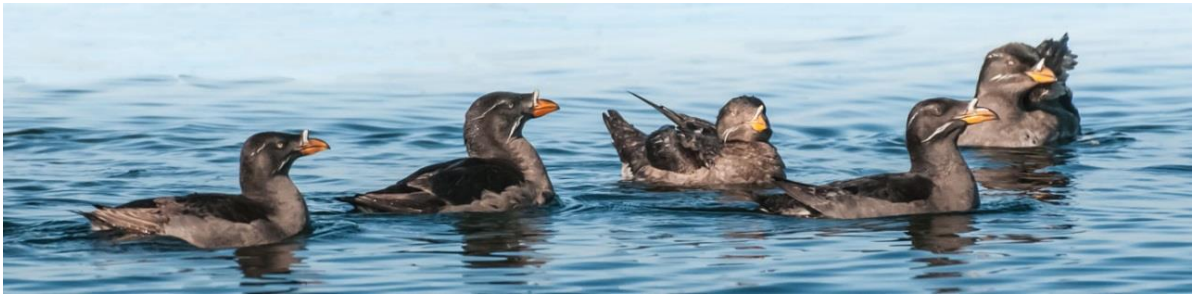
Avian and Marine Mammal Survey

Protection Island Aquatic Reserve



Prepared by:
Betsy Carlson, Port Townsend Marine Science Center
Bob Boekelheide, Citizen Stewardship Committee Member

December, 2018

Publication Information

This report describes the monthly survey of birds and marine mammals found in waters of Protection Island Aquatic Reserve from November 2016 to November 2018. This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement PC-00J90701 through the Washington Department of Fish and Wildlife. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency or the Washington Department of Fish and Wildlife, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Copies of the report will be available at DNR Aquatic Reserves website: https://www.dnr.wa.gov/managed-lands/aquatic-reserves as well as the Aquatic Reserves Citizen Stewardship Committee page: https://www.aquaticreserves.org/

Cover photo: David Gluckman

Author and Contact Information

Bob Boekelheide
Sequim, WA 98382
bboek@olympus.net

Betsy Carlson
Port Townsend Marine Science Center
532 Battery Way
Port Townsend, WA 98368
360-385-5582 x301
bcarlson@ptmsc.org

Acknowledgements

This project grew out of a collaboration between the Port Townsend Marine Science Center, DNR Aquatic Reserves Program, PIAR Citizen Stewardship Committee and the generous dedication of two individuals, Ross Anderson and Bob Boekelheide: Ross for being the competent and dedicated captain of the perfect vessel for this survey, and Bob for his keen eyes, deep knowledge and boundless enthusiasm for all things avian.

The idea for conducting this survey came after Dr. Scott Pearson gave a presentation to the Citizen Stewardship Committee on nesting bird research conducted on Protection Island. The need for year-round information of the avian use of the waters around Protection Island, in the aquatic reserve, was identified as a data gap. Betty Bookheim and Dr. Pearson provided guidance as we developed the protocol.

The following people have assisted with the surveys in the past two years:

Ross Anderson	Steve Evans	Mike Kennedy
Erica Bleke	Wendy Feltham	Terence Lee
Bob Boekelheide	Monica Fletcher	Teresa Michelsen
Betty Bookheim	Steve Grace	Tony Petrillo
Betsy Carlson	James Hayward	Barry Soble
John Comstock	Chuck Hommel	Bob Steelquist
Jonathan Crossman	Penny Jensen	Ken Wilson

Table of Contents

Publication Information 2

Author and Contact Information 2

Acknowledgements 2

List of Figures and Tables 5

Abstract 6

Introduction 6

- Project Background 6

Goals and Objectives 8

- Goals and Objectives of Avian and Marine Mammal Monitoring 8
  - Specific questions/goals 9
  - Objectives 9
- Methods 9
  - General description 9
  - Description of data collection and protocols 10
  - Survey site locations 12

Results and Discussion 13

Recommendations and Improvements Made 15

Possible Future Uses of this Data 15

References 15

Appendix 15

- Tables/Graphs of Data 16
- Transect Coordinates and Length 21
- Species list 22
- Field Forms 25

List of Figures and Tables

Figure 1 Protection Island Aquatic Reserve 7
Figure 2 M/V Sea Hardy 10
Figure 3 View from the flying bridge 10
Figure 4 Numbered transects 1 - 6 from Sept. 17, 2018 survey. 12
Figure 5 Density of Birds per sq km Nov. 2016- Sept. 2018 16
Figure 6 Number of Bird Species Monthly from Nov. 2016 - Sept. 2018 16
Figure 7 Monthly Ave. Densities of Common Murres, Pigeon Guillemots, and Rhinoceros Auklets 17
Figure 8 Monthly Average Densities of Gull Species 17
Figure 9 Monthly Average Densities of Scoters and Long-tailed Ducks 18
Figure 10 Monthly Average Densities of Marbled Murrelets 18
Figure 11 Monthly Average Densities of Yellow-billed Loons 19
Figure 12 Number of Feeding Flocks Observed per Transect Leg 19
Figure 13 Months of Occurrence of Feeding Flocks Nov. 2016 - Sept. 2018 20
Figure 14 Monthly Average Number of Harbor Seals in the Transect 20
Figure 15 Monthly Average Number of Harbor Porpoises Observed 21

Avian and Marine Mammal Survey in Protection Island Aquatic Reserve

Abstract

The Protection Island Aquatic Reserve Citizen Stewardship Committee conducted boat-based avian and marine mammal surveys in the aquatic reserve monthly starting November 2016, to document bird use of the PIAR and seasonal changes in bird and mammal populations. Following a predetermined transect, birds within 200 meters on the forward port or starboard side, away from the sun, were counted, and marine mammals were recorded as encountered. Observers continually scanned the transect area calling out birds and mammals to the data recorder who entered data on pre-printed data sheets. Species, quantity, behavior and zone where first observed were recorded. Data recorder also entered depth and boat speed obtained from the bridge along with latitude and longitude from a GPS cellphone app. Densities of birds (birds per square kilometer) were then calculated for each of the six transect legs and for each monthly cruise, to provide seasonal comparisons within this study and with other studies. As of November 15, 2018, 23 surveys have been conducted, over 23,000 birds and nearly 500 marine mammals were observed, and hundreds of volunteer hours were donated to the project.

Introduction

Project Background

Protection Island Aquatic Reserve (PIAR) created in 2010, is one of eight aquatic reserves established by the DNR in Washington State since 2004. PIAR Citizen Stewardship Committee grew out of the PIAR Implementation Committee and is currently coordinated by the Port Townsend Marine Science Center in collaboration with local community groups such as the Cape George Environment Committee.

The idea for conducting a survey of marine birds in the aquatic reserve came after Dr. Scott Pearson gave a presentation to the Citizen Stewardship Committee on nesting bird research conducted on Protection Island. The need for year-round information of the avian use of the waters around Protection Island, in the aquatic reserve, was identified as a data gap. Having a local volunteer group provide fine-grain survey data to supplement DNR's current information was seen as valuable for supporting and informing the management of the aquatic reserve. As of November 15, 2018, 23 surveys have been conducted, over 23,000 birds observed, nearly 500 marine mammals, and hundreds of volunteer hours were donated to the project.

DNR Aquatic Reserve Program received a NEP grant from EPA and contracted with the Port Townsend Marine Science Center staff to coordinate the Citizen Stewardship Committee's activities from 2016 - 2018. The avian and marine mammal project was one of three citizen science projects started during the grant period. The other two projects were a survey of Bald Eagle and harbor seal presence on Protection Island, and an intertidal monitoring project with the Cape George community on Quimper Peninsula. The Bald Eagle count was designed as a citizen science project by Dr. James Hayward who has spent 30 years studying the Glaucous-wing Gull colony on Protection Island and observed a significant increase in the number of Bald Eagles on the island in the summer months. The intertidal monitoring followed protocols developed and used by the Cherry Point and Fidalgo Bay Aquatic Reserve Citizen Stewardship Committees.

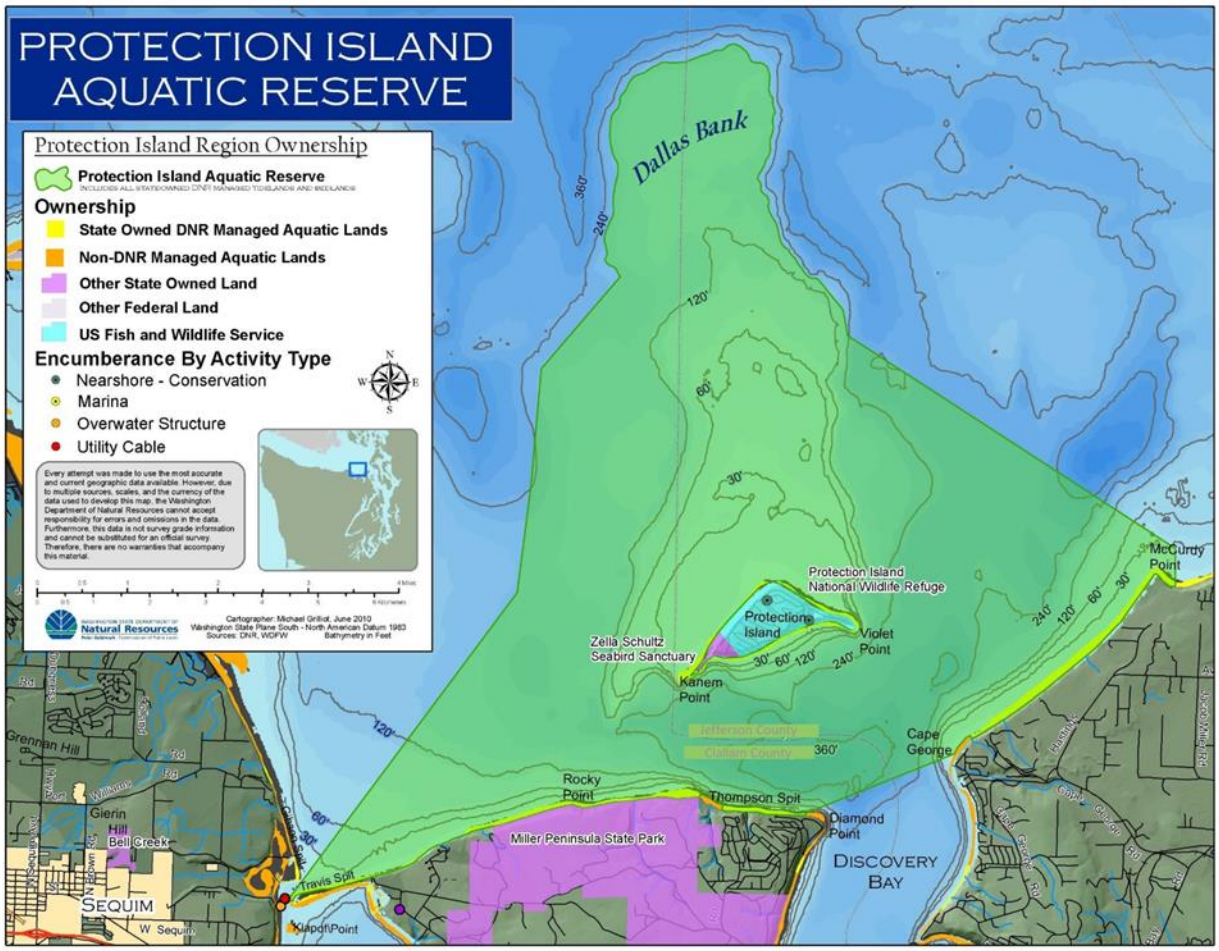


Figure 1 Protection Island Aquatic Reserve

Reserve background

DNR established the Aquatic Reserves Program in an effort to promote preservation, restoration, and enhancement of state-owned aquatic lands that provide benefits to the health of native aquatic habitats and species in Washington.

The Protection Island Aquatic Reserve was established in 2010 and encompasses approximately 23,778 acres of state-owned DNR managed tidelands and bedlands, surrounding Protection Island and adjacent to the Miller and Quimper peninsulas. The reserve contains diverse physical habitats that include; sand flats and beaches, sand and gravel flats and beaches, cobble flats, and extensive intertidal and subtidal vegetation as well as Dallas Bank, a large shallow area on the north side of Protection Island. These habitats are recognized as essential contributors to the reproductive, foraging, and rearing success of many fish and bird species. A primary goal for creating the Protection Island Aquatic Reserve was the preservation of the vegetation and habitat the region provides for numerous species that use the waters. A rich and complex community of submerged vegetation persists along the shores of Miller and Quimper Peninsulas and in areas around Protection Island. The extensive aquatic vegetation, eelgrass (*Zostera marina*) and seagrass

(*Phyllospadix* spp.) beds, and voluminous macroalgal beds are recognized as essential contributors to the reproductive, foraging, and rearing success of many bird and marine mammal species that frequent the region (WDNR Nearshore Habitat Program 2001).

PIAR southern reserve boundary includes those state-owned aquatic lands along the northern coast of Miller Peninsula and the northwest coast of the Quimper Peninsula from Cape George to just east of McCurdy Point. The reserve boundary extends seaward to include all state-owned aquatic lands, northeast from Travis Spit on the Miller Peninsula, to the 200 foot bathymetry contour. The boundary follows the 200 foot bathymetry line around to the east side of Dallas Bank then extends southeast to the eastern edge, just east of McCurdy Point. The southern boundary includes all state-owned aquatic lands between Miller Peninsula and the Quimper Peninsula from Thompson Spit and Cape George.

US Fish and Wildlife Service manages Protection Island National Wildlife Refuge in cooperation with the WDFW who is responsible for managing the Zella M. Schultz Seabird Sanctuary, on Protection Island. DNR has withdrawn the area within 200 yards (182.8 meters) of the island from the general leasing program, resulting in a 343-acre marine buffer area that is managed by the USFWS. About 1,000 harbor seals depend upon the island for a pupping and rest area at various times throughout the year.

Approximately 70 percent of the nesting seabird population of Puget Sound and the Strait of Juan de Fuca nest on Protection Island; this includes one of the largest nesting colonies of Rhinoceros Auklets in North America, one of the largest nesting colonies of Glaucous-winged Gulls and Pigeon Guillemots in Washington State, and one of the last two nesting colonies of Tufted Puffins in Puget Sound. In addition, northern elephant seals have re-colonized areas of the Pacific Northwest and regularly use Protection Island for pupping and molting (US Fish and Wildlife Service 2010).

Goals and Objectives

PIAR Management Plan lists a series of goals and objectives for the aquatic reserve. The primary focus is to "protect and restore the regions natural biological communities, habitats, ecosystems and processes, and the ecological services, uses and values they provide to current and future generations." The Avian and Marine Mammal survey addresses Goal Two: "Support opportunities for scientific research by supporting activities that survey and monitor sensitive habitats, species, and natural processes." Specifically, Objective 2.1 "Establish a baseline inventory of current ecological conditions and the habitats and species found in the reserve area." And 2.5 "Establish partnerships with research organizations and institutions to facilitate the collection of a broader range of data and to promote research sharing and cooperation."

Goals and Objectives of Avian and Marine Mammal Monitoring

Goals: The overall goal of this project is to determine how seabirds and marine mammals use the PIAR and how they distribute themselves within the PIAR. Another goal is to determine whether specific areas of the PIAR are particularly important for certain species, such as areas where feeding assemblages regularly occur, or areas where birds and mammals regularly congregate. Boat-based strip-transects rather than shore-based observations, were used to allow for recording offshore birds and mammals throughout the entire PIAR.

Specific questions/goals

1. What bird and mammal species use the PIAR?

2. How do species vary in their seasonal use of the PIAR (i.e. what is the annual cycle of species using the PIAR?)

3. What areas of the PIAR are most and least important for different birds and mammals? Related to this, are there specific areas of the PIAR that are clearly more important for birds and mammals, such as where feeding assemblages regularly occur?

4. How do numbers and densities of birds and mammals using this area of the eastern Strait of Juan de Fuca compare with numbers and densities determined by other studies, particularly with other studies conducted within the Salish Sea?

Objectives

1. Conduct monthly boat-based strip-transects counting birds and marine mammals within the PIAR, to determine the relative abundance and distribution of these species within the Aquatic Reserve throughout the year.

2. Use consistent, replicable methods to count birds, providing relative densities for comparisons within this study and with other studies.

3. The survey track should be consistent each month and cover as much of the PIAR as possible, yet allow the survey to be completed in about four hours from the Cape George marina.

4. For each bird sighting, as much as possible determine the species of bird, number of individuals, behavior, location (latitude & longitude), date and time, and depth of water.

5. Using the area of each transect (area = distance traveled X 200 m width of transect), calculate densities of each bird species for each leg and for each survey.

6. For each mammal sighting, as much as possible determine the species of mammal, number of individuals, location (latitude & longitude), date and time, and depth of water.

7. Separately record the location of observed feeding flocks, regardless of whether they lie within the 200-m transect or not. For each flock, as much as possible determine its location and species composition.

Methods

General description

Monthly boat-based surveys follow a predetermined transect through the aquatic reserve and outside of the 200 yard marine buffer area surrounding Protection Island Wildlife Refuge. From the flying bridge of a 30 foot diesel trawler, a team of 2-3 people spot and count birds within 200 meters on the forward port or starboard side depending on sun glare, and record marine mammals as encountered. Observers using binoculars, continually scan the transect area calling out birds and mammals to the data recorder who enters data on pre-printed data sheets. Species, quantity, behavior and zone where first observed, are recorded. Data recorder also enters depth and boat

speed obtained from the bridge along with latitude and longitude from a GPS cellphone app (GPS Tour).

Figure 2 M/V Sea Hardy

Figure 3 View from the flying bridge

Description of data collection and protocols

Protocol:

Boat-based marine bird observations typically involve one of two different transect methods -- strip-transects or line-transects. Line-transects, which measure distances between the transect line and observed birds, provide more accurate and statistically-testable comparisons of densities when counting smaller numbers of relatively few species. Unfortunately, line-transects become more difficult and require more time when sampling a wide variety of species and large number of birds. The use of strip-transects of 200 m width was selected because of their relative ease of use, suitability when surveying all species present, and the fact that the project had a number of citizen-scientists helping to spot birds during the surveys. Strip transects assume that all individuals within the strip are detected; even though this is extremely unlikely, observers continually scanned the sample area ahead of the boat with binoculars to make sure as many birds as possible were included in the samples. Prior to every survey, the primary bird observer measured and closely observed 100 m and 200 m distances on land, to reinforce these distances used while counting birds from the boat.

Safety: Float plans are filed with the staff on duty at the Port Townsend Marine Science Center prior to each survey. The captain gives a safety talk at the start of each survey (location of fire extinguishers, life jackets, first aid kit, and radio use). This was noted on the DNR volunteer form submitted after each survey.

Data sheet: Pre-printed data sheets are used for each leg of the transect. Data are hand written by a data recorder and then entered electronically into an Excel spreadsheet. Electronic spreadsheets are checked against hand-written sheets for errors. Information collected per leg includes: Date, start and end time, start and end coordinates, tide (high, low, rising, falling), sky (cloudy, partly cloudy, clear), visibility (distance), wind (beaufort), sea height (wave height), and boat speed. Species are recorded using a four letter code (e.g. RHAU = Rhinoceros Auklet, PHPH = *Phocoena phoocena*, harbor porpoise). For each species the following is recorded: Time, species code, number of animals, zone (distance from boat, zone 1 is 0 – 100 m, zone 2 is 100 – 200 m), age (when possible), sex (when possible), behavior (flying, swimming, flushed by boat, feeding flock, foraging, diving, perched on debris, carrying nest material, carrying food, mobbing, chasing, unknown), latitude, longitude, and depth. Boat speed and depth are reported from the bridge at regular intervals and recorded with latitude and longitude at the time.

Observations: Two to three people continually scan the transect area from the flying bridge and call out observations to the data recorder. Avian species are counted within 200 meters on one side forward of the boat (starboard 0 - 90 degrees or port 270 – 360/0 degrees). Marine mammals are recorded wherever they occur.

Transect: The survey followed a pre-determined transect line through the aquatic reserve, described below. Boat speed varied from 5.0 knots to 8.0 knots, depending on tides, currents, and depth.

Survey date and time of departure: Surveys were conducted in the morning and departure times ranged from 8am to 9:30 am. Cape George Marina access is dependent on tide levels and the vessel requires a 2'+ tide or higher to safely navigate in and out of the marina, this combined with weather predictions, influenced survey date selection.

Survey site locations

See map

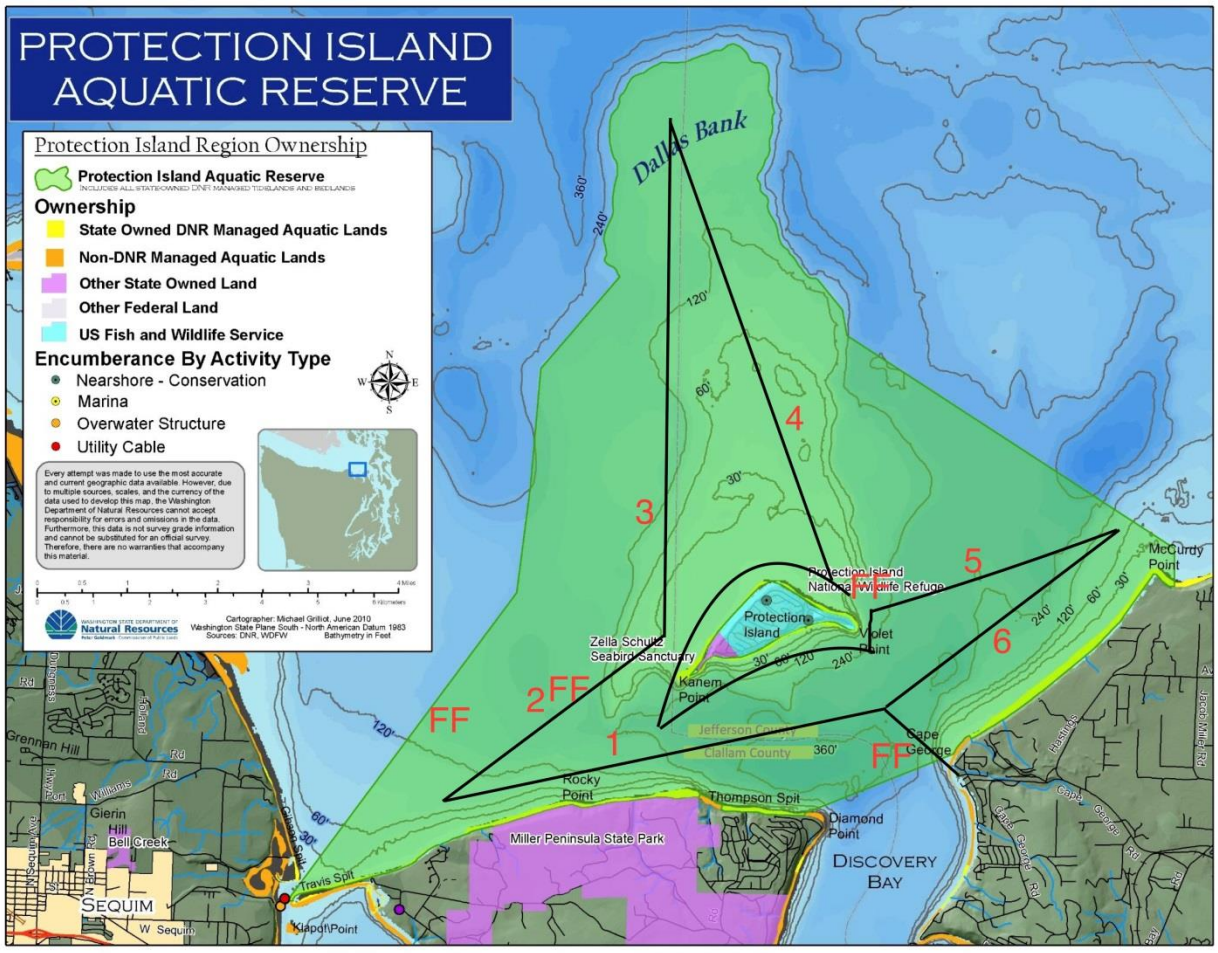


Figure 4 Numbered transects 1 - 6 from Sept. 17, 2018 survey. FF indicates feeding flocks. Circumnavigation of island is part of separate Bald Eagle survey.

During the first survey in November 2016, the cruise track followed a zigzag pattern through the Aquatic Reserved. It was decided for the purposes of the mostly volunteer crew, that it took too long and duplicated too many areas. Starting with the December 2016, the survey began using a "Witch's Hat" pattern comprised of six legs, as shown in Figure 5 above. The following is a description of the transect legs:

Leg 1: Travel WSW from offshore of Cape George, across the deep water at the mouth of Discovery Bay, then along the escarpment north of Miller Peninsula. Depths are 250-400 feet across the mouth of Discovery Bay, becoming less than 100 feet off of the Miller Peninsula.

Leg 2: Travel northeast from the NW corner of Miller Peninsula to the west side of Protection Island. Depths started less than 100 feet, typically reached 200+ feet in mid-transect, then became less than 50 feet by Protection Island.

Leg 3: Travel north from the west side of Protection Island to the northern area of Dallas Bank, skirting the western edge of the Bank. Depths are <50 feet deep near Protection Island, then vary between 100-180 feet for the rest of the leg.

Leg 4: Travel southeast over the middle of Dallas Bank from the northern area of PIAR to the northeast side of Protection Island. Depths on this leg vary from 140-145 feet deep in the north half to <60 feet on Dallas Bank.

Leg 5: Travel ENE over deep water from near Violet Spit to NW of McCurdy Point. Depths range from 200-300 feet for most of this transect.

Leg 6: Travel SW from McCurdy Point towards Cape George and the starting coordinates for leg 1 and staying offshore. Depths range from <100 feet at the start, to 150-250 ft in the middle, to less than 30 feet at the end.

Results and Discussion

Two years of observations revealed many noteworthy details about marine birds and mammals using the PIAR, and, by extension, the eastern Strait of Juan de Fuca. The team believes they have just begun to scratch the surface, and therefore plan to continue these surveys for several more years to confirm their observations as well as to observe natural variability in the system. They also plan to provide much greater in-depth presentations of these results in the future, through publications and public presentations. The following is a general summary of particularly important results observed to date:

1. Densities of birds (number of birds per square km) using the PIAR vary greatly through the year, typically lowest during the nesting season (May through mid-August) and highest in the fall (late August through November) (Figure 5). It was expected that densities would be highest during the nesting season, when the three most-abundant Protection Island nesting species -- Rhinoceros Auklet, Glaucous-winged Gull, and Pigeon Guillemot -- are present in large numbers. From the observations, however, it appears that species nesting on Protection Island, particularly Rhinoceros Auklets and Glaucous-winged Gulls, mostly fly far outside the PIAR during the nesting season to feed at other locations in the Salish Sea, such as Admiralty Inlet, Partridge Bank, or Rosario Strait. Even though nesting populations are high from May through August, at least one member of each nesting pair must remain at the nest much of the time, either to incubate eggs or to brood and protect young chicks. This likely equates to fewer birds on the water of PIAR. Additionally, the number of species using the PIAR drops during the nesting season, when most species present during winter depart the PIAR to nest elsewhere (Figure 6).

Following the nesting season, three other species that nest elsewhere -- Common Murre, California Gull, and Heermann's Gull -- converge in large numbers on the eastern Strait of Juan de Fuca, resulting in the highest annual densities within the PIAR (Figures 7 & 8). These three species are also important participants in feeding flocks that occur within the Aquatic Reserve during late summer and fall. The murres are particularly interesting, because the flightless father-chick pairs seen in the PIAR in September swim all the way from nesting colonies on the outer coast, at least from colonies on the outer Olympic coastline and possibly from as far as colonies in Oregon or northern California. The PIAR and surrounding waters in the eastern Strait provide an important migration stopover for the two gull species that migrate here from opposite directions -- California

Gulls from nesting colonies in the interior of North America, and Heermann's Gulls from nesting colonies in Mexico.

2. Three alcid species -- Common Murre, Pigeon Guillemot, and Rhinoceros Auklet -- were the most abundant species counted on these surveys. Tallies from 21 surveys conducted between November 2016 to September 2018, included 5123 murres, 4452 guillemots, and 2246 Rhino Auklets. Next most abundant species were two gulls, Glaucous-winged Gull (1867) and California Gull (1317), followed by three diving ducks, Surf Scoter (1065), Long-tailed Duck (645), and White-winged Scoter (632). Rounding out the top 10 most-abundant species were Ancient Murrelet (614), present for a relatively brief period during late fall and early winter, and Red-breasted Merganser (302).

3. The relatively shallow water of Dallas Bank supports a diverse guild of bottom feeders, particularly in fall, winter, and spring. These species include Surf and White-winged Scoters, Long-tailed Ducks, Pigeon Guillemots, and Pelagic Cormorants. Peak densities of scoters and Long-tailed Ducks occurred from December through February, with high numbers continuing through March for Long-tailed Ducks and May for the scoters (Figure 9). Because the surveys stayed outside the 200-yard disturbance closure around Protection Island, samples included low numbers of the diving duck species that typically remain close to shore, such as Goldeneyes, Buffleheads, and Harlequin Ducks.

4. Marbled Murrelet densities in the PIAR were low throughout the year with the exception of February and March (Figure 10). During February and March we found concentrations of Marbled Murrelets on the western edges of Dallas Bank, almost all in pairs as is typical of Marbled Murrelets at sea outside the nesting season.

5. There were multiple sightings of Yellow-billed Loons in the PIAR, a species considered uncommon in the Salish Sea (Figure 11). It appears possible that individual Yellow-billed Loons remain for months at a time within the PIAR because predictably individual loons were found numerous times in the same areas.

6. Even though feeding flocks were observed throughout Aquatic Reserve, the greatest number of feeding flocks were seen in the southern and western areas of PIAR (Figure 12). The area where the largest and most active flocks appeared was the area west of Protection Island towards Dungeness Bay, typically observed during Transect Leg 2. Other areas where feeding flocks recurred during the surveys were 1) at the northern end of Dallas Bank, 2) northeast off Violet Spit, and 3) off Cape George at the entrance to Discovery Bay.

The seasonality of feeding flocks was noteworthy, with more flocks and larger flocks occurring from late summer through late fall (Figure 13). This seasonality is undoubtedly due to the availability of forage fish during this period. Several feeding flocks were observed up close, and the principal prey item of several flocks appeared to be Pacific Sand Lance, *Ammodytes personatus.*

7. The two most abundant marine mammals observed during these surveys were harbor seals and harbor porpoises (Figures 14 & 15). Both of these species showed distinct seasonality in their use of PIAR, present in greater numbers from late spring through late summer, with far fewer present during winter. Their seasonal use of the PIAR is likely also related to the availability of prey, particularly forage fish, in reserve waters.

Six species of marine mammals were observed during these surveys. Other than harbor seals and harbor porpoises, the quantity of other marine mammals observed was very low. Pinniped species

swimming in the aquatic reserve also included Steller and California sea lion, along with northern elephant seals hauled out on Protection Island. Individual Steller sea lions were seen on four different surveys and single California sea lion on only one survey. Among cetaceans, a humpback whale was seen on one survey and single minke whales on two surveys. Lastly, although not a marine mammal a single North American river otter was observed on one survey.

Recommendations and Improvements Made

Currently, the plan is to continue these surveys for as long as possible, not only to fill in data gaps, but also to observe more variability in the natural system of the PIAR. For example, El Ninos have a disastrous effect on nesting seabirds on the outer coast, but El Nino effects on Protection Island-nesting species may not be as dramatic, possibly because tidal flows and other mixing of the water column support the food web in the eastern Strait as much as seasonal upwelling. Conversely, how do El Ninos and other perturbations to the food web affect non-breeding bird populations in the eastern Strait, when large numbers of murres and gulls gather in the PIAR? It all comes back to forage fish, so it would be very desirable to find out more about forage fish populations in the area.

There has been discussion of a slight alteration to the cruise track for a number of reasons. The northern ends of Legs 3 and 4 cross the main shipping lane entering Puget Sound, causing frequent stops or course alterations to let ships pass. To resolve these issues the team is considering shortening Legs 3 and 4 to just south of the shipping lane. This change may exclude an interesting area at the northern end of Dallas Bank, but for safety sake it is felt this change may be necessary. Another possible change it to extend Legs 1 and 2 slightly west to include areas where feeding flocks have been observed in the past.

Possible Future Uses of this Data

Bob Boekelheide is scheduled to give a public presentation at the Port Townsend Marine Science Center in February 2019. It is the intention of the group to give more public presentations and include these data in future reports and publications. There are many additional analyses of the data to complete, such as water depth preferences and behaviors of different species.

References

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

Nysewander, D.R., Evenson, J. R., Murphie, B. L., and Cyra, T. A. 2005. Report of marine bird and marine mammal component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 period. Olympia, WA: Washington Department of Fish and Wildlife. 181 pp.

Wahl, T. R., Speich, S. M., Manuwal, D. A., Hirsch, D. V. and Miller, C. 1981. Marine bird populations of the Strait of Juan de Fuca, Strait of Georgia, and adjacent waters in 1978 and 1979. Washington DC: Environmental Protection Agency. 384 pp.

WDNR. 2010. Protection Island Aquatic Reserve Management Plan. Available at: https://www.dnr.wa.gov/publications/aqr_rsve_protection_final_mgmtplan.pdf

Appendix

Tables/Graphs of Data

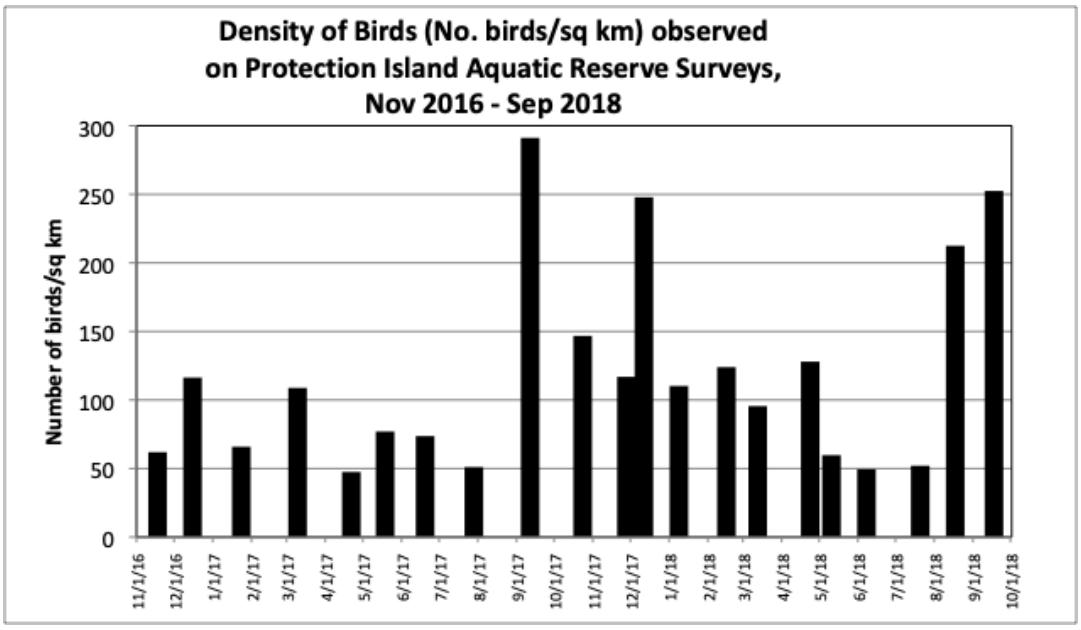


Figure 5 Density of Birds per sq km Nov. 2016- Sept. 2018

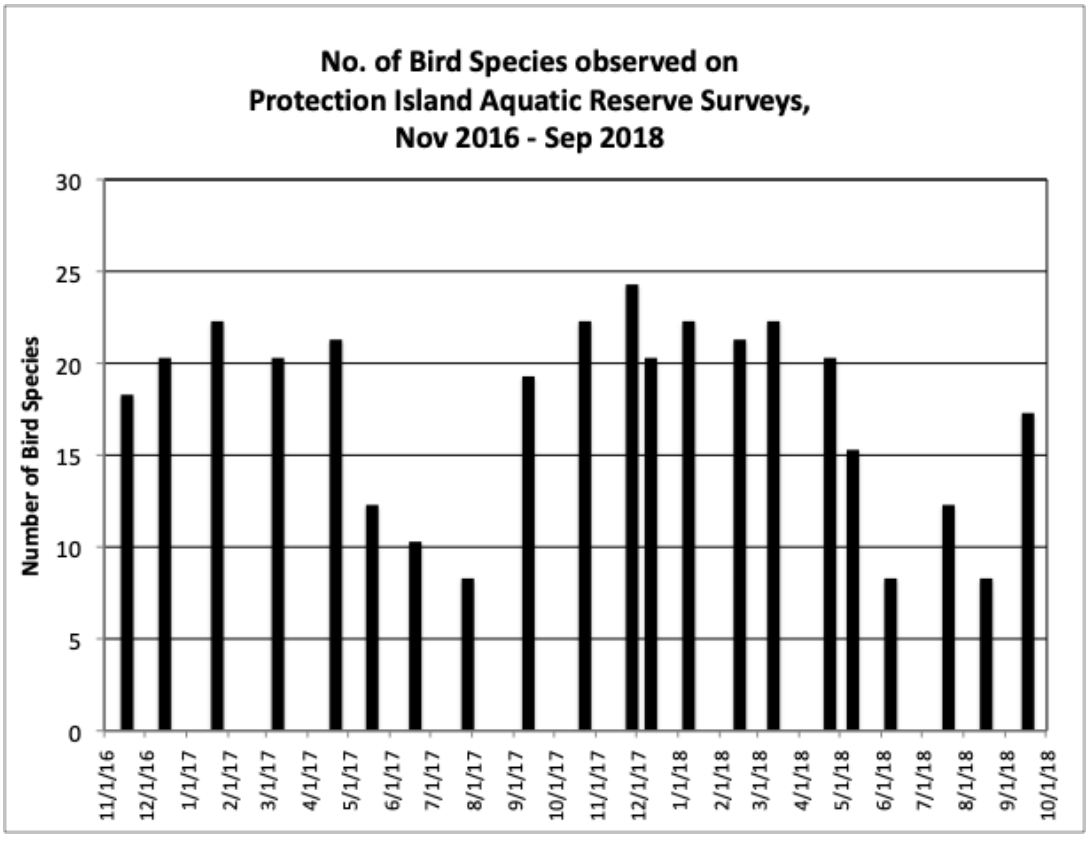


Figure 6 Number of Bird Species Monthly from Nov. 2016 – Sept. 2018

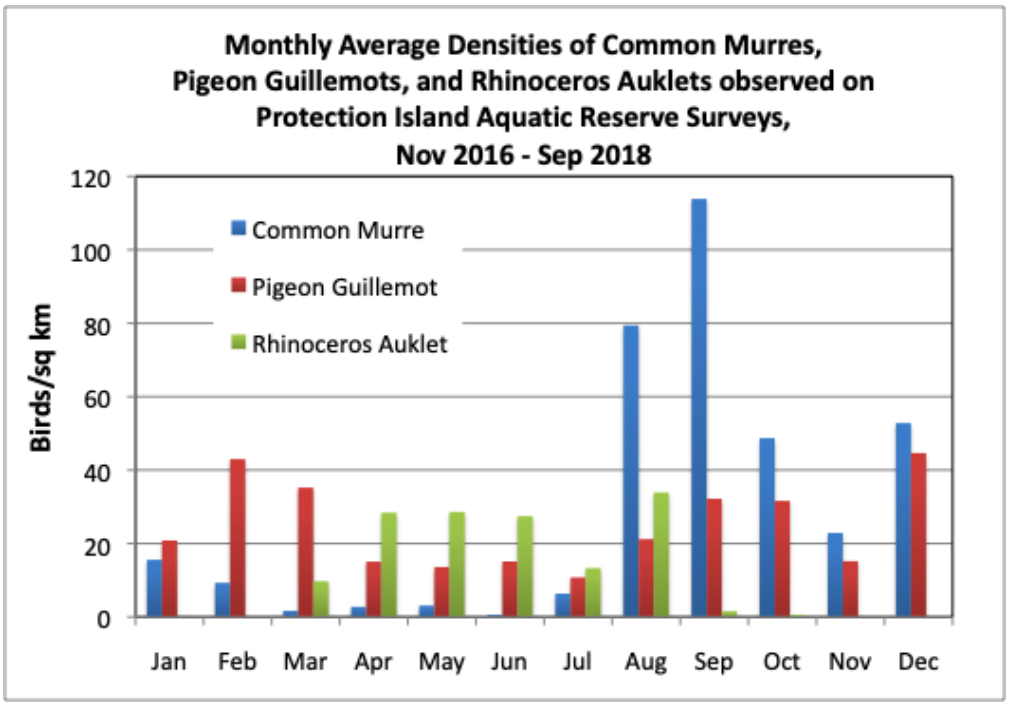


Figure 7 Monthly Average Densities of Common Murres, Pigeon Guillemots, and Rhinoceros Auklets

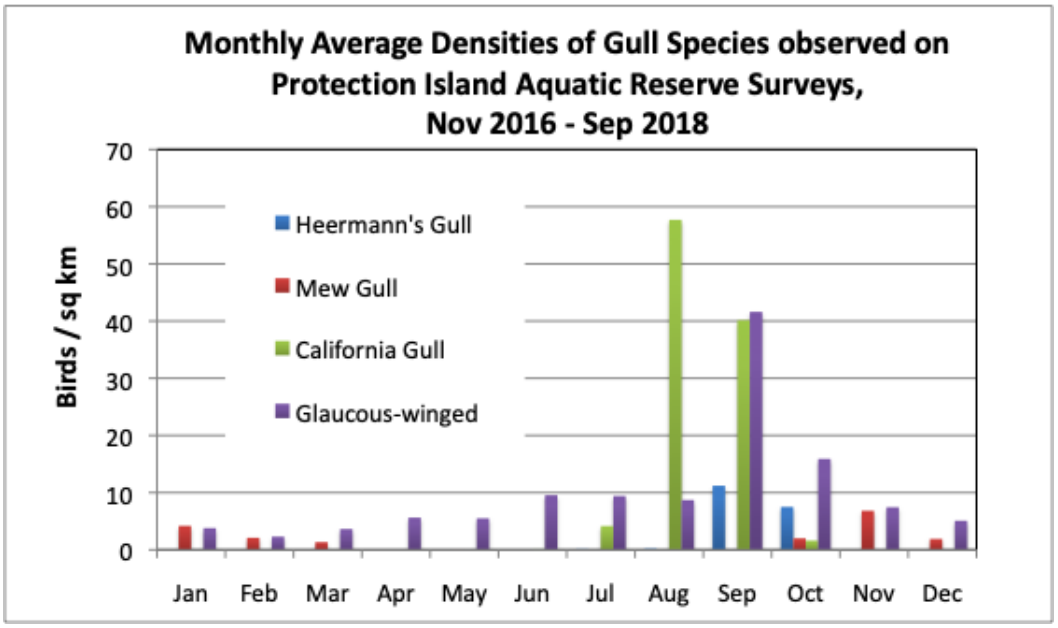


Figure 8 Monthly Average Densities of Gull Species

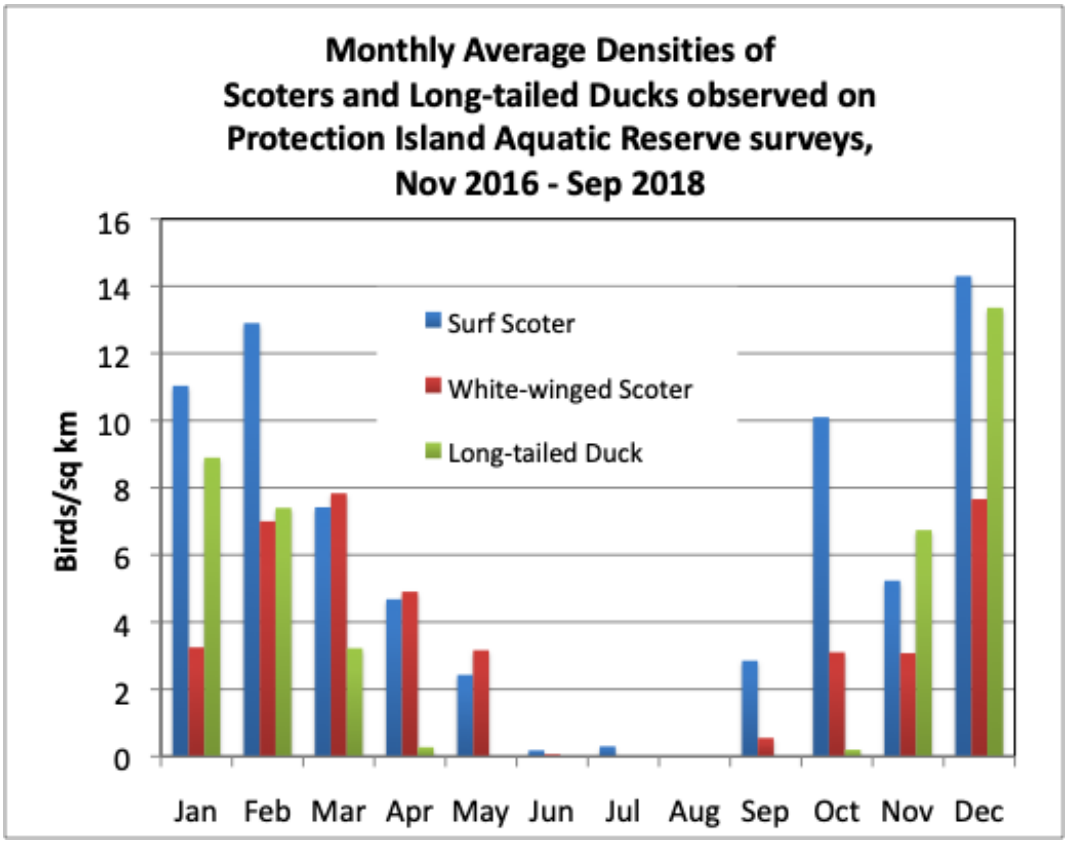


Figure 9 Monthly Average Densities of Scoters and Long-tailed Ducks

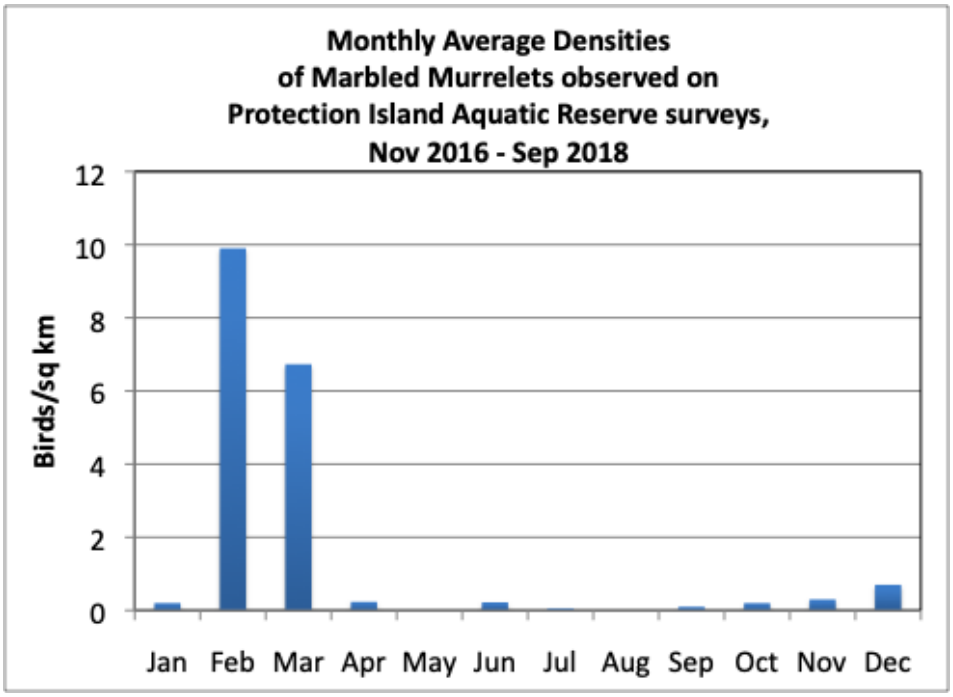


Figure 10 Monthly Average Densities of Marbled Murrelets

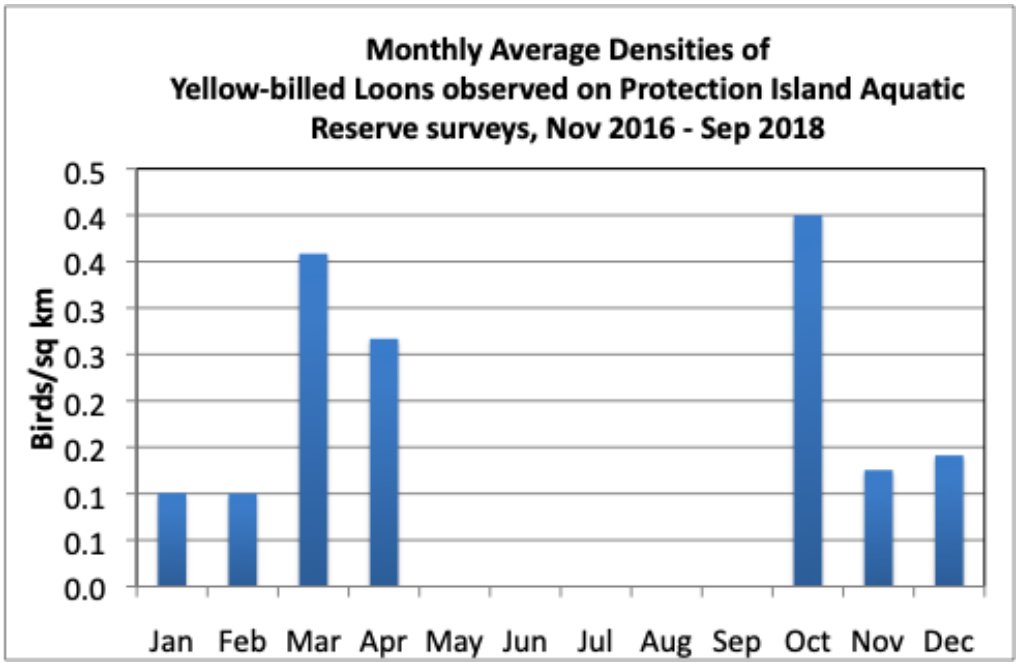


Figure 11 Monthly Average Densities of Yellow-billed Loons

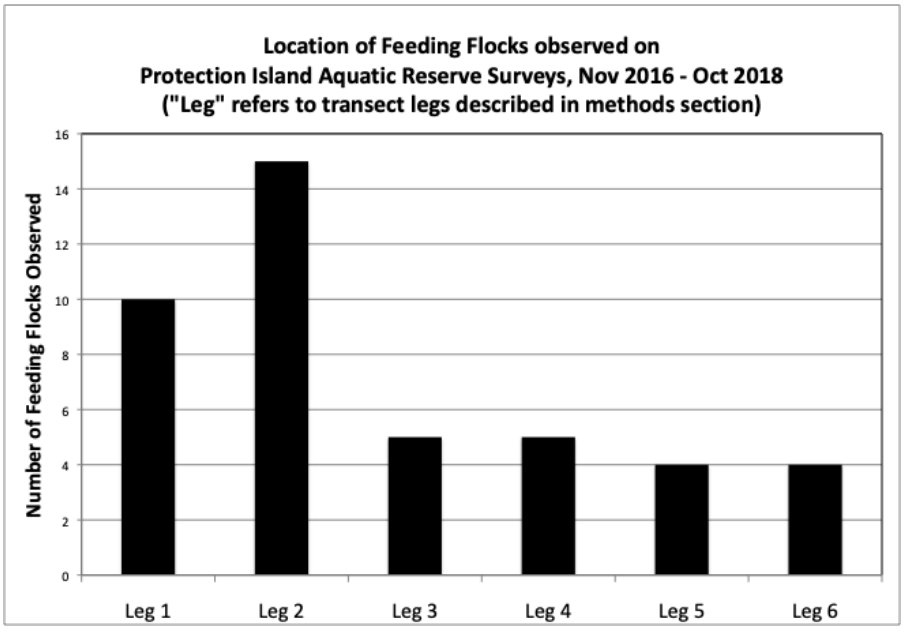


Figure 12 Number of Feeding Flocks Observed per Transect Leg

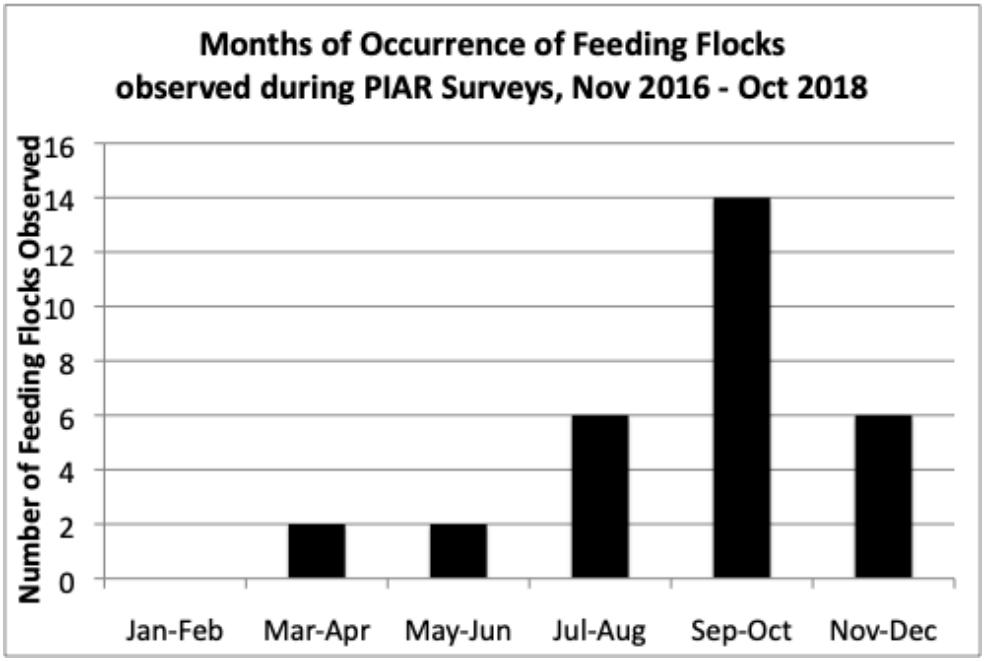


Figure 13 Months of Occurrence of Feeding Flocks Nov 2016 - Sep 2018

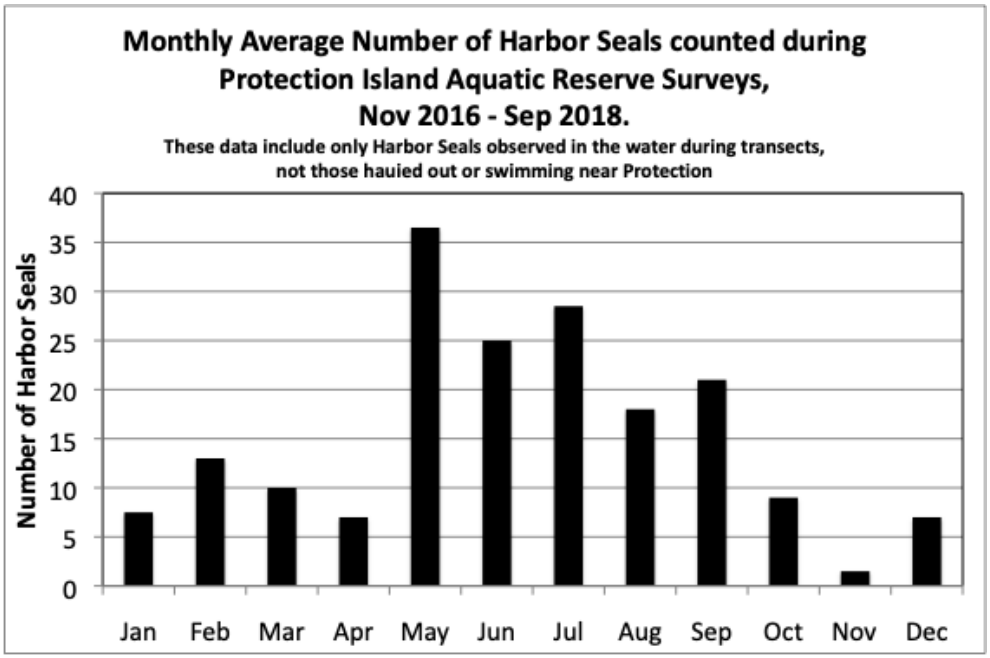


Figure 14 Monthly Average Number of Harbor Seals in the Transect

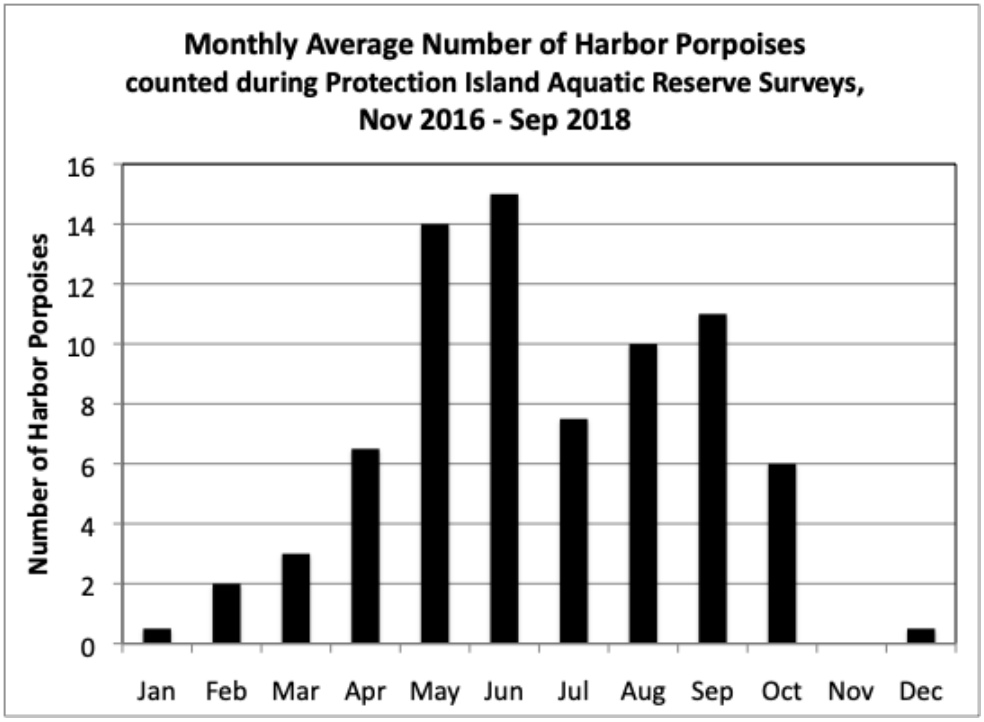


Figure 15 Monthly Average Number of Harbor Porpoises Observed

Transect Coordinates and Length

			Approx. Distance	Approx. Distance	Approx. Distance
Leg No.	Start Position	End Position	miles	kilometers	nautical miles
1	48.106N, -122.890W	48.095, -123.005	5.35	8.61	4.65
2	48.095, -123.005	48.118, -122.955	2.80	4.51	2.44
3	48.118, -122.955	48.205, -122.955	6.00	9.66	5.22
4	48.205, -122.955	48.132, -122.915	5.34	8.59	4.64
5	48.124, -122.909	48.135, -122.850	2.86	4.60	2.48
6	48.135, -122.850	48.106, -122.890	2.72	4.38	2.37
		TOTAL	25.07	40.35	21.8

Species list

Total Number Counted, Nov 2016 - Sep 2018:

Birds:

Brant	389
Canada Goose	1
American Wigeon	4
Mallard	19
Northern Pintail	26
dabbling duck sp.	4
unknown Duck sp.	1
Harlequin Duck	44
Surf Scoter	1065
White-winged Scoter	632
scoter sp.	15
Long-tailed Duck	645
Common Goldeneye	13
Bufflehead	24
Red-breasted Merganser	302
Bald Eagle	4
Red-throated Loon	9
Pacific Loon	240
Common Loon	51
Yellow-billed Loon	22
loon sp.	11
Horned Grebe	77
Eared Grebe	1
Red-necked Grebe	249
Western Grebe	75
Short-tailed Shearwater	1

Double-crested Cormorant	8
Brandt's Cormorant	44
Pelagic Cormorant	102
cormorant sp.	3
Great Blue Heron	1
sandpiper sp.	7
Red-necked Phalarope	77
Red Phalarope	4
Parasitic Jaeger	4
Common Murre	5123
Pigeon Guillemot	4452
Marbled Murrelet	254
Ancient Murrelet	614
murrelet sp.	9
Cassin's Auklet	2
Rhinoceros Auklet	2246
Tufted Puffin	7
Bonaparte's Gull	2
Heermann's Gull	270
Mew Gull	291
Western Gull	4
California Gull	1317
Glaucous-winged Gull	1867 (includes hybrids)
gull sp.	353
Caspian Tern	2
crow sp.	1
Common Raven	1
Barn Swallow	12

swallow sp.	3

Mammals:

Harbor seal	328
Steller sea lion	4
California sea lion	1
unknown sea lion	1
Harbor porpoise	134
Humpback whale	1
Minke whale	1
unknown cetacean	1
River otter	1

Field Forms

Protection Island Aquatic Reserve – Avian and Marine Mammal Survey Data Sheet

Date _____ Survey leg# _____ Starting coordinates _____ Ending coordinates _____ Page___/___

Start Time _____ End Time _____ Boat/Boat Owner _____ Observers _____

Tide _____ Sky _____ Vis _____ Wind (Bft) _____ Sea Ht. _____ Temp (F)_____ Precip_____ Boat Speed_____
(high, falling, rising, or low)

Behavior: FL=flying, SW=swimming, FB=flushed by boat, FF=feeding flock, FO=foraging, DI=diving, PE=perched on debris, CN=carrying nest material, CF=carrying food, MO=mobbing, CH=chasing, UK=unknown

Time	Species (4-ltr code)	Number	Zone (1 or 2)	Age	Sex	Behavior	Lat	Long	Depth	Speed	Notes/Associations