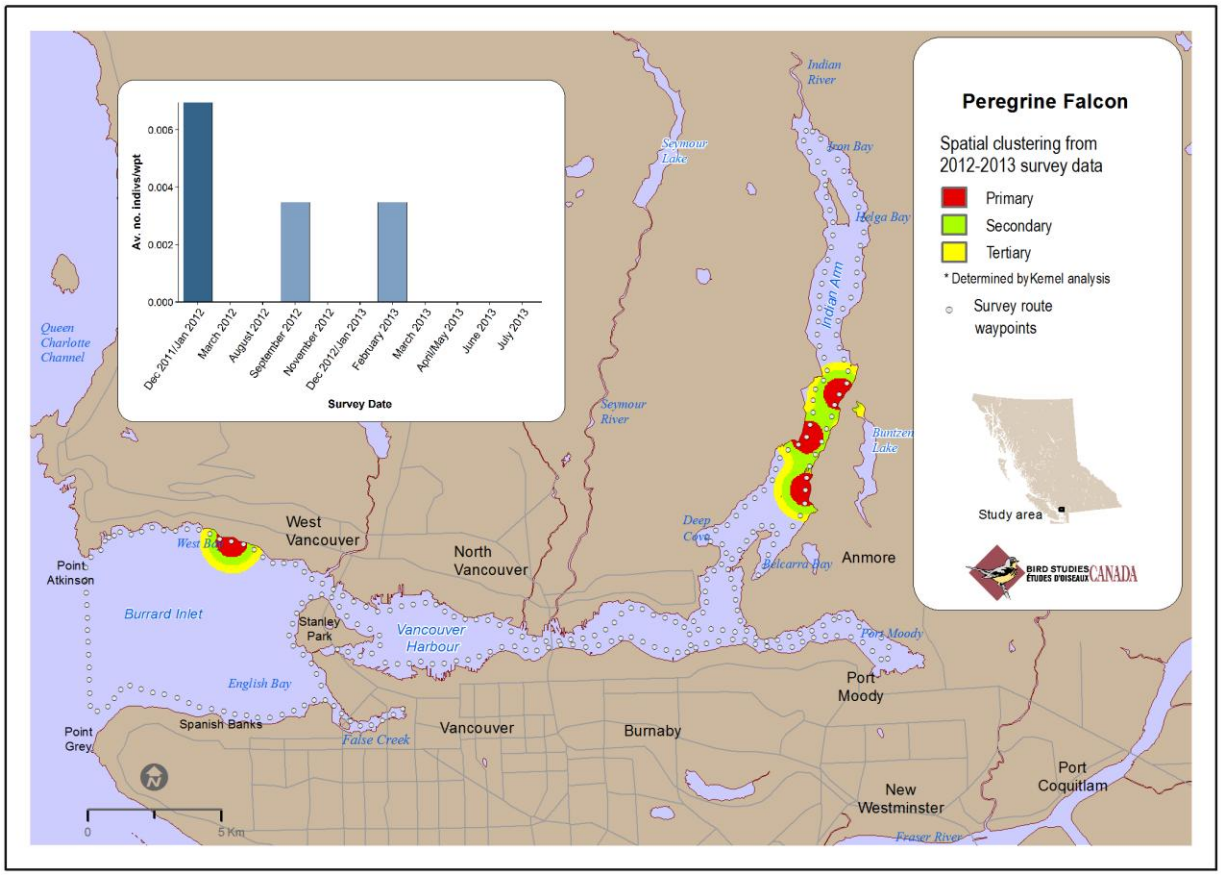

Fig. 37 Spatial distribution and seasonal abundance of Peregrine Falcon in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Three subspecies of Peregrine Falcon are reported to occur in British Columbia. The dark, resident coastal subspecies *F. p. pealei*, and the smaller, migratory, inland subspecies *F. p. anatum* breed within the province and the Arctic-breeding *F. p. tundrius* is a rare migrant (Campbell *et al.* 1990). The most likely subspecies inhabiting Burrard Inlet and Indian Arm is the coastal form. The Peregrine Falcon spends the winter and migrates in open coastal habitats of British Columbia where there is an abundance of shorebird and waterfowl prey. A few falcons hunt pigeons around the city of Vancouver year-round. Analyses of Christmas Bird Count data from British Columbia indicate a stable population from 1959–1988 (Sauer et al. 1996).

Salish Sea Status The Peregrine Falcon was considered a frequent winter species in the Vancouver region in 1970 (Campbell et al. 1972a), a situation that appears unchanged in recent years (Crewe et al. 2011). Ydenberg et al. (2001) showed that migrating peregrines

on the Fraser River delta increased in the 1990s. The species has nested in the Salish Sea for many years (Chutter 2015) and possibly nests in the study area.

Survey Records 2011-13 We saw Peregrines on three occasions in fall and winter (Table 2).

Conservation Issues In British Columbia, the coastal subspecies *P. f. pealei* is designated to the BC Blue list because of its small population (Chutter 2015). It is not clear if the peregrine in Burrard Inlet and Indian Arm is present because of natural prey or introduced species such as Rock Pigeons (*Columba livia*).

Recommendations No measures are proposed.

Osprey *Pandion haliaetus*

Conservation Status Conservation Data Centre: BC Yellow list

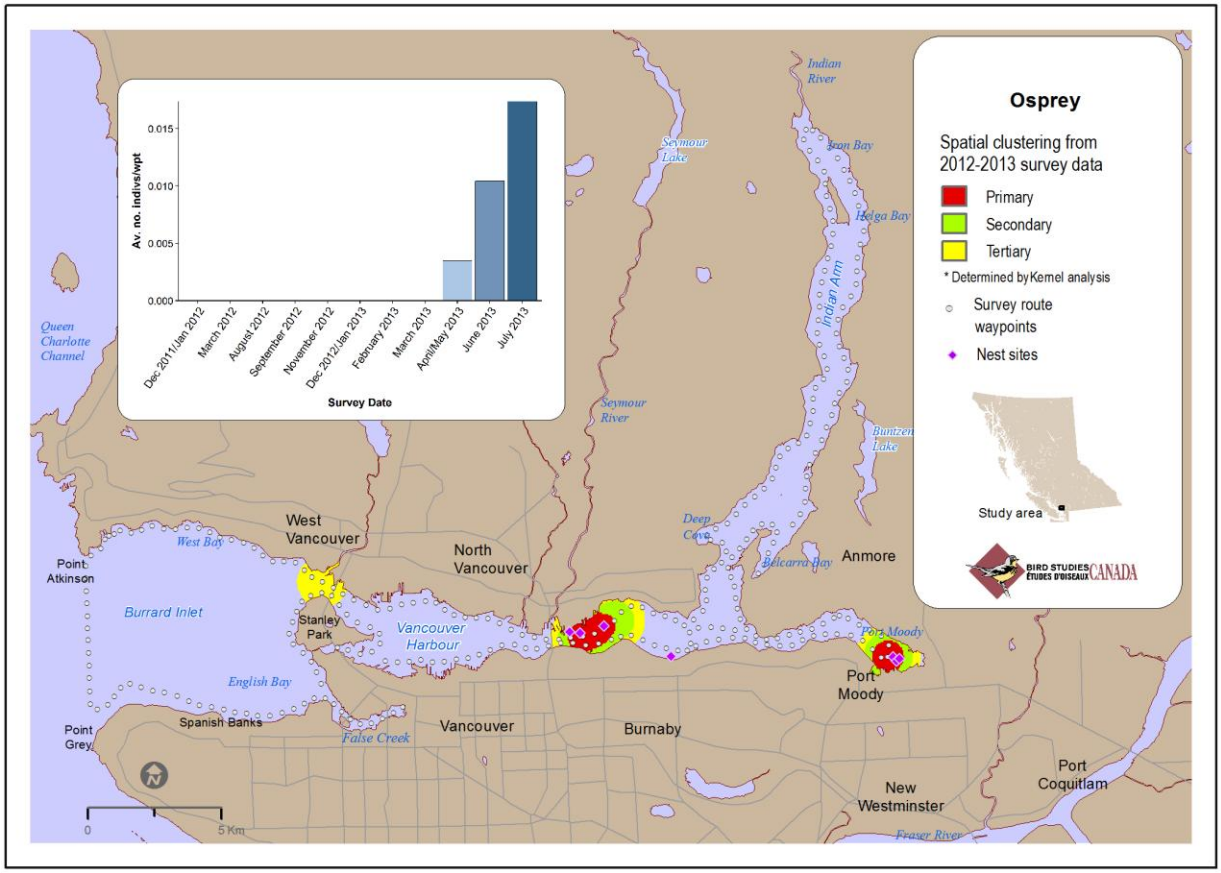

Fig. 38 Spatial distribution and seasonal abundance of Osprey in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Osprey is a summer breeder in the region including Burrard Inlet and Indian Arm where it eats fish caught during spectacular aerial dives. It is a widespread species throughout

	many parts of the world including southern British Columbia. There are several nesting pairs in the Lower Fraser River and a few in Burrard Inlet and Indian Arm.
Salish Sea Status	The osprey historically nested around the Salish Sea (Munro and Cowan 1947) but was considered to be 'rare' in summer in 1970 (Campbell et al 1972a). The first record of its return to Burrard Inlet was a sighting by one of the authors (RWB) in on May 23, 1970 (Campbell et al. 1972a). By 1992, the osprey was considered a common visitor to Port Moody but no nesting was reported (Hanrahan 1994).
Survey Records 2011-13	A few Ospreys were seen on surveys from April to July (Table 2) in the eastern study area near Maplewood Mudflats and Port Moody Inlet where in 2015, we counted seven nests on pilings.
Conservation Issues	The continued success of the Osprey as a nesting species is a supply of good quality fish and nest sites. The Osprey has not used trees for nest sites around Burrard Inlet and Indian Arm and instead has taken to nest platforms and tops of pilings around the harbour. Keeping exotic Canada Geese from using the nest platforms early in the spring could become an issue.
Recommendations	Repair of existing nesting platforms and installation of new ones would ensure nest sites for this species.

Bald Eagle *Haliaeetus leucocephalus*

Conservation Status COSEWIC (1984): Not at risk; Conservation Data Centre: BC Yellow list

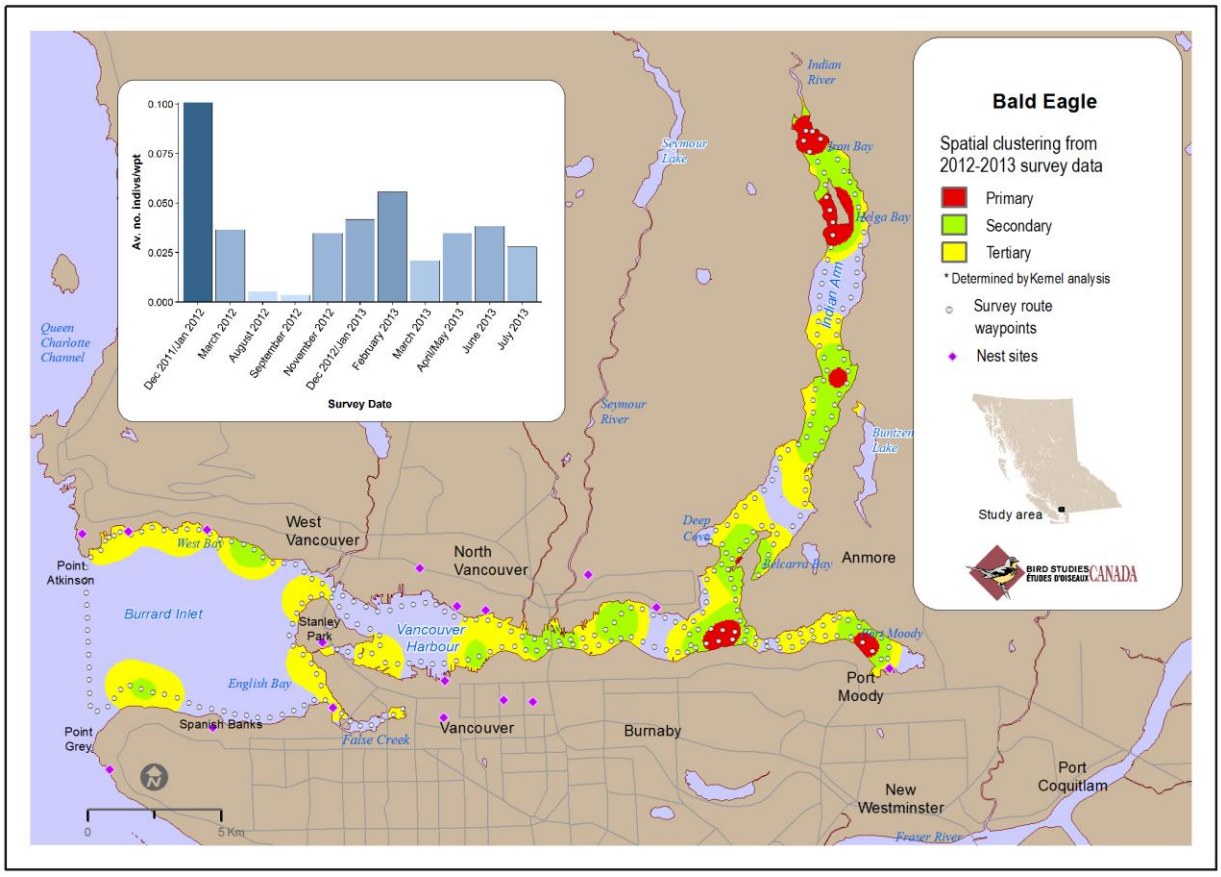

Fig. 39 Spatial distribution and seasonal abundance of Bald Eagle in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Nesting success of urban Bald Eagles in Vancouver is among the highest reported for North America (Goulet 2009). Their success is likely a result of an abundance of birds as prey through the year including gulls, ducks, pigeons and crows (Goulet 2009). Eagles are important bird predators in the Burrard Inlet-Indian Arm ecosystem and their recovery over the past few decades will likely have effects on the distribution and abundance of seabirds and seaducks.

Salish Sea Status In May 1977 there were two bald eagle nests in Stanley Park (Kautesk 1977). In 2013, there were four active eagle nests in the park (Stanley Park Ecology Society 2013). Eagles were present in Port Moody in 1992 but none nested there (Hanrahan 1994). From various sources, we have been able to locate at least 17 eagles nests around Burrard Inlet and Indian Arm. We cannot be certain if all of them were in use during our survey. In 2008, there were seven nests in use by eagles on the

	North Shore in English Bay and Burrard Inlet including Lighthouse Park, Piccadilly Place, Marine Drive, Mahon Park, Moodyville, Riverside Drive and Roche Point (Cook 2008). In 2013, there were nine active Bald Eagle nests along the Vancouver shore including four in Stanley Park, two between False Creek and Point Grey, and three along the inner harbour (Stanley Park Ecology Society 2013).
Survey Records 2011-13	Bald Eagles were present in small numbers often as individuals or pairs through the year (Table 2). We saw them on every survey and throughout the study area despite the only known nest sites being around Burrard Inlet. Primary areas for the eagle were the region around the Indian River mouth likely because of salmon and birds that assembled there, at the entrance in central Indian Arm, and Port Moody. Secondary use was along much of the remaining shore. Breault and Watts (1995) also reported the greatest number of eagles along the shore of Indian Arm.
Conservation Issues	The high nesting success of eagles is a result of suitable prey and nest sites.
Recommendations	A review of the state of suitable nest trees would assist in deciding what could be done to ensure future nest sites for eagles.

Black Oystercatcher *Haematopus bachmani*

Conservation Status Conservation Data Centre: BC Yellow list

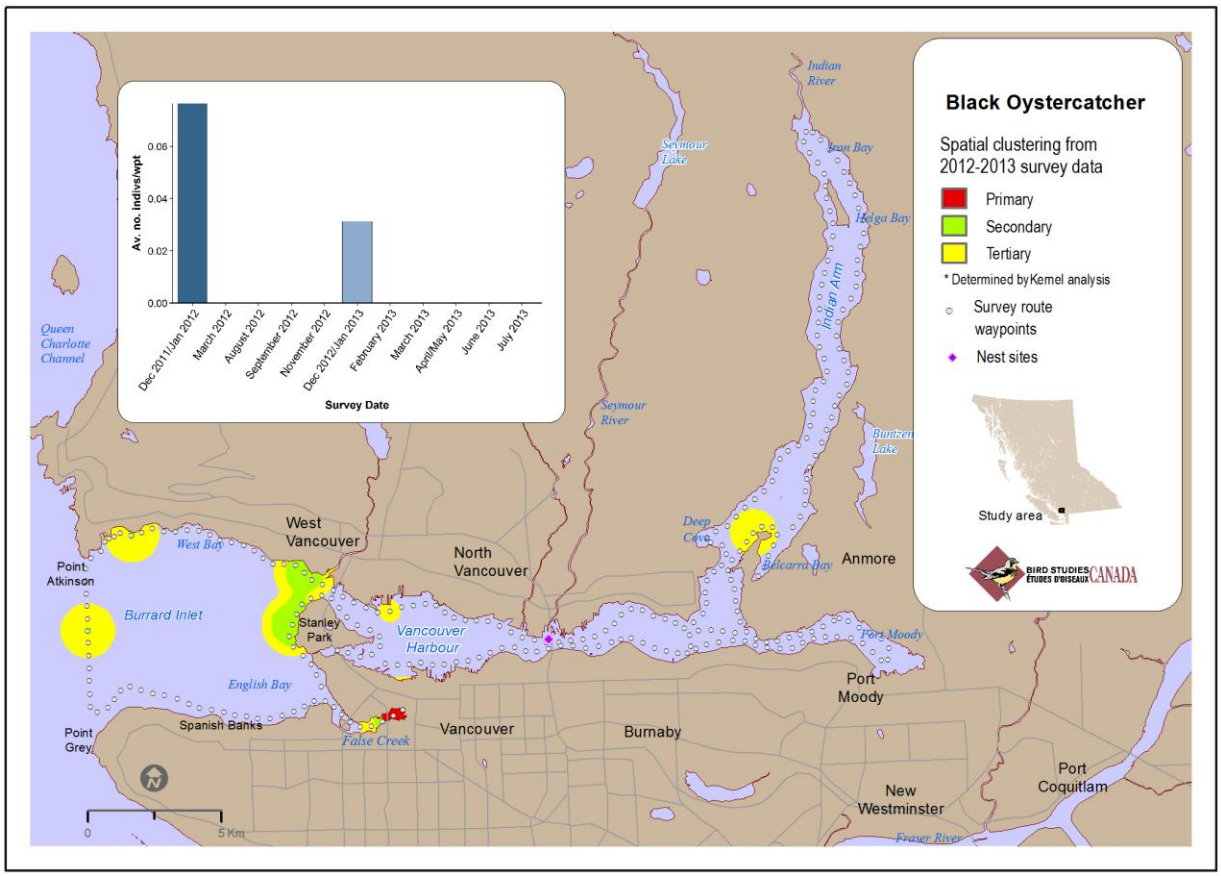

Fig. 40 Spatial distribution and seasonal abundance of Black Oystercatcher in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Black Oystercatcher is an endemic north Pacific species that frequents rocky shores to feed on limpets, mussels and other shellfish (Hipfner 2015b). The oystercatcher is a west coast species especially sought by birdwatchers.

British Columbia holds more than one-fifth of the global population of this species (Hipfner 2015).

Salish Sea Status The winter and breeding population of this species in the Salish Sea does not appear to have changed in recent years (Butler and Golumbia 2008, Crewe et al. 2011). About 210 pairs nested in the Salish Sea in 2005–06 (Golumbia et al. 2009).

Survey Records 2011-13 Small numbers of oystercatchers used Burrard Inlet and Indian Arm during our survey and a pair of oystercatchers nesting on a pier close to the western side of the Iron Worker's Memorial Bridge is the only breeding record for the study area (Fig. 40). We only saw oystercatchers in December 2012 and 2013 (Table 2) but the paucity of other sightings partly reflects the difficulty of seeing these shorebirds from a boat. Therefore, the accompanying map is not a good representation of its

distribution. Several oystercatchers regularly gathered at Cypress Creek to rest and bathe during our fall and winter surveys and at other times a few were regularly seen on the shores of Stanley Park (RWB, unpubl). The frequency of sightings contrasts with the 1970s when the oystercatcher was seldom seen around Vancouver (Campbell et al. (1972a).

Conservation Issues The oystercatcher joins the Black Turnstone, Barrow's Goldeneye, Harlequin Duck and Surf Scoter as rocky shore dependent species that rely on marine invertebrates for their prey. The oystercatcher is vulnerable to the immediate effects of oiled beaches (Andres 1999) but quickly recovers (Murphy and Mabee 2000). English Bay is a priority area for oil spill prevention for this species. Most nesting sites in the Salish Sea have some form of protection (Golumbia et al. 2009).

Recommendations No measures are proposed.

Spotted Sandpiper *Actitis macularius*

Conservation Status Conservation Data Centre: BC Yellow list

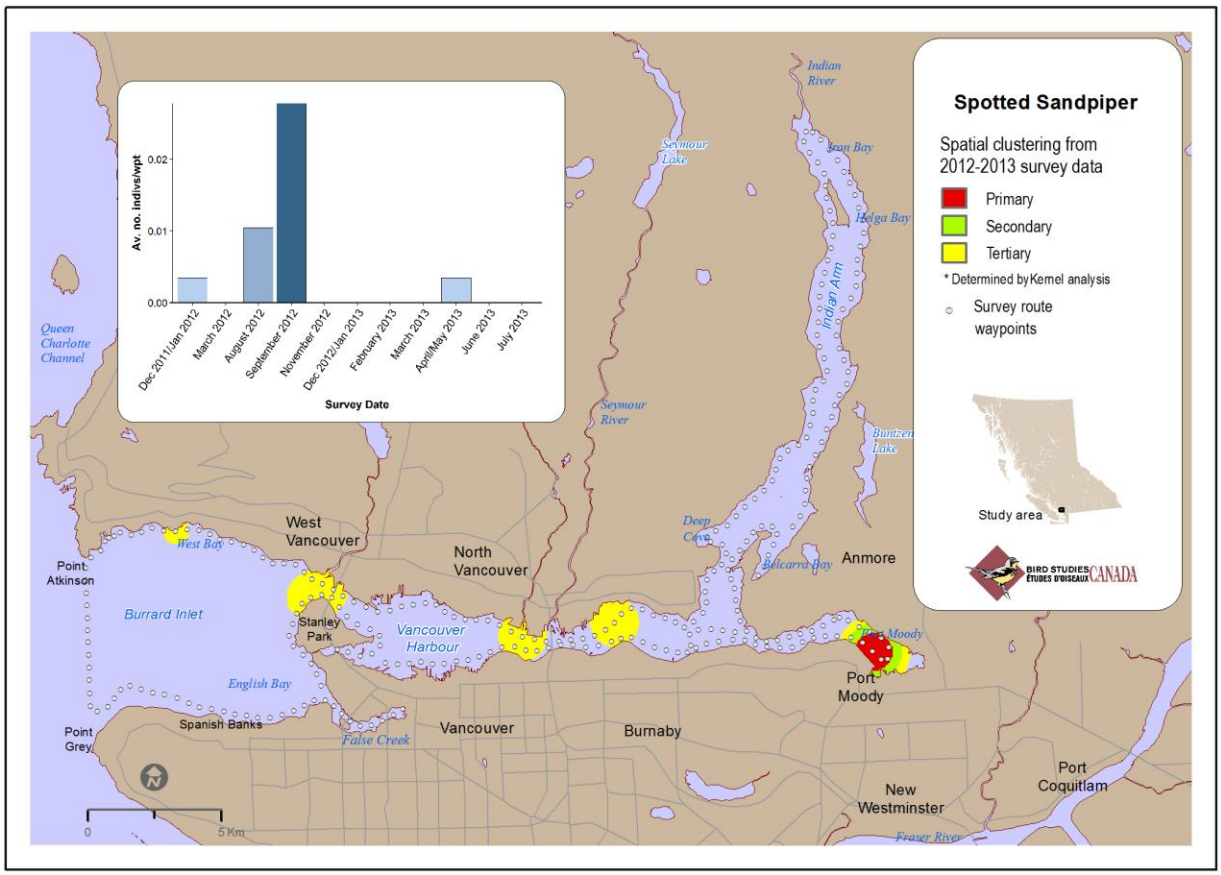

Fig. 41 Spatial distribution and seasonal abundance of Spotted Sandpiper in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends	Spotted Sandpipers are found across North America where water is present including marshes, estuaries and beaches (Reed et al. 2013). Nationally, surveys show declining trends in central and eastern Canada (Donaldson et al. 2000). Continentally, the trends are not well-defined (Andres et al. 2012). Breeding Bird Surveys show no significant changes (Sauer et al. 2011) suggesting that the species abundance has not appreciably changed (Andres et al. 2012).
Salish Sea Status	The Spotted Sandpiper is widespread along rivers and seashores of the Salish Sea and where it nests in summer. Campbell et al. (1972a) referred to this species as frequent in summer in the Vancouver region. The Spotted Sandpiper was not included in surveys reported by Crewe et al. (2012). Its presence during the breeding season suggests the Spotted Sandpiper nests along the shores of Burrard Inlet and Indian Arm.
Survey Records 2011-13	Spotted Sandpipers were seldom seen on our surveys. Although surveys by boat likely miss this species it is not abundant along shorelines (RWB, pers. obs.). The concentration seen in Port Moody was of several birds on a log boom.
Conservation Issues	Nationally, spotted sandpiper is considered a species of moderate concern because the population is stable but with moderate or unknown threats (Donaldson et al. 2000).
Recommendations	No measures are proposed

Black Turnstone *Arenaria melanocephala*

Conservation Status Conservation Data Centre: BC Yellow list

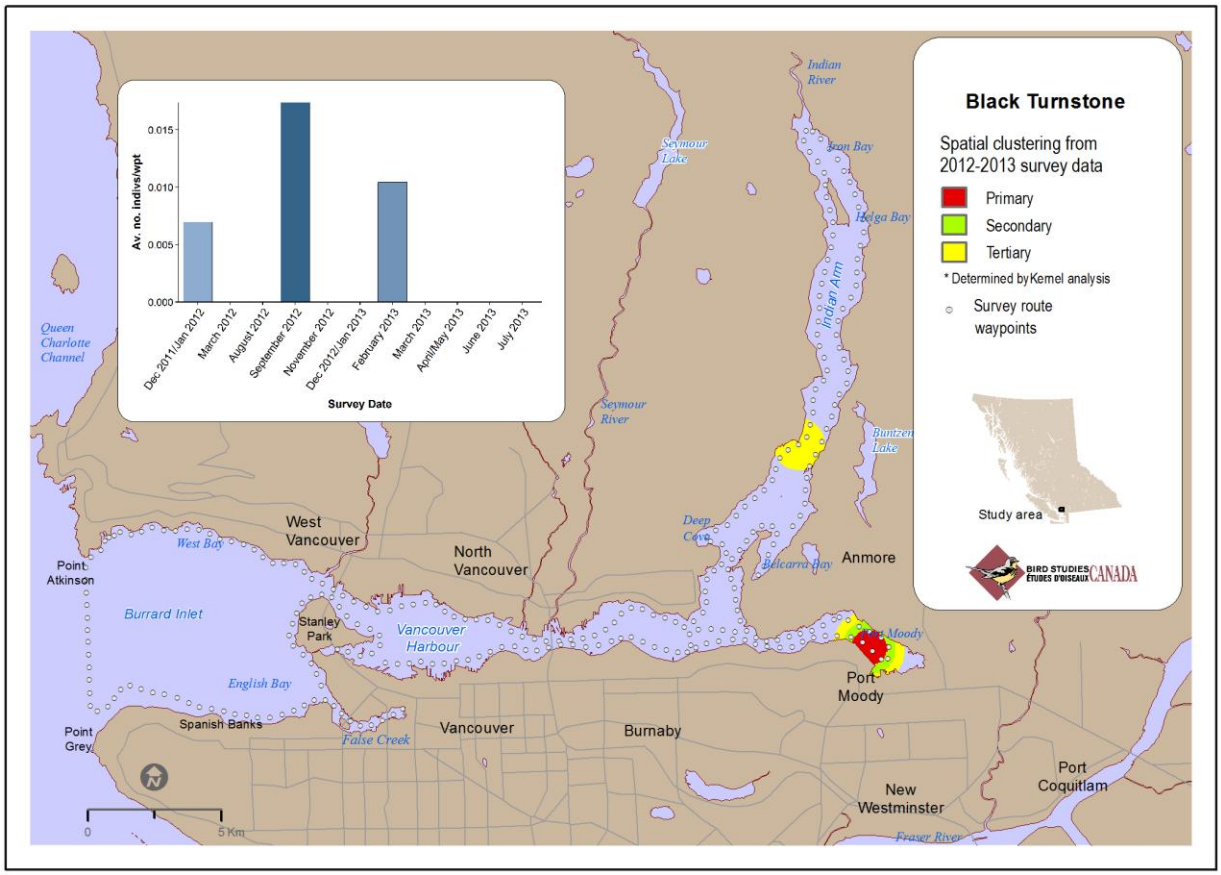

Fig. 42 Spatial distribution and seasonal abundance of Black Turnstone in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Black Turnstone is a north-Pacific endemic species especially sought by birdwatchers that occurs in Burrard Inlet and Indian Arm from mid-summer to early spring. Christmas Bird Count data from B.C., Washington and California indicate no change. The turnstone feeds on marine organisms along rocky intertidal shores and beneath wharves.

Salish Sea Status Crewe et al (2011) reported no apparent trend from the Coastal Waterbird Survey between 1999 and 2011 for the Strait of Georgia. Around Vancouver, 42 turnstones were seen at Lions Gate Bridge and 150 at Lighthouse Park in 1971 (Campbell et al. 1972b).

Survey Records 2011-13 Boat-based surveys are not a good way to census for this species. We saw small numbers on a few occasions (Table 2). About 20 Black Turnstones frequented a wharf at Rocky Point, Port Moody during our survey (RWB, pers.obs.). We saw a flock on one occasion along the shore of Indian Arm.

Conservation Issues There are no conservation issues for this species.

Recommendations No measures are proposed.

Western Sandpiper *Calidris mauri*

Conservation Status Conservation Data Centre: BC Yellow list

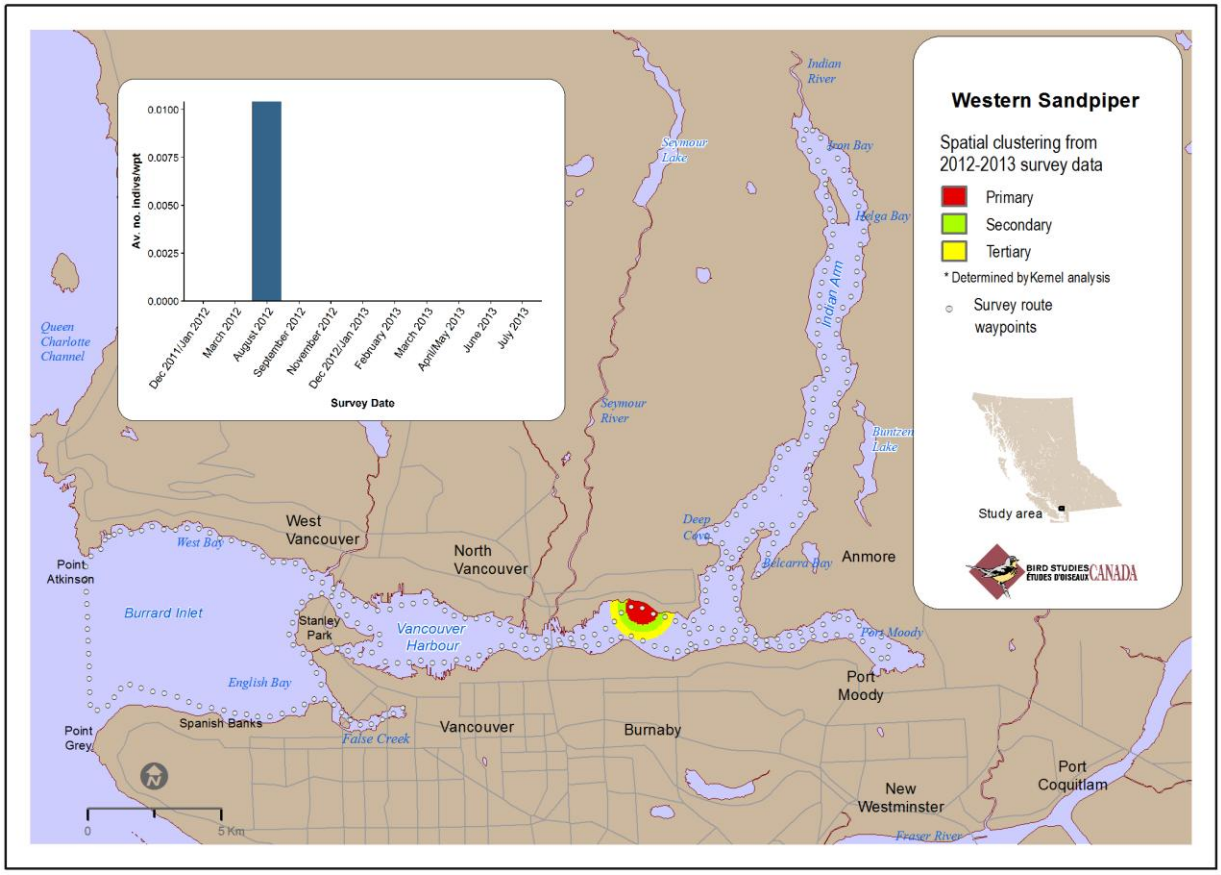

Fig. 43 Spatial distribution and seasonal abundance of Western Sandpiper in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Western Sandpiper is the most numerous sandpiper in British Columbia. The Western Sandpiper relies on invertebrates and biofilm in mudflats for its food (Kuwae et al. 2008, Jardine et al. 2014). It breeds in western Alaska and spends the non-breeding season from the southern USA to South America. The entire world population migrates along the Pacific Coast of Canada.

Salish Sea Status The Western Sandpiper is a northbound migrant in April and May through southern British Columbia and southbound from July to September. Hundreds of thousands migrate across the Fraser River Delta each spring where the numbers have remained stable since the 1990s (Drever et al. 2014). The species occurs in small numbers during migration at Maplewood

Mudflats, in Port Moody Inlet and English Bay.

Survey Records 2011-13 This species is not well surveyed by boat. We only saw a small flock and that was near Maplewood Mudflats in August. Small flocks have been encountered at the head of Port Moody Inlet, Spanish Banks and Stanley Park at other times (RWB, pers. comm.).

Conservation Issues The Western Sandpiper is the most numerous shorebird species during migration on the Fraser River delta but only a few settle in Vancouver harbour despite mudflats in Port Moody that are used by Dunlin. The reluctance to use Port Moody might be related to the absence of biofilm or a risk of predation by falcons (Ydenberg et al 2004).

Recommendations No measures are proposed.

Sanderling *Calidris alba*

Conservation Status Conservation Data Centre: BC Yellow list

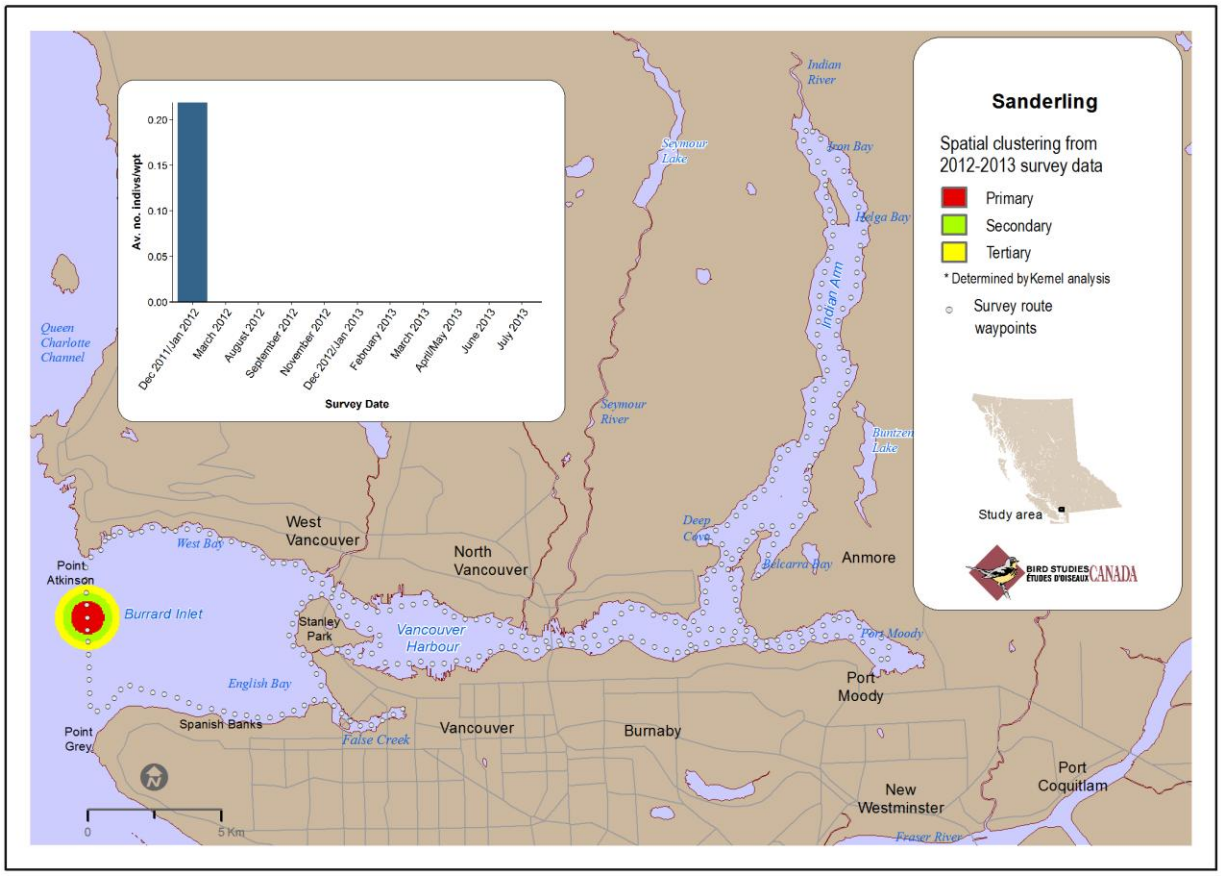

Fig. 44 Spatial distribution and seasonal abundance of Sanderling in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Sanderling is primarily associated with sandy beaches and

adjacent flats (Crewe et al. 2012). It is a high Arctic breeder that spends the non-breeding season along the coast of North and South America. Sanderlings are found in the Salish Sea in the largest numbers during spring and fall migration. No trend was found for BC in Christmas Bird Count data from 1959-1988 (Sauer et al. 1996). Data on the Canadian population is not robust but appears to be either stable or decreasing (Morrison 1994). Numbers have been declining in all monitored regions (Maritimes, Quebec, Ontario and eastern US) with significant declines in all regions except Ontario (Donaldson et al. 2000). Continental counts are highly variable among years but show no increasing or decreasing trend since the 1970s (Andres et al. 2012).

Salish Sea Status — The BC Coastal Waterbird Survey dataset reported no significant trend from 1999-2011 (Crewe et al. 2012). In Padilla Bay, Washington, significant declines were reported between 1978-79 to 2003-05 (Anderson et al. 2009).

Survey Records 2011-13 — Not much is known about the Sanderling in Burrard Inlet and Indian Arm. Boat surveys are not suitable for assessing this shorebird. The Coastal Waterbird Survey Kitsilano and Jericho beaches indicated the bird was sporadically encountered in small groups usually fewer than 100 individuals. The species also uses the western beaches of Stanley Park. We encountered a flock on one occasion as it flew over English Bay (Fig. 44) and which clearly does not represent its distribution in the study area.

Conservation Issues — The Sanderling relies on invertebrates in sand beaches for its food. The main threats to Sanderling are loss of coastal sand habitat to development and invasive *Spartina*, human disturbance at beaches and chronic or catastrophic oil spills in the Salish Sea (Environment Canada 2013). Sanderling are considered a species of high concern due to significant declines and significant potential threats (Donaldson et al. 2000).

Recommendations — A targeted survey for this species along English Bay beaches would assist in determining its status in Burrard Inlet and Indian Arm.

Dunlin *Calidris alpina*

Conservation Status Conservation Data Centre: BC Yellow list

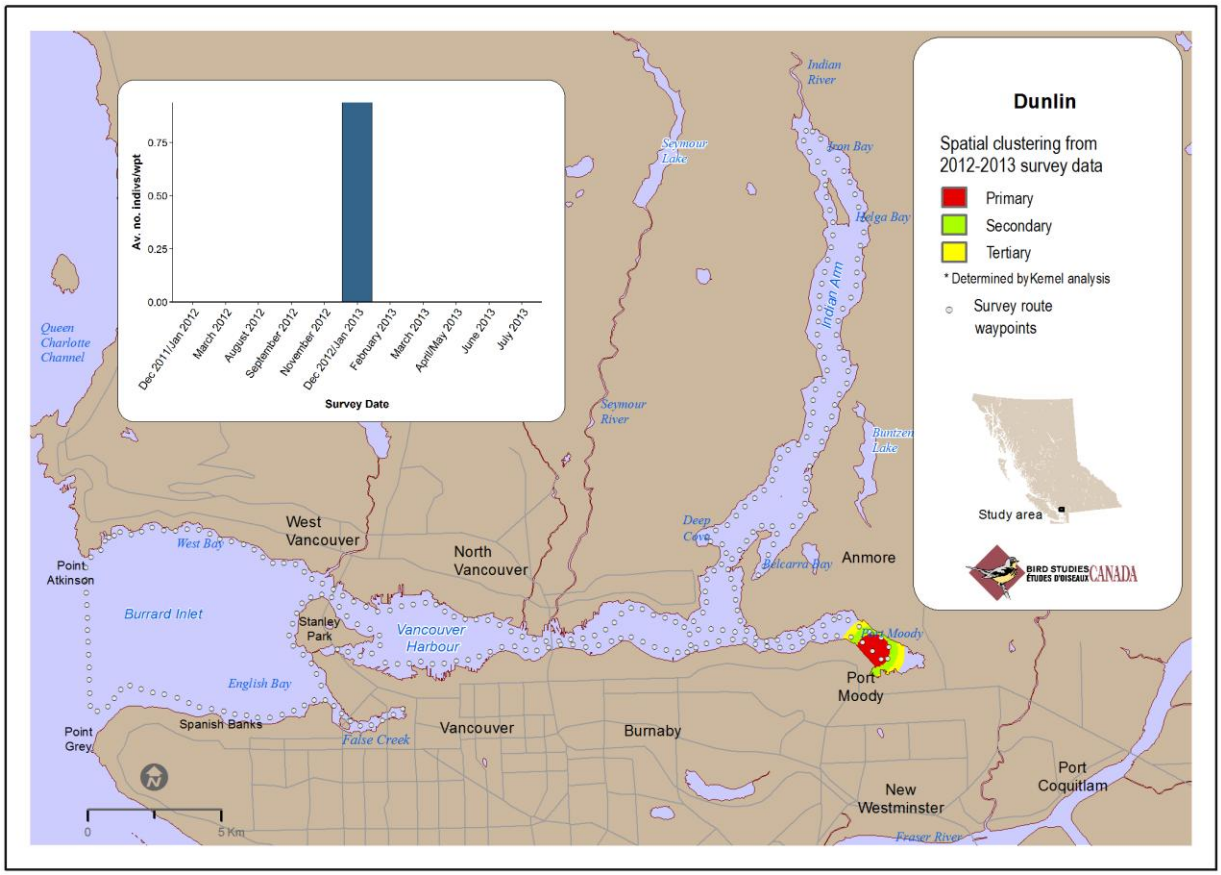

Fig. 45 Spatial distribution and seasonal abundance of Dunlin in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Dunlin is the most numerous shorebird in the Salish Sea in winter. The Fraser River delta holds tens of thousands of this species each year between November and April (Butler and Campbell 1987).

Salish Sea Status Crewe et al. (2012) showed that the population in the Strait of Georgia had declined by 8.9% per year in 1999-2011. A small number have historically resided in the study area in winter. Hanrahan (1994) reported that more than 350 Dunlin were present in Port Moody Inlet in fall and winter of 1992 and where a few hundred are present each year (RWB, pers. obs.).

Survey Records 2011-13 Our only record was a flock of 270 birds in December roosting on a log in Port Moody (Fig. 45). Where the species spends its time during the day is not clear.

Conservation Issues A few hundred Dunlin have occupied the inlet for many years but little is known about their movements. Maintaining the quality of its habitats in an urban environment is important to sustain this population.

Recommendations Tracking the local movements of the Dunlin would help define areas of importance and if conservation measures are warranted.

Bonaparte's Gull *Chroicocephalus philadelphia*

Conservation Status Conservation Data Centre: BC Yellow list

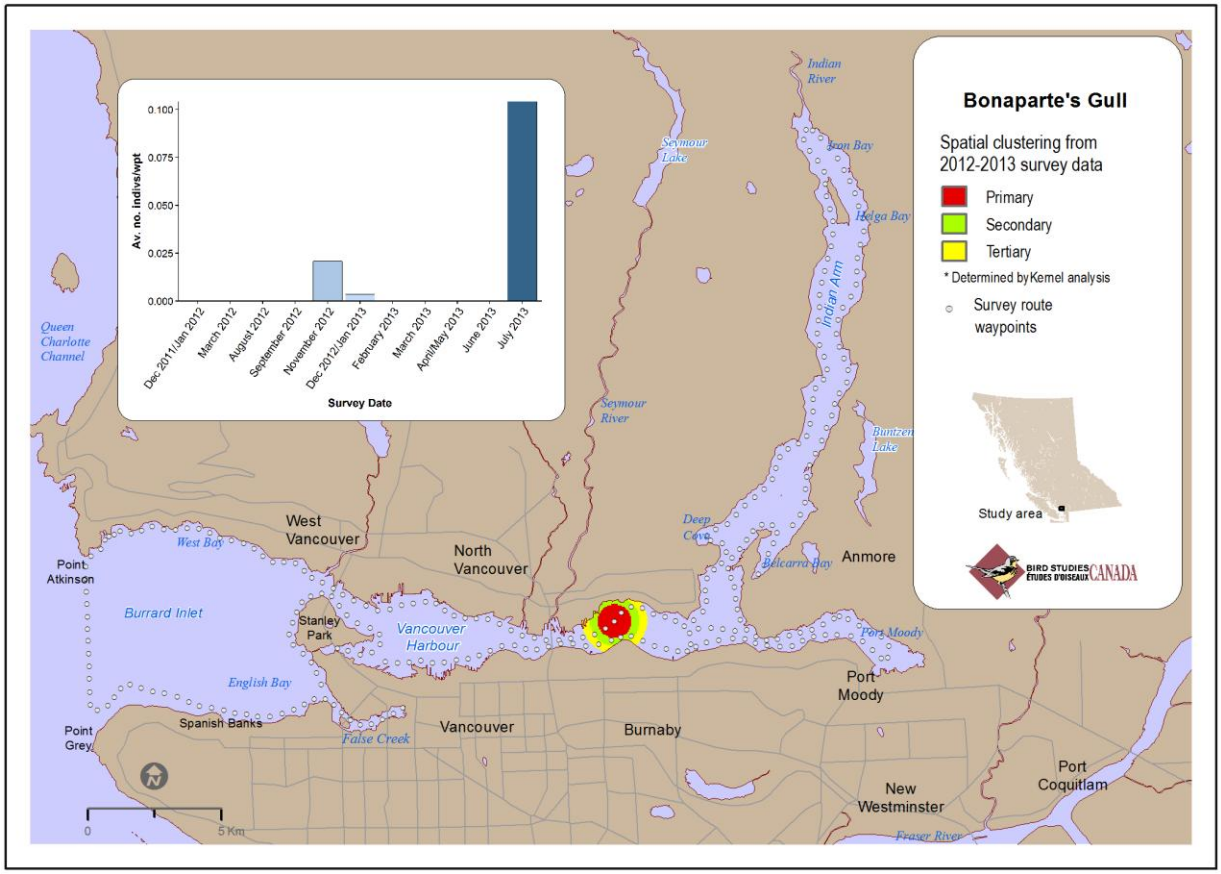

Fig. 46 Spatial distribution and seasonal abundance of Bonaparte's Gull in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Bonaparte's Gulls are passage migrants in the Salish Sea in large numbers at tidal channels (Vermeer et al. 1987, Campbell et al. 1990). Smaller numbers are present in winter (Crewe et al. 2012). Nationally, Breeding Bird Surveys trends in the boreal taiga plains of Alberta, Manitoba and Saskatchewan have been declining from the 1970s to 2012 (Environment Canada 2014.)

Salish Sea Status The BC Coastal Waterbird Survey reported a significant annual decline of 13% between 1999-2011 when focused on the period of passage migration (Crewe et al. 2012). Steep declines in the Salish Sea were reported in the Christmas Bird Count data from 1975-1984 and 1998-2007 and Washington's PSAMP monitoring

data (Bower 2009). Additionally, a significant decline in density was reported for Padilla Bay, Washington between 1978-79 and 2003-06 (Anderson et al. 2009). The authors noted that none of the monitoring programs adequately assessed this species that moves through in short, large pulses and concentrates in certain offshore areas (Anderson et al. 2009). Campbell et al (1972a) described the species as frequent in summer in the Vancouver region.

Survey Records 2011-13 The Bonaparte's Gull was not commonly encountered during our surveys. Thirty gulls seen in July, three in August, and one in December are our only records (Table 2). The few birds were seen in the western end of the study area and a flock roosted at Maplewood Mudflats.

Conservation Issues The presence of this species is a good indicator of schools of small fish prey and the absence of large numbers of Bonaparte's Gulls in Vancouver Harbour suggests that small fish that it preys upon are also no longer abundant.

Recommendations Efforts to restore small fish prey will benefit this species and the wider ecosystem that depends on forage fish as prey.

Mew Gull *Larus canus*

Conservation Status Conservation Data Centre: BC Yellow list

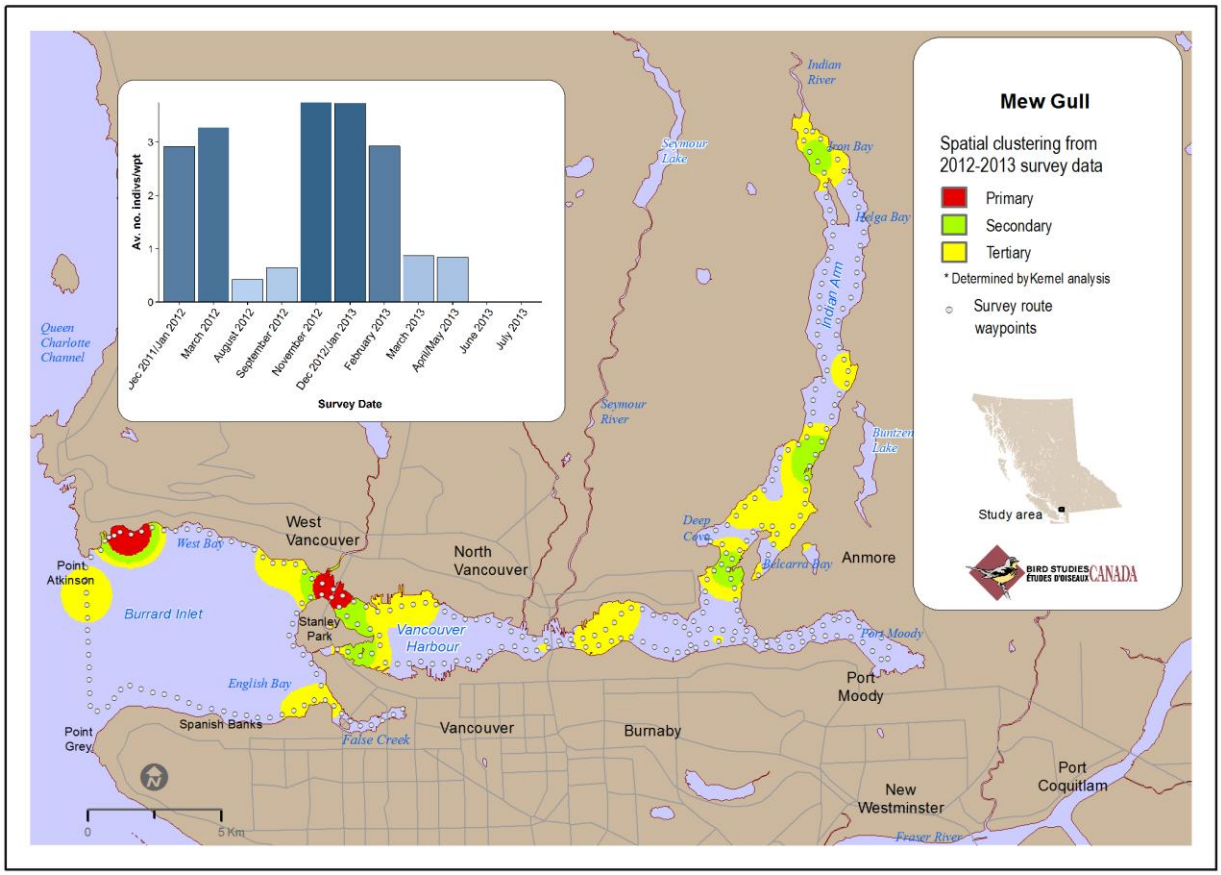

Fig. 47 Spatial distribution and seasonal abundance of Mew Gull in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Mew Gulls are found in nearshore coastal waters, estuaries, beaches, harbours and agricultural fields (Campbell et al. 1990, Moskoff and Bevier 2002). Large concentrations occur in March in response to herring spawning events (Crewe et al. 2012). Nationally, Breeding Bird Survey data from coastal and northern BC declined beginning in the 1970s and stabilized since the mid-2000s (Environment Canada 2014).

Salish Sea Status The BC Coastal Waterbird Survey reported no significant trend from 1999-2011 (Crewe et al. 2012). The Christmas Bird Count in British Columbia from 1959-1988 showed a 3% annual decline (Sauer et al. 1996) whereas a stable pattern was reported throughout the Salish Sea between 1975-84 and 1998-2007 (Bower 2009). Monitoring in Washington State from 1978-80 and 2003-05 showed a 25% decline (Anderson et al. 2009) yet numbers in Padilla Bay, Washington were stable during the same period (Anderson et al. 2009).

Survey Records 2011-13 The Mew Gull was a widespread and abundant species in

Burrard Inlet and Indian Arm. We tallied over 3700 Mew Gulls in spring, fall and winter (Table 2). It gathered in large flocks to bathe and rest at Cypress Creek in West Vancouver and Maplewood Mudflats in North Vancouver. Individuals or small numbers were seen throughout the study area.

Conservation Issues The BC Breeding Bird Atlas recommends expanded surveys of wetland breeding habitat in northern BC and the coast mountains to better understand the breeding distribution of Mew Gulls (Siddle 2015a).

Recommendations No measures are proposed.

Ring-billed Gull *Larus delawarensis*

Conservation Status Conservation Data Centre: BC Yellow list

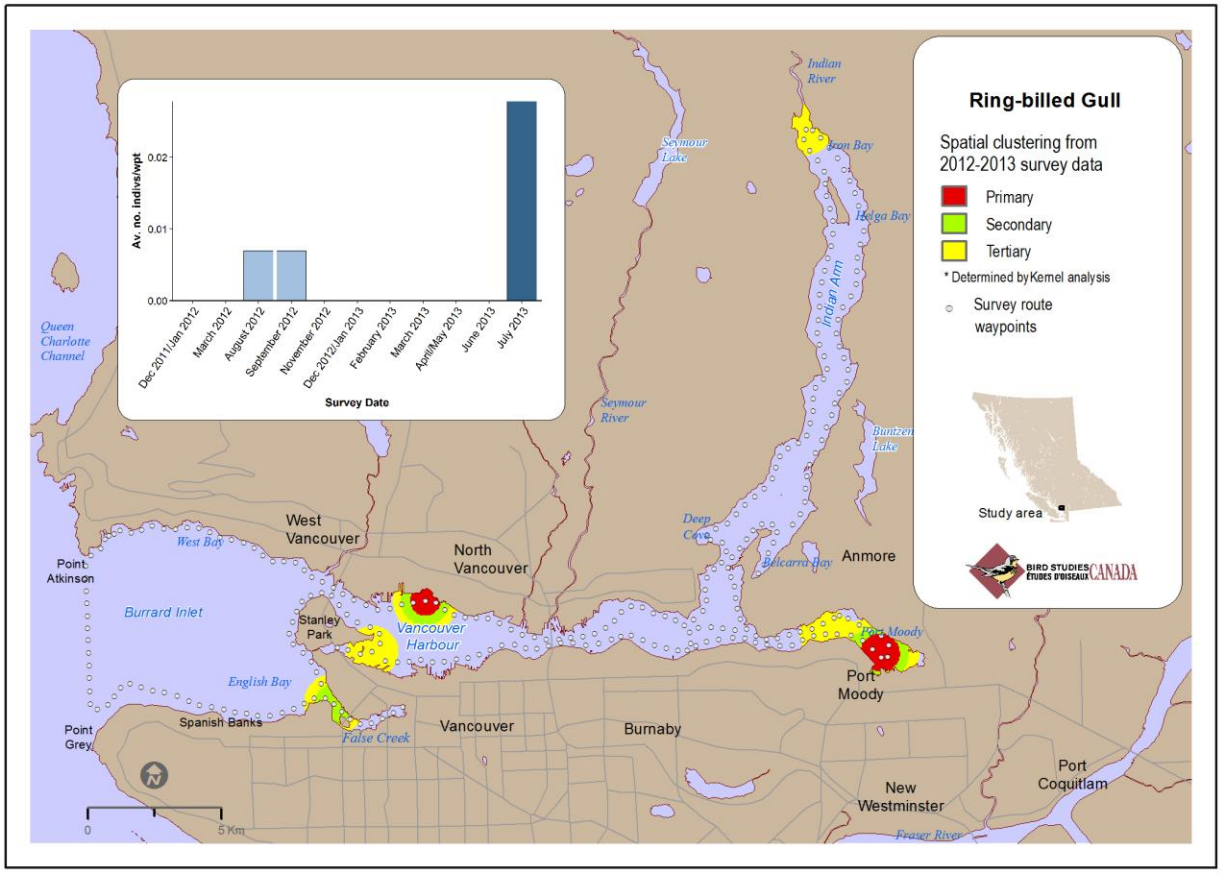

Fig. 48 Spatial distribution and seasonal abundance of Ring-billed Gull in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends This familiar, urban gull was nearly wiped out in the early 20th century due to feather and egg collecting and loss of breeding habitat to human settlement (Siddle 2015b). It thrives today due to its ability to exploit the expansion of agriculture, water

	reservoirs and garbage dumps (Pollett et al. 2012). It is frequently found in nearshore areas such as estuaries, beaches, mudflats, and adjacent waters (Pollett et al. 2012) and are attracted to sources of food from human activities such as harbours, fishing vessels, playgrounds, grassy parks, landfill sites and fast food locations (Pollett et al. 2012, Siddle 2015b). Ring-billed Gulls return to the region in late summer and fall. Some remain through winter (Crewe et al. 2012). Numbers have been increasing in British Columbia and elsewhere in Canada and the US. Breeding Bird Survey numbers show an increase of 3.3% per year from 1966-2009 (Sauer et al. 2011). The Christmas Bird Count shows an increase in British Columbia of 2.7% per year (Sauer et al. 1996).
Salish Sea Status	No significant trend was reported from either the BC Coastal Waterbird Survey between 1999-2011 (Crewe et al. 2012) or monitoring in Padilla Bay, Washington between 1978-80 to 2003-2006 (Anderson et al. 2009).
Survey Records 2011-13	The Ring-billed Gull was nowhere numerous on our survey. The few birds seen in summer and fall were present in Port Moody Inlet, the mouth of Lynn Creek, around Stanley Park and at the Indian River mouth.
Conservation Issues	The population is secure and possibly expanding its range (Siddle 2015b).
Recommendations	No measures are proposed.

California Gull *Larus californicus*

Conservation Status Conservation Data Centre: BC Blue list

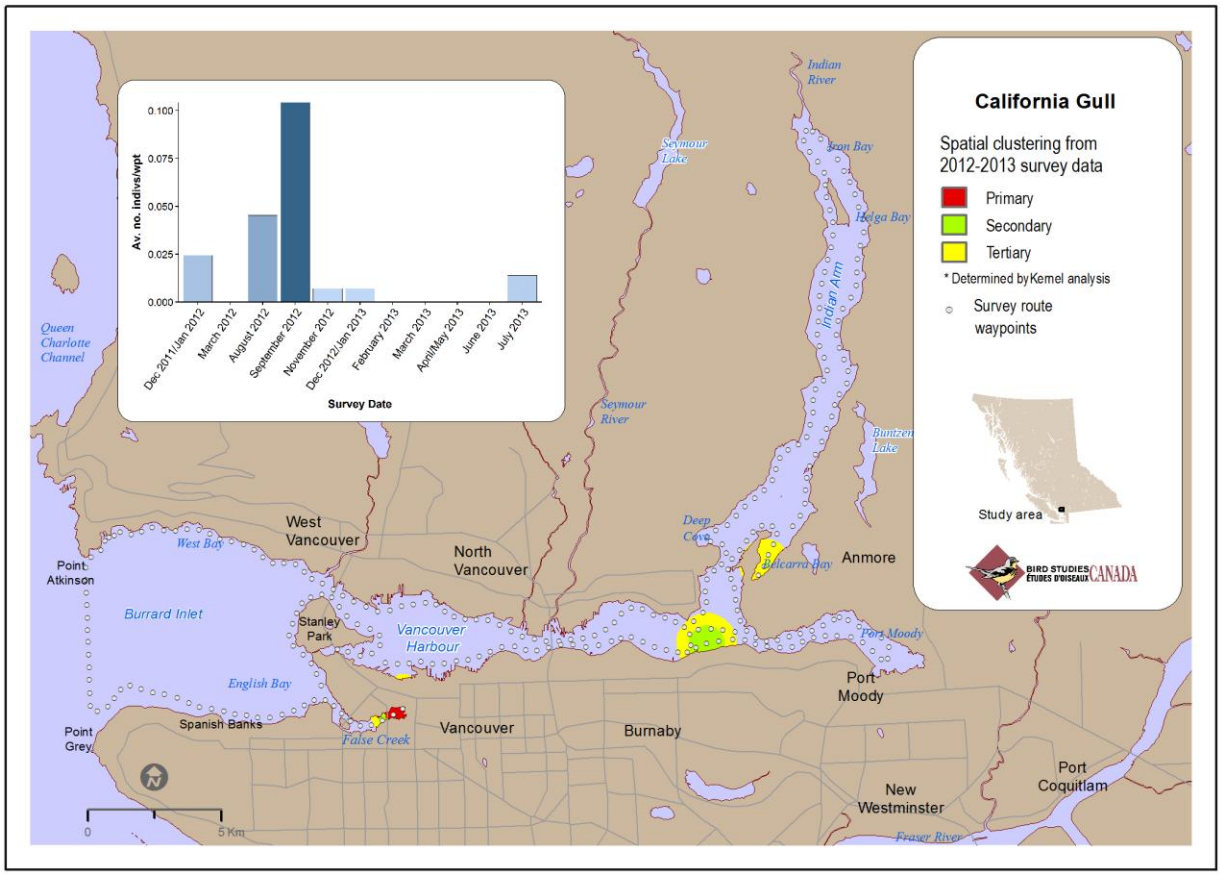

Fig. 49 Spatial distribution and seasonal abundance of California Gull in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends California Gulls use a wide variety of marine habitats from open ocean at the continental shelf to coastal estuaries, river deltas, beaches, mudflats and rocky coastlines (Winkler 1996). They winter in large numbers along the west coast of North America and migrate along the BC coast (Campbell et al. 1990). In British Columbia, Christmas Bird Count numbers were stable over the long term (Sauer et al. 1996).

Salish Sea Status No trend was apparent in the BC Coastal Waterbird Survey dataset over the period 1999-2011 (Crewe et al. 2012). Numbers in Puget Sound, Washington were stable over the same period (Anderson et al. 2009). The California Gull is a frequent transient in the Vancouver region (Campbell et al. 1972a).

Survey Records 2011-13 A few California Gulls were recorded in the study area and those were in summer and winter. We suspect more might be present on beaches we could not readily see from a boat.

Conservation Issues California Gulls are Blue listed in BC because their small

breeding population is susceptible to human disturbance and random environmental fluctuations (BC Conservation Data Centre 2015). They are listed as a regional stewardship species in the Bird Conservation Region 5 strategy (Environment Canada 2013). Threats to the wintering population include entanglement in gill nets and longlines, ingestion or entanglement in plastic waste in both marine and terrestrial environments and chronic and catastrophic oil spills (Environment Canada 2013.).

Recommendations This species needs to be assessed from ground based counts at roost sites.

Glaucous-winged Gull *Larus glaucescens*

Conservation Status Conservation Data Centre: BC Yellow list

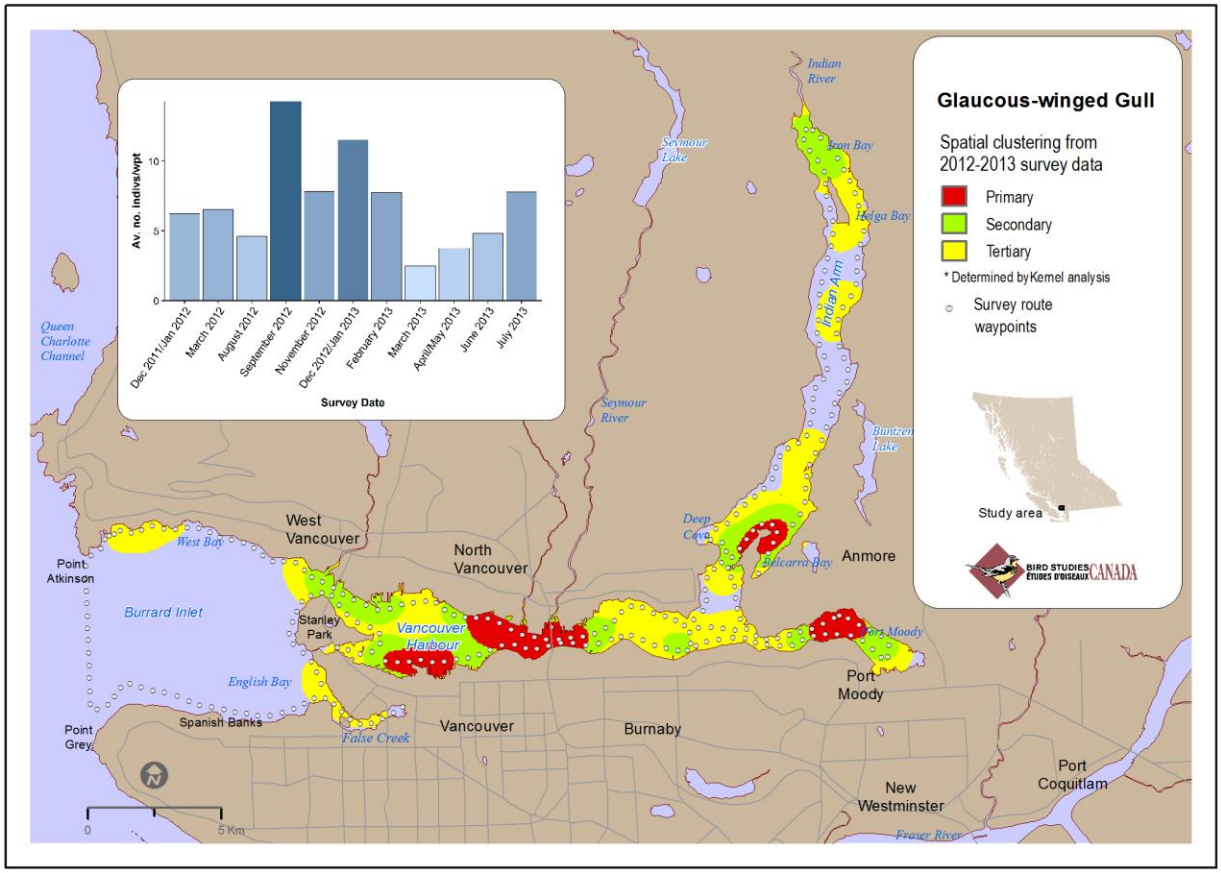

Fig. 50 Spatial distribution and seasonal abundance of Glaucous-winged Gull in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Glaucous-winged Gull is a year round resident in the Salish Sea. Large concentrations are routinely found, especially around herring spawning sites. Glaucous-winged Gulls forage in the

intertidal zone, estuaries and at landfills and breed on uninhabitated, tree-less islands, rooftops and undersides of urban bridges (Vermeer et al. 1994).

Nationally, Christmas Bird Counts suggest increases since the 1970s (Environment Canada 2011). In BC, Christmas Bird Counts and breeding surveys show declines since the 1990s possibly linked to increasing disturbance and predation by rising numbers of Bald Eagles (Environment Canada 2011).

Salish Sea Status

Glaucous-winged Gulls showed a significant declining trend of 4.3% in the BC Coastal Waterbird Survey dataset from 1999-2011 (Crewe et al. 2012). Significant declines of up to 37% were reported from Christmas Bird Count data from the Salish Sea and Puget Sound, Washington, between 1975-84 and 1998-2007, PSMAP monitoring 1978-80 and 2003-05 (Bower 2009) and in Padilla Bay, Washington between 1978-79 and 2003-06 (Anderson et al. 2009). The number of nesting pairs in colonies in the Strait of Georgia shrunk in size by up to 31% from 1986 to 1997-1999 (Vermeer and Devito 1989, Sullivan et al. 2002b). There were 8000 at the garbage dump in North Vancouver in 1971 (Campbell et al. 1972b). A large nighttime roost has been in use in English Bay since 1973 (Worcester 2010).

Survey Records 2011-13

By far the most numerous gull in the study area was the Glaucous-winged Gull. A few to several thousand were present on every survey (Table 3). Large numbers of gulls occupied the inner industrialized portion of the harbour as well as near Belcarra and Port Moody. Numbers peaked in fall when post breeding flocks and offspring gathered in the area to eat mussels.

Conservation Issues

Declines in the Strait of Georgia may be attributed to increasing disturbance and predation at breeding colonies as numbers of Bald Eagles rise (Sullivan et al. 2002b) and marine prey availability (Blight 2011). Threats to Glaucous-winged Gulls include entanglement in longlines, ingestion of marine plastic waste, mortality due to PCB exposure and chronic and catastrophic oil spills (Environment Canada 2013). The gull is a regional stewardship species in the Bird Conservation Region 5 strategy (Environment Canada 2013).

Recommendations

The large numbers of gulls that descend on the inlet after breeding to eat mussels underscores the significance of the inlet as a food source. Maintaining high quality conditions for mussels is important for this species as well as several seaducks. Locating mussels beds and a regular monitoring of pollutant levels in the harbor is recommended. Further, the location and number of gulls using English Bay as a nighttime roost (Worcester 2010) should be documented.

Common Murre *Uria aalge*

Conservation Status Conservation Data Centre: BC Red list

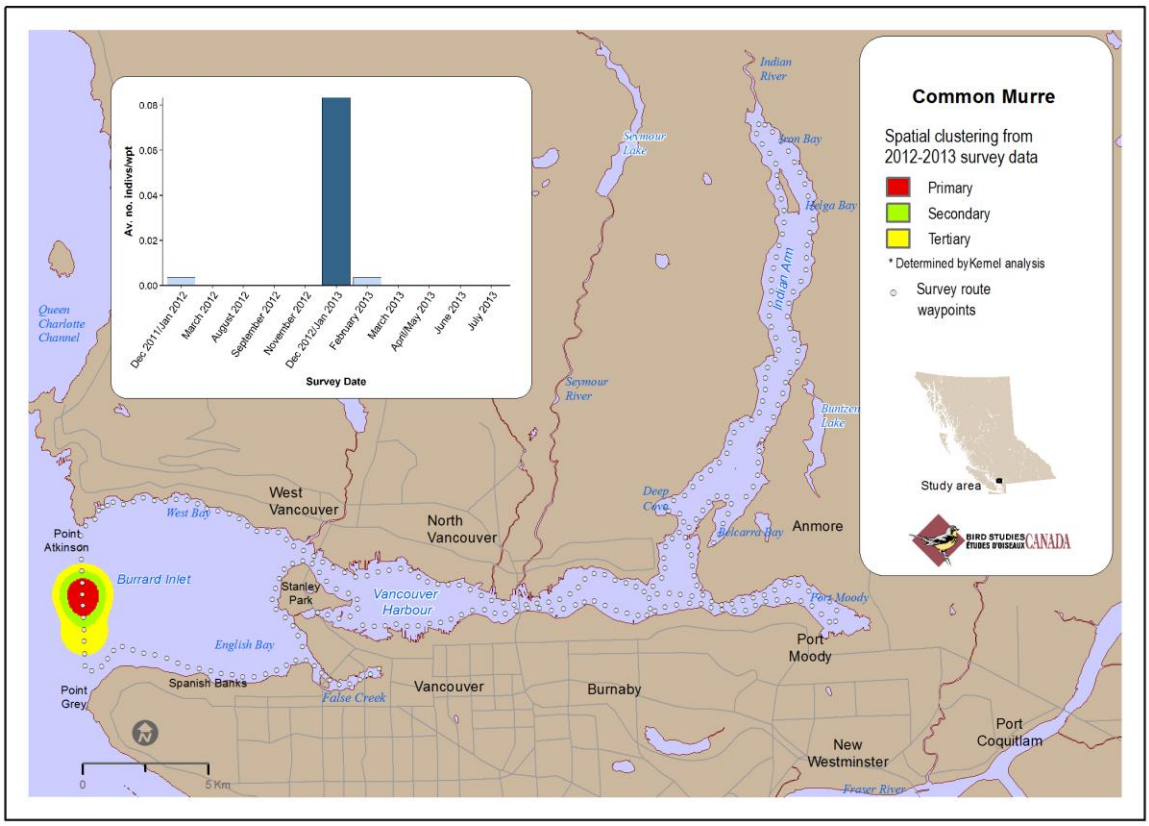

Fig. 51 Spatial distribution and seasonal abundance of Common Murre in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Large numbers of Common Murre that form colonies to nest along the Pacific Coast outside the Salish Sea enter the Strait of Georgia in summer to moult (Thompson et al. 1998). In spring, large numbers congregate around herring spawn sites and move farther offshore over the continental shelf break to overwinter (Morgan et al. 1991, Hipfner 2015a). Between 1989-2003 the largest breeding colony in BC at Triangle Island declined by 27% (Hipfner 2005).

Salish Sea Status Common Murres showed no significant trend in BC Coastal Waterbird Survey dataset from 1999-2011, but detection ability may be limited by a chiefly offshore distribution relative to survey locations (Crewe et al. 2012). Steep declines of 83-92% were reported from Christmas Bird Counts in the Salish Sea between 1975-84 and 1998-2007, and in the Puget Sound Ambient Monitoring Program in Washington between 1978-80 and 2003-2005 (Bower 2009).

Survey Records 2011-13 The Common Murre frequented marine waters far from shore. The few we encountered were at the western entrance to English Bay.

Conservation Issues Common Murres are Red listed in British Columbia due to high

risk of mortality to oil spills and high susceptibility to fisheries bycatch (BC Conservation Data Centre 2015). Common Murres face a variety of threats in their marine environment. They are highly susceptible to chronic and catastrophic oil spills, the most frequently captured bird in gill nets (Smith and Morgan 2005) and the most frequently found oiled bird in beached bird surveys (Hamel et al. 2009). Further threats include ingestion of marine and terrestrial plastic waste, competition with humans for prey stock, introduced predators at breeding colonies, exposure to contaminants and shifts in marine productivity and food webs due to climate change (Environment Canada 2013). The major breeding colonies in British Columbia are secured as provincial and federal protected areas (Hipfner 2015a). Common Murres are identified as a regional stewardship priority in Bird Conservation Region 5 strategy and expanded monitoring of the breeding population is recommended (Environment Canada 2013).

Recommendations

Despite few murres seen on our surveys, the possibility that more use the offshore waters in the central portion of English Bay that we did not survey needs to be assessed. Prevention and rapid cleanup response of oil spills in the outer harbor is a priority for the survival of this species.

Pigeon Guillemot *Cepphus columba*

Conservation Status Conservation Data Centre: BC Yellow list

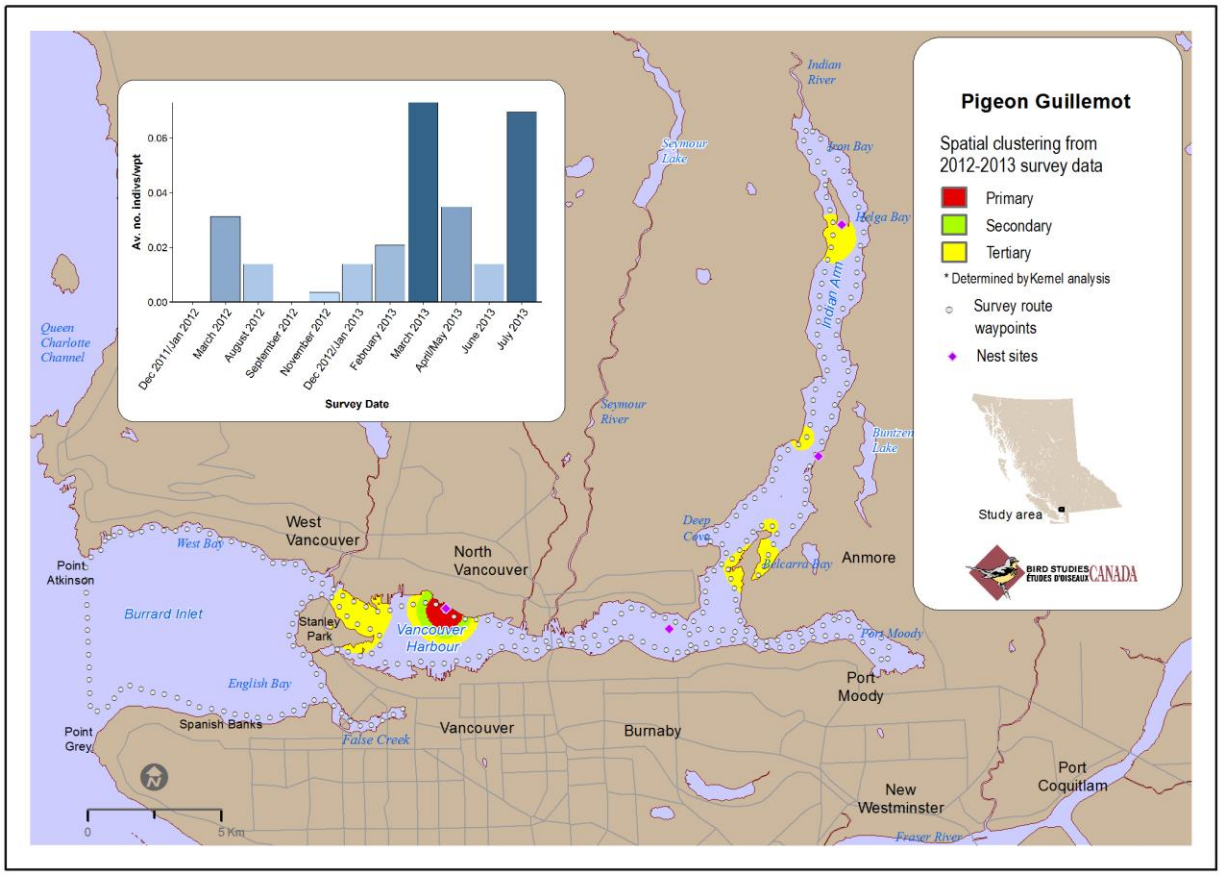

Fig. 52 Spatial distribution and seasonal abundance of Pigeon Guillemot in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Pigeon Guillemot is a resident species endemic to the Pacific Northwest, commonly found in sheltered, rocky inshore waters of the Salish Sea (Hipfner 2015b). The guillemot breeds along the British Columbia coast where it lays its eggs in rock crevices, under logs and among pilings and where it feeds primarily on fish in benthic, nearshore waters.

Salish Sea Status Pigeon Guillemots showed a strong upward trend of 21.7% per year from 1999-2011 in the BC Coastal Waterbird Survey dataset (Crewe et al. 2012). Most notable were the large uptick in numbers off Victoria and the Saanich Peninsula since 2005 (Crewe et al. 2012). Two nests were reported from Prospect Point and one from Siwash Rock in 1971 (Campbell et al. 1972b). Pigeon Guillemots showed a large increase in numbers in the Salish Sea Christmas Bird Counts between 1975-84 and 1998-2007 (Sauer et al. 1996) and in Puget Sound Ambient Monitoring Program surveys in Washington between 1978-80 and 2003-05 (Bower 2009). In contrast, aerial surveys in Puget

	Sound showed declines from 1992-1999 (Nysewander et al 2001).
Survey Records 2011-13	About 10 pairs of Pigeon Guillemots nested in Burrard Inlet and Indian Arm during our surveys and their activity was centred on these locations including Lonsdale Quay pier, cliffs north of Twin Islands, and south shore of Croker Island. Despite the small number of guillemots using the study area, it was present on every survey except in September and December/January 2012.
Conservation Issues	The main threats to Pigeon Guillemots include mortality in gillnets, ingestion of marine and terrestrial plastic waste, competition with humans for fish stock, introduced predators at breeding sites, human disturbance at nest sites, exposure to contaminants, chronic and catastrophic oil spills and changes in marine food webs and productivity due to climate change (Environment Canada 2013). They were found to have high mercury levels compared to other seabirds (Noble and Elliott 1986). Pigeon Guillemots are identified as a regional stewardship priority in Bird Conservation Region 5 strategy and expanded monitoring of the breeding population is recommended (Environment Canada 2013).
Recommendations	The species takes to artificial nest sites so a program to install boxes might enhance the small local population.

Marbled Murrelet *Brachyramphus marmoratus*

Conservation Status COSEWIC (2012): Threatened; SARA Status: Schedule 1, Threatened; Conservation Data Centre: BC Blue list

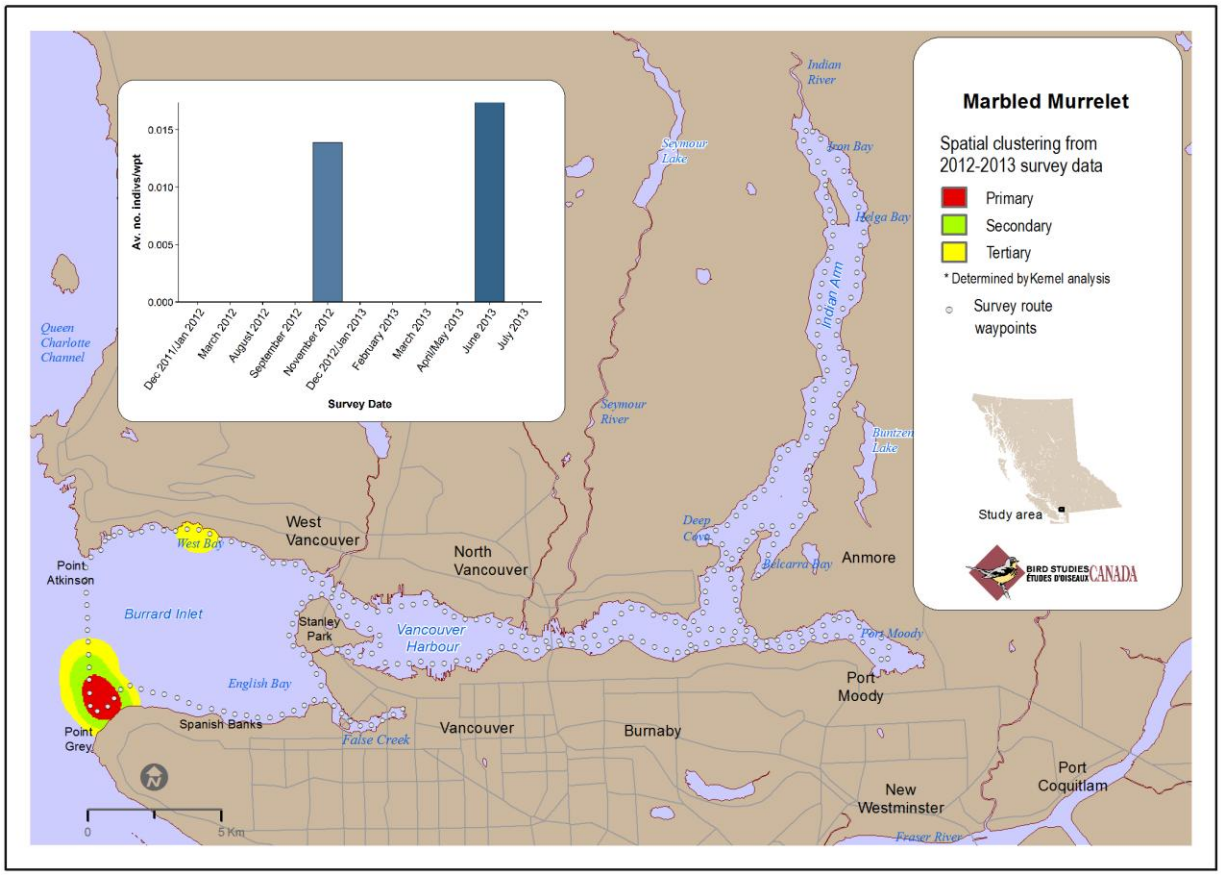

Fig. 53 Spatial distribution and seasonal abundance of Marbled Murrelet in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The number of Marbled Murrelets in Canada is estimated to be about 99,000 birds, or about 28% of the estimated global total of 357,900 birds (Environment Canada 2014). Murrelets forage on small fish and marine invertebrates such as crustaceans and amphipods (Norris et al. 2007). Breeding birds carry the prey for many kilometers to nests often built on limbs of old trees arriving under the cover of darkness.

Salish Sea Status In 1971 and 1972, the marbled murrelet was a frequent resident and widespread species in the Vancouver area (Campbell et al. 1972 a,b). The 1970 Christmas Bird Count reported 79 murrelets in Vancouver – the highest previous tally was 268 birds. It was a breeding species around that time evidenced by an adult seen carrying food in English Bay and 88 murrelets reported from English Bay including 8 young in July 1971. The numbers had declined noticeably by 1995 when the Vancouver Natural History Society (1995) wrote “The Marbled

Murrelet is a resident species which seems to be decreasing in numbers. Small numbers can be seen off Lighthouse Park and Ambleside Park during the winter". Results from our study. The decline in the number of murrelets counted in the Strait of Georgia over the past 40 years (Norris et al. 2007; Crewe et al. 2012) reinforce our grim assessment for Burrard Inlet and Indian Arm.

Survey Records 2011-13

The few murrelets we saw off Point Grey and West Vancouver do not bode well for this species in the harbour where it was once more numerous (Campbell et al. 1972a). Perhaps a glimmer of hope was a sighting in June coinciding with the nesting season (Table 2).

Conservation Issues

The risk to the Marbled Murrelet is thought to be loss of old growth forest nesting habitat, oil contamination, entanglement in fishing nets at sea, and disturbance from shipping traffic (Environment Canada 2014). However, Norris et al. (2007) suggested that murrelets in the Salish Sea were probably limited by factors other than diet quality until the 1950s when their diet quality began to change away from small fish. These authors believe that recovery might require restoration of marine as well as forest habitats. Murrelets in the 1990s appeared to catch fish prey at the junction of Burrard Inlet and Indian Arm, and fly westward to English Bay to wait for the cover of darkness before leaving for the forested North Shore where they presumably nested (Vancouver Natural History Society 1995). One of us (RWB) witnessed these flights from a viewpoint beneath the Lions Gate Bridge in the 1970s. In 1970, a 'nest fugitive young' was found in Stanley Park's Lost Lagoon in July (Campbell et al. 1972a) and a few years before the first nest ever of this species was discovered (Binford et al. 1975). The species also nests on the ground (Simons 1982) including in the Gulf Islands (W. Wartig, pers. comm.).

Recommendations

Efforts to recover small forage fish, especially Pacific herring and sandlance in Burrard Inlet and Indian Arm might be essential to recover the murrelet populations.

Belted Kingfisher *Megaceryle alcyon*

Conservation Status Conservation Data Centre: BC Yellow list

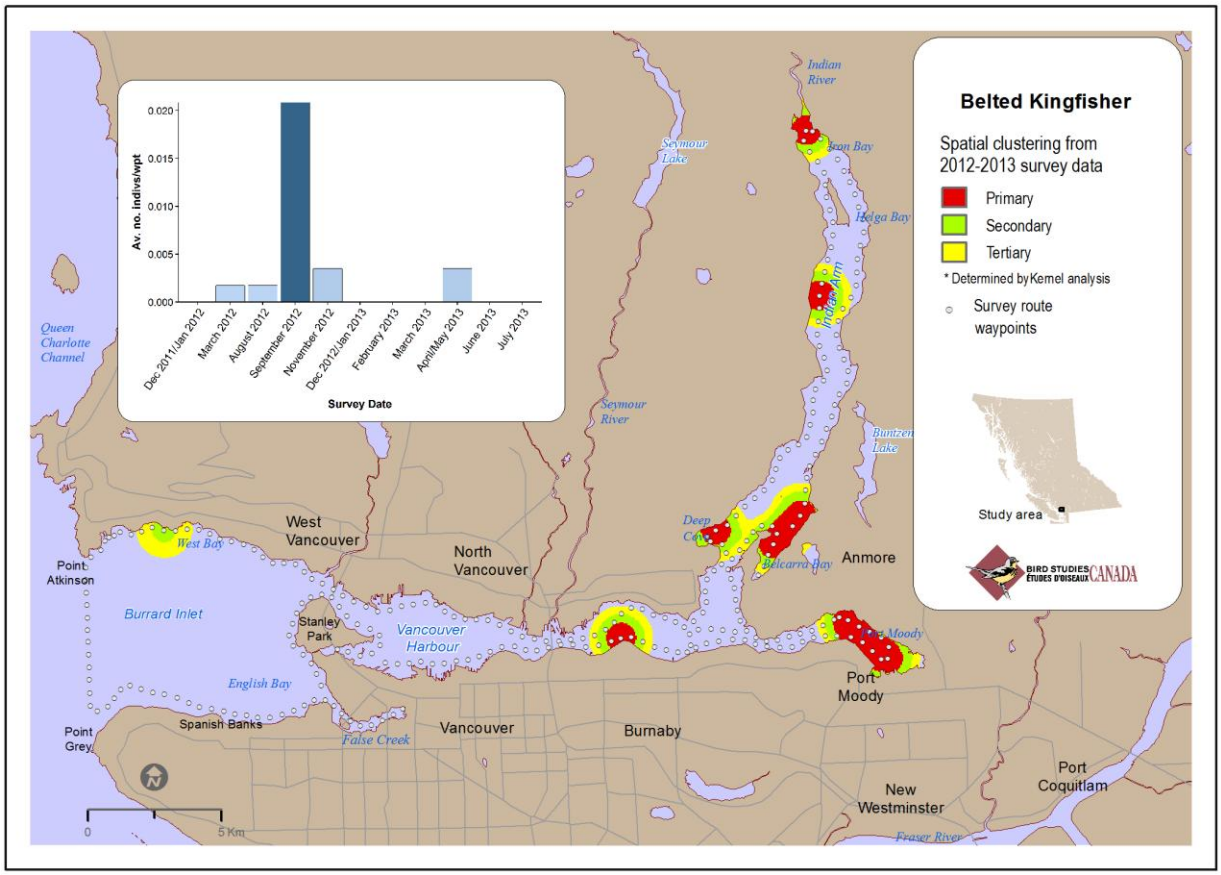

Fig. 54 Spatial distribution and seasonal abundance of Belted Kingfisher in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends Belted Kingfishers are strongly tied to shallow estuaries, rocky shores and clear marine waters where they hunt for small fish (Kelley et al. 2009, Environment Canada 2013. No significant trends in BC kingfisher populations were found in the Breeding Bird Surveys from 1965-1979 (Robbins et al. 1986).

Salish Sea Status The kingfisher is a migrant in much of British Columbia and a year round resident on the coast (Campbell et al. 1990b). This species has been overlooked in surveys around the Salish Sea and so its status is unclear.

Survey Records 2011-13 The Belted Kingfisher was nowhere numerous but it was mostly seen in the eastern harbour, particularly in Port Moody Inlet, Deep Cove, Belcarra Bay, the Indian River mouth and parts of Indian Arm. We also saw it along the shore of West Vancouver.

Conservation Issues Kingfishers are identified as a species of 'regional concern' and 'regional stewardship' in the Bird Conservation Region Strategy (Environment Canada 2013).

Recommendations No measures are proposed.

MAMMALS

Harbor Porpoise *Phocoena phocoena*

Conservation Status COSEWIC (2003): Special Concern; SARA status: Schedule 1, Special Concern; Conservation Data Centre: BC Blue list

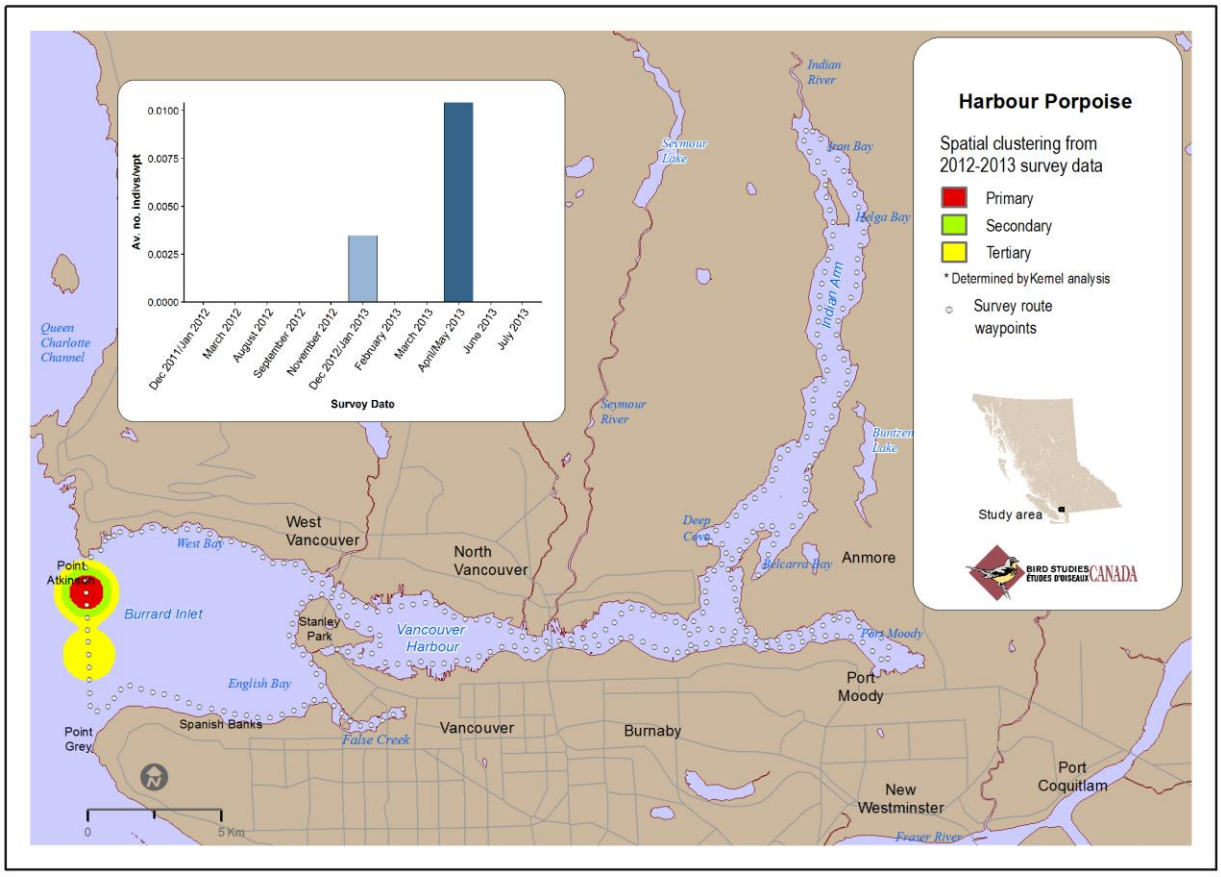

Fig. 55 Spatial distribution and seasonal abundance of Harbour Porpoise in Burrard Inlet and Indian Arm, British Columbia, December 2011 - July 2013.

Ecology and Regional Trends The Harbour Porpoise occurs along the British Columbia coast in waters usually less than 150 meters depth including in the Strait of Georgia (Ford 2014). The species is frequently encountered in Haro Strait to Race Rocks where there is strong tidal flow (Hall 2004, Davidson et al 2009).

Salish Sea Status There are no trend data but an estimated 6200 porpoises were present in the Strait of Georgia and Gulf Islands in 2002-03 (Ford 2014).

Survey Records 2011-13 Harbour Porpoises were encountered on two occasions, both in the open water between Lighthouse Park and Point Grey.

Conservation Issues Entanglement in fishing gear and possibly avoidance of underwater noise are considered important to this species (Ford 2014). It is unclear if or why porpoises avoid the shallow waters

of the inner harbour that is supposed to be to their liking.

Recommendations Increase the observations to better define the presence and use of the harbour, especially at the entrance to English Bay.

Harbor Seal *Phoca vitulina*

Conservation Status COSEWIC (1999): Not at risk; Conservation Data Centre: BC Yellow list

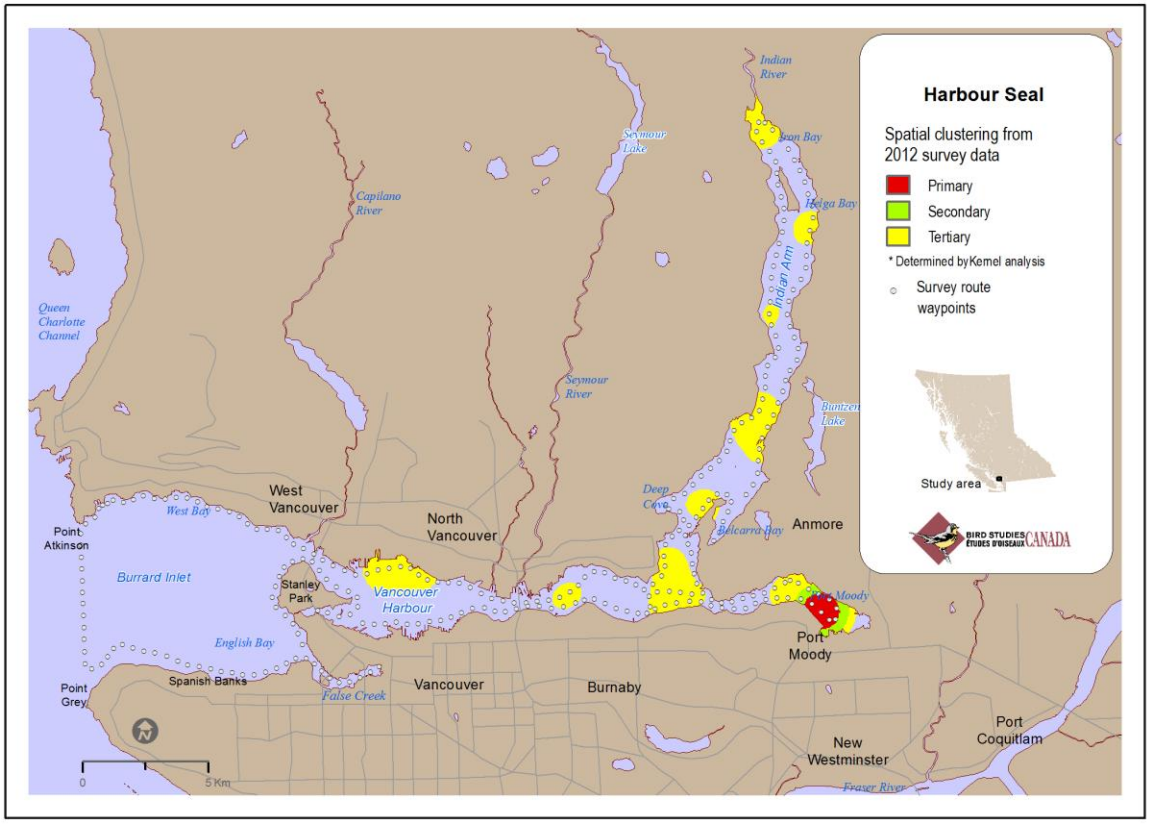

Fig. 56 Spatial distribution and seasonal abundance of Harbour Seal in Burrard Inlet and Indian Arm, British Columbia, December 2011 - November 2012.

Ecology and Regional Trends The harbour seal has become an abundant marine mammal along much of the British Columbia coast including in Burrard Inlet and Indian Arm. The California-Oregon-Washington-British Columbian Harbour Seal increased significantly over the past 40 years, and the eastern North Pacific population was estimated to number 285,000 individuals (Cresswell et al. 2007). Seals have become important prey for transient Killer Whales in the region.

Salish Sea Status The Harbour Seal increased in the Strait of Georgia for many years (Olesiuk 1999). The species is the most numerous marine mammal in the Salish Sea.

Survey Records 2011-13	Our 2012 survey data show Harbour seals were numerous and widespread (Fig. 56). Port Moody was an important location for this species where it hauled out and gave birth to pups on log booms. Seals also regularly hauled out on floating wharves near Mosquito Creek. More than 50 seals were encountered in Port Moody whereas mostly individual seals were seen elsewhere in the study area.
Conservation Issues	The seals require haul outs that were provided by mostly by log booms in Port Moody Inlet during our surveys.
Recommendations	Haul outs could be provided in locations so that people can watch seals.