U.S. Fish & Wildlife Service

Refuge Report 2016.1

Nearshore Marine Bird and Mammal Surveys in the Kodiak Archipelago, 2011-2013

Robin M. Corcoran

Robin Corcoran, USFWS

Kodiak National Wildlife Refuge
December, 2016

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Suggested Citation:

Corcoran, R.M. 2016. Nearshore Marine Bird and Mammal Surveys in the Kodiak Archipelago, 2011-2013. Refuge report no. 2016-1, Kodiak National Wildlife Refuge, U.S. Fish and Wildlife Service, Kodiak, AK.

Keywords: Alaska, Aleutian Tern, Arctic Tern, Bald Eagle, Barrow's Goldeneye, Black-legged Kittiwake, Black Oystercatcher, *Brachyramphus brevirostris, Brachyramphus marmoratus, Bucephala islandica, Cepphus Columba,* Common Murre, *Enhydra lutris kenyoni, Fratercula cirrhata*, *Fratercula corniculata*, Glaucous-winged Gull, Gulf of Alaska, *Haematopus bachmani*, *Haliaeetus leucocephalus*, Harbor Seal, Harlequin Duck, *Histrionicus histrionicus*, Horned Puffin, Kittlitz's Murrelet, Kodiak Archipelago*, Larus canus, Larus glaucescens,* Marbled Murrelet*,* Mew Gull, *Onychoprion aleuticus*, Pelagic Cormorant, *Phalacrocorax pelagicus, Phalacrocorax urile, Phoca vitulina,* Pigeon Guillemot, population estimate, productivity, Red-faced Cormorant, *Rissa tridactyla*, seabird colony, Northern Sea Otter, *Sterna paradisaea*, Tufted Puffin, *Uria aalge.*

Disclaimers: The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service. The use of trade names of commercial products in this report does not constitute endorsement or recommendation for use by the federal government.

TABLE OF CONTENTS Page

Abstract **1**

Introduction **2**

Objectives *3*

Study Area **5**

Methods **8**

Description of the Nearshore Region *8*

Transect Details and Survey Methods *9*

Density Calculations and Population Estimates *10*

Estimating Detectability via Distance Sampling and N-Mixture Models *11*

Habitat Use and Selection *11*

Productivity *12*

Results & Discussion **14**

Transect Details *14*

Survey Timing *15*

Occurrence and Relative Abundance of Marine Birds and Mammals *15*

Density and Population Estimates *16*

Priority Species *16*

Comparison of Colony Survey and Nearshore Marine Bird Survey Data *22*

Habitat Use and Selection *23*

Productivity *24*

Species Accounts **25**

Harlequin Duck *25*

Trends in Harlequin Duck 1994-2013 in Selected Bays 28

Barrow's Goldeneye *30*

Common Merganser *33*

Red-breasted Merganser *36*

Black Oystercatcher *38*

Trends in Black Oystercatchers 1994-2013 in Selected Bays 41

Bald Eagle *42*

Trends in Bald Eagles 1994-2013 in Selected Bays 46

Pelagic Cormorant *47*

Red-faced Cormorant *49*

TABLE OF CONTENTS (Continued) Page

Mew Gull *51*

Glaucous-winged Gull *52*

Black-legged Kittiwake *55*

Arctic Tern *57*

Aleutian Tern *59*

Common Murre *60*

Pigeon Guillemot *63*

Kittlitz's Murrelet *65*

Marbled Murrelet *68*

Tufted Puffin *71*

Horned Puffin *73*

Sea Otter *76*

Harbor Seal *79*

Acknowledgements **81**

Literature Cited **81**

Appendix A. Species list with number counted for all marine birds and mammals sighted on June and August surveys in the Kodiak Archipelago, Alaska, 2011-2013. ..... **89**

LIST OF TABLES Page

Table 1. The most abundant marine bird and mammal species surveyed by Kodiak Refuge nearshore marine bird and mammal surveys, 2011-2013. 4

Table 2. Marine bird and mammal species surveyed by the Kodiak Archipelago Nearshore Marine Bird and Mammal surveys, 2011-2013, identified as priority species for conservation 5

Table 3. Summary descriptions of the biophysical habitat classes in the Kodiak Archipelago 13

Table 4. Summary of shoreline length and total area for the nearshore and offshore survey zones in the Kodiak Archipelago 14

Table 5. Total shoreline length and percent by habitat type as classified by ShoreZone coastal habitat... 14

Table 6. Marbled and Kittlitz's Murrelet counts in August by age 15

Table 7. Density estimates for the most common marine bird and mammal species surveyed on nearshore and offshore transects in June 2011-2013. 18

Table 8. Density estimates for the most common marine bird and mammal species surveyed on nearshore and offshore transects in August 2011-2013. 19

Table 9. Population estimates for the most common species on the nearshore marine bird and mammal surveys 2011-2013 by region and year. 20

LIST OF TABLES (Continued) Page

Table 10. Combined 2011-2013 population estimates for the most common species on the nearshore marine bird and mammal surveys on the Kodiak Archipelago, Alaska. 21
Table 11. Comparison of seabird colony survey data from 2008-2010 with nearshore marine bird survey population estimates from 2011-2013 on the Kodiak Archipelago, Alaska. 22
Table 12. Harlequin Duck population estimates. 26
Table 13. Differential use of habitat types by Harlequin Ducks 26
Table 14. The number of Harlequin Ducks banded in the Kodiak Archipelago, Alaska, 1996-2013. 28
Table 15. Barrow's goldeneye population estimates 2011-2013. 31
Table 16. Differential use of habitat types by Barrow's Goldeneye. 31
Table 17. Common Merganser population estimates 2011-2013. 34
Table 18. Red-breasted Merganser population estimates 2011-2013. 36
Table 19. Black Oystercatcher population estimates 2011-2013. 39
Table 20. Differential use of habitat types by Black Oystercatchers 39
Table 21. Bald Eagle coastal population estimates 2011-2013. 43
Table 22. Differential use of habitat types by adult Bald Eagles 44
Table 23. Pelagic Cormorant density estimates 2011-2013. 47
Table 24. Pelagic Cormorant population estimates 2011-2013. 47
Table 25. Red-faced Cormorant density density estimates 2011-2013. 49
Table 26. Red-faced Cormorant population estimates 2011-2013. 49
Table 27. Mew Gull density estimates 2011-2013. 51
Table 28. Mew Gull population estimates 2011-2013. 51
Table 29. Glaucous-winged Gull density estimates 2011-2013. 53
Table 30. Glaucous-winged Gull population estimates 2011-2013. 53
Table 31. Black-legged Kittiwake density estimates 2011-2013. 55
Table 32. Black-legged Kittiwake population estimates Alaska, 2011-2013. 55
Table 33. Arctic Tern density estimates 2011-2013. 57
Table 34. Arctic Tern population estimates 2011-2013. 57
Table 35. Aleutian Tern density density estimates 2011-2013. 59
Table 36. Aleutian Tern population estimates 2011-2013. 59
Table 37. Common Murre density estimates 2011-2013. 61
Table 38. Common Murre population estimates 2011-2013. 61
Table 39. Pigeon Guillemot density estimates 2011-2013. 63
Table 40. Pigeon Guillemot population estimates 2011-2013. 64
Table 41. Kittlitz's Murrelet density estimates 2011-2013. 66
Table 42. Kittlitz's Murrelet population estimates 2011-2013. 66
Table 43. Kittlitz's Murrelet counts on and off transects 2011-2013. 67
Table 44. Marbled Murrelet density estimates 2011-2013. 69
Table 45. Marbled Murrelet population estimates 2011-2013. 69
Table 46. Tufted Puffin density estimates 2011-2013. 71
Table 47. Tufted Puffin population estimates 2011-2013. 72
Table 48. Horned Puffin density estimates 2011-2013. 74

LIST OF TABLES (Continued) Page

Table 49. Horned Puffin population estimates 2011-2013. 74
Table 50. Sea Otter density estimates 2011-2013. 77
Table 51. Counts of Sea Otter pups and adults 2012-2013. 77
Table 52. Sea Otter population estimates 2011-2013. 77
Table 53. Comparison of Sea Otter population estimates on Kodiak 1994-2014. 77
Table 54. Harbor Seal density estimates based 2011-2013. 79
Table 55. Harbor Seal population estimates 2011-2013. 80

LIST OF FIGURES Page

Figure 1. Map of the surveyed regions: East Kodiak (2011), Afognak (2012), West Kodiak (2013) 7
Figure 2. Nearshore and offshore survey zones illustrated. 8
Figure 3. Illustration of nearshore and offshore transect location and width 10
Figure 4. Standardized selection ratios of nearshore marine birds to biophysical habitat classes 23
Figure 5. Productivity measured as the ratio of juvenile to adult birds 2011-2013 24
Figure 6. Density estimates of Harlequin Ducks on the Kodiak Archipelago 2011-2013 26
Figure 7. Harlequin Duck numbers and locations on the Kodiak Archipelago 2011-2013 27
Figure 8. Comparison of Harlequin Duck population estimates for select bays 1994-2013. 29
Figure 9. Density estimates of Barrow's Goldeneye on the Kodiak Archipelago 2011-2013 31
Figure 10. Barrow's Goldeneye numbers and locations on Kodiak Archipelago 2011-2013. 32
Figure 11. Density estimates of Common Mergansers on the Kodiak Archipelago 2011-2013. 34
Figure 12. Common Merganser numbers and locations on the Kodiak Archipelago 2011-2013 35
Figure 13. Density estimates of Red-breasted Mergansers on the Kodiak Archipelago 2011-2013. 36
Figure 14. Red-breasted Merganser numbers and locations on the Kodiak Archipelago 2011-2013. 37
Figure 15. Density estimates of Black Oystercatchers on the Kodiak Archipelago 2011-2013 39
Figure 16. Black Oystercatcher numbers and locations on the Kodiak Archipelago 2011-2013 40
Figure 17. Comparison of Black Oystercatcher population estimates for select bays 1994-2013. 41
Figure 18. Density estimates of Adult Bald Eagles on the Kodiak Archipelago 2011-2013. 43
Figure 19. Photographs illustrating wetland/estuary habitat class.. 44
Figure 20. Bald Eagle numbers and locations on the Kodiak Archipelago 2011-2013 45
Figure 21. Comparison of Bald Eagle population estimates for select bays 1994-2013. 46
Figure 22. Pelagic Cormorant numbers and locations on the Kodiak Archipelago 2011-2013. 48
Figure 23. Red-faced Cormorant numbers and locations on the Kodiak Archipelago 2011-2013. 50
Figure 24. Mew Gull numbers and locations on the Kodiak Archipelago 2011-2013. 52
Figure 25. Glaucous-winged Gull numbers and locations on the Kodiak Archipelago 2011-2013. 54
Figure 26. Black-legged Kittiwake numbers and locations on th Kodiak Archipelago, 2011-2013. 56
Figure 27. Arctic Tern numbers and locations on the Kodiak Archipelago 2011-2013 58
Figure 28. Aleutian Tern numbers and locations on the Kodiak Archipelago 2011-2013. 60
Figure 29. Common Murre numbers and locations on the Kodiak Archipelago 2011-2013 62

LIST OF FIGURES (Continued) Page

Figure 30. Pigeon Guillemot numbers and locations on the Kodiak Archipelago 2011-2013.....64
Figure 31. Kittlitz's Murrelet numbers and locations on the Kodiak Archipelago 2011-2013.....67
Figure 32. Marbled Murrelet numbers and locations on the Kodiak Archipelago 2011-2013. 70
Figure 33. Tufted Puffin numbers and locations on the Kodiak Archipelago 2011-2013. 72
Figure 34. Horned Puffin numbers and locations on the Kodiak Archipelago 2011-2013.....75
Figure 35. Sea Otter numbers and locations on the Kodiak Archipelago 2011-2013.....78
Figure 36. Harbor Seal numbers and locations on the Kodiak Archipelago 2011-2013.....80

Photo: R. Corcoran; Molting Marbled Murrelet, Spiridon Bay, Kodiak, Alaska, August 2013

Nearshore Marine Bird and Mammal Surveys in the Kodiak Archipelago, 2011-2013

Robin M. Corcoran[1]

Abstract

Marine birds are conspicuous, abundant, and ecologically important members of nearshore marine communities in Alaska. As high trophic level consumers, they are also sensitive to change in the nearshore environment, and therefore excellent indicators of the health of marine habitats. For these reasons, Kodiak National Wildlife Refuge has monitored breeding marine birds since 1994. In 2011, the existing summer coastal bird survey on Kodiak was modified based on widely used and published methods to monitor marine birds in Prince William Sound, Kachemak Bay, and Cook Inlet, with transect selection and survey protocols directly comparable to National Park Service surveys conducted at Katmai and Kenai Fjords National Parks, and western Prince William Sound. Our goals for this program were to determine archipelago-wide population estimates, long-term trends, and an index to annual nesting productivity for key marine bird species relevant to Refuge management objectives and to contribute data to a regional monitoring program for birds throughout the Gulf of Alaska. The survey included systematic sampling from a random start point and transects surveyed represented 19-21% of the nearshore survey zone and 4-8% of the offshore survey zone. In surveys conducted from 2011-2013, we identified 65 marine bird and eight marine mammal species. Black-legged Kittiwake, Glaucous-winged Gull, Tufted Puffin, Marbled Murrelet, Pigeon Guillemot, and Common Murre were the most frequently encountered species and accounted for 78% of all nearshore marine birds observed across the three summers. The Kodiak Archipelago is an important breeding area for Marbled Murrelet and the June archipelago-wide population estimate of 38,926 (95% CI: 33,704-44,148) represents 14% of the current projected murrelet population estimate for Alaska. The June population estimate for another species of conservation concern, the Black Oystercatcher was 1,410 (95% CI: 1,191-1,629), which represents 13% of the estimated North American population for this species. Marine bird productivity as measured by the ratio of hatch-year to adult birds was relatively low in 2011 on East Kodiak Island and high in 2013 on West Kodiak Island. These results were consistent with broader patterns seen in the Gulf of Alaska where widespread seabird reproductive failures were documented in the summer of 2011, but reproductive success was average or high for most seabird species monitored in the region in 2012 and 2013.

Author: [1]Kodiak National Wildlife Refuge, 1390 Buskin River Rd., Kodiak, AK 99615

Introduction

Marine birds rely heavily on habitats and prey found within the nearshore environment of Alaska's coastline. They are top-level consumers of benthic invertebrates such as mussels, clams, snails, limpets, as well as pelagic nekton including krill, squid, and a variety of forage fish species. Marine birds are long-lived, conspicuous, abundant, and sensitive to changes in their environment. This makes seabirds useful indicators of ecosystem status because their reproductive success correlates well with prey availability and seabirds are typically more accessible and easily studied than fish or marine mammal populations (Piatt et al. 2007a).

Shallow nearshore marine waters are highly productive environments widely recognized as sensitive to a variety of both natural and human disturbances. There is a long list of potential threats that make the nearshore waters within the Kodiak Archipelago vulnerable to anthropogenic impacts including:

- The marine environment is at high risk to both catastrophic and chronic pollution because Kodiak is a major port for marine vessel traffic and is the hub of the Gulf of Alaska (GOA) container logistics system serving as a link between the Pacific Northwest, Alaska, and the Far East;
- The long military history (Navy, Coast Guard) has resulted in a number of contaminated sites close to the coast. Decades of military and Coast Guard operations have resulted in soil, groundwater, sediment and surface water contamination. Contaminants of potential concern include petroleum compounds, PCBs, paints, solvents, metals, herbicides, pesticides and leachate from solid waste. Legacy contaminants in near-shore and shoreline sediments are extremely high near Kodiak, an example being Drury Gulch, a drainage used as a disposal site during military operations where PCB levels in soil over 100,000 ppm were discovered in the 1990s (Alaska Department of Environmental Conservation Contaminated Sites Program);
- The island supports a year-round commercial fishing industry consistently ranked as the second to third largest in the United States, and both commercial and subsistence salmon gill net fisheries are seasonally active each year. Seabird mortality related to fishing gear is a globally recognized conservation issue and is believed to be responsible for declines of many bird populations (IUCN 2008, Zydelis et al. 2013). The Kodiak Island salmon gillnet fishery was estimated to kill 528 birds in 2002 and 1,097 in 2005, the most common species being Common Murre, Tufted Puffin, Pigeon Guillemot, Marbled Murrelet, Red-faced Cormorant, Pelagic Cormorant, and lower numbers of others (Manly 2007). Recent qualitative analysis of commercial salmon gillnet bycatch impacts to Kittlitz's Murrelets throughout the GOA identified Alitak Bay on Kodiak Island as an area of greatest risk for gill net mortality (Blejwas and Wright 2012);
- The timber industry has experienced a substantial and continued increase in production since 2010. One of the most significant challenges to protection of fish and wildlife habitat on the Kodiak Archipelago is continued habitat loss and fragmentation as a result of harvest of old growth coastal rainforest. Intact, old growth forests are particularly important to nesting Marbled Murrelets, and Kodiak waters support a large percentage of this species population in Alaska during the breeding season.

Finally, we need to monitor the potential impacts of climate change on the nearshore marine environment. It is challenging to predict these impacts, but in the GOA climate change might interrupt or accelerate shifts between natural cold and warm water climate regimes (Anderson and Piatt 1999, Hollowed et al. 2013). The end result is more variability, and less predictability, factors that are not generally beneficial to an ecosystem, particularly to long-lived species that feed high in the food chain (e.g. humans, marine birds and mammals). It may not be useful to focus on single, sentinel species as indicators of ecosystem-level changes, but to broaden our thinking by looking at aggregate indicators, such as the biomass of a class of consumers (Piatt et al. 2007a, Zador 2012). As conspicuous, abundant, high trophic level consumers, seabirds can contribute to this multi-species approach to monitoring the impacts of climate change on nearshore marine habitats.

To address concerns regarding anthropogenic impacts and climate change, in 2011, Kodiak National Wildlife Refuge (NWR) initiated a nearshore marine bird survey based on protocols developed by the National Park Service (NPS) and U.S. Geological Survey (USGS) for the Southwest Alaska Network Vital Signs Monitoring program in the GOA (Dean and Bodkin 2011). These protocols were in turn based on widely used and published methods to estimate marine bird densities (Irons el al. 2000). Since 2006 these protocols have been used to survey the nearshore marine bird and mammal community at Katmai and Kenai Fjords National Park (NP), and in western Prince William Sound (Coletti et al. 2014). This survey focuses on birds that are trophically linked to the nearshore food web such as sea ducks, shallow water pursuit divers, and shorebirds. Many of the species surveyed were impacted by the 1989 *Exxon Valdez* oil spill, and exhibited protracted recovery periods as a consequence of lingering oil in nearshore habitats. A full determination of the *Exxon Valdez* oil spills impacts was hampered by a lack of pre-spill data on marine resources in the region (Spies 1996). Detailed, up-to-date information including population estimates and trends of common nearshore marine bird species is required to assess damages from acute or chronic oil pollution.

Objectives

For the most abundant nearshore marine breeding bird and mammal species in the Kodiak Archipelago (Table 1), the objectives of our survey were to:

1) Estimate total population size within the study area, with 95% confidence interval (CI).
2) Determine long-term population trends with sufficient statistical power (typically 80%) to detect at minimum a 50% change in abundance over a period of twelve years.
3) Use ShoreZone coastal mapping data to identify habitat availability and use in the nearshore/intertidal zone.
4) Estimate an index of annual productivity by the ratio of juveniles (hatch year) to adults (after hatch year) for species with distinct juvenile plumages.

Table 1. The most abundant marine bird and mammal species surveyed by Kodiak Refuge nearshore marine bird and mammal surveys, 2011-2013.

Species	Scientific Name	Survey Zone
Harlequin Duck*	*Histrionicus histrionicus*	Intertidal - 400m (nearshore transects only)
Barrow's Goldeneye*	*Bucephala islandica*	
Common Merganser	*Mergus merganser*	
Red-breasted Merganser	*Mergus serrator*	
Black Oystercatcher*	*Haematopus bachmani*	
Bald Eagle*	*Haliaeetus leucocephalus*	
Pelagic Cormorant	*Phalacrocorax pelagicus*	Intertidal - 5km (nearshore and offshore transects)
Red-faced Cormorant	*Phalacrocorax urile*	
Mew Gull*	*Larus canus*	
Glaucous-winged Gull*	*Larus glaucescens*	
Black-legged Kittiwake*	*Rissa tridactyla*	
Arctic Tern*	*Sterna paradisaea*	
Aleutian Tern	*Onychoprion aleuticus*	
Common Murre	*Uria aalge*	
Pigeon Guillemot*	*Cepphus columba*	
Kittlitz's Murrelet*	*Brachyramphus brevirostris*	
Marbled Murrelet*	*Brachyramphus marmoratus*	
Tufted Puffin	*Fratercula cirrhata*	
Horned Puffin	*Fratercula corniculata*	
Sea Otter	*Enhydra lutris*	
Harbor Seal	*Phoca vitulina*	

*Species with distinctive juvenile plumage with estimates of productivity from 2011-2013 surveys.

Priority Species

To facilitate and coordinate the proactive conservation of wildlife populations among Federal, State, Tribal, and private partners, the U.S. Fish and Wildlife Service (USFWS) periodically evaluates and develops lists of bird species of conservation concern (priority species). Conservation concerns arise from widespread or long-term population declines, natural or human-caused reduction in range or population size, and/or threats to habitat. Since a primary goal of the USFWS is to conserve avian diversity in North America, development of priority species lists are necessary to foster coordinated efforts to implement comprehensive and integrated approaches for the study, management, and protection of non-Endangered Species Act listed bird species.

Seven of the species surveyed on the Kodiak nearshore marine bird survey were USFWS Birds of Conservation Concern (USFWS 2008a), and 12 were draft priority species in the USFWS Alaska Region (Table 2).

Table 2. Marine bird and mammal species surveyed by the Kodiak Archipelago Nearshore marine bird and mammal surveys, 2011-2013, identified as priority species for conservation actions by the Birds of Conservation Concern (USFWS 2008a) and the draft U.S. Fish and Wildlife Service Alaska Region Priority Species List.

Species	Birds of Conservation Concern 2008	Draft Priority Species 2013*
Harlequin Duck		Tier 1
Black Oystercatcher	Yes	Tier 2
Bald Eagle		Tier 2
Pelagic Cormorant	Yes	
Red-faced Cormorant	Yes	Tier 1
Black-legged Kittiwake		Tier 1
Arctic Tern	Yes	
Aleutian Tern	Yes	Tier 2
Common Murre		Tier 2
Pigeon Guillemot		Tier 2
Kittlitz's Murrelet	Yes	Tier 2
Marbled Murrelet	Yes	Tier 1
Tufted Puffin		Tier 1
Sea Otter	NA	Tier 1

*The U.S. Fish and Wildlife Service Alaska Region is currently developing a Priority Species List; Tier 1 identifies species for immediate consideration for the list and Tier 2 identifies species of less urgency.

In addition to being priority species for monitoring by the USFWS, several species currently surveyed on Kodiak were designated as injured resources by the *Exxon Valdez* Oil Spill Trustee Council (Trustee Council), and two of the species (Marbled Murrelet and Pigeon Guillemot) are considered not yet recovered from that event. In 1989 when the *Exxon Valdez* oil tanker ran aground in Prince William Sound (PWS), approximately 25% of the 40 million liters of crude oil spilled drifted out of the sound and spread more than 750 km southwest along the Kenai and Alaska Peninsulas and Kodiak Archipelago (Spies et al. 1996). Direct mortality of marine birds in PWS and the GOA was estimated at about 250,000 birds (Piatt and Ford 1996). Of the 30,000 carcasses of marine birds retrieved after the spill most (88%) were recovered outside of PWS (Piatt et al. 1990). Initial planning for a long-term monitoring program for the marine nearshore in the Gulf of Alaska by the Trustee Council included the Kodiak Archipelago. Implementation of the monitoring program included PWS and NPS lands on the Kenai and Alaska Peninsula. One of our primary goals with the current survey was to expand monitoring for nearshore marine birds to the Kodiak Archipelago as originally envisioned by the Nearshore Restoration and Ecosystem Monitoring (N-REM) Program (Dean and Bodkin 2006).

Study Area

The Kodiak Archipelago is located in the northern GOA, 50 km east of the Alaska Peninsula and 140 km southwest of the Kenai Peninsula. The archipelago is influenced by a maritime climate with an annual mean temperature of about 4°C. Total annual precipitation varies from 250 cm along the eastern coast to 60 cm over the western areas adjacent to Shelikof Strait. Mountains, several with peaks more than 1000 m traverse more than half the length of Kodiak Island and

dominant vegetation types range from Sitka spruce (*Picea sitchensis*) forest on the northern end of the archipelago to treeless tundra on the southern end. The area is characterized by approximately 4,500 km of rocky irregular coastlines with numerous glacially scoured straits, inlets, bays, and fjords with branching arms. Sea bluffs are generally steep and rocky and numerous offshore rocks and islets occur along the coast (USFWS 2008b).

The shores along the Kodiak Archipelago are considered among the most biologically significant areas in the GOA, providing breeding, nesting, feeding, and rearing habitat for a diverse array of wildlife species (USFWS 2012). The USFWS is the largest single land owner in the region, with Kodiak NWR comprising some 1.8 million acres or approximately two-thirds of the archipelago. State lands include the islands' extensive tidelands, plus almost all of Shuyak Island (47,000 acres), managed as Shuyak Island State Park. Approximately 20% of archipelago lands are private, owned and managed primarily by Koniag Alaska Regional Native Corporation and other village corporations. Alaska Maritime NWR's GOA Unit manages many of the offshore islands, islets, rocks, and spires with nesting seabirds and includes about 395,500 acres of submerged lands off Afognak Island, 7,000 acres along the Karluk coastline, and 4,500 acres in Women's Bay (USFWS 2011).

Coastal marine habitats were identified as a special value of the refuge in the Revised Comprehensive Conservation Plan for the Kodiak National Wildlife Refuge (USFWS 2008b). The GOA coastal ocean currents and the upwelling of nutrient-rich marine waters surrounding the Kodiak Archipelago continually inject large amounts of marine-derived nutrients into coastal habitats in the region. Nearshore habitats in the archipelago support resident and migratory marine bird and mammal populations and provide key habitat during portions of the like cycles of many commercially or biologically valuable pelagic and forage fish species.

Survey Regions

To survey marine birds, the Kodiak Archipelago was divided into three survey regions for logistical reasons: East Kodiak, Afognak, and West Kodiak (Figure 1). Surveys took a minimum of two to three weeks to complete for each region during each survey period (June and August), thus there was not enough time to survey the entire archipelago in one season. Monitoring began in 2011 with East Kodiak, continued in 2012 with Afognak, and was completed in 2013 with West Kodiak.

The East Kodiak survey region extended from Chiniak Bay southwest to Low Cape. The Afognak region included Marmot Bay and Kupreanof Strait on Kodiak, and Raspberry, Marmot, and Shuyak Islands. The West Kodiak survey region extended from Uganik Island southwest to Low Cape (Figure 1). There were marked differences in the range of tides on East Kodiak bordered by the GOA and West Kodiak adjacent to the Shelikof Strait. Mean annual tide range along the GOA side was 2.5-3.4 m in contrast to 4.0-4.4 m on shores adjacent to the Shelikof Strait (Plafker and Kachadoorian 1966). The difference in maximum annual tide height on the two sides of the archipelago was as much as 2.1 m. The Afognak region at the northeastern end of the archipelago is unique due to its strong resemblance to the coastal rainforests of southeast Alaska, while the southwestern end of the archipelago shares more in common with the sub-arctic heath of the Aleutians and Alaska Peninsula.

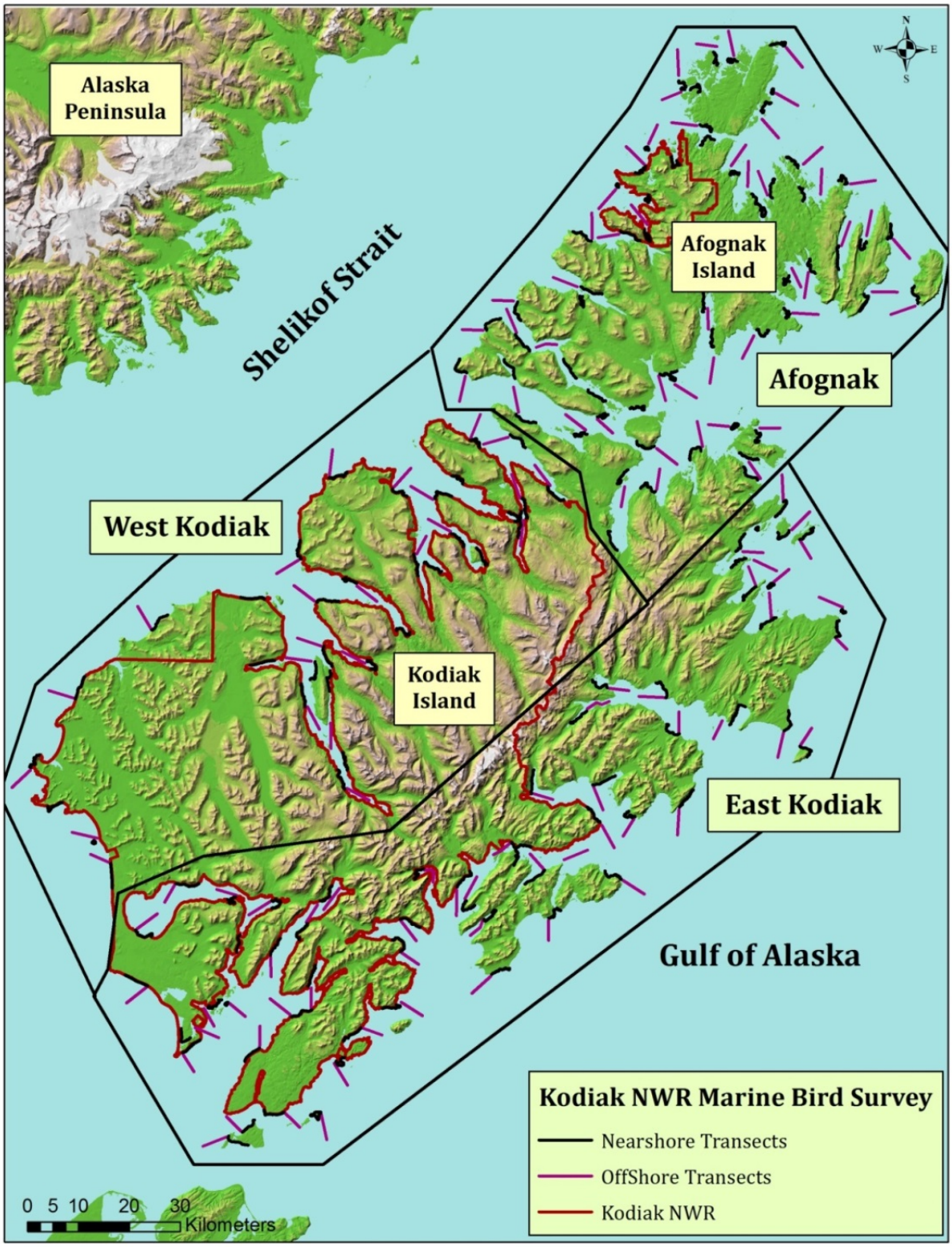

Figure 1. Map of the Kodiak Archipelago with Kodiak Refuge nearshore and offshore marine bird and mammal transects surveyed in three regions: East Kodiak (2011), Afognak (2012), West Kodiak (2013), Alaska.

Methods

Description of the Nearshore Region

For the purposes of this survey, the nearshore was defined as the section of the marine ecosystem that extended from the high-high tide line, offshore to depths of about 50 m (to 5 km offshore). It was divided into the nearshore/intertidal zone (tide-line to 400 m; between high tide water and nearshore subtidal to depths of about 20 m) and the shallow offshore zone (> 400 m offshore to 5 km) (Figure 2).

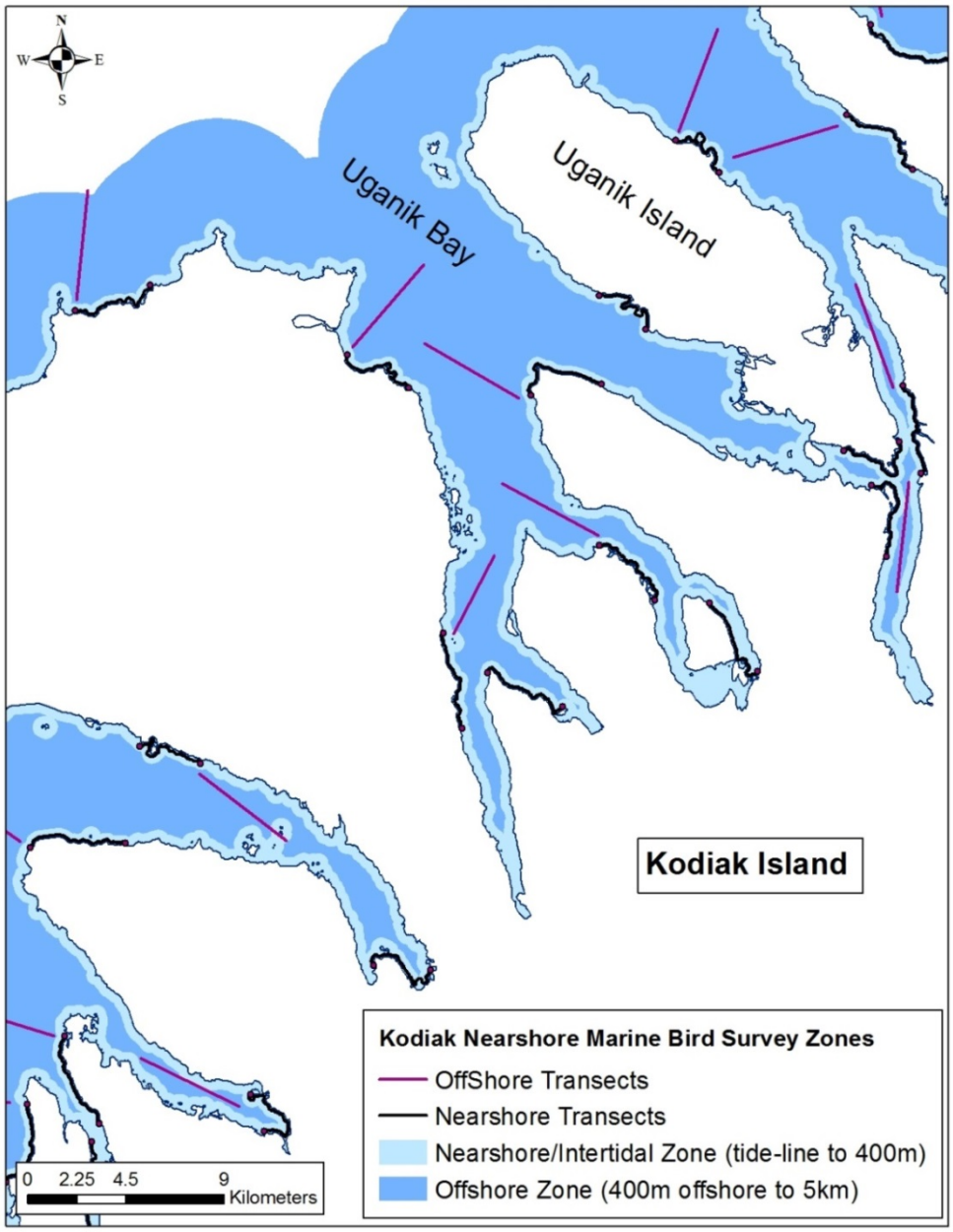

Figure 2. Detail map of the west side of Kodiak Island illustrating the nearshore/intertidal (tide-line to 400 m) and offshore (> 400 m offshore to 5 km) survey zones of the Kodiak Archipelago nearshore marine bird survey, Alaska.

Transect Details and Survey Methods

The survey design consisted of a series of transects along the shoreline such that a minimum of 20% of the shoreline was surveyed. Nearshore transects were systematically selected beginning at a random starting point from the pool of contiguous 2.5-5 km transects that were adjacent to the mainland or islands, including the lengths of transects that were associated with islands or groups of islands with less than 5 km of shoreline. The systematic survey design with a random start was recommended to achieve better spatial coverage and lower variance when using distance sampling (Thomas et al. 2010). Transects were generally 5 km long and nearshore transects were 100 m offshore and parallel to the shoreline. Because several abundant marine bird species used both the intertidal zone and shallow nearshore waters between 10-50 m deep to forage, we added offshore transects. Offshore transects started at the end of nearshore transects, 500 m offshore and perpendicular to the prevailing shoreline for a distance of approximately 5 km (Figures 2-3).

Transect width was 400 m for nearshore transects (100 m towards shore and 300 m for the observer looking offshore) and 600 m for offshore transects (300 m on either side of the skiff; see Figure 3). The survey skiff was 6 m in length and traveled at approximately 5 knots. Birds seen above the tide line were counted, primarily Black Oystercatchers, Bald Eagles, and nesting gulls and Alcids at colonies. Observers also counted birds seen 300 m forward of the skiff if these birds flushed from the water. On Kodiak, however, marine birds flushing in response to the skiff traveling at survey speed were rare. With the exception of cormorant species we observed little aversive movement by birds or marine mammals on the water in response to the skiff during the survey. We suspect the birds were acclimated to the presence of slow moving skiffs by the high level of fishing activity close to shore in the region, particularly salmon seining and commercial and subsistence gill-net fishing.

The survey crew usually consisted of four personnel including two designated observers, a data entry/secondary observer, and a skiff operator. In June, because there were fewer birds to be counted, occasionally the crew consisted of only three personnel and the team member responsible for entering observations into the computer was also an observer. Typically two observers searched each side of the vessel counting all marine birds and mammals and estimating distance to all birds and sea otters seen on the water with aid of a laser range finder. In the case of flocks of birds and large groups of sea otters, distance was estimated to the center of the flock or group. Flying birds were recorded continuously with behavior noted as flying to distinguish these observations from those of birds on the water. This was for transiting birds only, in the case of foraging flocks the distance to the center of the flock was estimated and all birds were considered on the water though at any given time some could be in diving flights. We recorded sea conditions including degree of chop and swell height at the start of each transect or as conditions changed. Sea state was described as calm (1), light chop (2), or moderate to heavy chop (3). Swell of over 0.5 m was noted as well, and we did not conduct surveys if weather conditions were unacceptable (Beaufort scale >3). Observations were recorded on a rugged laptop with a GPS using software developed for bird surveys (dLOG3, Ford 2009).

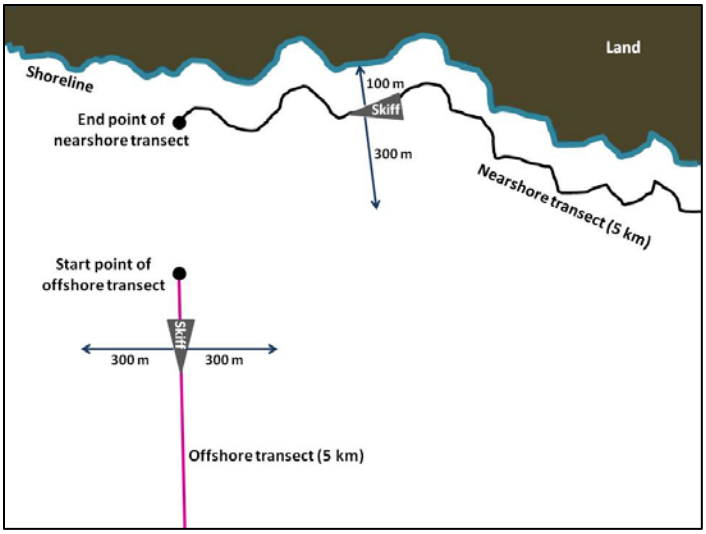

Figure 3. Illustration of nearshore and offshore transect location and width for the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska.

Density Calculations and Population Estimates

We used transect densities (birds/km for nearshore species; birds/km^2 for species recorded on nearshore and offshore transects) to calculate mean density and standard error (SE) for each region and survey. We used a ratio estimator (Cochran 1977, Williams et al. 2002) to estimate population sizes and variances (Klosiewski and Laing 1994, Agler et al. 1994). Population estimates were calculated for the species of interest using the formula:

$$\widehat{N}_r = \frac{\bar{y}}{\bar{a}} A$$

where:

$\widehat{N}_r$ = population estimate for a region.
A = total area of the region (see Table 4).
$\bar{y}$ = sample mean of birds counted on transects for the region.
$\bar{a}$ = sample mean of the transect area or length for the region.

The variance for the population estimate was calculated as follows:

$$\widehat{var}\left(\widehat{N}_r\right) = M^2 \frac{(1 - m/M)}{m} (s_y^2 + \widehat{D}^2 s_a^2 - 2\widehat{D} s_{ay})$$

where:

$\widehat{var}\left(\widehat{N}_r\right)$ = estimated variance of $\widehat{N}_r$.
M = total number of sampling units in the region.
m = number sampled units (transects) in the region.
$\widehat{D} = \bar{y}/\bar{a}$ = an estimate of population density.
s_y^2 = estimated variance for the bird counts.
s_a^2 = estimated variance of the transect areas or lengths.

s_{ay} = estimated covariance between the counts and the areas/lengths.

$$s_{ay} = \frac{\sum_{i=1}^{m}(y_i - \bar{y})(a_i - \bar{a})}{m-1}$$

The approximate 95% confidence limits for abundance were estimated by:

$$\widehat{\widehat{N}_r} \pm 1.96\sqrt{\widehat{var}(\widehat{\widehat{N}_r})}$$

Estimating Detectability via Distance Sampling and *N*-Mixture Models

In large scale monitoring efforts it is not possible to count entire populations and detect all individuals, some type of spatial sampling and accounting for detection probability is necessary (Pollock et al. 2002). For this reason we incorporated distance sampling, a widely used technique for estimating the size or density of biological populations (Thomas et al. 2010). The most widely used form of distance sampling is line transect sampling. For three species, Marbled Murrelet, Pigeon Guillemot, and Sea Otter, distance estimation will be used to account for detection in population estimates and we will present these results in single species reports in the near future.

Distance sampling may be inappropriate for species with strong associations with the shoreline. A critical assumption of distance sampling is that the transect line be placed randomly with respect to the distribution of objects ensuring a representative sample of the relevant distances and hence a valid detection function. Since the study design has transects placed 100 m from the tide line the majority of birds that feed almost exclusively in the intertidal were at this 100 m distance, rather than randomly distributed throughout the survey zone. *N*-mixture models derive estimates of abundance and detection probability from a set of spatially and temporally replicated counts and provide a flexible framework for modeling count data and covariates in large-scale bird monitoring programs designed to understand population change (Lyons et al. 2012). Nearshore transects were repeated when possible in rapid succession (within 1-2 days) during each survey. For the three most abundant nearshore species with strong intertidal associations (e.g. Harlequin Duck, Black Oystercatcher, Bald Eagle) we will use N-mixture models to estimate abundance incorporating detectability and we will present these results in single species reports in the near future.

Analysis is ongoing and detection probability is NOT included in the population estimates presented in this report.

Habitat Use and Selection

ShoreZone (http://www.shorezone.org/) is a coastal habitat mapping and classification system in which georeferenced aerial imagery is collected specifically for the interpretation and integration of geological and biological features of the intertidal zone and nearshore environment (Harney et al. 2008). The mapping system provides a spatial framework for coastal habitat assessment on local and regional scales. In the Kodiak Archipelago 4,981 km of shoreline were mapped with the ShoreZone protocol in 2002 and 2005 (Harney and Morris 2007). These data enabled us to identify and quantify dominant nearshore habitat availability and use by birds.

In an effort to understand the underlying mechanisms and processes responsible for patterns in distribution and abundance we used a simple statistical procedure to test for significant differences in the use of individual habitat classes via comparisons between observed and expected proportions. For species typically associated with the intertidal zone that were observed almost exclusively on nearshore transects we used a Geographical Information System (GIS) to link bird location to the nearest habitat type identified on the Alaska ShoreZone habitat class GIS layer. The 15 ShoreZone habitat classes were condensed into seven classes based on similarity in types of exposure and substrate (Table 3). To control for experiment-wise error rate (α) during the testing procedure for multiple pair-wise comparisons the upper bound on the overall significance level was set using Bonferroni's inequality (Haney and Solow 1992). Confidence intervals on all observed proportions (p_i) were calculated using the following formula for each habitat class:

$$p_i - Z_{(\alpha/2k)} \sqrt{p_i(1 - p_i)/n} \leq p_{io} \leq p_i + Z_{(\alpha/2k)} \sqrt{p_i(1 - p_i)/n}$$

where p_i = observed proportion for the ith resource, n = the total number of birds observed, k = the number of habitat categories, and $Z_{(\alpha/2k)}$ = the upper standard normal table value corresponding to a probability tail area of α /2k. Expected proportions (p_{io}) occurring, respectively, either above or below the confidence limits indicate that birds were using the designated habitat class less or more than expected by chance.

The relative probability of selection for each habitat class was determined using Manly's standardized selection ratio (Manly et al. 2002):

$$B_i = \widehat{w}_i \,/\, (\textstyle\sum_{i=1}^{I} \widehat{w}_i),$$

where w_i is the proportion of the population of available resource units in category i that are used (the resource selection probability function). This ratio represents the probability that an individual will use a particular habitat type, taking into account the difference in habitat availability.

Productivity

The ratio of juvenile (hatch-year) to adult (after-hatch-year) individuals is often used as a measure of avian productivity in species with distinct juvenile plumages. This ratio can be a cost-effective metric because it does not require monitoring individual breeding sites and can often be estimated across large geographic and temporal scales. This is particularly helpful for species for which it is difficult or impossible to monitor nest sites, such as Marbled Murrelet. Indeed, it has been used to monitor change in reproductive success of Marbled Murrelets in several regions (Kuletz and Kendall 1998, Kuletz and Piatt 1999, Lougheed et al. 2002, Peery et al. 2007, Wong et al. 2008). Observers on August surveys attempted to identify and record juveniles of 11 species (Table 1).

Table 3. Summary descriptions of the biophysical habitat classes in the Kodiak Archipelago from ShoreZone coastal habitat mapping, Alaska.

Exposure	Biophysical Habitat Description	Length (km)	% of Mapping	Habitat Class for Analysis
Exposed	**Mobile Substrate:** No epibenthic community in intertidal due to dynamic substrate.	181.2	4%	Exposed Mobile & Partially Mobile Substrates
	Partially Mobile Substrate: Rocky shorelines with sediments sufficiently mobile to limit epibenthos in some portions of the shore.	243.7	5%	
	Stable Substrate: Rocky shorelines with high wave exposure.	188.4	4%	Exposed and Semi-Exposed Stable Substrates
Semi-Exposed	**Stable Substrate:** Rocky shorelines with moderate to high wave exposure.	325.2	6%	
	Partially Mobile Substrate*:* Rocky shorelines with sediments that are sufficiently mobile to limit epibenthos in some portions of the shore.	632.4	13%	Semi-Exposed Mobile & Partially Mobile Substrates
	Mobile Substrate: Small-size sediment shores generally have no epibenthic community. Cobble/boulder beaches may have biota. Dunes frequent in backshore.	183.4	4%	
Semi-Protected	**Mobile Substrate:** Small-size sediment shores generally have low biotic diversity. Cobble/boulder beaches usually support biota, especially in low intertidal/upper subtidal	284.5	6%	Semi-Protected Mobile & Partially Mobile Substrates
	Partially Mobile Substrate: Rocky shorelines with sediments sufficiently mobile to limit epibenthos in some portions of the shore.	1101.3	22%	
	Stable Substrate: Rocky shorelines with moderate to low wave exposure.	215.6	4%	Protected and Semi-Protected Stable Substrates*
Channel	**Current-Dominated Channel:** Channels where high tidal currents create anomalous assemblages of biota. Usually associated with lower wave exposure conditions in adjacent shore units.	48.0	1%	
Man-Made	**Anthropogenic Features:** unit modified by shorezone disturbances, such as rip rap, wharves or fill.	27.1	<1%	
Protected	**Stable Substrate:** Rocky shorelines with low wave exposure.	52.4	1%	
	Partially Mobile Substrate: Rocky shorelines with sediments sufficiently mobile to limit epibenthos in some portions of the shore.	896.7	18%	Protected Mobile & Partially Mobile Substrates
	Mobile Substrate: Small-size sediment shores generally have low biotic diversity. Cobble/boulder beaches usually support biota, especially in low intertidal/upper subtidal.	264.9	5%	
Wetland/ Estuary	**Estuary:** Generally low energy sediment shores with wetlands and marsh vegetation. Usually influenced by freshwater.	334.7	7%	Wetland/Estuary
	TOTALS:	**4980.5**	**100%**	

*Man-Made Anthropogenic Features and Channels were combined with Protected and Semi-Protected Stable Substrates for habitat selection analysis due to the limited availability of these habitat types and their similarity in exposure and substrate characteristics.

Results & Discussion

Transect Details

The original survey design consisted of 235 transects; 150 nearshore and 85 offshore. Of those 235 transects, counts of marine birds and mammals were made along 217 in June, and 214 in August, from 2011-2013. We used a buffer created in GIS with the Alaska ShoreZone coastal habitat mapping polyline shapefile to calculate survey area (km^2) for the nearshore and offshore survey zones (Table 4). Transects surveyed represent 19-21% of the nearshore survey zone and 4-8% of the offshore survey zone (Table 4).

Table 4. Summary of shoreline length (km) and total area (km^2) for the nearshore and offshore survey zones in the Kodiak Archipelago by region and percent of each zone surveyed by nearshore marine bird survey transects 2011-2013, Alaska.

		Area (km^2)		% Area Surveyed by Transects			
Survey Region	Shoreline Length (km)	Nearshore Survey Zone	Offshore Survey Zone	Nearshore Zone		Offshore Zone	
				June	August	June	August
East Kodiak	1,623	569	2,750	19	19	4	4
West Kodiak	1,012	318	1,284	21	20	8	6
Afognak	2,022	578	2,222	19	20	7	7
TOTALS	**4,657**	**1,465**	**6,256**				

We used the Alaska ShoreZone coastal habitat mapping GIS layer to calculate total shoreline length in the Kodiak Archipelago (4,657 km), as well as shoreline length by habitat class. Using GIS we compared the percentage of each habitat class surveyed by our systematic transects to the total available in the archipelago, which confirmed that transects were representative of the available shoreline habitat types (Table 5).

Table 5. Total shoreline length and percent by habitat type as classified by ShoreZone coastal habitat mapping for the entire Kodiak Archipelago and for surveyed transects on the Kodiak Refuge nearshore marine bird surveys, Alaska.

Habitat Description	Total Shore length (km)	Total Shore %	Surveyed Shore Length (km)	Surveyed Shore %
Channel	48	1	3	<1
Estuary	317	7	63	6
Exposed Mobile	105	2	20	2
Exposed Partially Mobile	222	5	50	5
Exposed Stable Substrate	188	4	42	4
Man-Made Anthropogenic Features	27	1	5	1
Protected Mobile Substrate	228	5	27	3
Protected Partially Mobile Substrate	887	19	155	15
Protected Stable Substrate	52	1	13	1
Semi-Exposed Mobile Substrate	145	3	35	3
Semi-Exposed Partially Mobile Substrate	615	13	143	14
Semi-Exposed Stable Substrate	325	7	73	7
Semi-Protected Mobile Substrate	217	5	56	5

Table 5. (Continued)

Habitat Description	Total Shore length (km)	Total Shore %	Surveyed Shore Length (km)	Surveyed Shore %
Semi-Protected Partially Mobile Substrate	1,065	23	270	27
Semi-Protected Stable Substrate	216	5	62	6
TOTALS	**4,657**		**1,018**	

Survey Timing

June surveys were conducted from 11 June-2 July, 2011; 4 June-1 July, 2012; and 12-25 June, 2013. August surveys were conducted from 9 August-1 September, 2011; 31 July-6 September 2012; and 13-26 August, 2013.

Occurrence and Relative Abundance of Marine Birds and Mammals

During the breeding season surveys in June and August 2011-2013, we identified 65 marine bird species and eight marine mammal species (Appendix A). Two species of larids, the Black-legged Kittiwake and the Glaucous-winged Gull, were the most numerous species encountered. Several Alcid species were also abundant, including Tufted Puffin, Marbled Murrelet, Pigeon Guillemot, and Common Murre. Collectively these six species accounted for 78% of all nearshore marine birds observed across the three summers.

Marbled Murrelets greatly outnumbered Kittlitz's Murrelets in all years (Table 6). We counted only 37 Kittlitz's Murrelets on transect during surveys across all years combined (2011-2013). The species is rarely sighted in the marine waters around the Kodiak Archipelago (Stenhouse et al. 2008, Madison et al. 2011) despite an eight year nesting ecology study during which time 134 nests have been monitored on the southwestern end of Kodiak Island (Lawonn 2012, Knudson et al. 2016). More Kittlitz's Murrelets were seen on August (34) surveys then in June (3), and a high percentage (47%) of the birds seen in August were juveniles (hatch-year) (Table 6). Kodiak NWR has a long history of surveying coastal and marine birds and in systematic surveys in May through August from 1984-2005 only 34 Kittlitz's Murrelets were recorded (see Appendix 1 in Stenhouse et al. 2008). However, a relatively high percentage (24%) of the observed birds were juvenile. In addition, several Kittlitz's Murrelets satellite-tagged in Icy Bay in southeast Alaska in 2010 moved west at the end of the breeding season, including one hatch-year bird tagged on 30 July that moved to southwest Kodiak Island on 15 August and remained in the Geese Channel region until 20 September (John Piatt, personal communication). Results from this satellite telemetry study indicate that hatch-year birds seen in August on Kodiak do not necessarily represent local production of young.

Table 6. Marbled and Kittlitz's Murrelet counts in August by age (adult, juvenile, and unknown) on the Kodiak Refuge nearshore marine bird surveys 2011-2013, Alaska.

	East Kodiak			Afognak			West Kodiak			Totals		
	August 2011			August 2012			August 2013			August 2011-2013		
Species	**Ad**	**Juv**	**Unk**	**Ad**	**Juv**	**Unk**	**Ad**	**Juv**	**Unk**	**Ad**	**Juv**	**Unk**
Marbled Murrelet	1,396	59	5	4,391	103	14	1,233	106	7	7,020	268	26
Kittlitz's Murrelet	3	3	0	5	11	0	10	2	0	18	16	0

Sea Otters were the most abundant marine mammal species, followed by Harbor Seals (Appendix A). Sea Otters were commonly seen on the west side of Kodiak Island and around Afognak and Shuyak Islands on the northeastern end of the archipelago. However, they were nearly absent from the east side of Kodiak Island outside of Chiniak Bay. Only two Sea Otters were counted on the June 2011 survey along 1,373 km of shoreline on the southeast side of Kodiak Island, with five counted in that region in August 2011. We did not see Sea Otters with pups on the east side of Kodiak Island in 2011.

Density and Population Estimates

The density of many nearshore marine bird and mammal species increased from June to August. The increase in the number of birds in August likely resulted from the end of nesting activities when both breeding adults and juveniles were at-sea rather than concealed on nests which is more typical in June. In addition failed breeding birds and early migrants from other regions were also moving into the nearshore waters around Kodiak at this time. For many species numbers tended to be more variable in August than in June based on the coefficient of variation (Table 10).

Of the thirteen marine bird and two mammal species that occurred on both nearshore and offshore transects, densities were typically greater in the nearshore compared to the offshore region. Three exceptions were Common Murre, Marbled Murrelet, and Tufted Puffin which were generally as common or more abundant offshore (Tables 7 and 8).

One of the primary goals of the nearshore marine bird surveys was to generate population estimates for several marine bird species in the Kodiak Archipelago that were directly comparable to other regions (Tables 9 and 10). This information is required for setting population objectives for priority species, particularly when surveys indicate that a substantial proportion of the Alaska breeding population occurs in the archipelago. This report focuses on results for two species of conservation concern, Marbled Murrelet and Black Oystercatcher.

Priority Species

Marbled Murrelet The combined June 2011-2013 population estimate for Marbled Murrelet was 38,926 (95% CI: 33,704-44,148; Table 10) which represents 14% of the current projected murrelet population estimate for Alaska of 270,000 (Piatt et al. 2007b). The August archipelago-wide population estimate was 85,269 (95% CI: 67,320-103,218) which represents almost 32% of the current population estimate for Alaska. In general murrelet density (birds/km^2) was higher in the Afognak Region and the August 2012 population estimate of 48,264 (95% CI: 34,587-62,661) for this region contributed more than half the total population estimate for the archipelago (Table 9).

The August population estimate may include migrating and/or wintering birds. However, average winter Marbled Murrelet density based on annual surveys conducted from 1986-2005 in four large bay systems on Kodiak Island ranged from 2.36 -3.70 birds/km^2 (Zwiefelhofer et al. 2008). This range of estimates in winter was lower than any of the current June or August density estimates with the exception of the nearshore survey zone in June 2011 of 2.67 birds/km^2 (Table 8). Based on lower winter density it is reasonable to conclude that the increase in density in August represents migrating Marbled Murrelets. There is recent anecdotal evidence that Marbled Murrelets breeding in coastal British Columbia migrate to the GOA at the end of the

breeding season. One of six Marbled Murrelets tagged with satellite transmitters during the pre-laying period (April 2014) in Kitimat, British Columbia, made an August post breeding migration of 1,886 km to the GOA. This individual remained near Takli Island off the Alaska Peninsula north of Kodiak Island from August 27-September 15, at which point the bird either died or dropped the transmitter (Bertram et al. 2016). Increased August density on Kodiak could be related to post-breeding migrations from other regions, perhaps to molting locations prior to additional movements to wintering grounds.

The Kodiak Archipelago is an important breeding area for Marbled Murrelets yet the status and trends of this species in the region are poorly known. In the 1970s and 1980s, based on at-sea survey data obtained under the Outer Continental Shelf Environmental Assessment Program (OCSEAP) more than 97% of the Marbled Murrelet population in Alaska was concentrated in three main areas: the Kodiak Archipelago, PWS, and the Alexander Archipelago (Piatt and Ford 1993). Studies conducted in the 1990s compared inland flight behavior indicative of nesting at sites on Afognak Island in the archipelago with high density population sites in PWS and Kenai Fjords. The greatest level of dawn inland activity occurred at sites on Afognak Island (Kuletz et al. 1995). The only previous breeding population estimate for Marbled Murrelets in the Kodiak Archipelago was 21,900 (Piatt and Ford 1993). However, this estimate was based on OCSEAP surveys generally conducted from large vessels operating opportunistically in outside waters, thus some sheltered inside waters preferred by murrelets were not sampled. Given the potential importance of the archipelago to this species they were a major focus of the nearshore marine bird survey from 2011-2013.

Black Oystercatcher Population estimates for Black Oystercatchers in the Kodiak Archipelago from the current survey were 1,410 (95% CI: 1,191-1,629) in June 2011-2013 and 3,402 (95% CI: 1,991-4,814) in August 2011-2013 (Table 10). The more than twofold increase between the June and August population estimates in this survey could be explained by the secretive nature of the nesting birds during incubation in June. While oystercatchers may alarm call or engage in broken wing displays in response to disturbance at the nest, they will also silently hide behind rocks and vegetation (Andres and Falxa 1995). In general, oystercatchers did not react to the survey skiff 100 m offshore during June surveys, and approximately 57% of detections were of single birds (104 out of 183 records). In many of these cases a second bird was likely concealed nearby on a nest. In contrast, detection was believed to be greater in August when both adults were attending chicks and failed breeders were often found in large flocks. Only 38% of observed oystercatchers were single birds in August (71 of 185 records) and average flock size increased from 2 (SE = 0.1) in June to 4 (SE = 0.6) in August.

The Black Oystercatcher is a species of high conservation concern throughout its range because of its small population size (8,900–11,000 individuals) and threats to the birds and their coastal habitats throughout the annual cycle (USSCP 2004, Tessler et al. 2007, Johnson et al. 2010). Previous research with radio-tagged Black Oystercatchers in Alaska indicated the species is most likely resident year-round in the Kodiak Archipelago, with most individuals tagged in Kodiak remaining <15 km away from nesting territories during the non-breeding season (Johnson et al. 2010). Previous surveys by Kodiak NWR biologists in both winter and summer estimated comparable numbers of around 1,700 oystercatchers (Tessler et al. 2007). This consistency in oystercatcher numbers suggests minimal influx to Kodiak from other regions during the non-breeding season.

Table 7. Density estimates* and standard error (SE) for the most common marine bird and mammal species surveyed on nearshore and offshore transects in June 2011-2013, on the Kodiak Archipelago, Alaska.

	June 2011 East Kodiak		June 2012 Afognak		June 2013 West Kodiak	
	Nearshore	Offshore	Nearshore	Offshore	Nearshore	Offshore
	Density (SE)	Density (SE)	Density (SE)	Density (SE)	Density (SE)	Density (SE)
Harlequin Duck	5.92 (1.79)		3.00 (0.93)		1.63 (0.60)	
Barrow's Goldeneye	0.15 (0.10)		0.11 (0.05)		0.09 (0.05)	
Common Merganser	1.05 (0.66)		0.07 (0.05)		2.32 (1.69)	
Red-breasted Merganser	0.69 (0.22)		0.72 (0.16)		0.51 (0.48)	
Black Oystercatcher	0.45 (0.20)		0.99 (0.17)		0.59 (0.21)	
Bald Eagle Adult	1.33 (0.16)		1.36 (0.21)		1.87 (0.23)	
Bald Eagle Subadult	0.14 (0.06)		0.37 (0.14)		0.09 (0.05)	
Pelagic Cormorant	0.69 (0.26)	0.15 (0.07)	4.20 (1.60)	0.36 (0.14)	0.80 (0.93)	0.01 (0.01)
Red-faced Cormorant	1.13 (0.57)	0.01 (0.01)	0.19 (0.12)	0.02 (0.02)	0.03 (0.04)	0 (0)
Mew Gull	0.92 (0.26)	0.07 (0.06)	1.23 (0.31)	0.43 (0.48)	1.70 (1.53)	0 (0)
Glaucous-winged Gull	18.24 (6.27)	1.59 (0.68)	21.69 (5.24)	4.43 (1.27)	11.41 (4.58)	1.69 (0.64)
Black-legged Kittiwake	64.18 (23.59)	5.40 (1.68)	23.20 (7.85)	3.49 (0.96)	31.37 (11.61)	10.49 (3.83)
Arctic Tern	0.82 (0.20)	0.24 (0.21)	1.34 (1.21)	0.31 (0.20)	1.03 (0.60)	0.51 (0.26)
Aleutian Tern	0.53 (0.18)	0.27 (0.14)	0.04 (0.04)	0.01 (0.20)	0 (0)	0.02 (0.02)
Common Murre	10.60 (4.75)	8.32 (5.51)	0.02 (0.01)	0.31 (0.12)	0.32 (0.34)	5.28 (2.22)
Pigeon Guillemot	7.43 (1.02)	0.70 (0.26)	7.56 (0.90)	0.66 (0.21)	5.17 (1.01)	0.62 (0.22)
Kittlitz's Murrelet	0 (0)	0.01 (0.01)	0 (0)	0.01 (0.01)	0 (0)	0.01 (0.01)
Marbled Murrelet	2.67 (0.61)	4.23 (1.12)	2.95 (0.62)	7.64 (1.38)	8.24 (1.52)	4.01 (1.85)
Tufted Puffin	9.97 (9.08)	4.90 (2.88)	4.31 (1.81)	6.79 (3.09)	1.44 (0.87)	2.24 (1.19)
Horned Puffin	1.99 (0.67)	0.14 (0.08)	1.74 (0.40)	0.73 (0.27)	1.31 (1.28)	0.17 (0.11)
Marine Mammals:						
Sea Otter	0.09 (0.04)	0.19 (0.18)	4.63 (0.80)	2.94 (1.28)	5.93 (1.75)	2.89 (1.43)
Harbor Seal	1.04 (0.58)	0.05 (0.03)	2.98 (2.06)	0.43 (0.25)	2.41 (1.46)	0.36(0.26)

* Density estimates - birds/km for nearshore species; birds/km^2 for species recorded on nearshore and offshore transects.

Table 8. Density estimates* and standard error (SE) for the most common marine bird and mammal species surveyed on nearshore and offshore transects in August 2011-2013, on the Kodiak Archipelago, Alaska.

	August 2011 East Kodiak		August 2012 Afognak		August 2013 West Kodiak	
	Nearshore	Offshore	Nearshore	Offshore	Nearshore	Offshore
	Density (SE)	Density (SE)	Density (SE)	Density (SE)	Density (SE)	Density (SE)
Harlequin Duck	9.78 (2.12)		9.43 (1.81)		5.72 (1.97)	
Barrow's Goldeneye	1.28 (0.74)		0.21 (0.11)		1.92 (1.33)	
Common Merganser	2.72 (2.18)		0.78 (0.36)		1.78 (1.20)	
Red-breasted Merganser	0.56 (0.34)		0.51 (0.21)		0 (0)	
Black Oystercatcher	3.20 (2.59)		2.35 (0.62)		0.52 (0.22)	
Bald Eagle Adult	0.99 (0.17)		1.16 (0.14)		1.72 (0.24)	
Bald Eagle Subadult	0.11 (0.05)		0.23 (0.07)		0.17 (0.05)	
Pelagic Cormorant	1.14 (0.39)	0.83 (0.73)	1.58 (0.49)	0.31 (0.24)	0.37 (0.27)	0.07 (0.04)
Red-faced Cormorant	1.77 (0.87)	0.25 (0.30)	0.11 (0.05)	0.02 (0.02)	0 (0)	0 (0)
Mew Gull	8.80 (2.98)	0.19 (0.13)	8.27 (2.46)	0.31 (0.21)	24.29 (5.99)	0.31 (0.12)
Glaucous-winged Gull	35.66 (10.79)	6.17 (4.04)	22.31 (4.15)	6.40 (1.63)	20.04 (5.55)	2.84 (1.09)
Black-legged Kittiwake	115.79 (28.75)	22.14 (8.16)	47.73 (21.16)	15.18 (4.78)	52.24 (10.88)	11.45 (2.32)
Arctic Tern	0.66 (0.27)	0.23 (0.13)	0.64 (0.67)	0.16 (0.15)	2.59 (1.36)	0.81 (0.31)
Aleutian Tern	0.07 (0.05)	0.19 (0.18)	0.03 (0.04)	0 (0)	0 (0)	0 (0)
Common Murre	6.89 (2.25)	7.77 (2.19)	0.13 (0.07)	2.09 (0.87)	0.42 (0.16)	5.37 (2.16)
Pigeon Guillemot	7.84 (1.26)	1.75 (0.67)	9.60 (0.99)	1.57 (0.40)	4.85 (1.01)	1.51 (0.69)
Kittlitz's Murrelet	0.04 (0.02)	0 (0)	0.09 (0.03)	0.02 (0.02)	0.10 (0.05)	0.05 (0.04)
Marbled Murrelet	5.70 (1.46)	6.69 (2.64)	10.53 (2.39)	19.39 (5.71)	8.14 (1.98)	9.98 (3.63)
Tufted Puffin	7.49 (2.45)	8.44 (2.29)	3.81 (0.97)	10.31 (3.31)	2.59 (1.06)	2.43 (0.95)
Horned Puffin	5.00 (1.43)	2.13 (1.01)	4.10 (0.90)	1.61 (0.37)	2.51 (2.23)	0.48 (0.19)
Marine Mammals:						
Sea Otter	0.24 (0.14)	1.85 (2.18)	7.00 (1.26)	4.30 (1.68)	4.23 (0.91)	2.59 (0.91)
Harbor Seal	5.32 (4.47)	0.08 (0.05)	1.02 (0.35)	0.98 (0.47)	5.58 (2.39)	0.28(0.08)

* Density estimates - birds/km for nearshore species; birds/km^2 for species recorded on nearshore and offshore transects.

Table 9. Population estimates (PE) and lower and upper 95% confidence limits (LCL, UCL) for the most common species on the nearshore marine bird and mammal surveys 2011-2013 by region and year surveyed on the Kodiak Archipelago, Alaska.

	East Kodiak						Afognak						West Kodiak					
	June 2011			August 2011			June 2012			August 2012			June 2013			August 2013		
	PE	LCL	UCL	PE	LCL	UCL	PE	LCL	UCL	PE	LCL	UCL	PE	LCL	UCL	PE	LCL	UCL
Nearshore Transects																		
Harlequin Duck	4,105	2,646	5,563	6,593	372	12,815	2,719	1,906	3,532	8,428	6,539	10,317	779	477	1,081	2,671	1,525	3,818
Barrow's Goldeneye	112	28	197	889	204	1,573	103	62	143	183	67	299	43	20	65	781	50	1,513
Common Merganser	843	196	1,491	1,768	-674	4,209	58	14	102	653	310	996	1,191	260	2,123	739	64	1,414
Red-breasted Merganser	506	304	709	425	128	723	722	558	886	445	229	662	213	7	418	0	0	0
Black Oystercatcher	276	150	403	1,300	23	2,577	878	731	1,026	1,881	1,291	2,470	255	154	356	222	100	344
Bald Eagle Adult	1,022	895	1,148	780	606	954	1,190	1,038	1,343	1,034	916	1,152	864	784	943	766	633	898
Bald Eagle Subadult	94	55	133	85	39	131	303	194	412	208	138	278	47	19	75	79	48	110
Nearshore & Offshore Transects																		
Pelagic Cormorant	841	533	1,149	2,908	630	5,185	3,027	2,143	3,910	1,453	854	2052	167	-13	346	198	73	323
Red-faced Cormorant	625	296	955	1,787	581	2,994	125	72	178	109	47	171	6	-2	15	0	0	0
Mew Gull	683	433	932	5,352	3,370	7,333	1,701	570	2,831	5,443	3,815	7,071	233	109	356	7,718	5,128	10,308
Glaucous-winged Gull	13,238	9,908	16,568	34,302	20,529	48,074	22,246	18,216	26,277	26,762	21,579	31,945	5,748	4,079	7,418	10,300	6,967	13,633
Black-legged Kittiwake	42,082	31,493	52,671	117,293	86,058	148,527	21,346	16,464	26,228	59,492	41,669	77,315	23,591	16,854	30,327	32,139	25,419	38,860
Arctic Tern	1,101	377	1,824	985	512	1,458	1,297	697	1,897	745	134	1,356	997	567	1,428	1,782	958	2,606
Aleutian Tern	1,023	556	1,489	579	6	1,152	43	3	82	17	-6	41	25	0	50	0	0	0
Common Murre	27,416	9,601	45,231	25,531	18,445	32,617	711	427	996	5,063	2,551	7,575	7,356	4,144	10,568	7,086	2,671	11,502
Pigeon Guillemot	6,001	4,983	7,019	9,073	6,828	11,317	5,685	5,039	6,330	8,811	7,606	10,016	2,380	1,912	2,848	3,443	1,955	4,931
Kittlitz's Murrelet	27	-14	69	23	12	34	13	-5	32	91	48	135	12	-5	30	102	27	178
Marbled Murrelet	13,041	9,481	16,600	21,341	13,007	29,675	18,504	15,308	21,700	48,624	34,587	62,661	7,382	5,289	9,474	15,304	7,842	22,765
Tufted Puffin	18,765	7,843	29,687	26,988	19,565	34,412	17,290	10,645	23,936	24,789	16,296	33,281	3,467	1,670	5,264	4,034	2,024	6,045
Horned Puffin	1,513	1,036	1,990	8,442	5,256	11,628	2,685	2,003	3,367	5,836	4,723	6,948	589	181	997	1,355	463	2,248
Marine Mammals																		
Sea Otter	562	-27	1,151	5,099	-1,721	11,918	8,573	6,160	10,985	13,319	8,559	18,080	5,438	3,328	7,548	4,514	2,711	6,316
Harbor Seal	728	305	1,150	2,365	535	4,194	1,984	1,205	2,764	2,814	1,460	4,168	1,247	638	1,857	1,996	1,084	2,908

Table 10. Combined 2011-2013 population estimates and upper and lower 95% confidence limits (LCL, UCL) for the most common species on the nearshore marine bird and mammal surveys on the Kodiak Archipelago, Alaska.

	June 2011-2013				August 2011-2013			
	Population Estimate	95% LCL	95% UCL	CV*	Population Estimate	95% LCL	95% UCL	CV*
Nearshore Transects								
Harlequin Duck	7,603	5,906	9,300	0.11	17,693	11,091	24,295	0.19
Barrow's Goldeneye	258	161	354	0.19	1,853	844	2,862	0.28
Common Merganser	2,093	958	3,228	0.28	3,160	604	5,716	0.41
Red-breasted Merganser	1,441	1,109	1,773	0.12	871	503	1,239	0.22
Black Oystercatcher	1,410	1,191	1,629	0.08	3,402	1,991	4,814	0.21
Bald Eagle Adult	3,075	2,862	3,289	0.04	2,580	2,331	2,828	0.05
Bald Eagle Subadult	444	325	563	0.14	372	282	462	0.12
Nearshore & Offshore Transects								
Pelagic Cormorant	4,034	3,081	4,987	0.12	4,558	2,200	6,916	0.26
Red-faced Cormorant	756	423	1,090	0.23	1,896	688	3,104	0.33
Mew Gull	2,616	1,452	3,780	0.23	18,513	14,868	22,157	0.10
Glaucous-winged Gull	41,233	35,744	46,721	0.07	71,364	56,276	86,452	0.11
Black-legged Kittiwake	87,019	73,552	100,485	0.08	208,924	172,340	245,509	0.09
Arctic Tern	3,394	2,361	4,428	0.16	3,512	2,382	4,641	0.16
Aleutian Tern	1,090	621	1,559	0.22	596	23	1,170	0.49
Common Murre	35,484	17,379	53,588	0.26	37,680	28,961	46,399	0.12
Pigeon Guillemot	14,065	12,772	15,359	0.05	21,327	18,376	24,277	0.07
Kittlitz's Murrelet	53	5	102	0.47	217	129	305	0.21
Marbled Murrelet	38,926	33,704	44,148	0.07	85,269	67,320	103,218	0.11
Tufted Puffin	39,522	26,611	52,433	0.17	55,811	44,354	67,269	0.10
Horned Puffin	4,788	3,861	5,714	0.10	15,633	12,142	19,124	0.11
Marine Mammals								
Sea Otter	14,573	11,314	17,831	0.11	22,932	14,422	31,442	0.19
Harbor Seal	3,960	2,883	5,036	0.14	7,175	4,723	9,627	0.17

* Coefficient of variation (CV) of the population estimate calculated using the ratio estimator method (Caughley 1997, Williams et al. 2002).

Comparison of Colony Survey and Nearshore Marine Bird Survey Data

We compared population estimates generated from transect based nearshore marine bird surveys in June to recent seabird colony counts conducted in June 2008-2010 which included censuses of 86% (324 of 377) of known seabird colonies in the Kodiak Archipelago (Corcoran 2013). During designated colony surveys every effort was made to adhere to the Beringian Seabird Colony Catalog Manual for Censusing Seabird Colonies (USFWS 1999). Population estimates were higher for the recent transect based survey compared to the colony counts for all of the most common species with the exception of Black-legged Kittiwake (Table 11).

The greatest disparity between transect population estimates and colony counts was seen in Arctic and Aleutian Tern, Common Murre, Pigeon Guillemot, and Horned Puffin (Table 11). These results are not surprising since, with the exception of Black-legged Kittiwakes, many nesting birds are difficult to observe at colonies due to concealed nesting locations, either in burrows and crevices (puffins and cormorants), or tall grass (terns and gulls). Common Murre were seen at nesting ledges in very few locations on Kodiak. The majority of murres counted during the summer were in small groups offshore with a large percentage retaining non-breeding plumage. Pigeon Guillemots were dispersed and common making identification and delineation of colonies challenging, and many were missed during designated colony surveys due to small colony size. Birds concealed on the nest at colonies were also not available to be counted on transect-based surveys. However, most of these species often concentrate some distance from the nesting colony in foraging aggregations in response to fish schools. The majority of these foraging birds were not counted on colony surveys but were available to be counted on transect based surveys. In addition to foraging birds, non-breeding and failed breeders were more likely represented in transect based surveys than at colonies, increasing population estimates based on transects.

The few studies comparing colony counts with at-sea survey data have had similar results to our recent surveys on Kodiak. Estimates derived from at-sea surveys for 13 common Alaskan seabird species in the 1970s and 1980s were well correlated with estimates obtained from whole-colony counts, and in general at-sea survey counts were 30% higher than colony counts (Piatt and Ford 1993). Piatt and Ford concluded these results were reasonable because at-sea counts included non-breeding birds (ca.30-50%) not associated with colonies. Colony based estimates of breeding populations of gulls and murres from 1980 to 1994 in the Farallon Islands, California, usually lay within the 95% confidence intervals of sea-based estimates (Clark et al. 2003).

Table 11. Comparison of seabird colony survey data from 2008-2010 with nearshore marine bird survey population estimates from 2011-2013 on the Kodiak Archipelago, Alaska.

Species	June Kodiak Colony Survey 2008-2010 Population Count	June Kodiak Nearshore Marine Bird Survey 2011-2013 Population Estimate	Percentage Difference
Pelagic Cormorant	3,187	4,034	23
Red-faced Cormorant	496	756	42
Glaucous-winged Gull	22,567	41,233	59
Black-legged Kittiwake	144,582	87,019	-50
Arctic Tern	390	3,394	159
Aleutian Tern	234	1,090	129

Table 11. (Continued)

Species	June Kodiak Colony Survey 2008-2010 Population Count	June Kodiak Nearshore Marine Bird Survey 2011-2013 Population Estimate	Percentage Difference
Common Murre	1,520	35,484	184
Pigeon Guillemot	1,926	14,065	152
Tufted Puffin	27,179	39,522	37
Horned Puffin	967	4,788	133

Habitat Use and Selection

For four species found mostly in the intertidal zone that were observed only on nearshore transects we tested for differences in the use of individual habitat classes (Table 3) by comparing observed and expected proportions. Based on their standardized selection ratio, Barrow's Goldeneye exhibited preference for protected mobile and partially mobile substrates and less than expected use of stable substrates and exposed and semi-exposed mobile and partially mobile substrates (Figure 4). Preference for protected habitats by goldeneyes was not unexpected since the most birds surveyed were observed in August and were molting females with broods. Harlequin Duck and Black Oystercatcher preferentially used areas characterized by stable substrates irrespective of exposure (Figure 4). Preferences for stable substrates were consistent with other studies where the primary foraging strategy for both species was to pick epibenthic food items from rocks and cobbles, which required relatively stable substrates. Bald Eagles, a dispersed and abundant species in the Kodiak Archipelago, used most habitat types in proportion to their availability, but did show significantly less than expected use of wetland/estuaries and exposed mobile and partially mobile substrates (Figure 4). See species accounts for more discussion on habitat preference results.

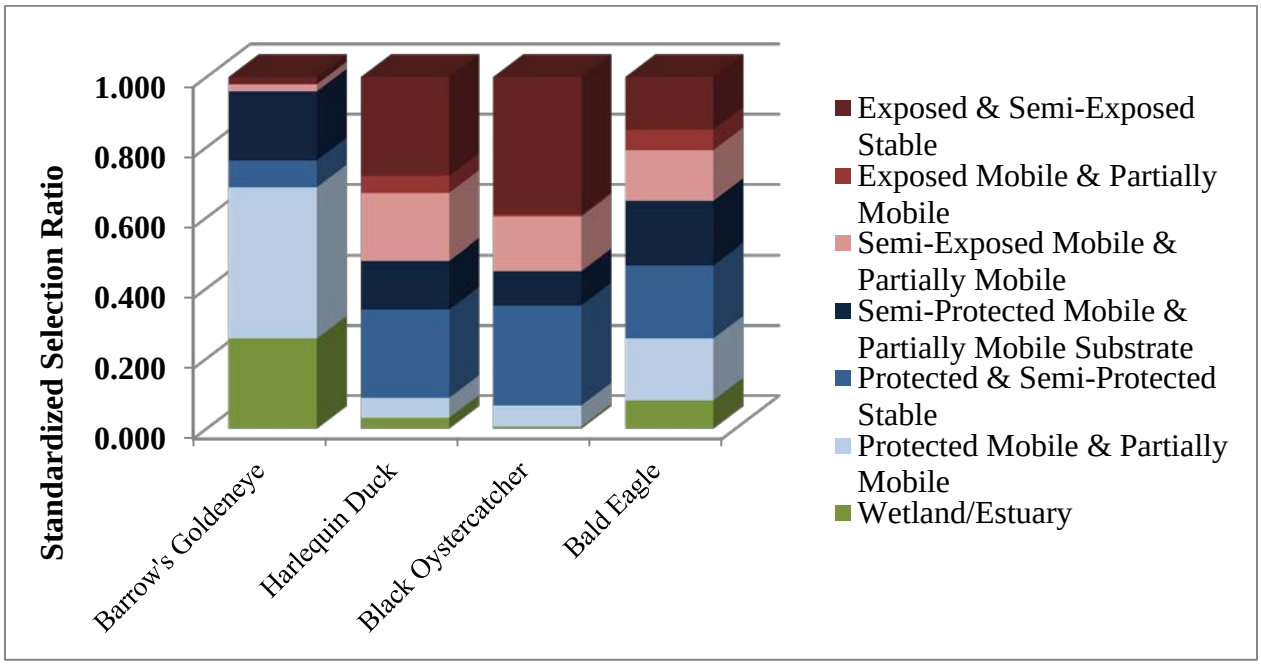

Figure 4. Standardized selection ratios of nearshore marine birds to biophysical habitat classes (defined by Alaska ShoreZone habitat mapping) from surveys in the Kodiak Archipelago, June and August, 2011-2013.

Productivity

For most of the species for which we recorded the juvenile (hatch-year):adult (after-hatch-year) ratio, productivity was relatively low in 2011 on East Kodiak Island, and high in 2013 on West Kodiak Island, with the exception of Kittlitz's Murrelet (Figure 5). These results were consistent with broader patterns seen in the GOA where widespread seabird reproductive failures were documented in the summer of 2011 at Aiktak Island; Chowiet Island, in the Semidi Islands; East Amatuli Island, in the Barren Islands, and Middleton Island, south of PWS (Zador 2012). Much of the reproductive failure occurred early in the breeding season during the egg stage, and widespread sampling of low trophic level zooplankton and small fish indicated poor foraging conditions for upper trophic level predators like seabirds during 2011 (Zador 2012). Reproductive success was average or high for most seabird species monitored throughout the GOA in 2012 and 2013 (Dragoo et al. 2013, Dragoo 2014).

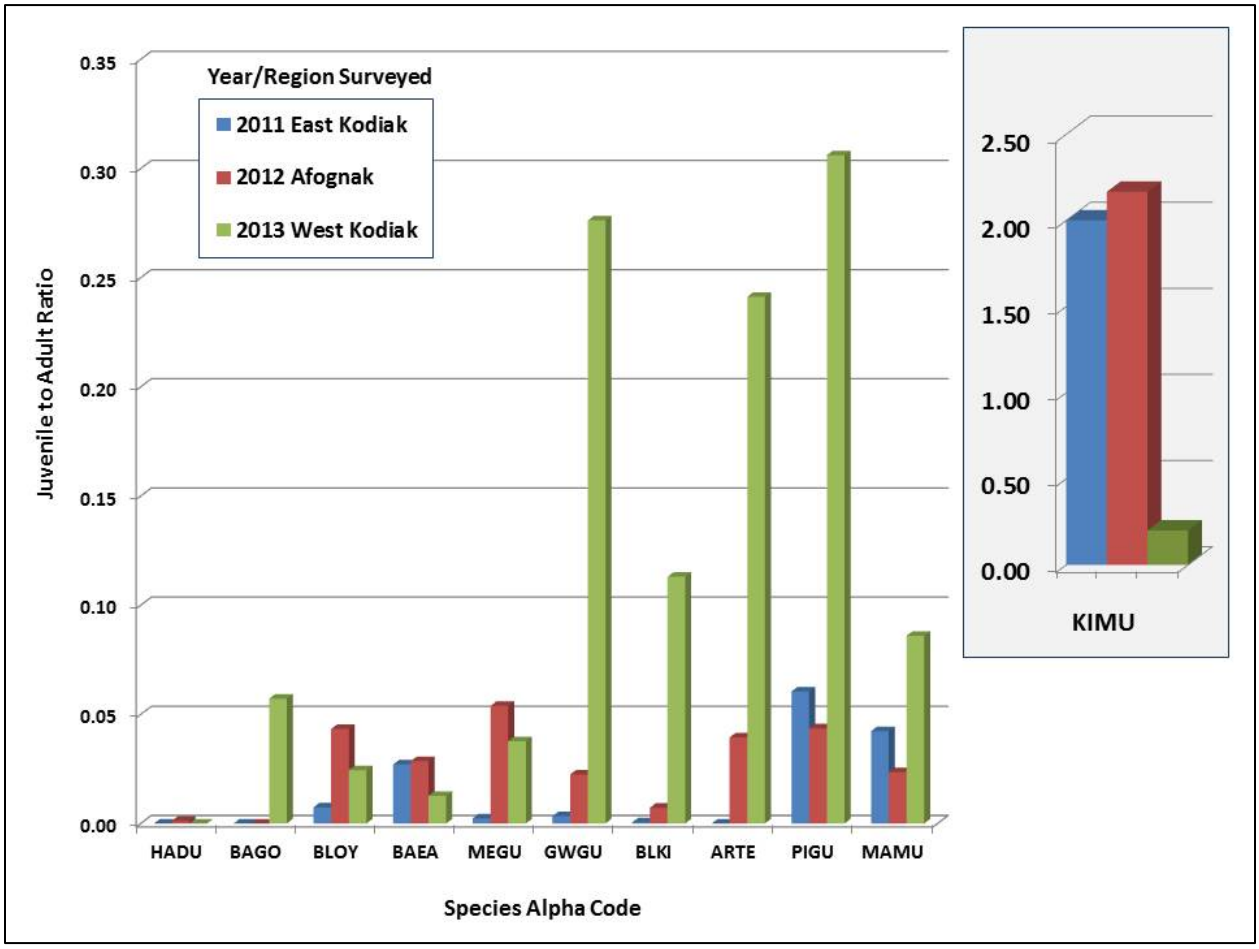

Figure 5. Productivity measured as the ratio of juvenile (hatch-year) to adult birds surveyed on the Kodiak Refuge marine bird transects 2011-2013 by species (HADU: Harlequin Duck, BAGO: Barrow's Goldeneye, BLOY: Black Oystercatcher, BAEA: Bald Eagle, MEGU: Mew Gull, GWGU: Glaucous-winged Gull, BLKI: Black-legged Kittiwake, ARTE: Arctic Tern, PIGU: Pigeon Guillemot, MAMU: Marbled Murrelet, KIMU: Kittlitz's Murrelet.

One exception to this pattern was the unusually low index of productivity for Kittlitz's Murretels on the west side of Kodiak in 2013. The low 2013 productivity index was also in contrast to

results from the Kodiak NWR Kittlitz's Murrelet nesting ecology study in which apparent nest success increased from 17% from 2008-2011 to 45% in 2012-2013. The low productivity index in 2013 could be attributed to small sample size, and the higher number of adults seen in 2013 than in previous surveys. In 2013 we counted 10 adult Kittlitz's Murrelets, twice more than seen on previous August surveys (Table 6).

Species Accounts

The following sections provide species specific summaries including general distribution patterns and habitat associations.

Harlequin Duck

Harlequin ducks are a small sea duck that nests on clear, fast-flowing rivers and streams. The nonbreeding season is spent in the shallow intertidal zones of rocky coastlines where they forage close to shore on a variety of prey items. In Alaska most individuals remain to winter in the general area where they molted (Robertson and Goudie 1999). They are one of the most abundant sea ducks found on Kodiak year-round, and the Refuge dedicated a summer coastal survey to this species from 1994 until 2010. In addition to surveys, molting Harlequin Ducks have been banded by Kodiak NWR biologists on a near-annual basis since 1996.

During the current nearshore marine bird survey numbers of Harlequin Ducks were typically lower in June when breeding birds had moved to sites along rivers and streams to nest, but increased in August as failed breeders and females with fledged young returned to coastal locations to molt and overwinter (Figure 6). In total 1,693 harlequin ducks were counted in June, and 3,608 were counted in August, over three field seasons 2011-2013 (Figure 7). Harlequin Ducks were recorded on 44% of nearshore transects in June, and 67% of transects in August. The species was most abundant on East Kodiak and least abundant on West Kodiak (Table 12).

Tests for differences in the use of individual habitat classes using standardized selection ratios identified Harlequin Ducks preference for stable habitats and against mobile sediments on Kodiak (Table 13). These results were consistent with other studies where the primary foraging strategy of the species was to pick epibenthic food items from rocks and cobbles with high densities of harlequin ducks sometimes found over mussel (*Mytilus adulis*) beds (Patten et al. 1998). On Kodiak the species often uses clusters of offshore rocks as foraging and haul-out locations.

Photo: R. Corcoran; Harlequin Ducks, Partition Cove, Sitkalidak Island, Kodiak, Alaska, June 2011

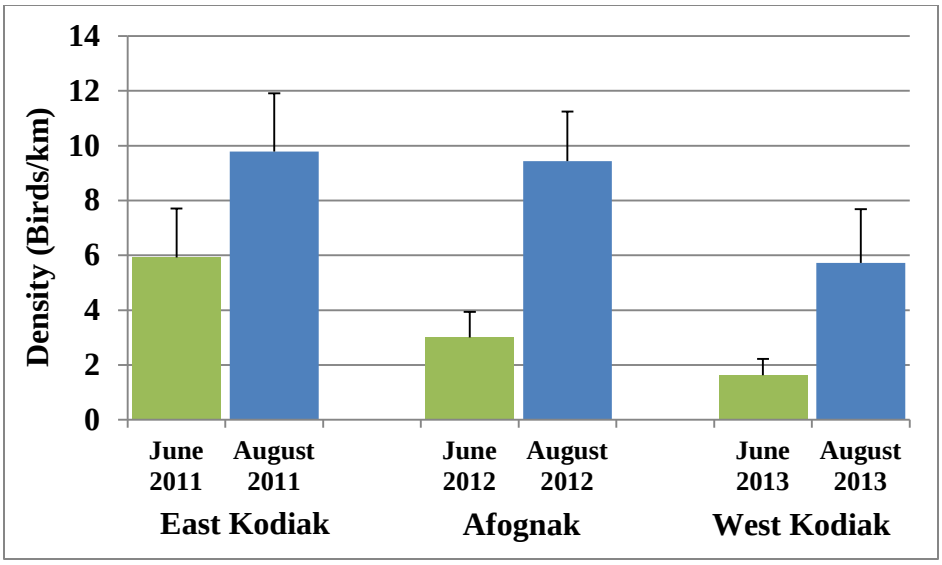

Figure 6. Density estimates (birds/km) and standard error (SE) of Harlequin Ducks surveyed on nearshore transects in June and August in 2011 (East Kodiak), 2012 (Afognak) and 2013 (West Kodiak) on the Kodiak Archipelago, Alaska.

Table 12. Harlequin Duck population estimates and lower and upper 95% confidence limits (LCL-UCL) in June and August from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**7,603 (5,906-9,300)**	**4,105 (2,646-5,563)**	**2,719 (1,906-3,532)**	**779 (477-1,081)**
August	**17,693 (11,091-24,295)**	**6,593 (372-12,815)**	**8,428 (6,539-10,317)**	**2,671 (1,525-3,818)**

Table 13. Differential use of habitat types from Alaska ShoreZone habitat mapping by Harlequin Ducks (n = 5,275) counted on 1,018 linear km of skiff based transects in the Kodiak Archipelago, Alaska, in June and August 2011-2013. Transects were systematically selected from a random starting point such that 20% of the coastline was surveyed. Tests are based on individual comparisons of observed proportions (p_i) to expected proportions (p_{io}).

ShoreZone Habitat Description	Census effort in km; effort ratio(p_{io})	Number; proportion of Harlequin Ducks observed (p_i)	Confidence interval on observed proportion of occurrence (p_i) (95% family confidence coefficient)
Exposed & Semi-Exposed Stable	115 (0.113)	1148 (0.218)	$0.202 \leq p_1 \leq 0.233$ [a]
Protected & Semi-Protected Stable	83 (0.082)	743 (0.141)	$0.128 \leq p_2 \leq 0.154$ [a]
Semi-Exposed Mobile & Partially Mobile	178 (0.175)	1219 (0.231)	$0.216 \leq p_3 \leq 0.247$ [a]
Semi-Protected Mobile & Partially Mobile Substrate	326 (0.320)	1607 (0.305)	$0.288 \leq p_4 \leq 0.322$
Protected Mobile & Partially Mobile	183 (0.179)	368 (0.070)	$0.060 \leq p_5 \leq 0.079$ [b]
Exposed Mobile & Partially Mobile	70 (0.069)	120 (0.023)	$0.017 \leq p_6 \leq 0.028$ [b]
Wetland/Estuary	63 (0.062)	70 (0.013)	$0.009 \leq p_7 \leq 0.018$ [b]

[a] Significantly ($p < 0.05$) greater than expected use.
[b] Significantly ($p < 0.05$) less than expected use.

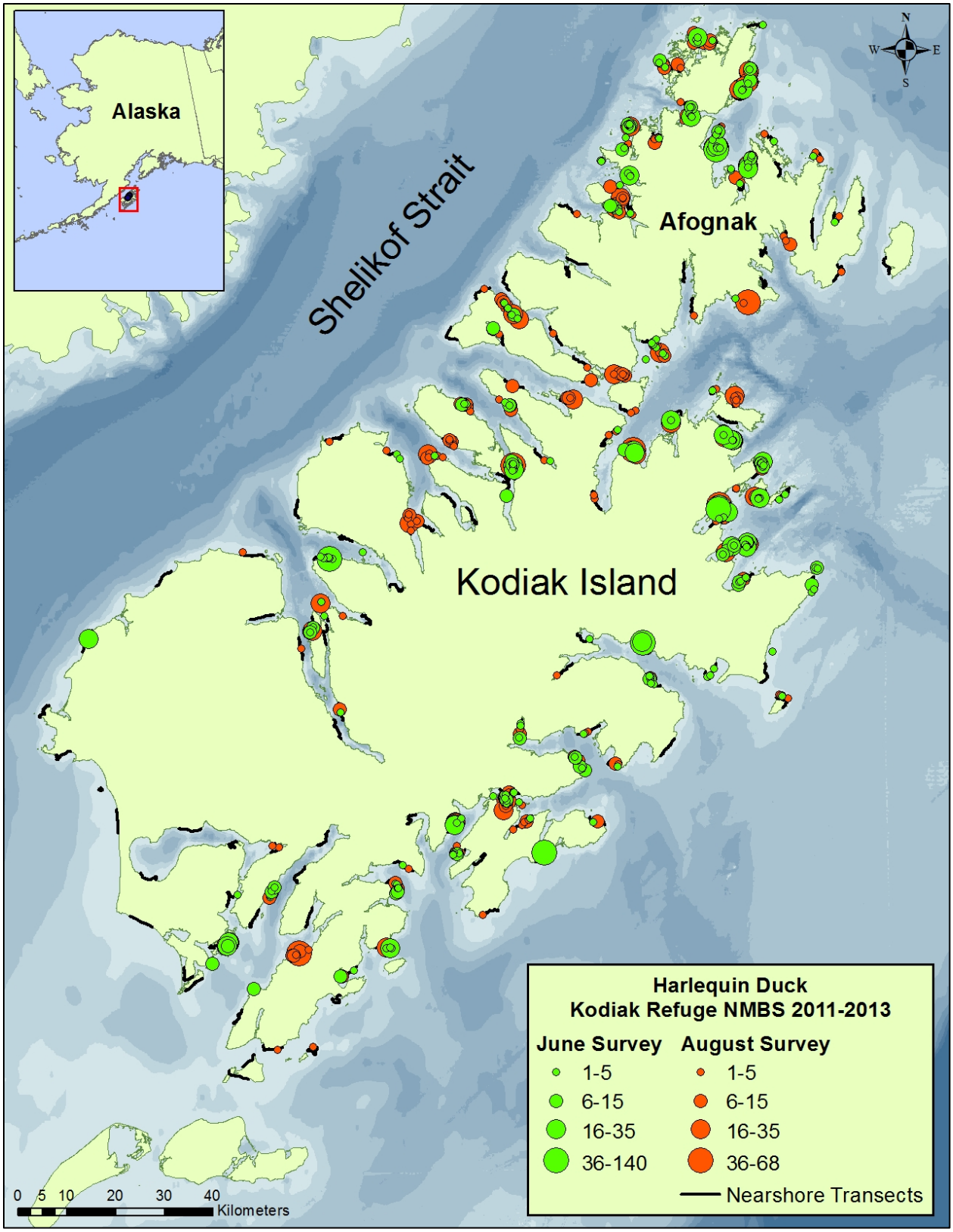

Figure 7. Harlequin Duck numbers (n = 5,301) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Trends in Harlequin Duck 1994-2013 in Selected Bays

We compared population counts of Harlequin Ducks in selected bays from August 1994-2010 to a population estimate based on a subset of the nearshore marine bird survey transects surveyed in specific bays (August 2011-2013). Population estimates for the bays were consistent with previous counts, with non-significant increases on East Kodiak (Alitak Bay and Sitklaidak Island) and stable to declining populations on West Kodiak (Uyak and Uganik Bays) and Afognak Islands (Figure 8). The only significant result based on simple linear regression was declines observed in Uyak Bay ($F = 34.08$; $p < 0.001$).

Localized declines in Harlequin Duck numbers in Uyak Bay on the west side of Kodiak Island were documented by the Refuge coastal bird surveys from 1994-2010. The declines (Figure 8) may have resulted from high hunter harvest rates. In addition to surveys, Kodiak NWR biologists have been banding molting Harlequin Ducks annually in August since 1996, and in that time 1,386 have been banded. Table 14 is a summary of Harlequins Ducks banded at seven areas in the Kodiak Archipelago, and includes both ducks that have been recaptured in subsequent years by biologists, and hunter killed band returns reported to the Patuxent Wildlife Research Center Bird Banding Laboratory. Based on recaptures and hunter killed band returns the species demonstrated a high degree of site fidelity to molting locations; between year recaptures and birds shot in the Fall and Winter were all located within a few kilometers of the initial banding location. The number of hunter killed birds in Uyak Bay (39) was more than four times the number killed in Uganik Bay (9), even though approximately the same numbers of birds were banded in each bay. A minimum of 68% of all hunter killed banded birds (44 of 65) were shot by non-resident hunters. The Kodiak Archipelago is a very well-known destination for sea duck hunting with numerous lodges and charter boat operations devoted specifically to targeting Harlequin and Long-tailed Ducks, all three species of scoters, and Common and Barrow's Goldeneye.

Table 14. The number of Harlequin Ducks banded by area in the Kodiak Archipelago, Alaska, 1996-2013. Recaptures are banded birds that are captured in subsequent years by Refuge biologists and released. Hunter killed birds are reported to the Patuxent Wildlife Research Center Bird Banding Laboratory after being shot.

BANDING AREA	1996-2015 TOTAL BANDED	1996-2015 RECAPTURES	1996-2015 HUNTER KILL
Uyak Bay	424	27	39
Uganik Bay	470	17	9
Afognak Island	167	8	6
Sitkalidak Island	90	8	4
Alitak Bay	135	0	1
Chiniak Bay	74	0	6
Karluk Lake	26	3	0
TOTALS	**1,386**	**63**	**65**

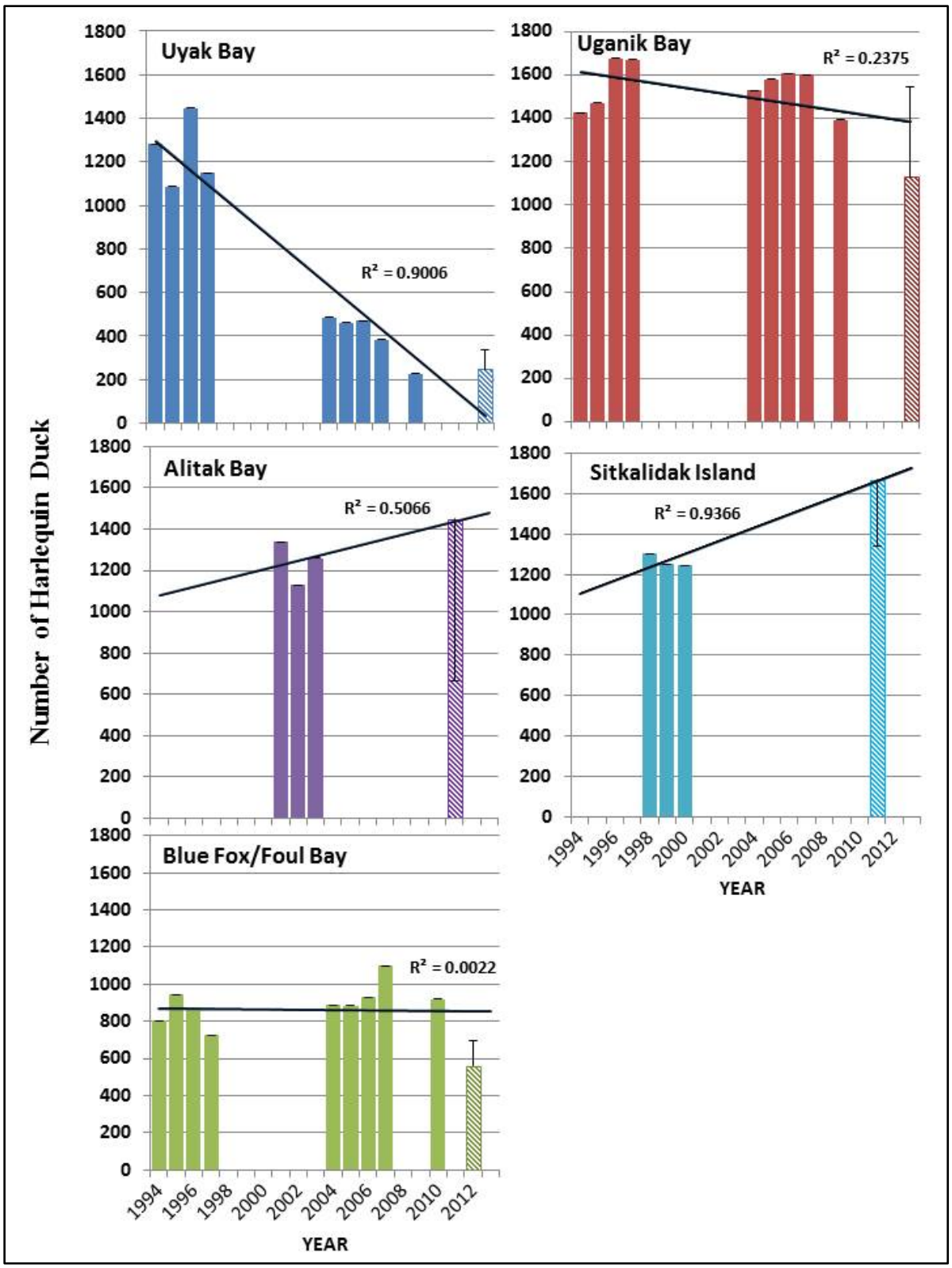

Figure 8. Comparison of Harlequin Duck counts from coastal Harlequin Duck surveys (1994-2010) and population estimates from nearshore marine bird surveys (2011-2013) for select bays in the Kodiak Archipelago, Alaska. Bars on the nearshore marine bird survey data (2011-2013) = 1 standard error.

Barrow's Goldeneye

Primarily a duck of the western mountains of North America, Barrow's Goldeneye are generally restricted to areas west of the Continental Divide, with small numbers found in the eastern Canadian Maritime Provinces and United States. They breed in tree cavities on interior fresh-water lakes and ponds and spend fall and winter on salt water or estuaries along the coast. Because of the restricted distribution of this species (60% of the world population breeds and winters in a single Canadian province) and relatively small global population (estimated 200,000 – 250,000 birds), this species warrants careful monitoring (Eadie et al. 2000). Potential threats include oil spills on wintering areas, accumulation of heavy metals in prey items, recreational development on breeding lakes, and loss of nesting habitat (especially large nesting trees) due to logging.

Barrow's Goldeneye were common year round on Kodiak, although they were less frequently seen in summer on the nearshore marine bird survey when females were breeding on lakes and small ponds, and males leave the island to molt in large concentrations at sites in interior Alaska. Density estimates in June were low but similar across regions. Density (and population estimates) increased in August as breeding females returned from freshwater nesting habitat to the nearshore marine environment, and were higher on East and West Kodiak Island than Afognak (Figure 9; Table 15). During the current survey, 57 Barrow's Goldeneye were counted in June, and 373 were counted in August over three field seasons 2011-2013 (Figure 10). Barrow's Goldeneye were recorded on 11% of nearshore transects in June, and 9% of transects in August. Unique to Kodiak were several relatively large concentrations of molting female goldeneye in the salt water environment. These were the only known marine molting locations for this species on the west coast of North America.

Habitat analysis indicated significantly greater use of protected habitats with mobile and partially mobile substrates, and significantly less use of stable substrates on Kodiak (Table 16). Preference for protected habitats was not unexpected since most birds surveyed were in August, and consisted of flocks of molting females with broods. The diets of Barrow's Goldeneye vary with season and habitat (fresh water versus salt water) but are dominated by insects, mollusks, and crustaceans. They prefer shallow open water without emergent or dense submerged vegetation along shorelines (usually < 4 m deep) (Eadie et al. 2000). Mobile and partially mobile substrates on Kodiak may support higher densities of goldeneyes preferred prey.

Photo: R. Corcoran; Barrow's Goldeneye, Ugak Bay, Kodiak, Alaska, June 2011

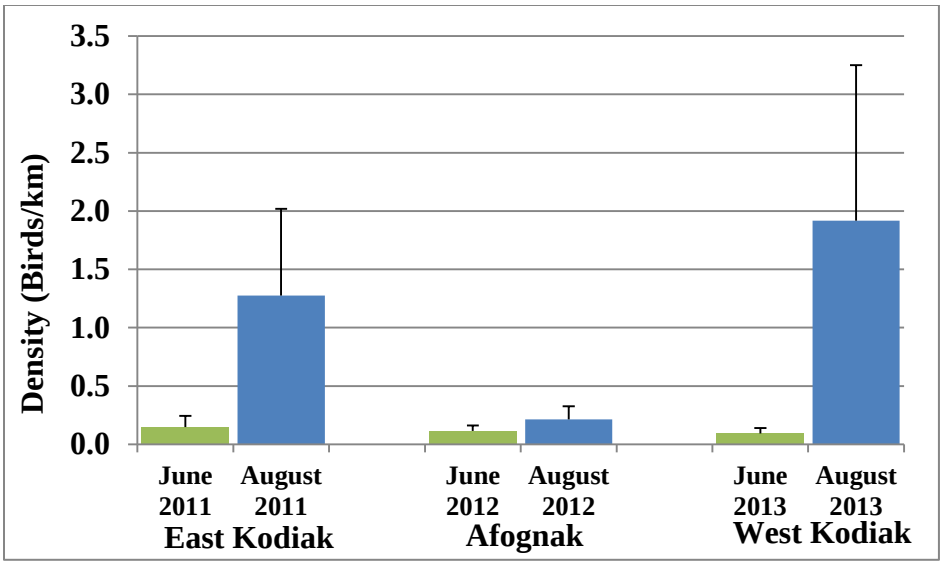

Figure 9. Density estimates (birds/km) and standard error (SE) of Barrow's Goldeneye surveyed on nearshore transects in June and August in 2011 (East Kodiak), 2012 (Afognak) and 2013 (West Kodiak) on the Kodiak Archipelago, Alaska.

Table 15. Barrow's goldeneye population estimates and lower and upper 95% confidence limits (LCL-UCL) in June and August from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**258 (161-354)**	**112 (28-197)**	**103 (62-143)**	**43 (20-65)**
August	**1,853 (844-2,862)**	**889 (204-1,573)**	**183 (67-299)**	**781 (50-1,513)**

Table 16. Differential use of habitat types from Alaska ShoreZone habitat mapping by Barrow's Goldeneye (n = 430) counted on 1,018 linear km of skiff based transects in the Kodiak Archipelago, Alaska, in June and August 2011-2013. Transects were systematically selected from a random starting point such that 20% of the coastline was surveyed. Tests are based on individual comparisons of observed proportions (p_i) to expected proportions (p_{io}).

ShoreZone Habitat Description	Census effort in km; effort ratio (p_{io})	Number; proportion of Barrow's Goldeneye observed (p_i)	Confidence interval on observed proportion of occurrence (p_i) (95% family confidence coefficient)
Protected Mobile & Partially Mobile	183 (0.179)	197 (0.458)	$0.394 \leq p_1 \leq 0.523$ [a]
Wetland/Estuary	63 (0.062)	41 (0.095)	$0.057 \leq p_2 \leq 0.133$
Semi-Protected Mobile & Partially Mobile Substrate	326 (0.320)	161 (0.374)	$0.312 \leq p_3 \leq 0.437$
Protected & Semi-Protected Stable	83 (0.082)	16 (0.037)	$0.013 \leq p_4 \leq 0.062$ [b]
Exposed & Semi-Exposed Stable	115 (0.113)	6 (0.014)	$-0.002 \leq p_5 \leq 0.029$ [b]
Semi-Exposed Mobile & Partially Mobile	178 (0.175)	9 (0.021)	$0.002 \leq p_6 \leq 0.040$ [b]
Exposed Mobile & Partially Mobile	70 (0.069)	0 (0.000)	$0.000 \leq p_3 \leq 0.00$ [b]

[a] Significantly ($p < 0.05$) greater than expected use.
[b] Significantly ($p < 0.05$) less than expected use.

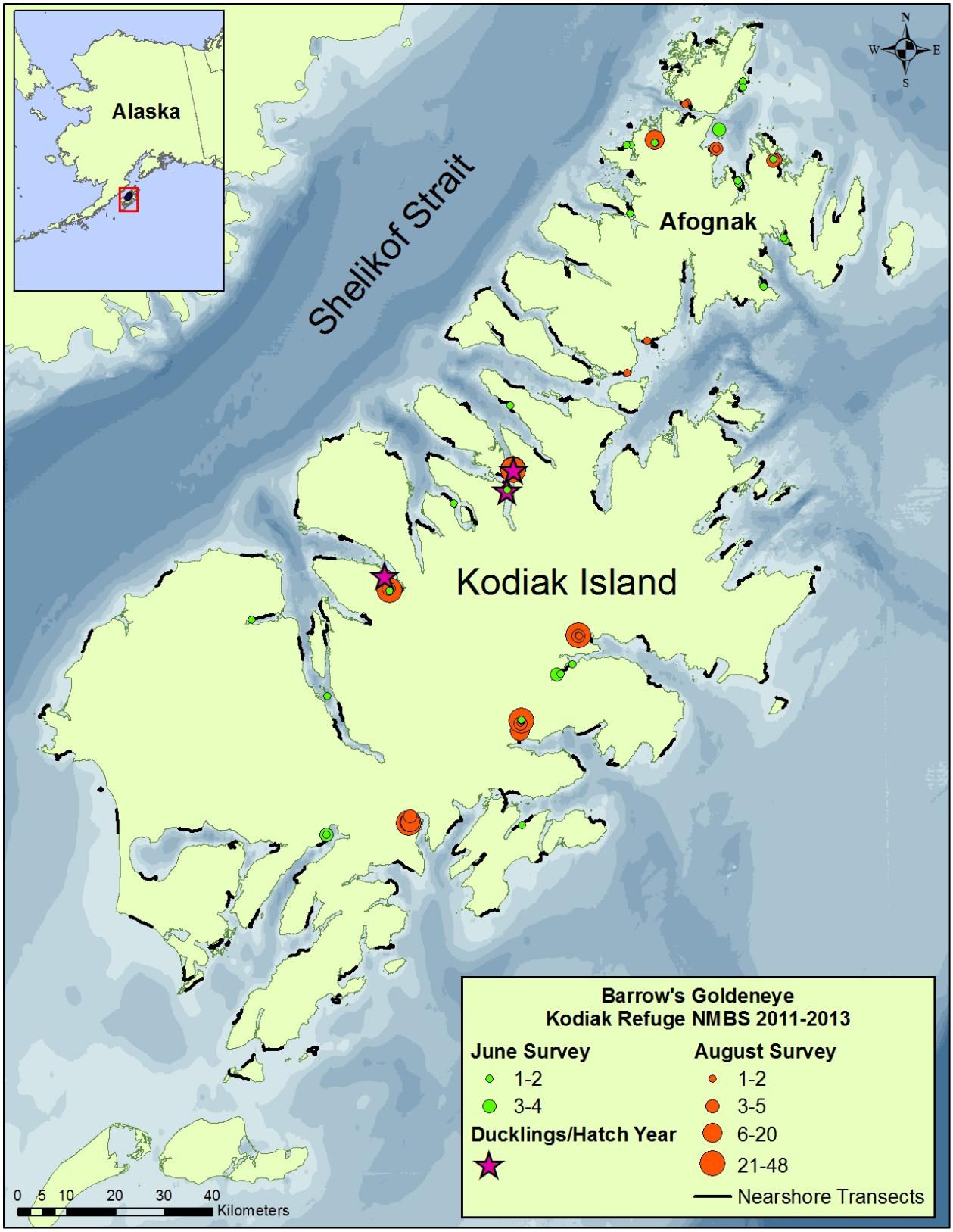

Figure 10. Barrow's Goldeneye numbers (n = 430) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Common Merganser

As a top predator in aquatic food chains, the Common Merganser has served as an indicator of environmental health both for contaminants (pesticides, toxic metals) and lake acidification, particularly in eastern North America and the Great Lakes region. Both sport and subsistence hunting pressure are low since the species is not considered good table fare. Most hunting occurs along the Atlantic and Pacific flyways, and subsistence harvest is estimated at < 1,000 mergansers/year in northern Canada and 1,558 mergansers/year in Alaska (Rothe et al. 2015). Although a reliable estimate of current population size is lacking, trend data suggest that the North American population is generally stable or increasing (Pearce et al. 2015).

A common species on Kodiak year round, Common Mergansers spend much of the breeding season on freshwater rivers and lakes where they nest in tree cavities. At the end of the breeding season they are found in large molting flocks on larger lakes and several estuaries on Kodiak. Molting flocks of common mergansers may be composed of individuals from multiple natal and breeding areas because male mergansers migrate to molting areas whereas females molt near where they breed. Limited evidence from band recoveries and mtDNA suggests that some males at Kodiak are migrating between natal and molting areas. Four birds banded on Kodiak Island during molt were recovered while wintering in Washington, Oregon, and California. A DNA sample from one of these was most closely related to Common Mergansers breeding in the continental United States, suggesting this bird migrated to Kodiak for molt before returning to its natal area to winter (Pearce et al. 2009). Long-distance migration to molting areas has also been documented by banding for the Common Merganser in Europe (Little and Furness 1985). The long-distance migrations implied by band recovery data from Kodiak could also be interpreted as annual migration north to breeding and molting areas in Alaska followed by a return migration to wintering areas farther south.

In general Common Merganser density was higher on East and West Kodiak than Afognak, and densities were higher in August on East Kodiak and Afognak (Figure 11). Population estimates did not differ significantly between June and August (Table 17). During the current survey, 473 Common Mergansers were counted in June, and 648 were counted in August over three field seasons 2011-2013 (Figure 12). Common Mergansers exhibited a clumped distribution and were recorded on only 9% of nearshore transects surveyed in both June and August, leading to high variance on density and population estimates (Figure 11; Table 10).

Photo: R. Corcoran; Common Mergansers, Foul Bay, Afognak Island, Kodiak, Alaska, August 2012

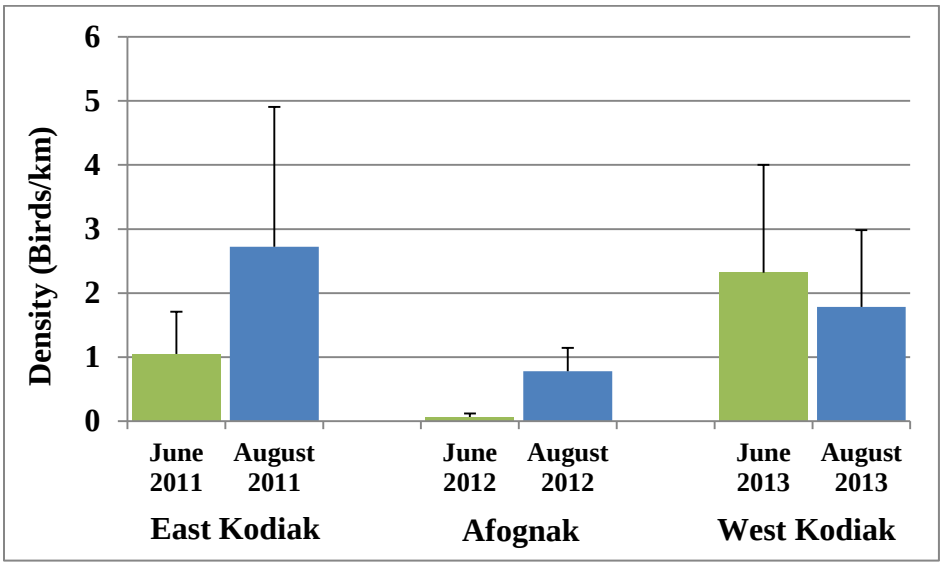

Figure 11. Density estimates (birds/km) and standard error (SE) of Common Mergansers surveyed on nearshore transects in June and August in 2011 (East Kodiak), 2012 (Afognak) and 2013 (West Kodiak) on the Kodiak Archipelago, Alaska.

Table 17. Common Merganser population estimates and lower and upper 95% confidence limits (LCL-UCL) in June and August from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**2,093 (958-3,228)**	**843 (196-1,491)**	**58 (14-102)**	**1,191 (260-2,123)**
August	**3,160 (604-5,716)**	**1,768 (-674-4,209)**	**653 (310-996)**	**739 (64-1,414)**

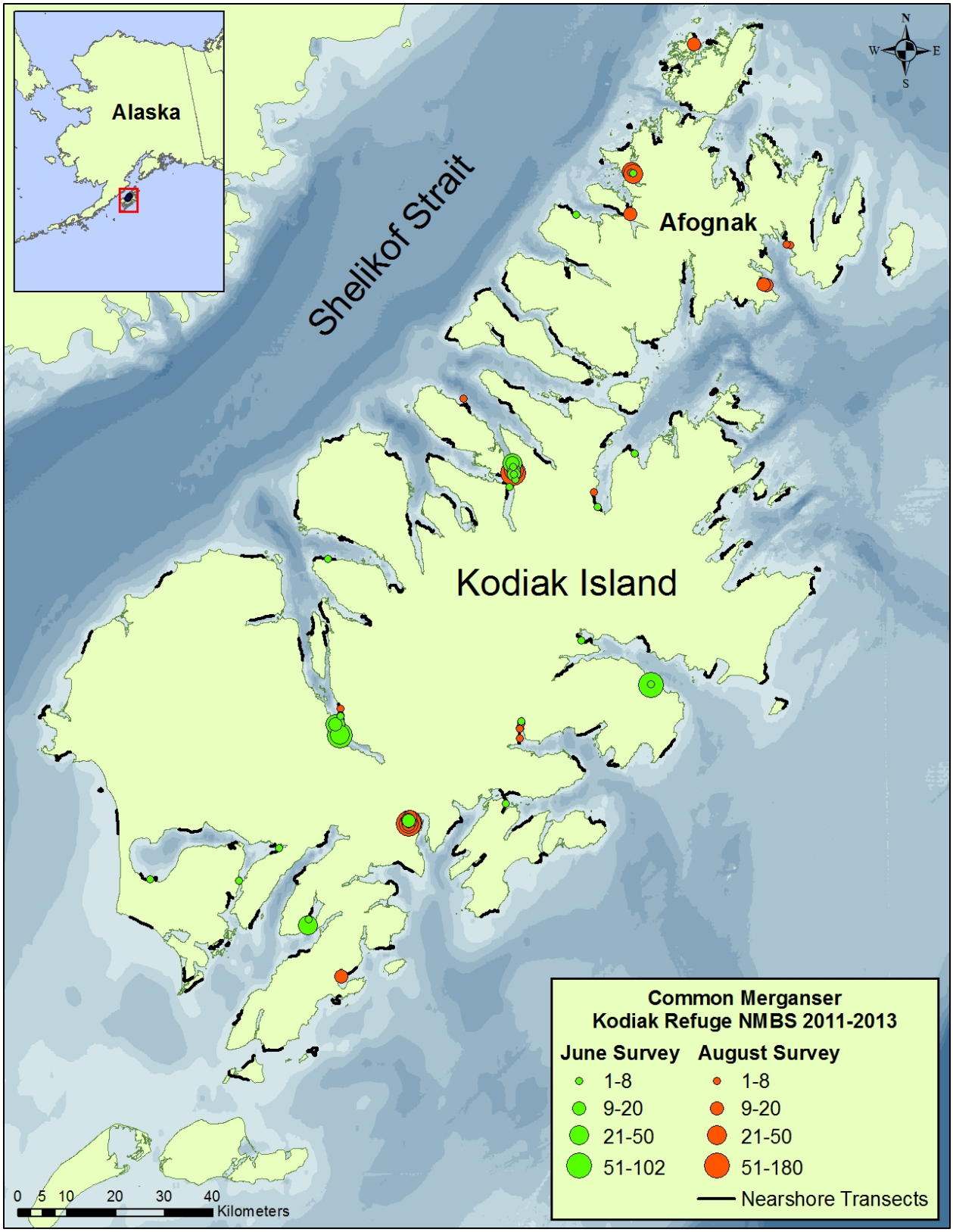

Figure 12. Common Merganser numbers (n = 1,121) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Red-breasted Merganser

The Red-breasted Merganser is a medium-sized diving duck that is common year round on Kodiak. It is similar in distribution and ecology to the Common Merganser, but in contrast it occurs more frequently in salt water and estuaries. It is a late breeder having young that often do not fledge until September. Data from the Waterfowl Breeding Population and Habitat Survey indicate that merganser populations (Red-breasted and Common combined) in the mid-continent and Alaska regions increased from the early 1970s to mid-1980s and have been relatively stable since (Bowman et al. 2015).

Red-breasted Merganser density was similar across regions, although none were recorded on transects on West Kodiak in August 2013 (Figure 13). Abundance was higher in June, the archipelago-wide population estimate for June 2011-2013 was 1,441 compared to 871 in August 2011-2013 (Table 18). During the current nearshore marine bird survey, 326 Red-breasted Mergansers were counted in June, and 180 were counted in August over three field seasons 2011-2013 (Figure 14). Red-breasted Mergansers were recorded on 32% of nearshore transects in June, but only 9% of transects in August.

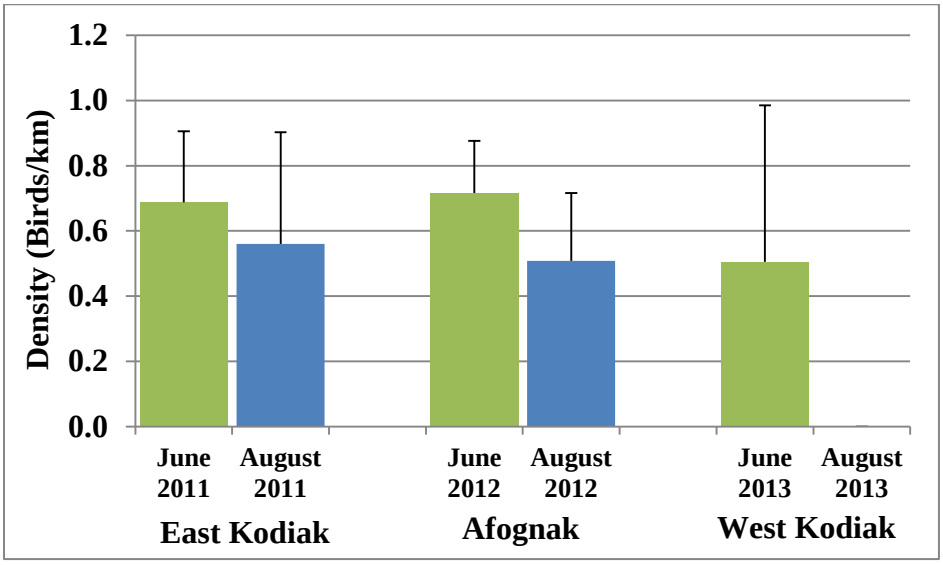

Figure 13. Density estimates (birds/km) and standard error (SE) of Red-breasted Mergansers surveyed on nearshore transects in June and August in 2011 (East Kodiak), 2012 (Afognak) and 2013 (West Kodiak) on the Kodiak Archipelago, Alaska.

Table 18. Red-breasted Merganser population estimates and lower and upper 95% confidence limits (LCL-UCL) in June and August from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**1,441 (1,109-1,773)**	**506 (304-709)**	**722 (558-886)**	**213 (7-418)**
August	**871 (503-1,239)**	**425 (128-723)**	**445 (229-662)**	**0**

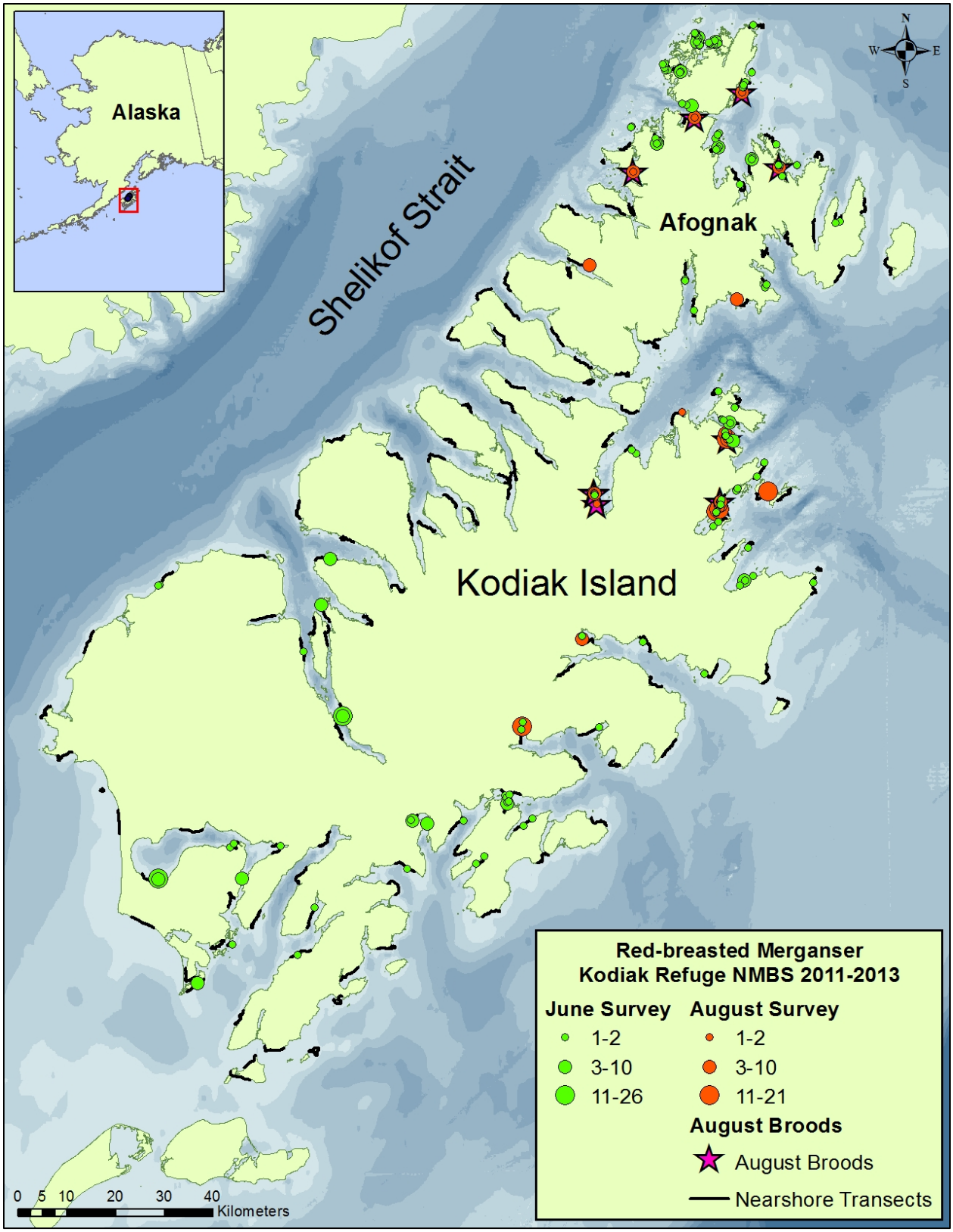

Figure 14. Red-breasted Merganser numbers (n = 506) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Black Oystercatcher

The Black Oystercatcher is a species of high conservation concern throughout its range because of its small population size (8,900–11,000 individuals) and threats to the birds and their coastal habitats throughout the annual cycle (Hickey et al. 2003, USSCP 2004, Tessler et al. 2007). It is a keystone species along the North Pacific shoreline and is considered a sensitive indicator of the overall health of the rocky intertidal community. The species was selected as a USFWS Focal Species for priority conservation action due to its small population size and restricted range, threats to preferred habitat, susceptibility to human-related disturbances, a lack of base-line data to assess conservation status, and a suite of ongoing anthropogenic and natural factors that may potentially limit long-term viability (USFWS 2012). It is also listed as a species of high conservation concern within the United States, Canadian, Alaskan, and Northern and Southern Pacific shorebird conservation plans; is on the Audubon Society's Watch List (National Audubon Society 2002); and is a featured species in the Comprehensive Wildlife Conservation Strategies for the states in which it occurs.

A total of 1,021 Black Oystercatchers were counted in June (n = 318) and August (n = 703) over three field seasons 2011-2013 on the Kodiak Archipelago. Eight birds were removed from the analysis because they were observed flying on offshore transects that did not include appropriate island habitat (considered flyovers), therefore, the total number of Black Oystercatcher observations in the analysis was 1,013 (Figure 16). Eleven offshore transects included islands with suitable Black Oystercatcher habitat and these were combined with the nearshore data in the analysis. Hatch-year Black Oystercatchers were seen on only eight transects, a total of 25 were counted including repeated transects; 14 without repeats. Most (88%) hatch-year Black Oystercatchers were seen on Afognak in 2012. Black Oystercatchers were recorded on 35% of nearshore transects in June, and 37% of transects in August. The June population estimate for Black Oystercatcher of 1,410 (95% CL: 1,191-1,629) represents 13% of the estimated North American population for this species (Table 19).

Previous research with radio-tagged Black Oystercatchers in Alaska indicated the species is most likely resident year round in the Kodiak Archipelago, with most individuals tagged in Kodiak remaining < 15 km away from nesting territories during the non-breeding season (Johnson et al. 2010). Previous surveys by Kodiak NWR biologists in both winter and summer estimated comparable numbers of around 1,700 oystercatchers (Tessler et al. 2007). This consistency in oystercatcher numbers suggests there is not a large influx to Kodiak from other regions during the non-breeding season.

Black Oystercatcher preferentially used areas characterized by stable substrates irrespective of exposure (Table 20). Habitat selection was very similar to Harlequin Ducks (Figure 4) and probably reflects oystercatcher diet preferences for mollusks that typically attach themselves to hard stable surfaces, especially mussels and limpets (Andres and Falxa 1995).

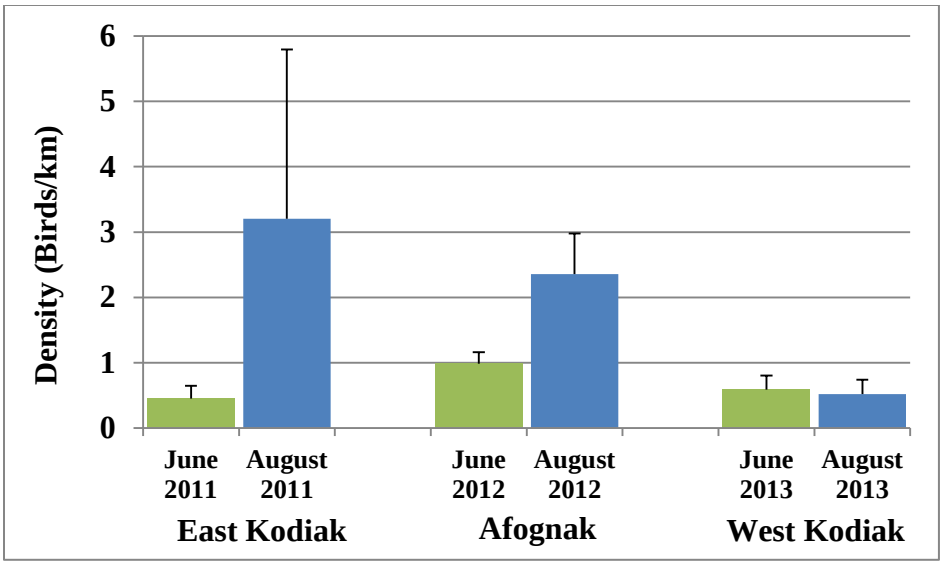

Figure 15. Density estimates (birds/km) and standard error (SE) of Black Oystercatchers surveyed on nearshore transects in June and August in 2011 (East Kodiak), 2012 (Afognak) and 2013 (West Kodiak) on the Kodiak Archipelago, Alaska.

Table 19. Black Oystercatcher population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**1,410 (1,191-1,629)**	**276 (150-403)**	**878 (731-1,026)**	**255 (154-356)**
August	**3,402 (1,991-4,814)**	**1,300 (23-2,577)**	**1,881 (1,291-2,470)**	**222 (100-344)**

Table 20. Differential use of habitat types from Alaska ShoreZone habitat mapping by Black Oystercatchers (n = 1021) counted on 1018 linear km of skiff based transects in the Kodiak Archipelago, Alaska, in June and August 2011-2013. Transects were systematically selected from a random starting point such that 20% of the coastline was surveyed. Tests are based on individual comparisons of observed proportions (p_i) to expected proportions (p_{io}).

ShoreZone Habitat Description	Census effort in km; effort ratio(p_{io})	Number; proportion of Black Oystercatchers observed (p_i)	Confidence interval on observed proportion of occurrence (p_i) (95% family confidence coefficient)
Exposed & Semi-Exposed Stable	115 (0.113)	328 (0.321)	$0.281 \leq p_1 \leq 0.361$ [a]
Protected & Semi-Protected Stable	83 (0.082)	173 (0.169)	$0.138 \leq p_2 \leq 0.201$ [a]
Semi-Exposed Mobile & Partially Mobile	178 (0.175)	201 (0.197)	$0.163 \leq p_3 \leq 0.230$
Semi-Protected Mobile & Partially Mobile Substrate	326 (0.320)	233 (0.228)	$0.193 \leq p_4 \leq 0.264$ [b]
Protected Mobile & Partially Mobile	183 (0.179)	80 (0.078)	$0.056 \leq p_5 \leq 0.101$ [b]
Wetland/Estuary	63 (0.062)	3 (0.003)	$-0.002 \leq p_6 \leq 0.008$ [b]
Exposed Mobile & Partially Mobile	70 (0.069)	3 (0.003)	$-0.002 \leq p_7 \leq 0.008$ [b]

[a] Significantly ($p < 0.05$) greater than expected use.
[b] Significantly ($p < 0.05$) less than expected use.

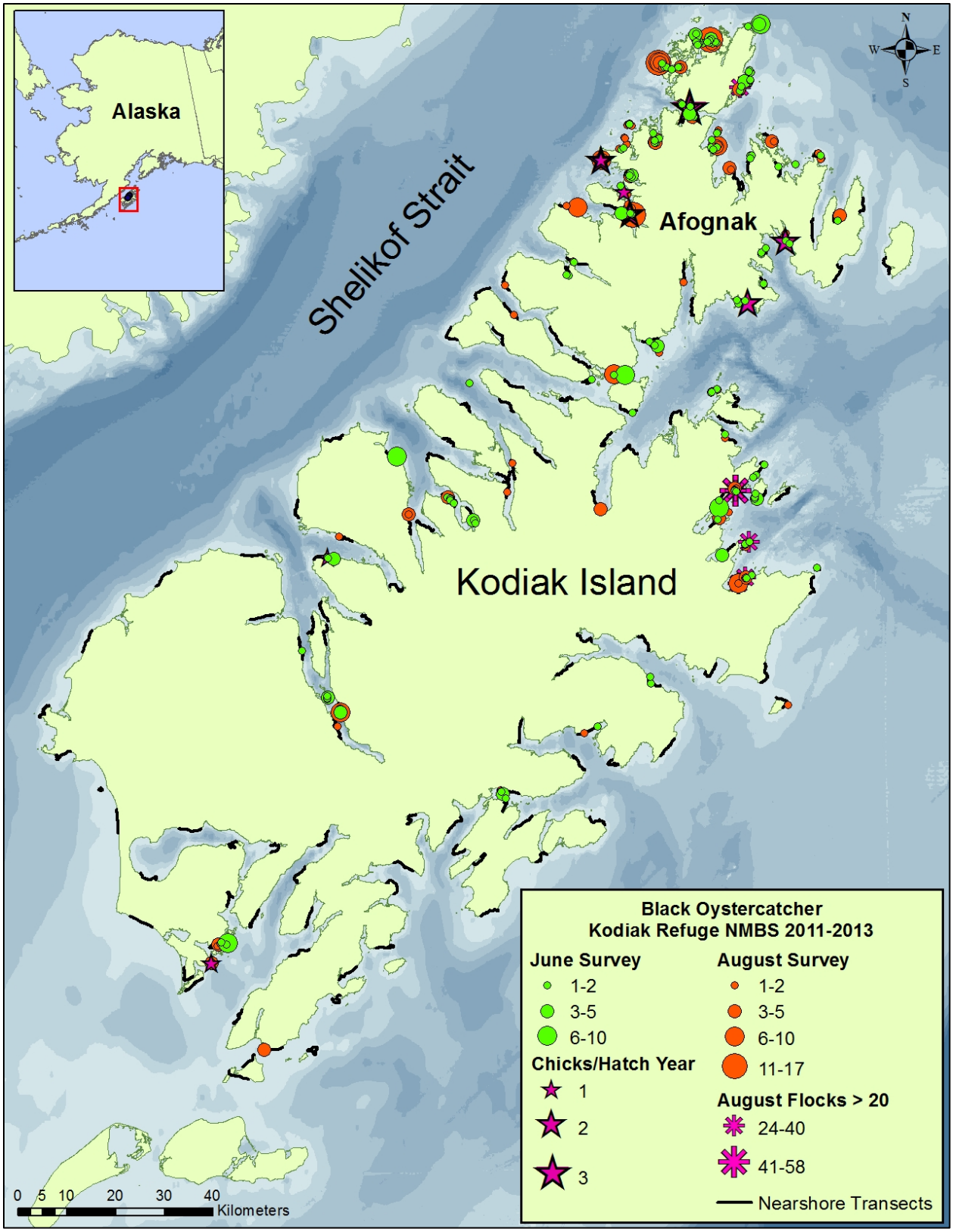

Figure 16. Black Oystercatcher numbers (n = 1,013) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Trends in Black Oystercatchers 1994-2013 in Selected Bays

We compared population counts of Black Oystercatchers in selected bays from August 1994-2010 to a population estimate based on a subset of the nearshore marine bird survey data of transects surveyed in specific bays (August 2011-2013). Population estimates for Blue Fox and Foul Bays on Afognak and Alitak Bay on East Kodiak were very similar to earlier counts (Figure 17). However, declines were seen in two bays surveyed on the West Kodiak (Uyak and Uganik Bays), with significant declines in Uyak Bay ($F_1 = 13.98$; $p < 0.005$). Black Oystercatchers were least common in the Sitkalidak Island region and sample sizes were too small to determine trends.

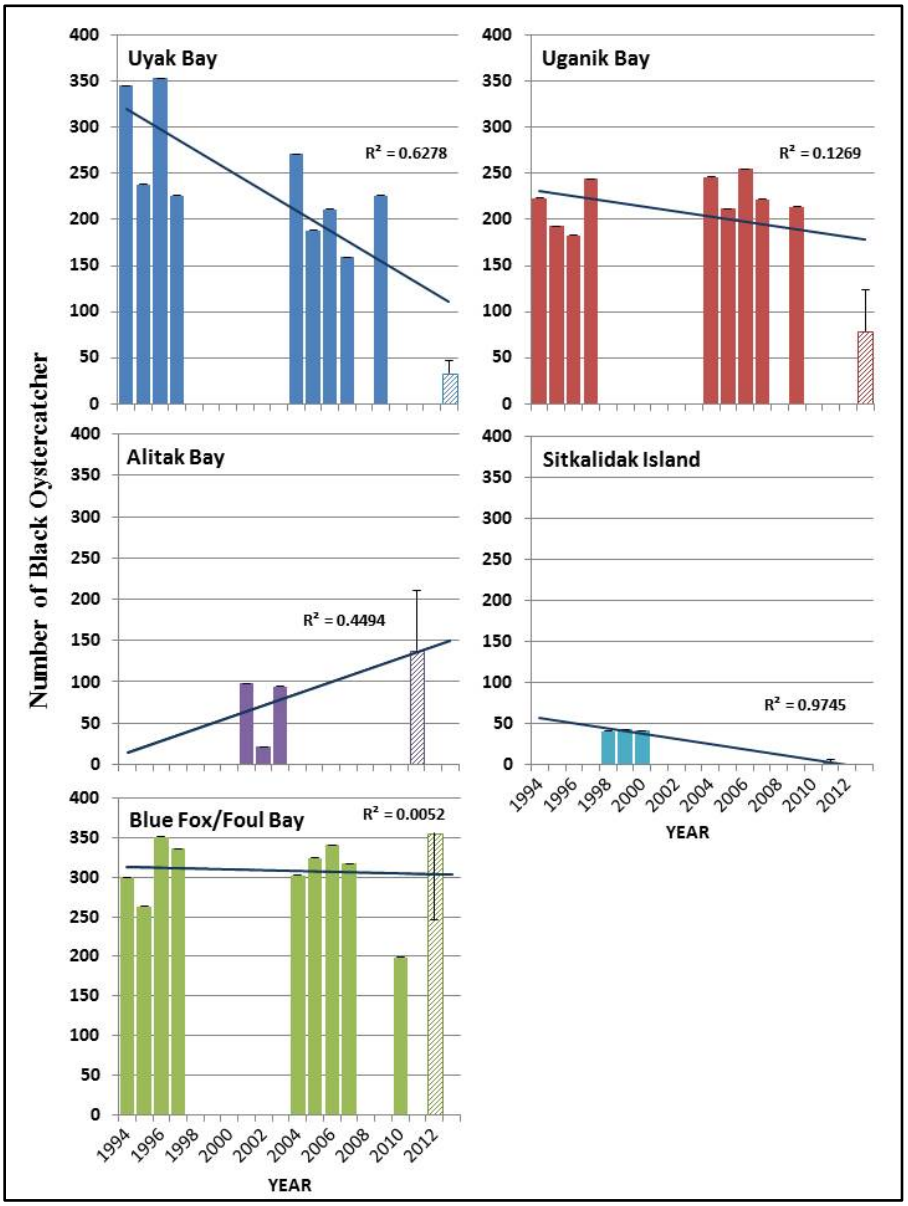

Figure 17. Comparison of Black Oystercatcher counts from coastal Harlequin Duck surveys, 1994-2010, to population estimates from nearshore marine bird surveys, 2011-2013, for select bays in the Kodiak Archipelago, Alaska. Bars on the nearshore marine bird survey data (2011-2013) = 1 standard error.

Bald Eagle

There is a long history of monitoring Bald Eagles on Kodiak Island. This program began in the 1950s with boat surveys along the shores of Karluk Lake, and the first aerial survey was conducted covering all potential habitat on Kodiak Refuge in 1963 (Troyer and Hensel 1965).

Data from Kodiak NWR Bald Eagle nest occupancy and success aerial census conducted every five years between 1963 and 2002 were published in 2007 (Zweifelhofer 2007a). Results indicated that the number of active eagle nests increased from 158 in 1963 to 538 in 2002. Based on annual reports the number of nests declined to 398 in 2007, and including regions added to the survey in more recent years (Afognak and Sitkalidak) there was a 2002 peak of 628 nests which declined to 439 in 2007 (Zwiefelhofer 2007b). The increase in nest number corresponds to similar patterns of growth in other Alaskan Bald Eagle populations in PWS, southeast, and interior Alaska. Possible factors considered for the increase included: 1) elimination of the bounty on eagles set the stage for future population growth, over 128,000 Bald Eagles were killed for bounty in Alaska between 1917 and 1952 (it is unknown how many were taken on Kodiak); 2) warmer climatic conditions provided increased food availability (shift in marine forage fish communities that occurred in the GOA in the early 1980s); and 3) growth and range expansion of introduced black-tailed deer on Kodiak provided carrion and increased over-winter survival.

In general density estimates for Bald Eagles were slightly higher in June for all regions surveyed during the current survey (Figure 18). In total 699 adult Bald Eagles were counted in June, and 523 were counted in August across three field seasons 2011-2013 (Figure 19). Adult Bald Eagles were recorded on 87% of nearshore transects in June, and 82% of transects in August. Subadult Bald Eagles were recorded on 21% of nearshore transects in June, and 23% of transects in August. Of the 175 subadult eagles observed, 16 were identified as hatch year individuals, most (14) still in the nest. In total, 31 active eagle nests were documented (Figure 19).

Archipelago-wide population estimates for breeding Bald Eagles based on nearshore marine bird surveys from 2011-2013 were 3,075 (95% CL: 2,862–3,289) in June, and 2,580 (95% CL: 2.331-2,828) (Table 22) in August. This population estimate represents Bald Eagles that nest on or near the coast, and does not include birds that nest on interior rivers and lakes. However, the historical Bald Eagle survey data from Kodiak (1963-2007) that included all potential nesting habitat, identified a total of 1,983 nests, 1,712 (86.3%) of which were located within 1 km of the coast. Despite decades of aerial surveys to determine Bald Eagle nest occupancy and success no previous population estimate exists for the Kodiak Archipelago. Interestingly the adult Bald Eagle population estimate in this study had the lowest coefficient of variation of any species included on the survey indicating our methods have high potential to identify changes in the coastal breeding population.

Bald Eagle nest density was high on Kodiak and it was not unusual for active nests to be within sight of each other along the coastline. Given this high nest density, and the high percentage of nearshore transects on which they occurred it was not unexpected that eagles used most habitat types in proportion to their availability. However, eagles did show significantly less than expected use of wetland/estuaries and exposed mobile and partially mobile substrates. The result for wetland/estuaries was unexpected since these areas were often concentrated sites for eagles foraging on spawning salmon. Lower than expected use may have occurred because there were

potentially more limited nesting opportunities in treeless estuaries that were common at the heads of bays on Kodiak (Figure 20).

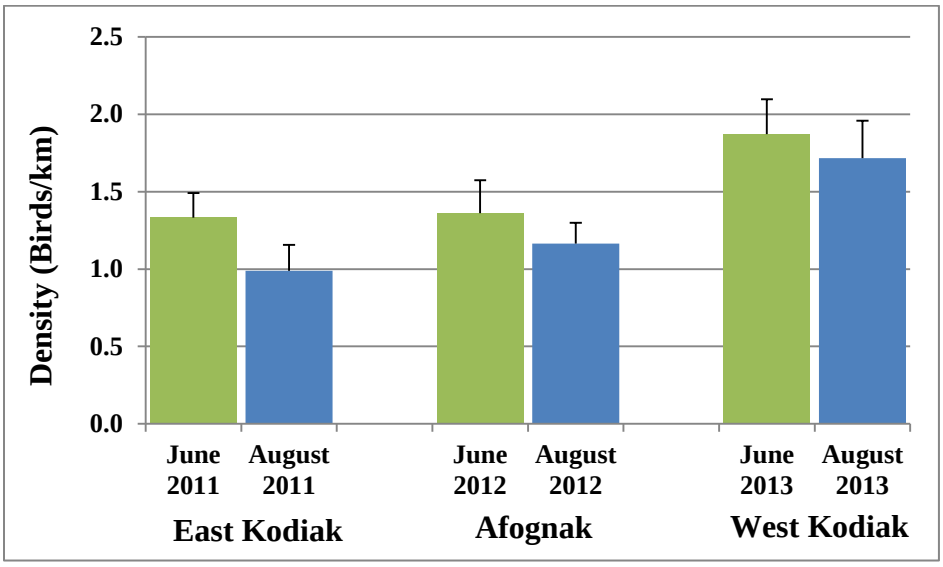

Figure 18. Density estimates (birds/km) and standard error (SE) of Adult Bald Eagles surveyed on nearshore transects in June and August in 2011 (East Kodiak), 2012 (Afognak) and 2013 (West Kodiak) on the Kodiak Archipelago, Alaska.

Table 21. Bald Eagle coastal population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

		Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	Adult	3,075 (2,862-3,289)	1,022 (895-1,148)	1,190 (1,038-1,343)	864 (784-943)
	Subadult	444 (325-563)	94 (55-133)	303 (194-412)	47 (19-75)
August	Adult	2,580 (2,331-2,828)	780 (606-954)	1,034 (916-1,152)	766 (633-898)
	Subadult	372 (282-462)	85 (39-131)	208 (138-278)	79 (48-110)

Table 22. Differential use of habitat types from Alaska ShoreZone habitat mapping by adult Bald Eagles (n = 1,221) counted on 1,018 linear km of skiff based transects in the Kodiak Archipelago, Alaska, in June and August 2011-2013. Transects were systematically selected from a random starting point such that 20% of the coastline was surveyed. Tests were based on individual comparisons of observed proportions (p_i) to expected proportions (p_{io}).

ShoreZone Habitat Description	Census effort in km; effort ratio(p_{io})	Number; proportion of Bald Eagles observed (p_i)	Confidence interval on observed proportion of occurrence (p_i) (95% family confidence coefficient)
Protected & Semi-Protected Stable	83 (0.082)	131 (0.107)	$0.084 \leq p_1 \leq 0.131$
Semi-Protected Mobile & Partially Mobile Substrate	326 (0.320)	451 (0.369)	$0.332 \leq p_2 \leq 0.407$
Protected Mobile & Partially Mobile	183 (0.179)	244 (0.200)	$0.169 \leq p_3 \leq 0.231$
Exposed & Semi-Exposed Stable	115 (0.113)	130 (0.106)	$0.083 \leq p_4 \leq 0.130$
Semi-Exposed Mobile & Partially Mobile	178 (0.175)	195 (0.160)	$0.132 \leq p_5 \leq 0.188$
Wetland/Estuary	63 (0.062)	39 (0.032)	$0.018 \leq p_6 \leq 0.046$ [b]
Exposed Mobile & Partially Mobile	70 (0.069)	31 (0.025)	$0.013 \leq p_7 \leq 0.038$ [b]

[b] Significantly ($p < 0.05$) less than expected use.

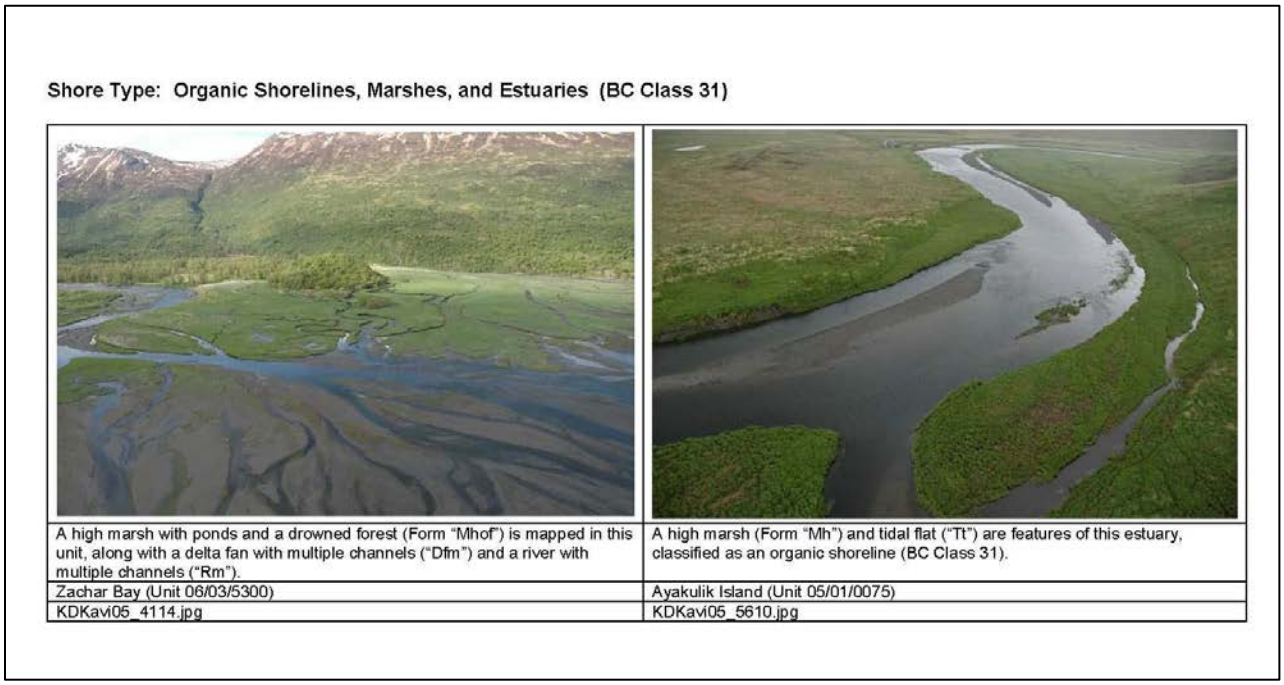

Figure 19. Shore type photographs from Kodiak Shorezone coastal mapping (Harney and Morris 2007) illustrating wetland/estuary habitat class. These habitats on Kodiak generally lack trees or other potential structures for Bald Eagles to place their nests.

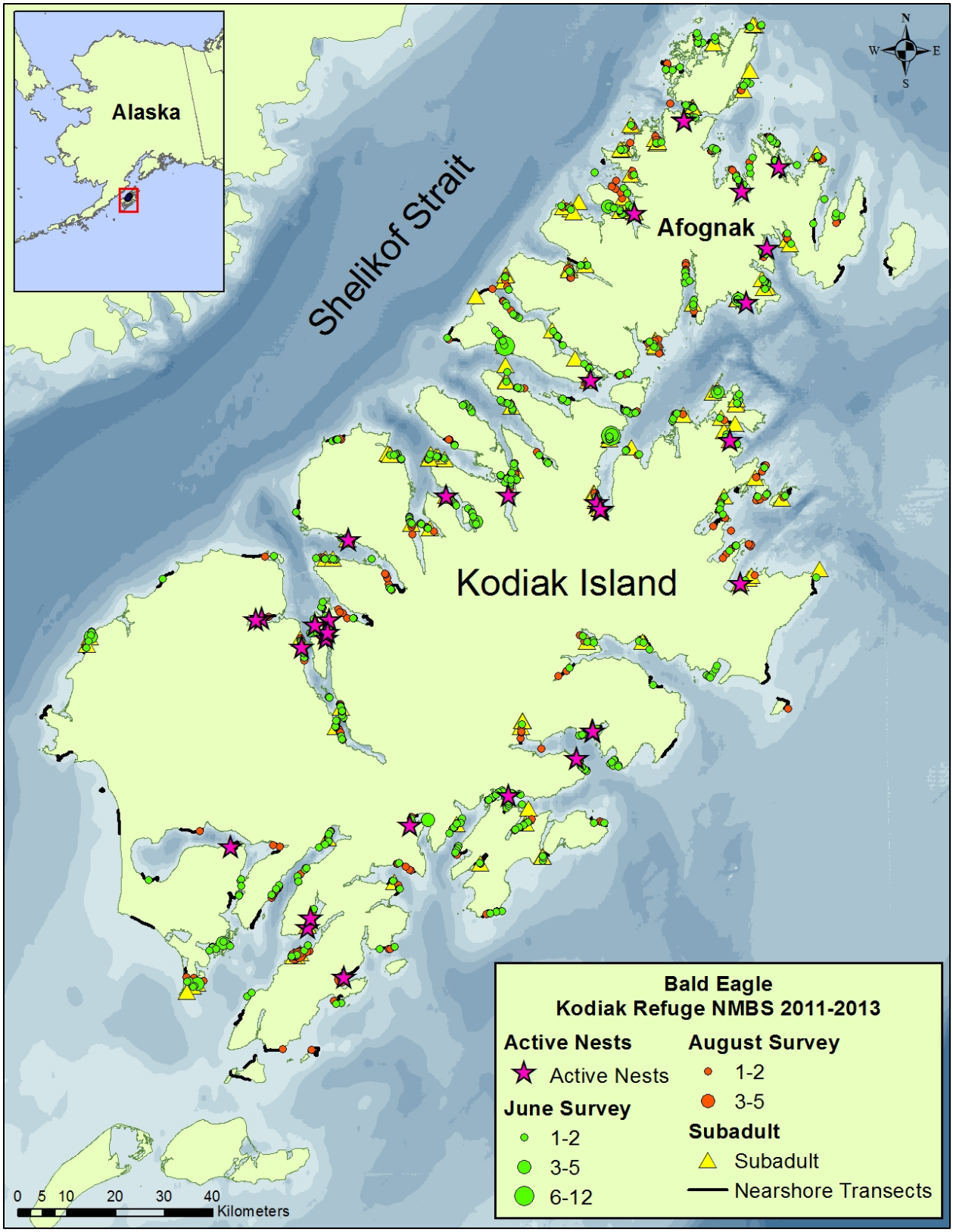

Figure 20. Bald Eagle numbers (n = 1,221 adult; n = 175 subadult; n = 31 nests) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Trends in Bald Eagles 1994-2013 in Selected Bays

We compared population counts of adult Bald Eagles in selected bays from August 1994-2010 to a population estimate based on a subset of the nearshore marine bird survey data of transects surveyed in specific bays (August 2011-2013) using linear regression. Bald Eagle numbers appeared relatively stable in the regions surveyed from 1994-2013 (Figure 21).

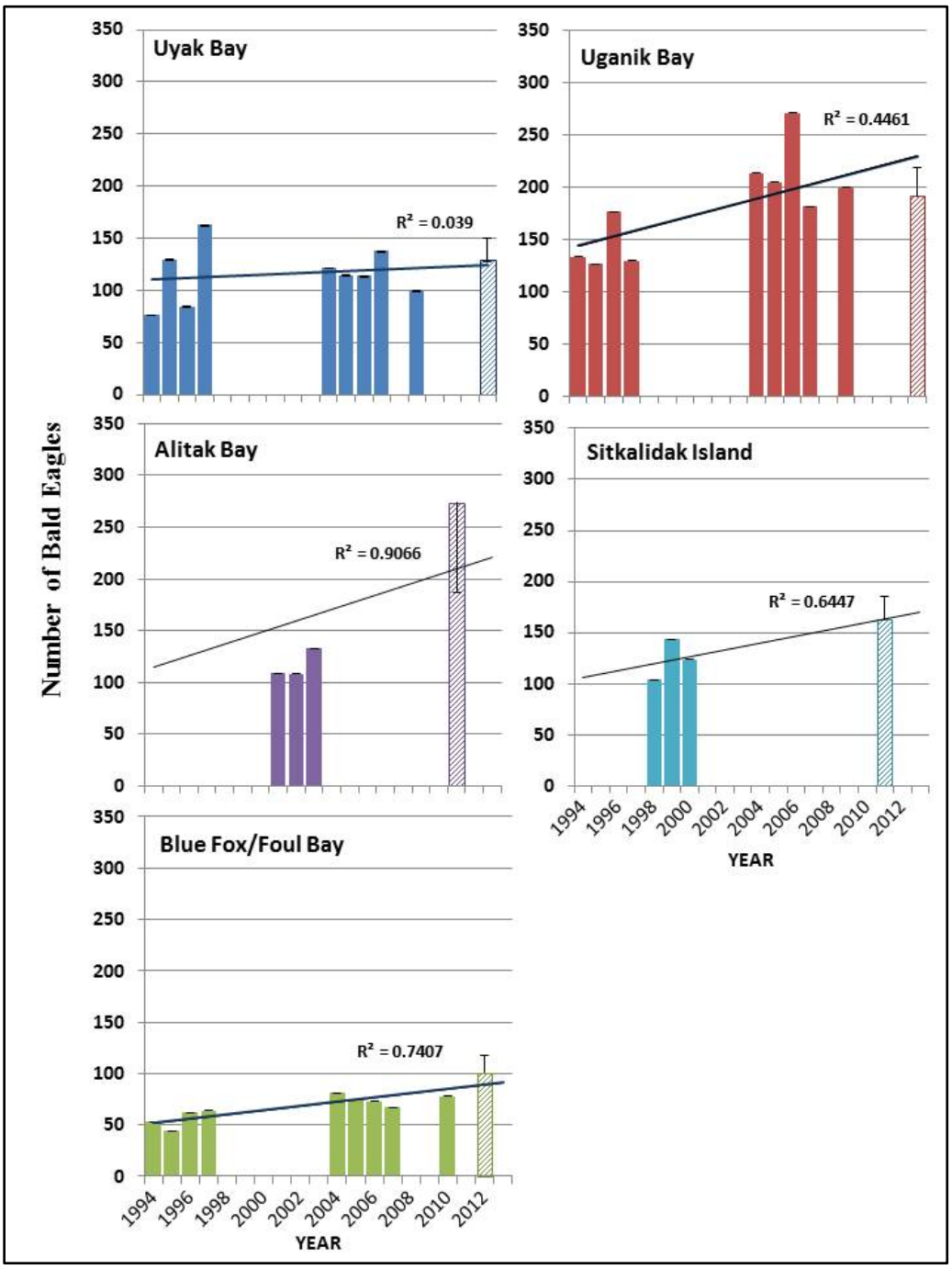

Figure 21. Comparison of Bald Eagle counts from coastal Harlequin Duck surveys, 1994-2010, to population estimates from nearshore marine bird survey, 2011-2013, for select bays in the Kodiak Archipelago, Alaska. Bars on the nearshore marine bird survey data (2011-2013) = 1 standard error.

Pelagic Cormorant

The Pelagic Cormorant is a nearshore species that feeds primarily on solitary fish and invertebrates by diving to the bottom in shallow inshore or intertidal waters. It is among the least social of the cormorants preferring to nest in small isolated colonies along rocky and exposed shorelines. The North American population is estimated at about 130,000 birds, most occurring in Alaska. Like all cormorant species it is sensitive to disturbance at colonies and vulnerable to oil spills, gill-net bycatch, and contamination of marine food webs. In 1973–1976 in Alaska, of 19 species studied, frequency of organochlorine residues was found to be highest in Pelagic Cormorants (Ohlendorf et al. 1982). In Alaska, the numbers of Pelagic Cormorants or nests (the index used at some sites) have remained relatively stable at most monitored sites. However, at Chiniak Bay on Kodiak Island, there was a significant negative trend (-5.5% per annum) between 1975 and 2003 (Denlinger 2006). Bycatch mortality was recorded from the set gillnet fishery for Kodiak Island for 2002 and 2005. The total bycatch estimate for Pelagic Cormorants was 14 in 2002 and 178 in 2005, with the 2005 estimate being among the highest for any species recorded (Manly 2007).

Pelagic Cormorants were the most abundant of the three cormorant species that regularly breed in the Kodiak Archipelago. During the current nearshore marine bird survey, 952 Pelagic Cormorants were counted in June, and 561 were counted in August over three field seasons 2011-2013 (Figure 22). Pelagic Cormorants were recorded on 29% of transects in June, and 27% of transects in August. Density estimates were consistently higher on nearshore transects within 400 m of shore than on offshore transects conducted > 500 m from shore (Table 23). The June Kodiak Archipelago population estimate for Pelagic Cormorant of 4,034 (95% CL 3,081-4,987; Table 24) from the current survey was similar to June colony survey counts from 2008-2010 of 3,187 (Table 11).

Table 23. Pelagic Cormorant density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	2.23 (0.71)	0.69 (0.26)	4.20 (1.60)	0.80 (0.93)
	Offshore	0.20 (0.06)	0.15 (0.07)	0.36 (0.14)	0.01 (0.01)
August	Nearshore	1.19 (0.26)	1.14 (0.39)	1.56 (0.49)	0.37 (0.27)
	Offshore	0.44 (0.27)	0.83 (0.73)	0.31 (0.24)	0.07 (0.04)

Table 24. Pelagic Cormorant population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	4,034 (3,081-4,987)	841 (533-1,149)	3,027 (2,143-3,910)	167 (-13-346)
August	4,558 (2,200-6,916)	2,908 (630-5,185)	1,453 (854-2,052)	198 (73-323)

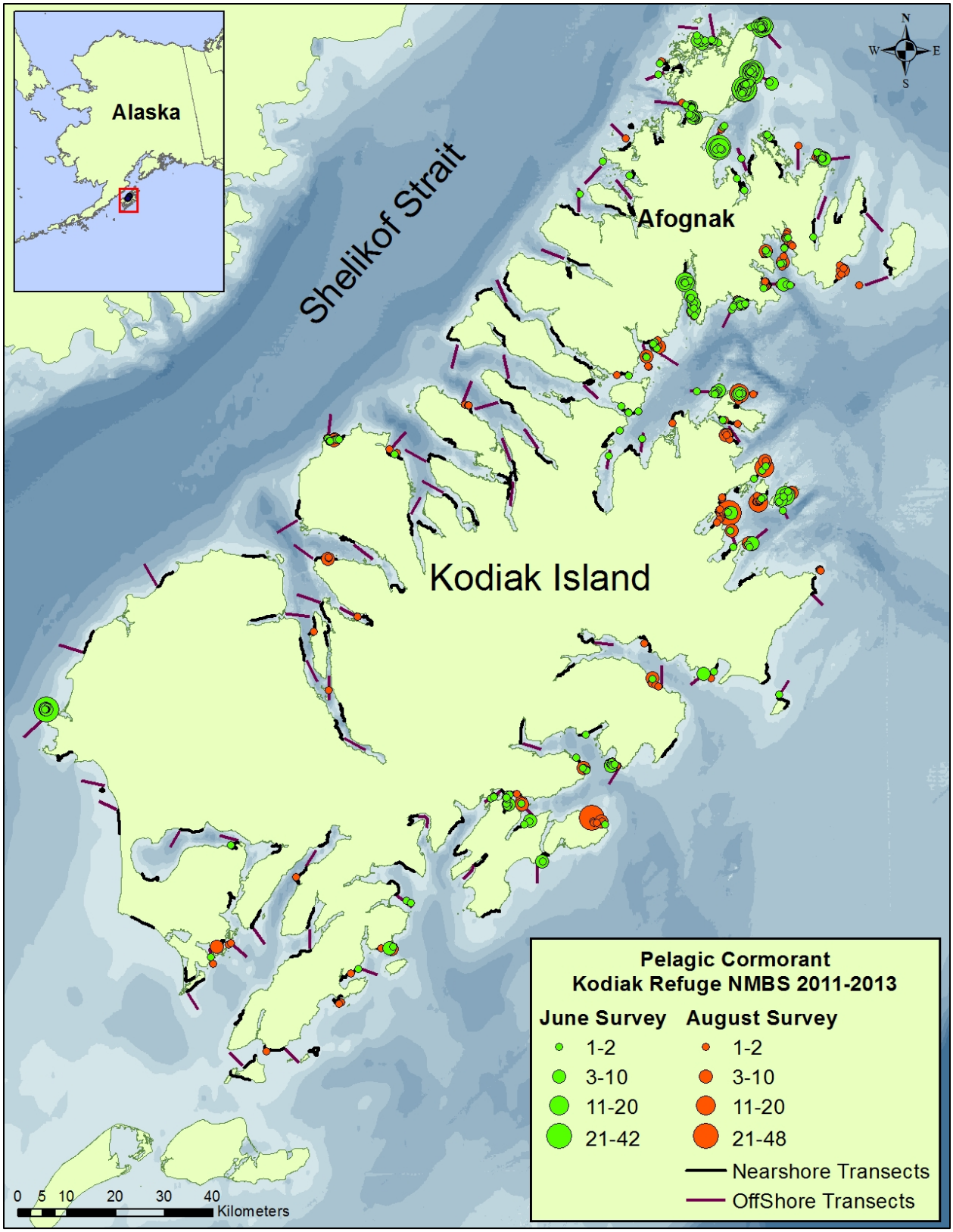

Figure 22. Pelagic Cormorant numbers (n = 1,121) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Red-faced Cormorant

The Red-faced Cormorant is similar in habitat and appearance to the Pelagic Cormorant. Recent Alaskan estimates are approximately 20,000 birds, with the largest colonies in North America located in the western Aleutian Islands. Movement of colony locations may result in high annual variation in numbers between years, and incomplete census data and problems with determining numbers make identification of trends difficult. Generally, Alaskan populations are thought to have decreased in the western and central Aleutian Islands and increased in the GOA (Denlinger 2006). However, at a site monitored in Chiniak Bay on Kodiak Island, the Red-faced Cormorant colony declined between 1978 and 2001 (Dragoo et al. 2003). Data are sparse, but some bycatch mortality was recorded from the set gillnet fishery for Kodiak Island for 2002, and the total bycatch estimate for Red-faced Cormorants was 28 individuals (Manly 2007). Cormorants are known to be extremely sensitive to local environmental conditions and disturbance at nesting and roosting sites.

Red-faced Cormorants were the second most abundant of the three cormorant species that regularly breed in the Kodiak Archipelago during the current nearshore marine bird survey. In total, 197 Red-faced Cormorants were counted in June and 313 were counted in August over three field seasons 2011-2013 (Figure 23). Red-faced Cormorants were recorded on 8% of transects surveyed in June, and 7% of transects in August. Density estimates were consistently higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 25). The June 2011-2013 Kodiak Archipelago population estimate for Red-faced Cormorant of 756 (95% CL 423-1,090; Table 26) was similar to June colony survey counts from 2008-2010 of 496 (Table 11).

Table 25. Red-faced Cormorant density density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2) (SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	0.48 (0.22)	1.13 (0.57)	0.19 (0.12)	0.03 (0.04)
	Offshore	0.01 (0.01)	0.01 (0.01)	0.02 (0.02)	0
August	Nearshore	0.72 (0.33)	1.77 (0.87)	0.11 (0.05)	0
	Offshore	0.10 (0.10)	0.25 (0.30)	0.02 (0.02)	0

Table 26. Red-faced Cormorant population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	756 (423-1,090)	625 (296-955)	125 (72-178)	6 (-2-15)
August	1,896 (688-3,104)	1,787 (581-2,994)	109 (47-171)	0

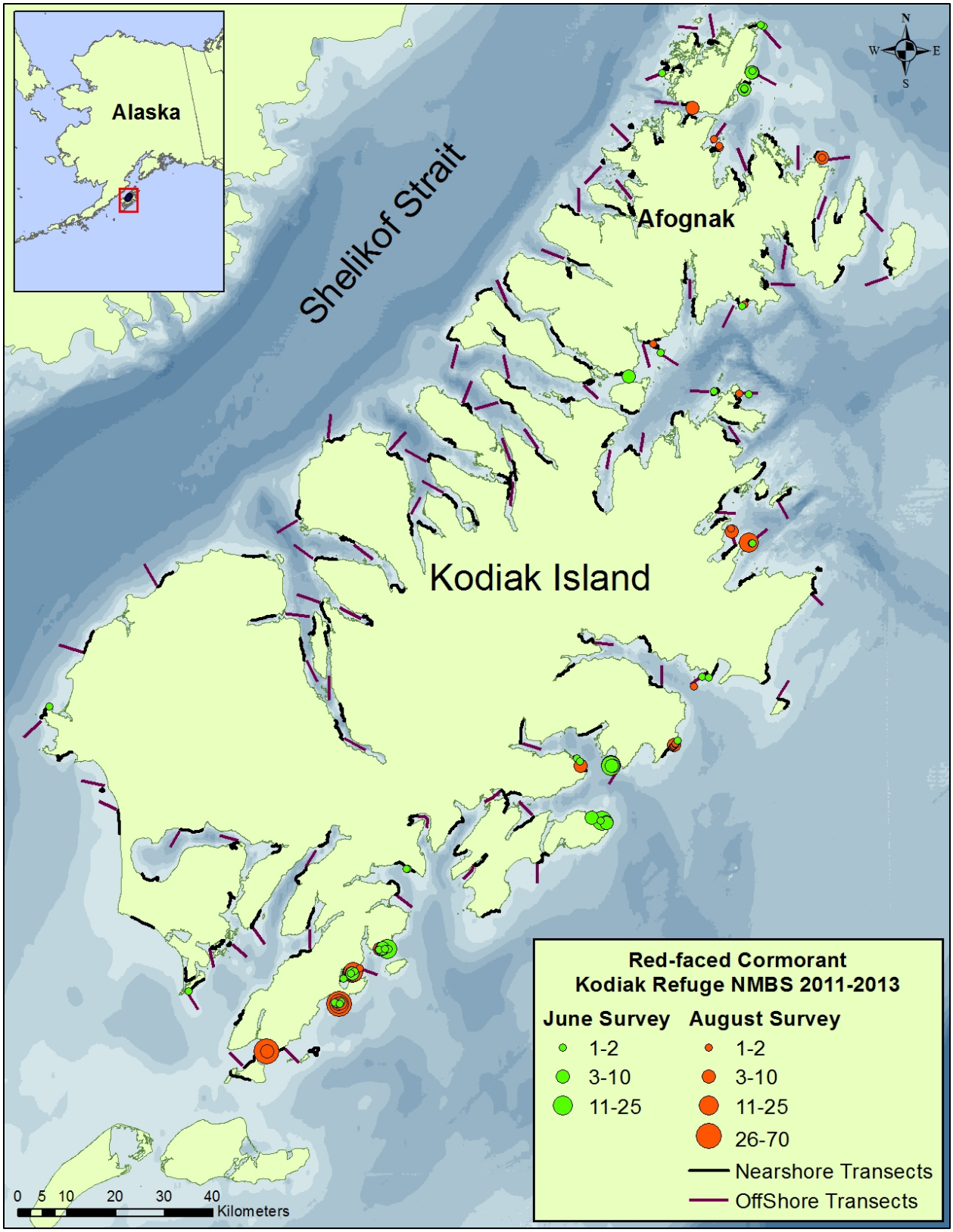

Figure 23. Red-faced Cormorant numbers (n = 510) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Mew Gull

Mew Gulls nest in a variety of habitats across their extensive breeding range throughout western North America. They breed in both marine and freshwater habitats, and nest in both conifers and on the ground on islands and in marsh vegetation. There is no precise data on population status but the global population may number more than 1 million pairs (Moskoff and Bevier 2002). This species does not appear to be threatened in any part of its range throughout northwestern North America (Denlinger 2006). Mew Gulls were a common breeding and wintering species in the Kodiak Archipelago. The species was more abundant in winter than in summer on Kodiak, and high numbers on the August survey most likely represent failed breeders or non-breeding individuals moving from more northerly breeding locations in Alaska.

During the current nearshore marine bird survey, 522 Mew Gulls were counted in June and 4,592 were counted in August over three field seasons 2011-2013 (Figure 24). Mew Gulls were recorded on 28% of transects in June, and 59% of transects in August. Density estimates were consistently higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 27). The archipelago-wide June population estimate (2,616, 95% CL = 1,452-3,780) most likely reflects the breeding population, while high August estimates for this species represent migrants and overwintering birds (Table 28).

Table 27. Mew Gull density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2) (SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	1.23 (0.37)	0.92 (0.26)	1.23 (0.31)	1.70 (1.53)
	Offshore	0.20 (0.20)	0.07 (0.06)	0.43 (0.48)	0
August	Nearshore	11.39 (1.98)	8.80 (2.98)	8.27(2.46)	24.29 (5.99)
	Offshore	0.27 (0.10)	0.19 (0.13)	0.31 (0.21)	0.32 (0.12)

Table 28. Mew Gull population estimates with 95% lower and upper confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	2,616 (1,452-3,780)	683 (433-932)	1,701 (570-2,831)	233 (109-356)
August	18,513 (14,868-22,157)	5,352 (3,370-7,333)	5,443 (3,815-7,071)	7,718 (5,128-10,308)

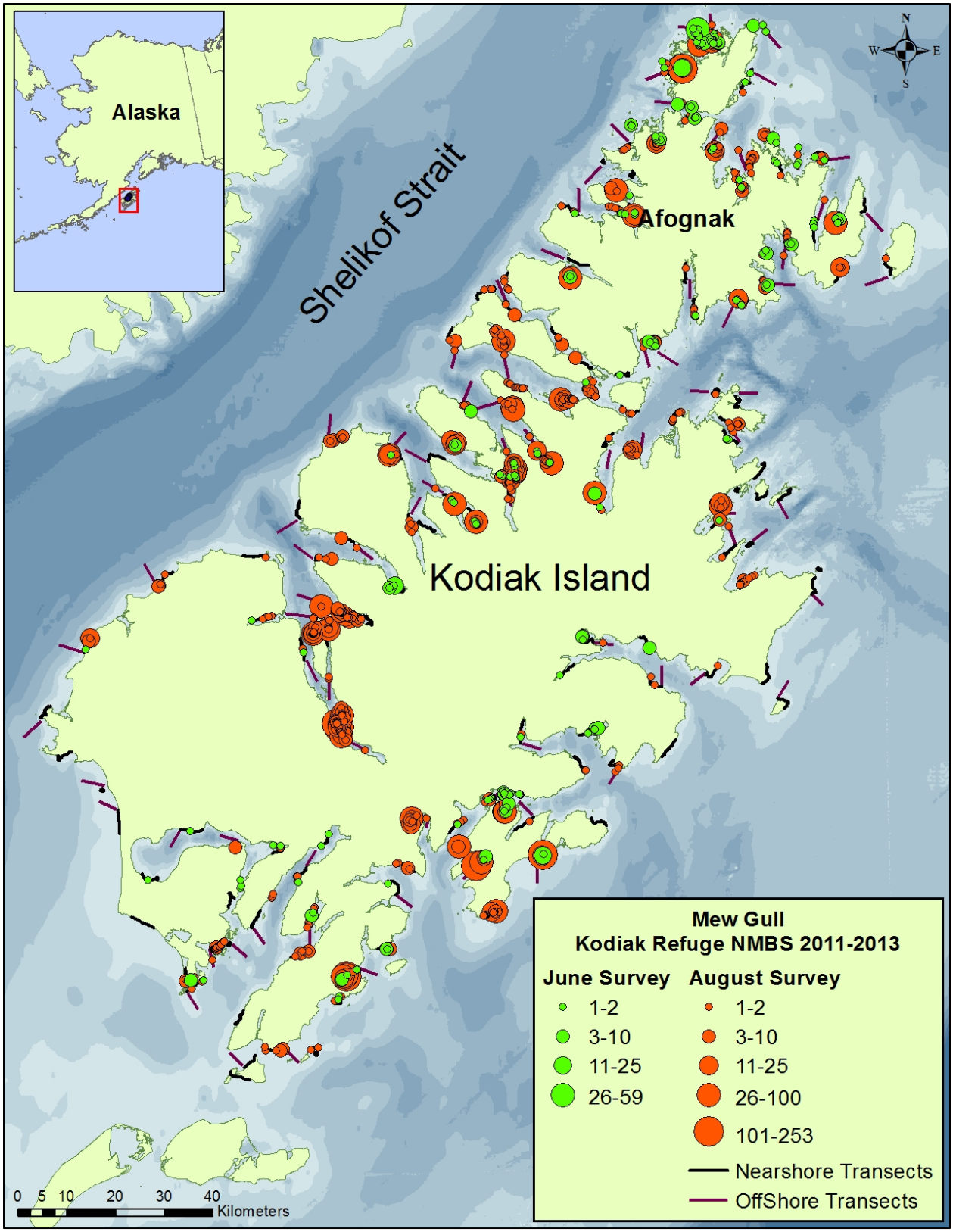

Figure 24. Mew Gull numbers (n = 5,114) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Glaucous-winged Gull

Glaucous-winged Gulls are abundant in bays, harbors, estuaries, and rivers during all seasons in northwestern North America. They are a well-known gull in coastal cities and towns due to their diverse feeding strategies and adaptability around human population centers. Due to environmental changes, availability of fish waste from fish processing, and garbage at landfills, this gull has increased in numbers over much of its range. Declining Bald Eagle numbers may have contributed to population increases in this species from the 1920s to early 1990s (Reid 1988). Bald Eagles are both a competitor and a predator on Glaucous-winged Gulls, and increasing Bald Eagle numbers were associated with declines of Glaucous-winged Gulls in some areas (Galusha and Hayward 2002, Sullivan et al. 2002, Blight et al. 2015)

Glaucous-winged Gulls were the second most abundant breeding gull species in the Kodiak Archipelago. During the current nearshore marine bird survey, 8,599 Glaucous-winged Gulls were counted in June, and 11,581 were counted in August over three field seasons 2011-2013 (Figure 25). Glaucous-winged Gulls were recorded on 83% of transects in June, and 92% of transects in August. Density estimates were consistently higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 29). The increase in the number of gulls in August likely resulted from the end of nesting activities when both breeding adults and juveniles were at-sea rather than concealed on nests which is more typical in June (Table 30). Productivity, as measured by the ratio of hatch-year to adult gulls, was highest on West Kodiak in 2013 (0.276), and lower on Afognak in 2012 (0.023), and East Kodiak in 2011 (0.003) (Figure 5).

Table 29. Glaucous-winged Gull density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2)(SE) 2013
June	Nearshore	18.22 (3.31)	18.24 (6.27)	21.69 (5.24)	11.41 (4.58)
	Offshore	2.82 (0.61)	1.59 (0.68)	4.43 (1.27)	1.69 (0.64)
August	Nearshore	26.96 (4.58)	35.66 (10.79)	23.31 (4.15)	20.05 (5.55)
	Offshore	5.56 (1.54)	6.18 (4.04)	6.40 (1.63)	2.84 (1.09)

Table 30. Glaucous-winged Gull population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	41,233 (35,744-46,721)	13,238 (9,908-16,568)	22,246 (18,216-26,277)	5,748 (4,079-7,418)
August	71,364 (56,276-86,452)	34,302 (20,529-48,074)	26,762 (21,579-31,945)	10,300 (6,967-13,633)

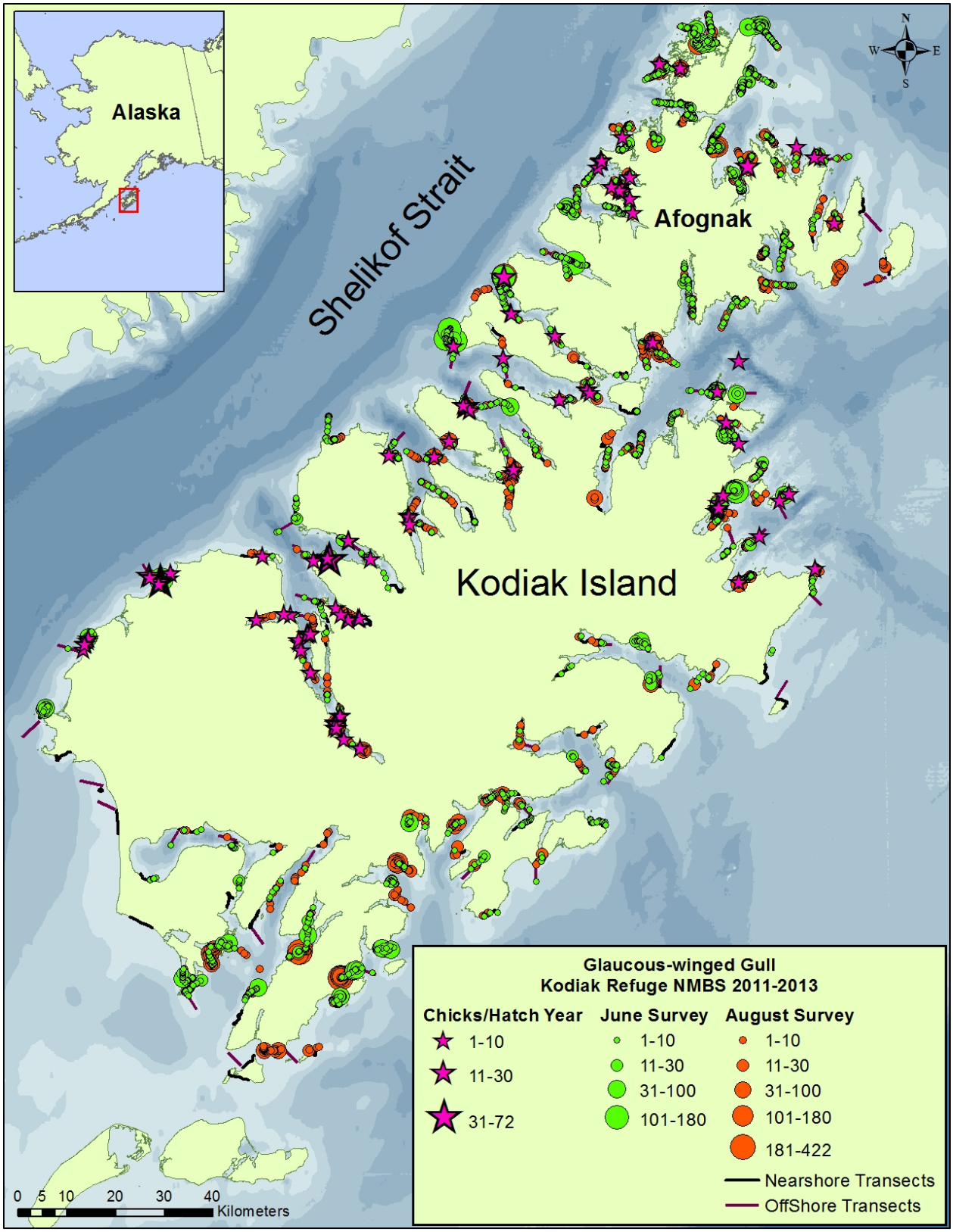

Figure 25. Glaucous-winged Gull numbers (n = 20,180) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Black-legged Kittiwake

More than 371 Black-legged Kittiwake colony sites have been identified in Alaska with a population estimate of ~ 1,322,000 individuals (Denlinger 2006). Most colonies support fewer than 5,000 birds, but a few larger colonies support > 30,000 individuals. On Kodiak two colonies number > 10,000 kittiwakes (Whale Island and Boulder Bay, Corcoran 2013). There is evidence of population declines in some colonies in Alaska, and causes for persistent breeding failure at many colonies remain ambiguous. Potential causes of declines include scarcity of food available at the surface during the breeding season and predation by a wide variety of predators including other gulls, raptors, and corvids. Black-legged Kittiwakes are considered excellent indicators of both short and long-term changes in marine ecosystems through annual reproductive success and life history patterns (Hatch et al. 2009).

Black-legged Kittiwakes were the most abundant breeding gull species in the Kodiak Archipelago. During the current nearshore marine bird survey, 17,179 Black-legged Kittiwakes were counted in June, and 31,890 were counted in August over three field seasons 2011-2013 (Figure 26). Black-legged Kittiwakes were recorded on 86% of transects in June, and 96% of transects in August. Density estimates were consistently higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 31). The archipelago-wide August population estimate was more than double the June population estimate, perhaps representing kittiwakes migrating through the region in late summer (Table 32). Productivity, as measured by the ratio of hatch-year to adult kittiwakes, was highest on West Kodiak in 2013 (0.113), and lower on Afognak in 2012 (0.007) and East Kodiak in 2011 (0.001) (Figure 5).

Table 31. Black-legged Kittiwake density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	39.22 (9.62)	64.18 (23.59)	23.20 (7.85)	31.37 (11.61)
	Offshore	5.95 (1.26)	5.40 (1.68)	3.49 (0.96)	10.49 (3.83)
August	Nearshore	74.33 (14.52)	115.80 (28.75)	47.73 (21.16)	52.24 (10.88)
	Offshore	16.85 (3.58)	22.14 (8.61)	15.18 (4.78)	11.45 (2.32)

Table 32. Black-legged Kittiwake population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	87,019 (73,552-100,485)	42,082 (31,493-52,671)	21,346 (16,464-26,228)	23,591 (16,854-30,327)
August	208,924 (172,340-245,509)	117,293 (86,058-148,527)	59,492 (41,669-77,315)	32,139 (25,419-38,860)

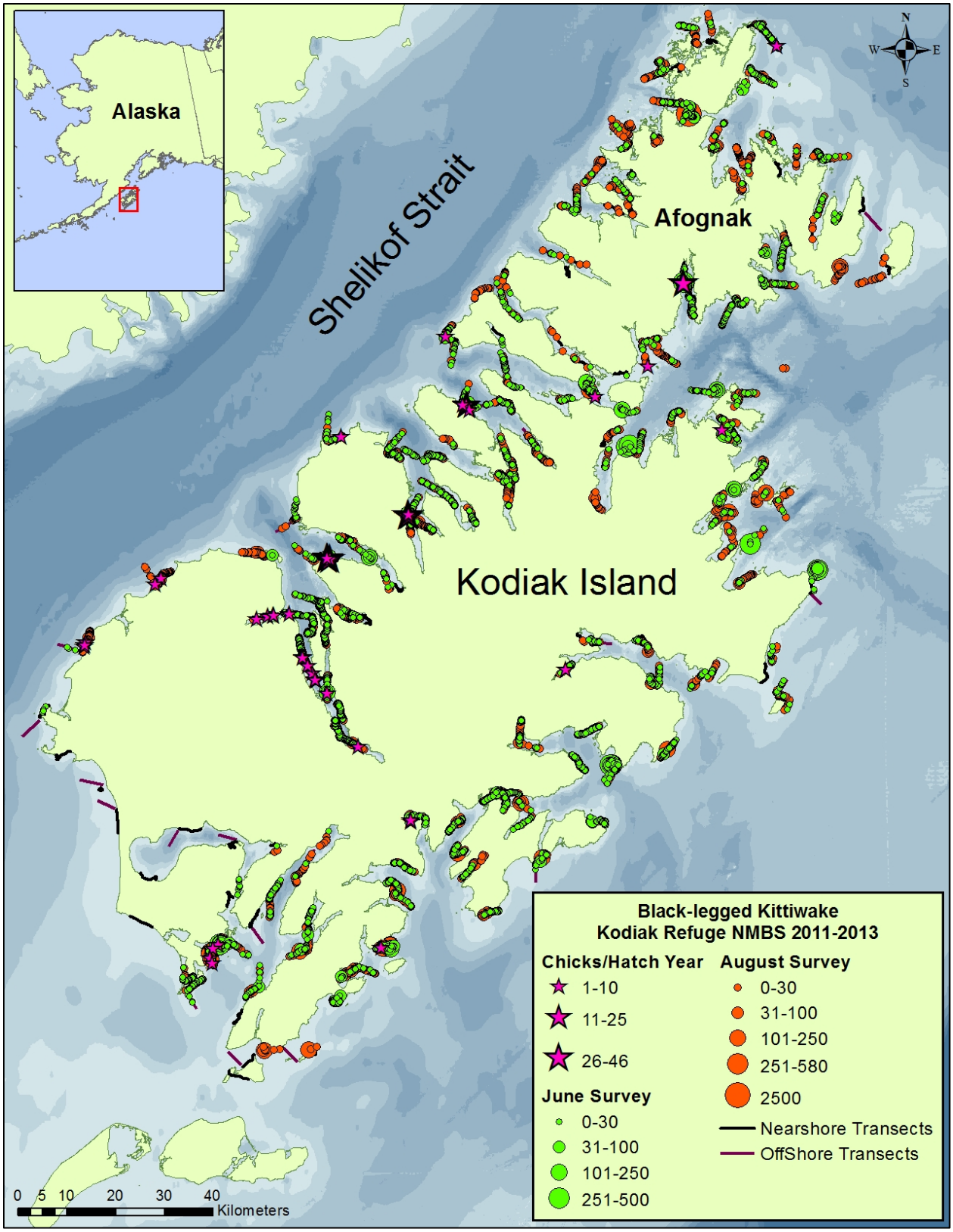

Figure 26. Black-legged Kittiwake numbers (49,069) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Arctic Tern

Arctic Terns have the longest annual migration of any bird in the world. In fact, a new record was set recently by an Arctic Tern migrating 96,000 km round-trip in a single year from her breeding site in the northern United Kingdom to her wintering grounds off Antarctica (Newcastle University Press Release, 7 June 2016). No population estimates are available for most of the species' range, but worldwide numbers of Arctic Terns may be 1-2 million breeding pairs. In Alaska, there may be several hundred thousand, most nesting inland. The North Pacific Seabird Colony Catalog lists 218 Alaskan coastal colonies with a breeding population of approximately 11,000 birds (Denlinger 2006). There are no data for general population trends in Canada, Alaska, or on the Atlantic Coast, but declines have been reported within each of these areas. In the Gulf of Alaska, both coastal colony counts on Kodiak Island and surveys at sea in PWS indicated declines of more than 90% (Agler et al. 1999, Stephensen et al. 2001, 2002, 2003). Except for the effects of the 1964 earthquake in Alaska, factors causing population decline and preventing population recovery are unknown.

During the current nearshore marine bird survey, 539 Arctic Terns were counted in June, and 495 were counted in August over three field seasons 2011-2013 (Figure 27). Arctic Terns were recorded on 17% of transects in June, and 15% of transects in August. Density estimates were consistently higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 33). Population estimates did not differ between June and August (Table 34). Productivity, as measured by the ratio of hatch-year to adult Arctic Terns, was highest on West Kodiak in 2013 (0.241), and lower on Afognak in 2012 (0.044) (Figure 5). Hatch-year terns were not observed on East Kodiak in 2011 (Figure 5).

Table 33. Arctic Tern density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	1.09 (0.52)	0.82 (0.20)	1.34 (1.21)	1.03 (0.60)
	Offshore	0.34 (0.13)	0.24 (0.21)	0.31 (0.20)	0.51 (0.26)
August	Nearshore	1.00 (0.40)	0.66 (0.27)	0.64 (0.67)	2.59 (1.36)
	Offshore	0.32 (0.11)	0.23 (0.14)	0.16 (0.16)	0.81 (0.31)

Table 34. Arctic Tern population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	3,394 (2,361-4,428)	1,101 (377-1,824)	1,297 (697-1,897)	997 (567-1,428)
August	3,512 (2,382-4,641)	985 (512-1,458)	745 (134-1,356)	1,782 (958- 2,606)

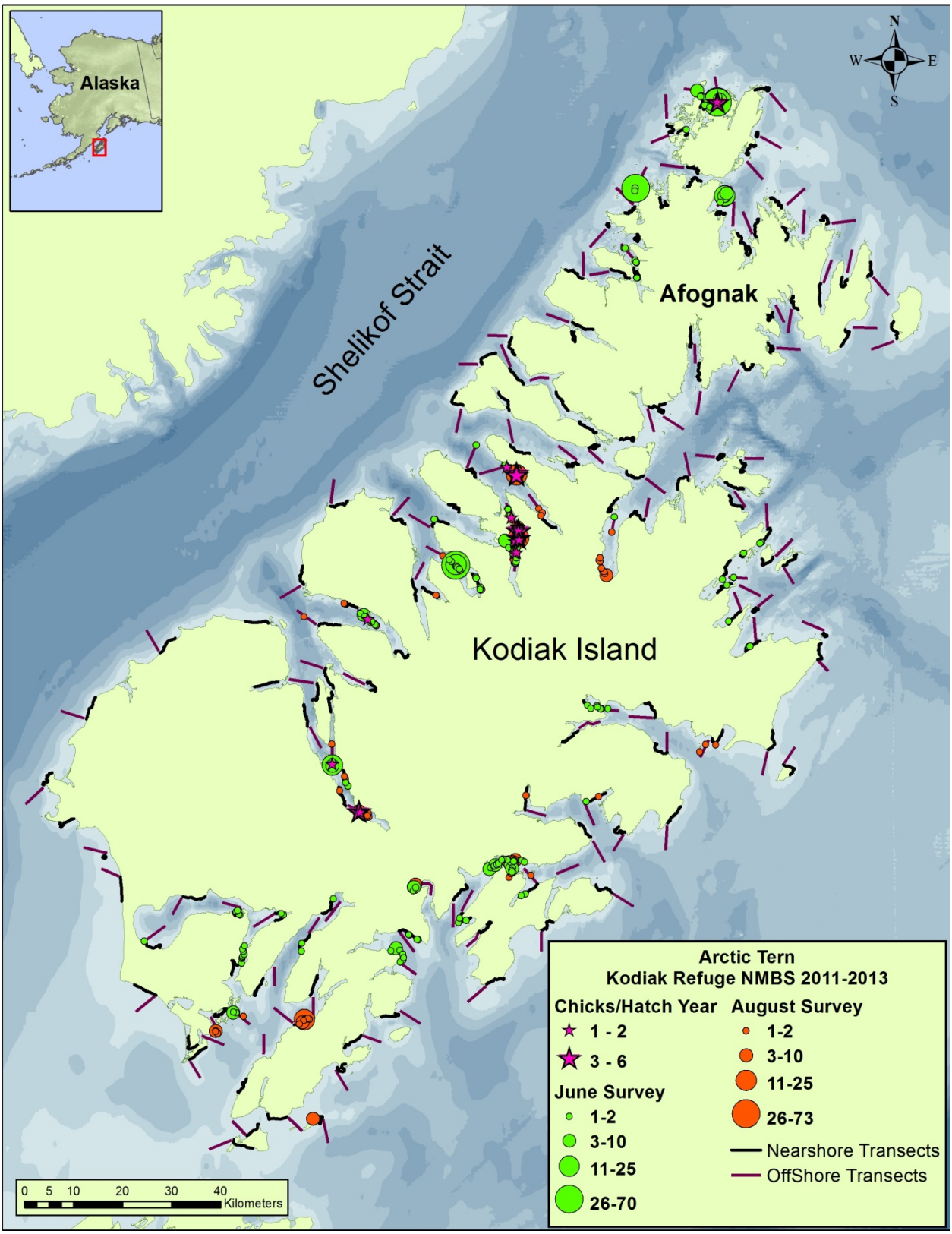

Figure 27. Arctic Tern numbers (n = 1,034) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Aleutian Tern

The Aleutian Tern nests in coastal colonies that are distributed over a wide range in Alaska and eastern Siberia. In Alaska, it frequently associates with Arctic Terns on the breeding grounds. Nesting occurs in a variety of habitats including islands, shrub-tundra, grass or sedge meadows, and freshwater and coastal marshes (Denlinger 2006). The global population size is estimated at 31,000 birds, which is among the lowest of any tern species, about 5,100 of which are thought to breed in Alaska (Renner et al. 2015). Recent trend analysis of numbers of Aleutian Tern at colonies in Alaska indicates that this poorly known seabird has declined by almost 93% over the past three decades (Renner et al. 2015). Based on records from the North Pacific Seabird Colony database it appears that Aleutian Tern numbers have declined on the Kodiak Archipelago since the 1970s (Corcoran 2012). The four largest colonies that supported from 240-3000 individual terns in the 1970s now are used intermittently and at reduced numbers with 2014-2015 counts ranging from 0-25 terns. Because terns are known to shift nesting locations between years, trends are difficult to evaluate.

During the current nearshore marine bird survey, 113 Aleutian Terns were counted in June, and 35 were counted in August over three field seasons 2011-2013 (Figure 28). Aleutian Terns were recorded on 13% of transects in June, and only 3% of transects in August. In general, density estimates were higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore in June, but were higher offshore in August (Table 35). The June 2011-2013 population estimate (1,090, Table 36) based on the current transect survey was nearly five times the estimate from recent colony surveys (234, Table 11). There were no breeding records for this species on West Kodiak and only two were seen in this region in 2013. No chicks or recently fledged hatch-year Aleutian Terns were recorded on transects during surveys from 2011-2013.

Table 35. Aleutian Tern density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2) (SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	0.20 (0.07)	0.53 (0.18)	0.04 (0.04)	0
	Offshore	0.09 (0.05)	0.27 (0.14)	0.01 (0.02)	0.02 (0.02)
August	Nearshore	0.04 (0.03)	0.07 (0.05)	0.03 (0.04)	0
	Offshore	0.07 (0.06)	0.19 (0.18)	0	0

Table 36. Aleutian Tern population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	1,090 (621-1,559)	1,023 (556-1,489)	43 (3-82)	25 (0-50)
August	596 (23-1,170)	579 (6-1,152)	17 (-6-41)	0

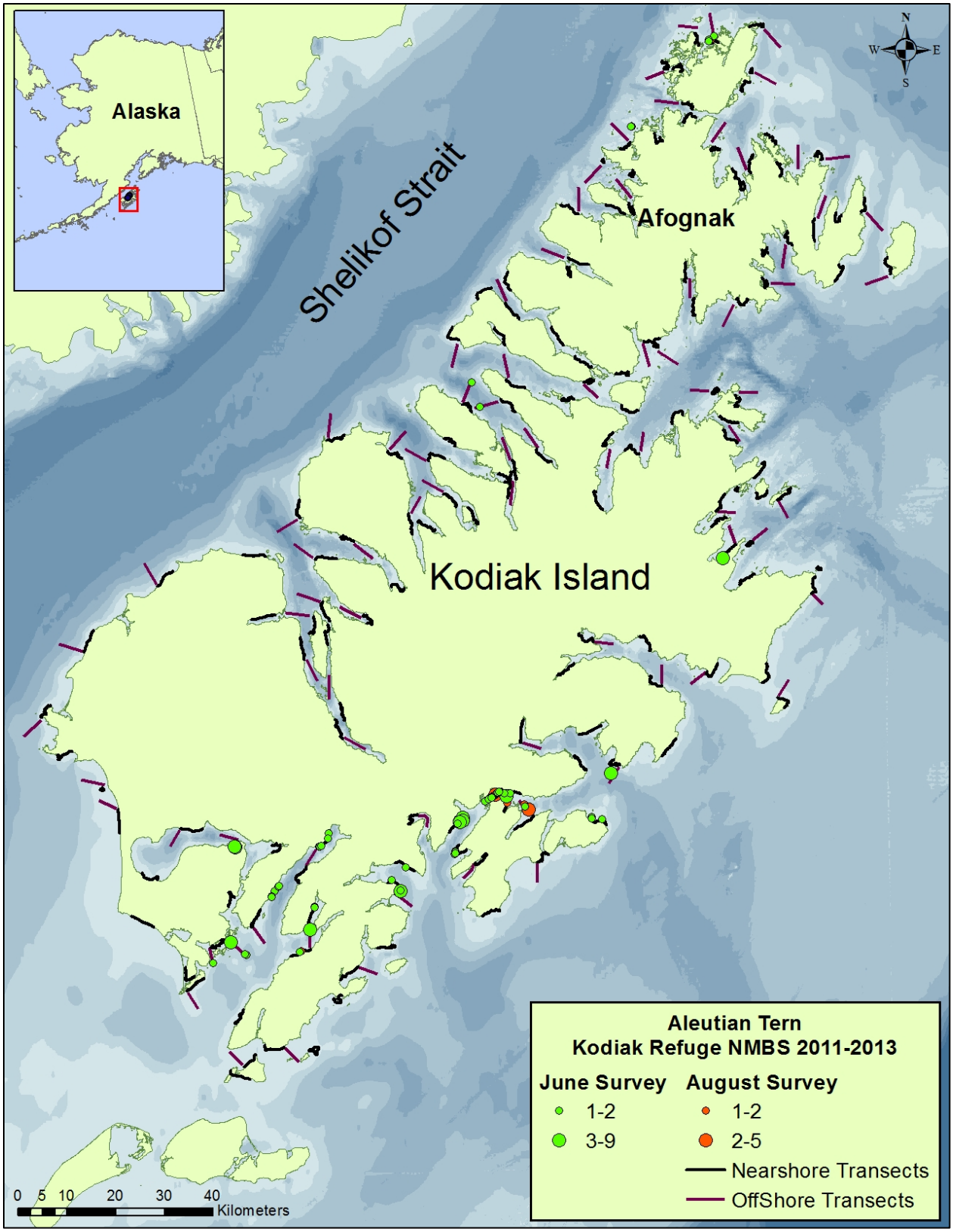

Figure 28. Aleutian Tern numbers (n = 261) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Common Murre

The Common Murre is one of the most numerous marine birds in the Northern Hemisphere, and the Alaska population is approximately 2.8 million breeding birds at 230 colonies (Denlinger 2006). Changes in sea surface temperatures are associated with changes in murre population levels and oscillating patterns are typical of many colonies in the Bering Sea and Aleutian Islands. This species comprised 34-44% of the total bycatch in the set gillnet fishery on Kodiak Island with an estimated bycatch of 185 individuals in 2002 and 484 in 2005 (Manly 2007). On nearly the entire North American coast where murres occurred oil spills during the past 50 years resulted in major die-off events. Estimated mortality from the *Exxon Valdez* oil spill in 1989 in PWS was 185,000 murres (Piatt and Anderson 1996). Long-term beached bird surveys also indicate chronic oiling, often without a known source. This susceptibility to oiling is what drives much of the research and management on the species (Ainley et al. 2002).

During the current nearshore marine bird survey, 2,870 Common Murre were counted in June, and 2,580 were counted in August over three field seasons 2011-2013 (Figure 29). Common Murre were recorded on 27% of all transects in June, and 44% of transects in August. Density estimates were generally higher on offshore transects conducted > 500 m from shore than on nearshore transects within 400 m of the tide line (Table 37). Population estimates were high despite the fact that there were few known breeding colonies in the Kodiak Archipelago and all known colonies were > 500 nesting individuals (Table 38). The majority of Common Murre were seen in small groups (mean group size = 3.9; SE = 0.4) offshore and many retained nonbreeding plumage.

Table 37. Common Murre density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	3.75 (1.77)	10.60 (4.75)	0.02 (0.01)	0.32 (0.34)
	Offshore	4.13 (1.90)	8.32 (5.51)	0.31 (0.12)	5.29 (2.22)
August	Nearshore	2.75 (0.89)	6.89 (2.25)	0.13 (0.07)	0.42 (0.16)
	Offshore	4.80 (1.00)	7.78 (2.19)	2.09 (0.87)	5.37 (2.16)

Table 38. Common Murre population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	35,484 (17,379-53,588)	27,416 (9,601-45,231)	711 (427-996)	7,356 (4,144-10,568)
August	37,680 (28,961-46,399)	25,531 (18,445-32,617)	5,063 (2,551-7,575)	7,086 (2,671-11,502)

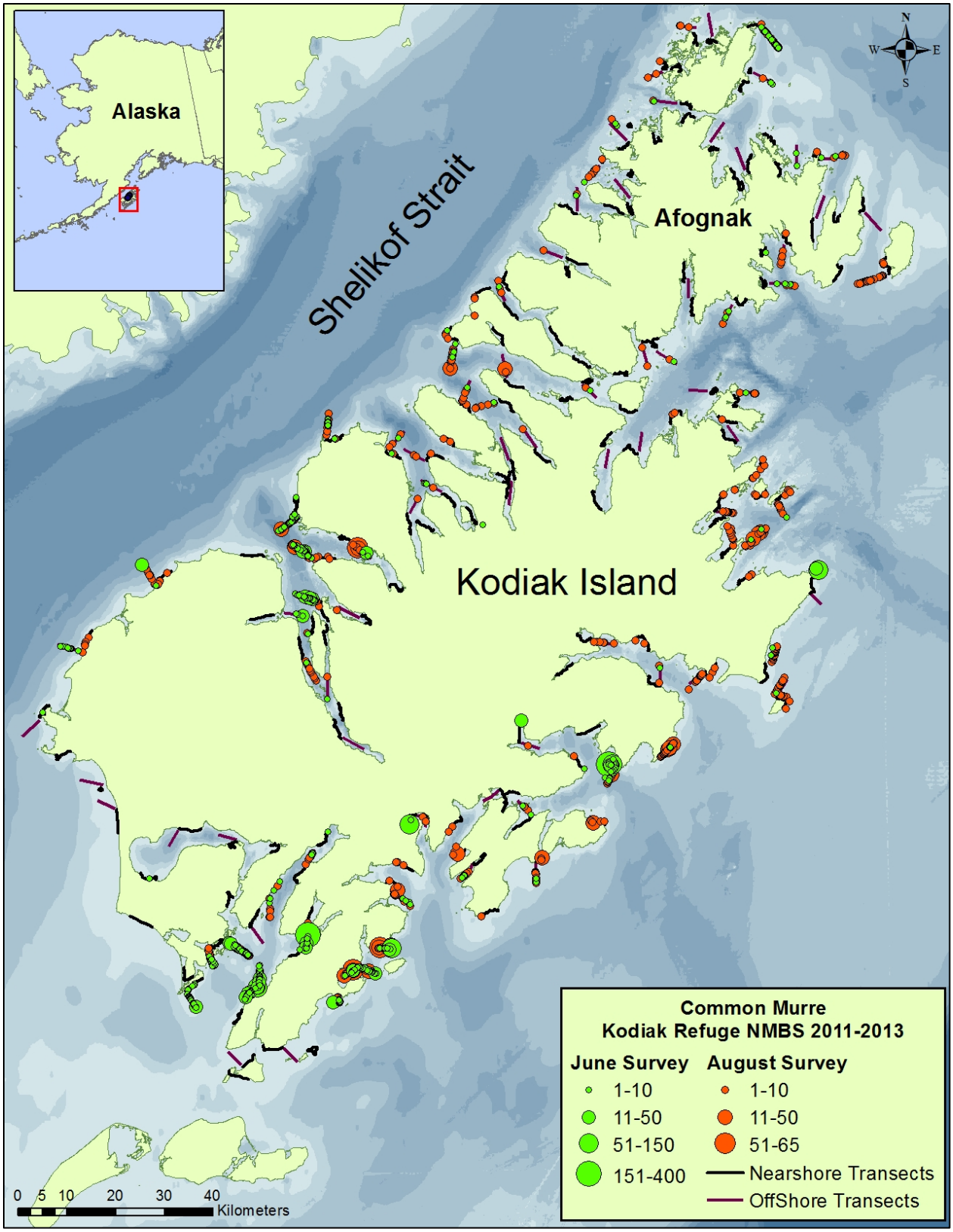

Figure 29. Common Murre numbers (n = 8,320) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Pigeon Guillemot

This species nests along rocky coastlines from California to Alaska and along the eastern shores of Siberia. Pigeon Guillemots are flexible in their nest site selection and will use remote offshore islands or onshore sites. They generally feed inshore on benthic fish and invertebrates in water 10-30 m deep (Ewins 1993). Nesting occurs as isolated pairs or as small colonies scattered along the coastline. The estimated world population of Pigeon Guillemots is about 235,000 and at least 50% breed in Alaska (Denlinger 2006). The bycatch of guillemots in the set gillnet fishery for Kodiak Island was estimated at 76 individuals in 2002 and 118 in 2005 (Manly 2007), and this species was estimated to comprise 11-14% of total seabird bycatch in the region.

Pigeon Guillemots were one of the most commonly seen breeding seabird species in the Kodiak Archipelago. During the current nearshore marine bird survey, 3,241 Pigeon Guillemots were counted in June, and 3,550 were counted in August over three field seasons 2011-2013 (Figure 30). Density estimates were significantly higher on nearshore transects within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 39). Pigeon Guillemots were recorded on 77% of transects in June, and 85% of transects in August. Population estimates from the current survey (Table 40) far exceed estimates from previous colony based surveys (~ 2000 breeding individuals). For a loosely colonial, ubiquitous species like Pigeon Guillemots, transect based surveys appear to be more useful in estimating abundance on Kodiak than designated colony surveys. For example, on the current survey the mean group size based on 3,642 records for this species was two individuals (range = 1-28; SE = 0.03), making targeted surveys to count individuals at colony sites impractical. The coefficient of variation (CV) on the population estimate was lower for Pigeon Guillemot than for any other species surveyed on both nearshore and offshore transects in June (CV = 0.05) and August (CV = 0.07) (Table 10), indicating potentially high power to detect changes over time.

Pigeon Guillemot productivity as measured by the ratio of hatch-year to adult birds was similar in 2011 on East Kodiak (0.060) and 2012 on Afognak (0.044), but was higher in 2013 on West Kodiak (0.306) (Figure 5). Guillemot density was lowest on West Kodiak, and far fewer adults were seen in this region, with three times the number of adults recorded on East Kodiak and five times the number of adults counted on Afognak. Despite lower adult numbers about 36% more hatch year guillemots were recorded on transects on West Kodiak in 2013.

Table 39. Pigeon Guillemot density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	6.99 (0.56)	7.43 (1.02)	7.56 (0.90)	5.17 (1.01)
	Offshore	0.67 (0.13)	0.70 (0.26)	0.66 (0.21)	0.63 (0.22)
August	Nearshore	8.07 (0.68)	7.84 (1.26)	9.60 (0.99)	4.85 (1.01)
	Offshore	1.62 (0.32)	1.75 (0.67)	1.57 (0.40)	1.51 (0.69)

Table 40. Pigeon Guillemot population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**14,065 (12,772-15,359)**	**6,001 (4,983-7,019)**	**5,685 (5,039-6,330)**	**2,380 (1,912-2,848)**
August	**21,327 (18,376-24,277)**	**9,073 (6,828-11,317)**	**8,811 (7,606-10,016)**	**3,443 (1,955-4,391)**

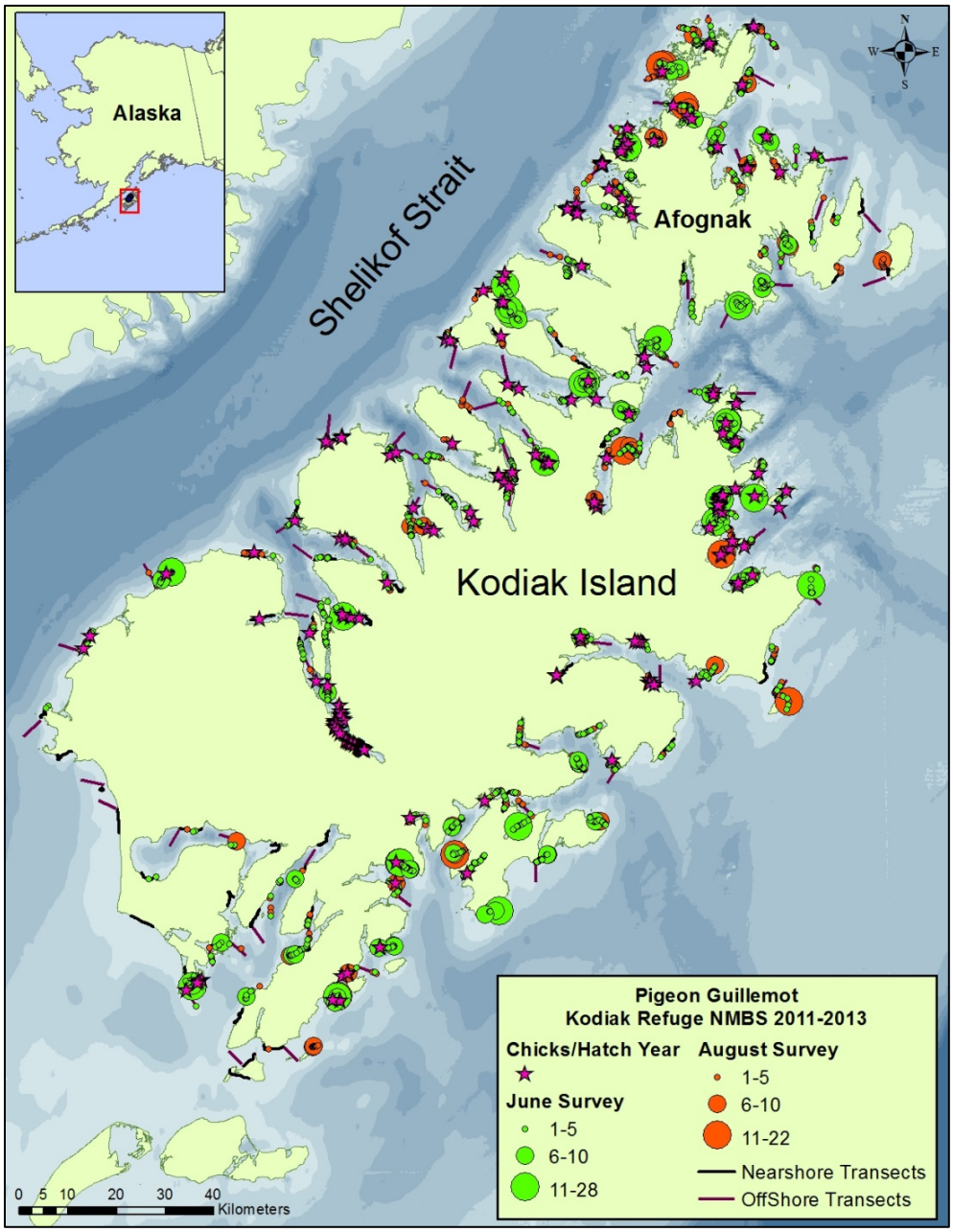

Figure 30. Pigeon Guillemot numbers (n = 6,791) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Kittlitz's Murrelet

The Kittlitz's Murrelet is one of rarest and least known seabirds in North America. They nest on the ground, generally on unvegetated scree fields and occasionally on cliff faces in rugged mountains near glaciers or in previously glaciated areas, sometimes up to 75 km inland. Unlike most other seabirds they are solitary nesters and rely on camouflage and secretive behavior to avoid predation. All of the North American and most of the world population of Kittlitz's Murrelets breed, molt, and winter in Alaska (Day et al. 1999).

Due to range-wide population declines and several potential anthropogenic threats, the species was designated a candidate for listing under the Endangered Species Act (ESA) by the USFWS in 2004. In October 2013 the USFWS determined that listing the species under the ESA was not warranted (Federal Register 2013). Despite at-sea survey data indicating annual declines of 30% between 1980 and 2000, more recent data indicated populations had stabilized and no single stressor, or combination of stressors, could be identified as having a population- or species-level impact on this widely distributed species. However, because reasons for the dramatically lowered numbers remain unknown, the listing committee strongly recommended that the species remain a priority for research and monitoring throughout its range (Federal Register 2013).

The recent ESA listing decision emphasized that boat-based surveys for Kittlitz's Murrelets on the water during the breeding season were the most efficient method for establishing population size and trends of this species. However, the marine waters around Kodiak Island were identified as a region of notable survey gaps in a symposium devoted to the species "Population status and trends in Kittlitz's Murrelets" (Kissling 2011). This assertion was only partially accurate, as coastal marine bird surveys by Refuge biologists have been conducted for several decades, and a survey for Kittlitz's Murrelets was conducted by USGS researchers on the western side of Kodiak Island in July 2009 (Madison et al. 2011). These surveys documented very few Kittlitz's Murrelets and a pressing conservation need for the region was to identify marine foraging locations of breeding adults so that an at-sea survey could be designed to estimate populations and trends.

In June all observations of Kittlitz's Murrelets were on offshore transects while in August densities were higher on nearshore rather than offshore transects (Table 41). Consistent with previous observations, Kittlitz's Murrelets were rarely seen during our archipelago-wide surveys and were outnumbered by Marbled Murrelets 303:1. Population estimates were low in both June and August 2011-2013 (Table 42). Most (13 of 16) hatch-year Kittlitz's Murrelets seen on transects in August were in the nearshore survey zone (intertidal to 400 m offshore).

Productivity as measured by the ratio of juvenile or hatch-year to adult birds was higher for Kittlitz's Murrelets in 2011-2012 than in 2013, in contrast to several other marine bird species on Kodiak who experienced higher productivity in 2013 (Figure 5). These results were also not consistent with a long-term nesting ecology study conducted on southwestern Kodiak Island from 2008-2015. Apparent nest success on the Kodiak study sites was only 17% from 2008-2011 but increased to 45% in 2012-2013 (Knudson et al. 2016). The low productivity index in 2013 could be attributed to small sample size, and the higher number of adults seen in 2013 than in previous surveys. In 2013 we counted 10 adult Kittlitz's Murrelets, twice more than seen on previous August surveys, and all adults were seen in Uyak Bay from 19-22 August 2016. The unusually large number of adult Kittlitz's Murrelets in a single bay over a short period of time

was unprecedented based on the long history of at-sea marine bird surveys in the region. In addition, measuring productivity by ratios of birds counted at sea might not reflect local breeding success since it is not known if most hatch year birds seen on Kodiak originated from nests in the Archipelago or were migrants from other regions. Satellite telemetry data indicated that birds from Icy Bay made a western migration to wintering areas. In August 2010 a hatch-year Kittlitz's Murrelet, satellite-tagged earlier in the summer in Icy Bay, was located on southwest Kodiak Island on 15 August and remained in the Geese Channel region until 20 September (John Piatt, personal communication).

Because previous marine bird surveys documented very few Kittlitz's Murrelets in contrast to the relatively high numbers nesting on Kodiak NWR, every effort was made to record this species when traveling between transects (off transect locations). While only 37 Kittlitz's Murrelets were recorded on transects used to calculate density and population estimates, an additional 17 were seen off transect (Table 43, Figure 31). These off transect locations provide additional information on marine habitat preferences and identified the Geese Channel and Alitak Bay region, where nine of the 17 birds were recorded, as a potentially important area in the Archipelago for this species.

Table 41. Kittlitz's Murrelet density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	0	0	0	0
	Offshore	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
August	Nearshore	0.07 (0.02)	0.04 (0.02)	0.09 (0.03)	0.10 (0.05)
	Offshore	0.02 (0.01)	0	0.02 (0.02)	0.06 (0.04)

Table 42. Kittlitz's Murrelet population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	53 (5-102)	27 (-14-69)	13 (-5-32)	12 (-5-30)
August	217 (129-305)	23 (12-34)	91 (48-135)	102 (27-178)

Table 43. Kittlitz's Murrelet counts (n = 54 birds) on and off transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	2011			2012			2013		
Month	On Transect	Off Transect	Total (No. Hatch Year)	On Transect	Off Transect	Total (No. Hatch Year)	On Transect	Off Transect	Total (No. Hatch Year)
June	1	8	9	1	2	3	1	1	2
August	6	3	9 (6)	16	3	19 (13)	12	0	12 (2)

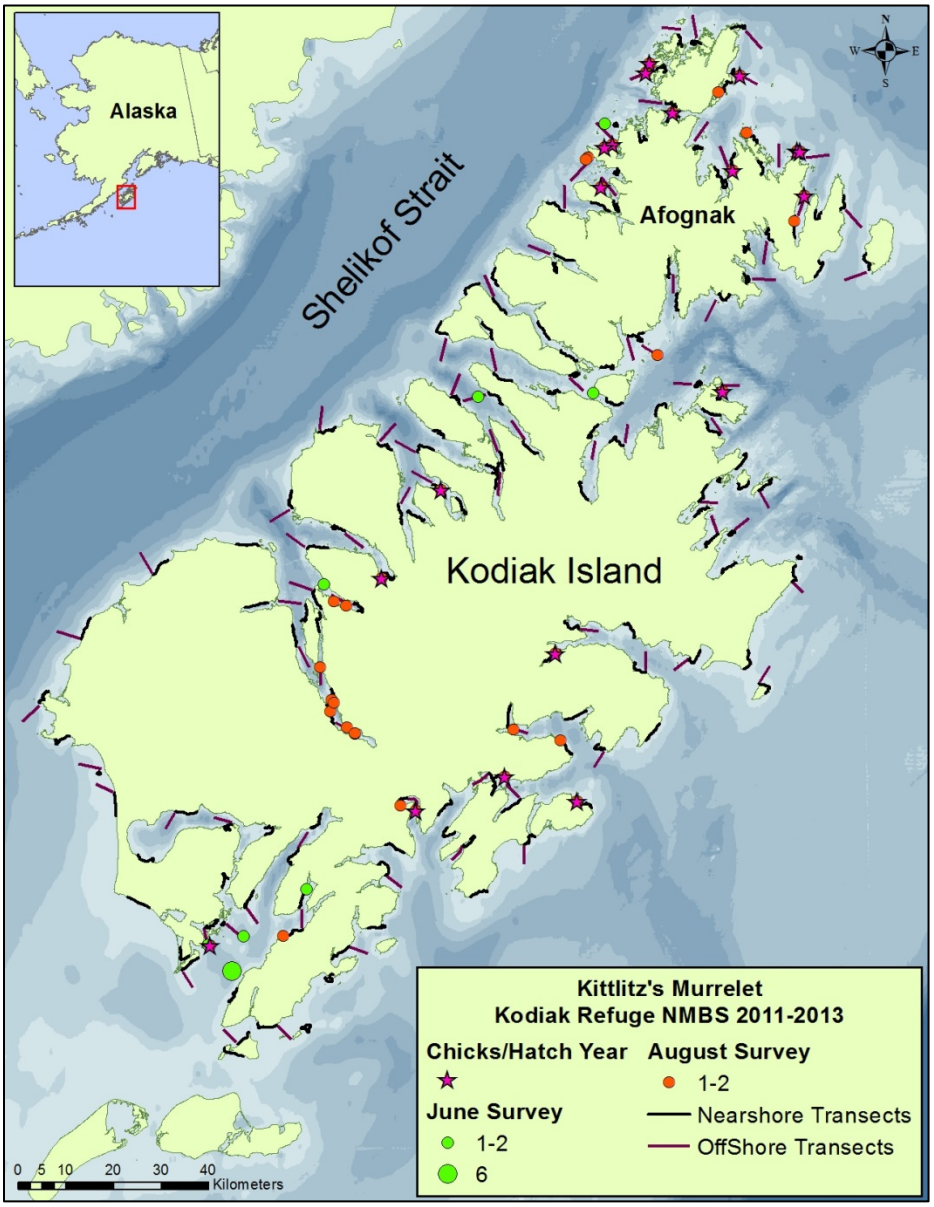

Figure 31. Kittlitz's Murrelet numbers (n = 54) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska (includes incidental off-transect locations).

Marbled Murrelet

Marbled Murrelets are declining in number throughout their range and the species has been listed as threatened under the ESA since 1993 within the southern part of its range (Washington, Oregon, and California) (Piatt et al. 2007b). The Canadian population in British Columbia was assigned Threatened status in 1990. In Alaska, Marbled Murrelets are broadly distributed from the western Aleutian Islands to the Alexander Archipelago; however, breeding areas are largely concentrated in three important areas: the Kodiak Archipelago, PWS, and the Alexander Archipelago (Piatt and Ford 1993). Using trend information from at-sea surveys spanning a wide geographic range in Alaska, murrelet numbers declined significantly at five of eight sites at annual rates of -5.4 to -12.7 percent since the early 1990s. Applying these rates of decline to the historical population estimate, the current murrelet population in Alaska is projected to be on the order of 270,000 birds. This represents an overall population decline of about 70 percent during the past 25 years (Piatt et al. 2007b). The most complete trend data for Alaska were from PWS, where the population declined 89% between 1972 and 2004. Trends in other regions of Alaska also showed declines. *Brachyramphus* Murrelet densities declined in Glacier Bay by 74% (1991-2000), along the Malaspina Forelands by 44% (1992-2002), and in Kachemak Bay by 52% (1988-2004). In the Kenai Fjords, murrelets declined 62% between 1976 and 1986, but then increased 10% per year from 1986-2002. No trend data are available for Southeast Alaska, which was last surveyed comprehensively in 1994.

Marbled Murrelets normally feed in nearshore marine waters, including shallow bays, fjords, and inlets. The loss of old-growth nesting habitat is believed to be a key factor in the decline of Marbled Murrelets in some areas. Documented sources of mortality include bycatch in gillnet fisheries and oil spills. A 1990-1991 study of gillnet fisheries in PWS, estimated that between 450-1,470 *Brachyramphus* murrelets were killed annually as accidental bycatch. Estimates of gillnet mortality for other areas include 37 birds (Cook Inlet 2000), and 56 and 143 Marbled Murrelets in 2002 and 2005, respectively, on Kodiak Island (Manly 2007). Gillnet fisheries occur widely in Alaska and Carter *et al.* (1995) suggested that many thousands of Marbled Murrelets may be killed annually in Alaskan fishing nets. Additionally, changes in oceanic conditions since the 1970s in the GOA, may have negatively affected the availability of forage fish for Marbled Murrelets. To raise chicks, they require energy rich fish like juvenile herring *(Clupea pallasi)* and adult sand lance (*Ammodytes hexapterus).* In PWS, the crash of herring stocks in the early 1990s may have exacerbated the decline of Marbled Murrelets (Piatt et al. 2007b).

The Kodiak Archipelago is an important breeding area for Marbled Murrelets yet the status and trends of this species in the region are poorly known. Studies conducted in the 1990s compared inland flight behavior indicative of nesting at sites on Afognak Island in the archipelago with sites in PWS and Kenai Fjords. The greatest level of activity occurred at sites on Afognak and researchers concluded that due to large trees and high epiphyte cover the high activity level could have been due to truly higher nesting densities (Kuletz et al. 1995). Given the importance of the region to this species they were a major focus of the nearshore marine bird survey from 2011-2013. The June Archipelago-wide population estimate of 38,926 Marbled Murrelet represents about 14% of the current projected murrelet population estimate for Alaska. In general density (birds/km^2) was highest in the Afognak survey region and the August population estimate of 48,264 for this region contributed more than half the total population estimate for the archipelago (Tables 44 and 45).

Marbled Murrelets were one of the most commonly seen breeding seabird species in the Kodiak Archipelago during the current nearshore marine bird survey. In total 3,888 Marbled Murrelets were counted in June, and 7,314 were counted in August over three field seasons 2011-2013 (Figure 32). Marbled Murrelets were recorded on 73% of all transects in June, and 85% of transects in August. In general Marbled Murrelet density was higher in the offshore survey zone > 500 m from shore than in the nearshore zone within 400m of the tide line (Table 44). In August 2011-2013, we identified 268 hatch-year Marbled Murrelets and most (68%) were on nearshore transects.

Productivity as measured by the ratio of hatch-year to adult birds was highest on West Kodiak in 2013 (0.086) and lowest on Afognak in 2013 (0.024) (Figure 5). The range in Marbled Murrelet productivity on Kodiak from 2011-2013 was similar to murrelet production at six sites in PWS based on the core survey period from late July to late August 1995 which ranged from 0.020 to 0.118, averaging 0.075 across all sites (Kuletz and Kendall 1998). The PWS results were generally higher than those reported in British Columbia, California, and Oregon.

Table 44. Marbled Murrelet density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	4.02 (0.51)	2.67 (0.61)	2.96 (0.62)	8.24 (1.52)
	Offshore	5.61 (0.85)	4.23 (1.12)	7.64 (1.38)	4.01 (1.85)
August	Nearshore	8.26 (1.24)	5.70 (1.46)	10.53 (2.39)	8.14 (1.98)
	Offshore	12.89 (2.78)	6.69 (2.64)	19.39 (5.71)	9.98 (3.63)

Table 45. Marbled Murrelet population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	38,926 (33,704-44,148)	13,041 (9,481-16,600)	18,504 (15,308-21,700)	7,382 (5,289-9,474)
August	85,269 (67,320-103,218)	21,341 (13,007-29,675)	48,624 (34,587-62,661)	15,304 (7,842-22,765)

Photo: R. Corcoran; Marbled Murrelets, Uyak Bay, Kodiak, Alaska, August 2013

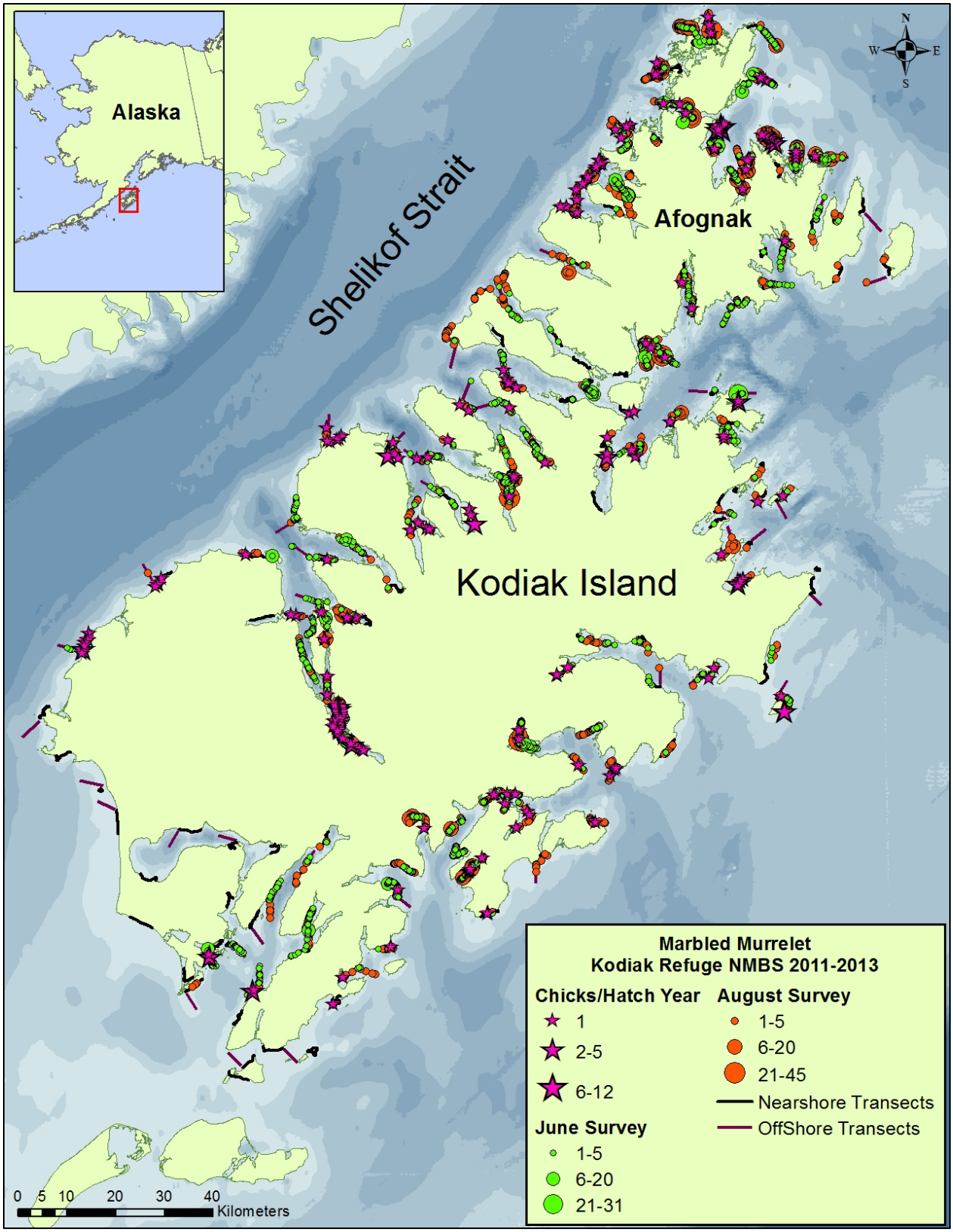

Figure 32. Marbled Murrelet numbers (n = 11,202) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Tufted Puffin

Tufted Puffins are widespread in the North Pacific Ocean, and nest on coastlines and offshore islands from California to Alaska and across the ocean from Japan to the shores of northeastern Asia. Adult Tufted Puffins are the most pelagic of the alcids, ranging widely from colonies in summer to find fish for their young, and spending the nonbreeding season at-sea in the Central North Pacific ocean (Piatt and Kitaysky 2002a). The total world population estimate is 2,970,000 individuals, of which 82% nest in North America (Piatt and Kitaysky 2002a). In Alaska, there are 693 breeding colonies with an estimated population of 2,280,000 individuals (Denlinger 2006). Owing to variability among census counts or low numbers of counts, or both, calculated trends are marginal or insignificant in half of the sites monitored. However, results suggest that populations are increasing in the GOA and westward and declining throughout Southeast Alaska, British Columbia, Washington, Oregon, and California (Piatt and Kitaysky 2002a). Tufted Puffin bycatch mortality in the salmon set gillnet fishery on Kodiak Island was estimated at 110 individuals in 2002 and 96 individuals in 2005 (Manly 2007).

Tufted Puffins were among the most common breeding seabird species in the Kodiak Archipelago. During the current nearshore marine bird survey, 10,931 Tufted Puffins were counted in June, and 4,331 were counted in August over three field seasons 2011-2013 (Figure 33). Tufted Puffins were recorded on 42% of all transects in June, and 59% of transects in August. In general Tufted Puffins were as common offshore as they were in the nearshore survey zone (Table 46). The June 2011-2013 population estimate of 39,522 individuals (Table 47) was comparable to the most recent estimate based on colony surveys of 27,179 (Table 11). Only one hatch-year Tufted Puffin was recorded on 30 August 2011 in Chiniak Bay, however recently fledged puffins are infrequently recorded in the nearshore and are believed to move to foraging locations far from shore soon after leaving the nest. Adult Tufted Puffins were seen returning to burrows with bill loads of fish to feed young in late August in all years of the survey, and into early September in Chiniak Bay on East Kodiak in 2011.

Table 46. Tufted Puffin density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	5.62 (3.35)	9.97 (9.08)	4.31 (1.81)	1.44 (0.87)
	Offshore	4.99 (1.60)	4.90 (2.88)	6.79 (3.09)	2.24 (1.19)
August	Nearshore	4.98 (1.04)	7.49 (2.45)	3.81 (0.97)	2.59 (1.06)
	Offshore	7.98 (1.64)	8.44 (2.29)	10.31 (3.31)	2.43 (0.95)

Table 47. Tufted Puffin population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**39,522 (26,611-52,433)**	**18,765 (7,843-29,687)**	**17,290 (10,645-23,936)**	**3,467 (1,670-5,264)**
August	**55,811 (44,354-67,269)**	**26,988 (19,565-34,412)**	**24,789 (16,296-33,281)**	**4,034 (2,024-6,045)**

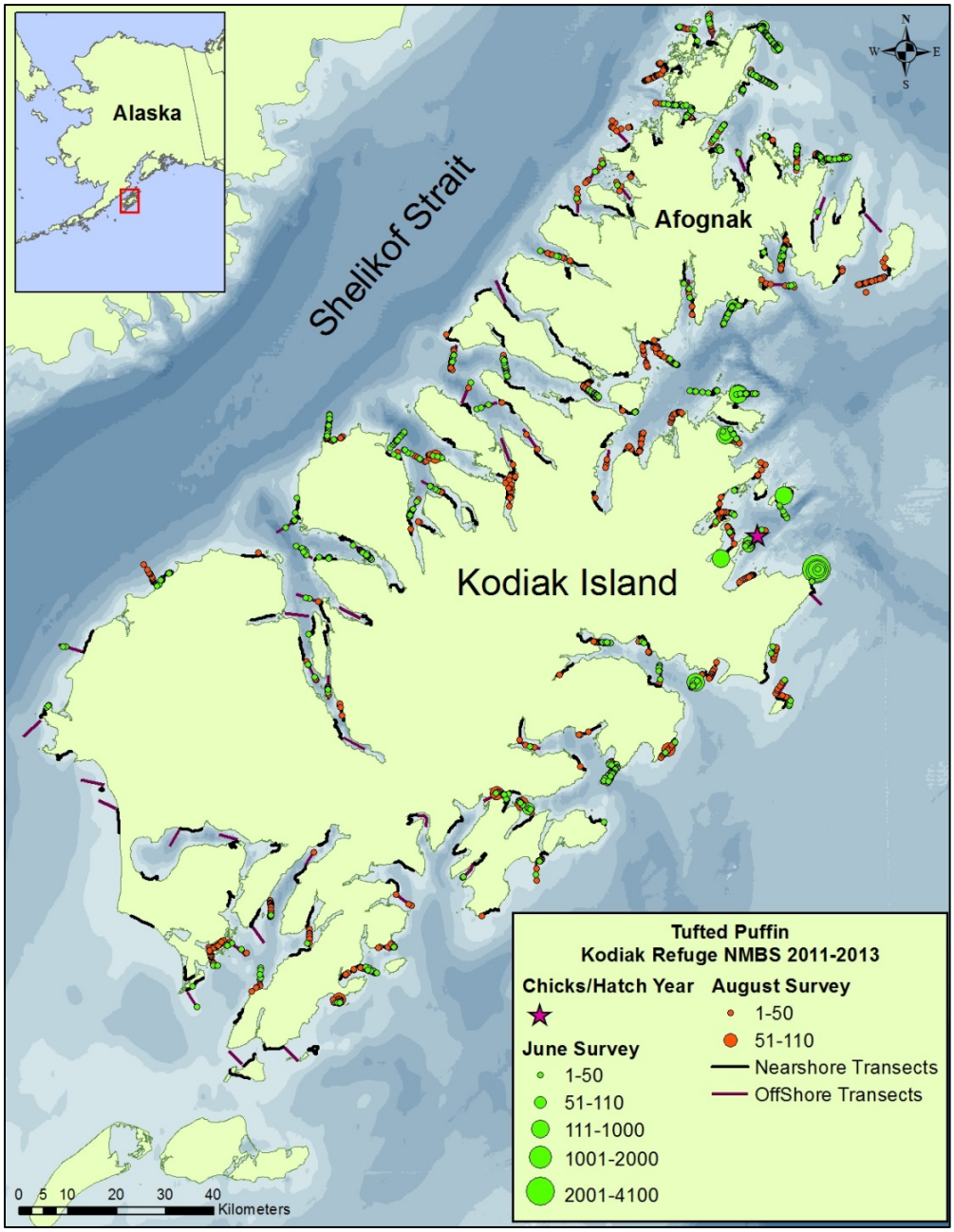

Figure 33. Tufted Puffin numbers (n = 15,262) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Horned Puffin

Horned Puffins are widespread in the North Pacific Ocean, nesting on coastlines and offshore islands from British Columbia (where they are rare) to Alaska, and southwest to the Sea of Okhotsk and the Kuril Islands. In Alaska, the largest colonies are concentrated in the northwest GOA and along the Alaska Peninsula in the Semidi, Shumagin, and Sanak islands. The total world population estimate is 1,088,500 individuals, of which 86% nest in North America (Piatt and Kitaysky 2002b). In Alaska, there are 608 breeding colonies with an estimated population of 921,000 individuals. The population estimates are unreliable due to the difficulty of censusing birds in rock crevices and burrows (Denlinger 2006), and among the highest priorities for research for this species is development of standardized methods for monitoring populations and implementation of a regional monitoring program.

Boat-based surveys of seabirds in PWS, Alaska, suggest an overall 79% decline of Horned Puffins from 1972-1998. This paralleled a similar rate of decline for other fish-eating seabirds in PWS and for murres *(Uria spp.)* in the GOA (Denlinger 2006). Major changes in the food base, apparently the result of a changing marine climate, have been correlated to the decline of murres and may have played a role in the declines of Horned Puffins as well. Other information about trends for Horned Puffins is limited. Coastal gillnet fisheries continue to catch birds in Alaska, and bycatch has periodically been monitored and recorded by the National Marine Fisheries Service, Alaska Marine Mammal Observer Program. Bycatch of Horned Puffins has been recorded in various gillnet fisheries, but the magnitude is minimal compared to the high-seas (Denlinger 2006). For example, in 2002 and 2005, the bycatch of Horned Puffins from the set gillnet fishery for Kodiak Island was estimated at 14 individuals (Manly 2007).

During the current nearshore marine bird survey, 2,206 Horned Puffins were counted in June, and 2,392 were counted in August over three field seasons 2011-2013 (Figure 34). Horned Puffins were recorded on 31% of all transects in June, and 56% of transects in August. In general Horned Puffin density was higher in the nearshore survey zone within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 48). Like Tufted Puffins, recently fledged Horned Puffins were infrequently recorded in the nearshore and were believed to move to foraging locations far from shore soon after leaving the nest. Only nine hatch-year puffins were recorded across three field seasons with eight of these recorded on East Kodiak in 2011.

The June 2011-2013 population estimate of 4,788 individuals (Table 49) was almost five times the 967 individuals (Table 11) recorded during 2008-2010 June colony counts of the region. This large disparity may have resulted from the difficulty in locating many small Horned Puffin colonies in the Kodiak Archipelago. Based on the most recent colony counts on Kodiak there were at minimum 157 Horned Puffin colonies with a mean count per colony of 12 individuals (95% CI 8-16 individuals; Corcoran 2013). However, the mean group size for counts on nearshore transects on the current survey was 2.63 (SE = 0.01; range = 1-36). Low numbers of birds at a nesting site might lead to colonies being missed entirely during designated colony surveys. Other factors may have contributed to higher transect based counts, for instance, where local productivity is high Horned Puffins foraged mostly within 1-2 km of colonies, however, they were also frequently observed foraging 10-120 km from colonies at many locations during the breeding season (Piatt and Kitaysky 2002b). The majority of foraging birds would not be counted on designated colony surveys but were available to be counted on systematic transect based surveys. In addition to foraging birds, non-breeding and failed breeders were more likely

to be represented in transect based surveys than at colonies, increasing population estimates based on transects.

Table 48. Horned Puffin density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (birds/km^2) (SE) 2011-2013	East Kodiak Density (birds/km^2) (SE) 2011	Afognak Density (birds/km^2)(SE) 2012	West Kodiak Density (birds/km^2) (SE) 2013
June	Nearshore	1.73 (0.41)	1.99 (0.67)	1.74 (0.41)	1.31 (1.28)
	Offshore	0.40 (0.12)	0.14 (0.08)	0.73 (0.41)	0.17 (0.11)
August	Nearshore	4.14 (0.79)	5.00 (1.43)	4.10 (0.90)	2.51 (2.23)
	Offshore	1.54 (0.37)	2.13 (1.01)	1.61 (0.37)	0.48 (0.19)

Table 49. Horned Puffin population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	4,788 (3,861-5,714)	1,513 (1,036-1,990)	2,685 (2,003-3,367)	589 (181-997)
August	15,633 (12,142-19,124)	8,442 (5,256-11,628)	5,836 (4,723-6,948)	1,355 (463-2,248)

Photo: R. Corcoran; Horned Puffins, Spiridon Bay, Kodiak, Alaska, August 2013

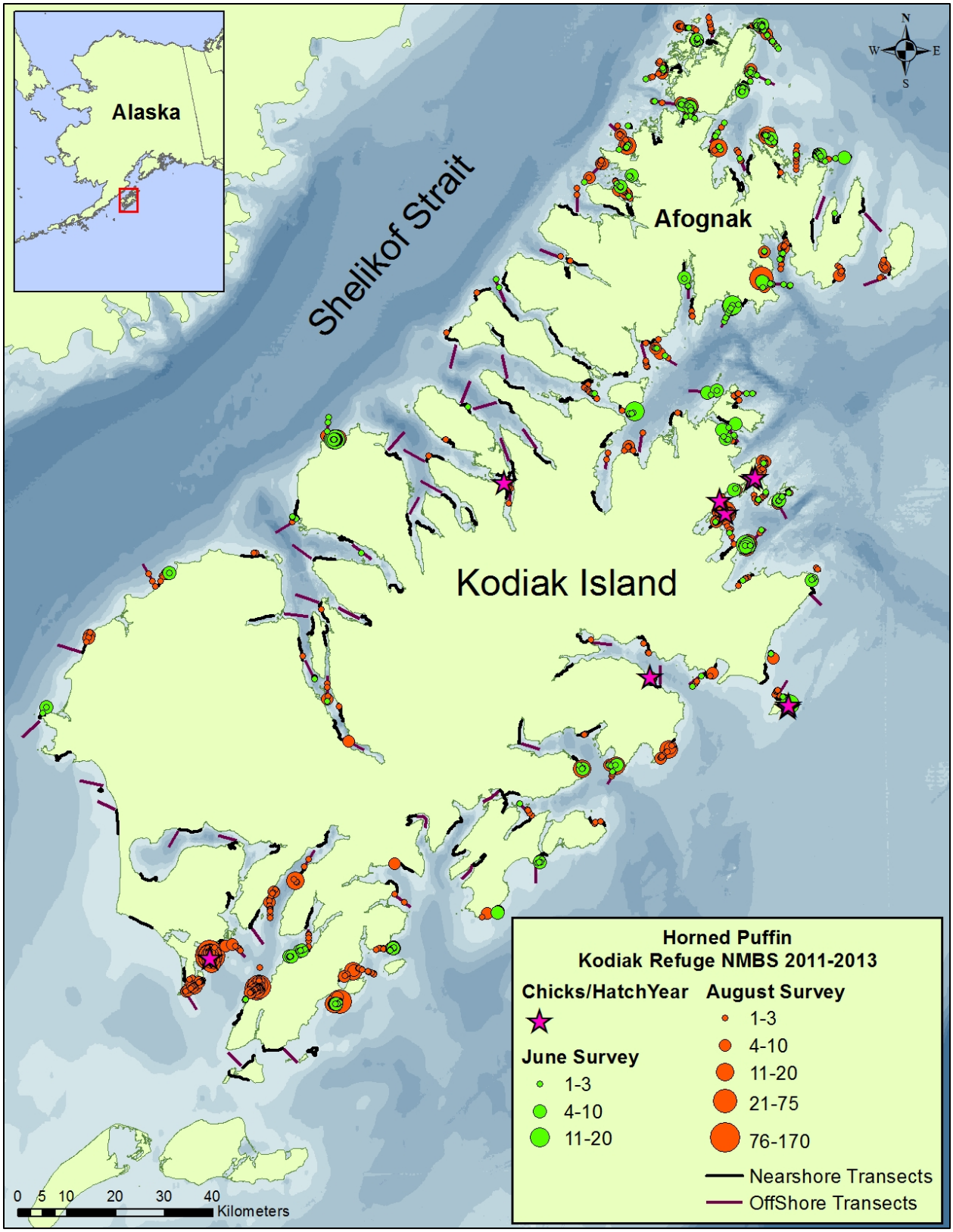

Figure 34. Horned Puffin numbers (n = 3,773) and locations on marine bird survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Sea Otter

Sea Otter numbers have declined in southwestern Alaska over the past 20 years. Once containing more than half of the world's sea otters, this population segment, which ranges from Kodiak Island through the western Aleutian Islands, has undergone an overall population decline of at least 55–67% since the mid-1980s (USFWS 2013). In October 2005, the USFWS listed the southwest Alaska Distinct Population Segment (DPS) of the Northern Sea Otter (*Enhydra lutris kenyoni*) as threatened under the ESA.

Sea Otters were the most abundant marine mammal species recorded on the current nearshore marine bird survey. In total 2,206 Sea Otters were counted in June, and 2,392 were counted in August over three field seasons 2011-2013 (Figure 35). Sea Otters were recorded on 55% of all transects in June, and 57% of transects in August. In general Sea Otter density was higher in the nearshore survey zone within 400 m of the tide line than on offshore transects conducted > 500 m from shore (Table 50). A total of 129 Sea Otter pups were counted in 2012-2013. More pups were seen in June than on August surveys and the ratio of the count of Sea Otter pups to adults was similar across regions (Table 51).

Sea Otters were commonly seen on the west side of Kodiak Island and around Afognak and Shuyak Islands on the northeastern end of the archipelago. However, they were nearly absent from the east side of Kodiak Island outside of Chiniak Bay. Due to the rarity of Sea Otters outside Chiniak Bay and their clumped distribution within the bay, variability on the population estimate for East Kodiak was high (Table 52). Only two Sea Otters were counted on the June 2011 survey along 1,373 km of shoreline on the southeast side of Kodiak Island, with five counted in that region in August 2011. We did not see Sea Otters with pups on the east side of Kodiak Island in 2011.

Sea Otter numbers in the Kodiak Archipelago are considered stable and may be increasing (USFWS 2013). In the 1980s the Sea Otter population on Kodiak was described as growing and female otters on Kodiak were in better body condition and had higher weaning success than otters at a high-density near-equilibrium population on Amchitka Island in the Aleutians (Monson et al. 2000). There have been four archipelago–wide aerial surveys conducted for Sea Otters using the methods of Bodkin and Udevitz (1999). Table 53 is a comparison of population estimates for Sea Otters in the Kodiak Archipelago from aerial surveys conducted from 1994-2014 to the current at-sea surveys. The population estimate of 13,274 Sea Otters based on aerial surveys conducted in 2014 was similar to the June 2011-2013 population estimate of 14,573 from at-sea surveys, but is lower than the August estimate of 22,932 Sea Otters (Tables 52-53).

An aerial survey of Sea Otters along the coastline of Katmai National Park and Preserve was completed in July 2012 from Cape Douglas to the southwest end of Cape Kubugakli; resulting in an estimated density of 5.96 otters/km^2 (USFWS 2013). This density estimate for the neighboring Katmai coast was comparable to nearshore densities around Afogank Island in 2012 (4.63-7.00 otters/km^2), and on West Kodiak Island in 2013 (4.23-5.93 otters/km^2), where Sea Otters were abundant.

Table 50. Sea Otter density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (otters/km^2) (SE) 2011-2013	East Kodiak Density (otters/km^2) (SE) 2011	Afognak Density (otters/km^2)(SE) 2012	West Kodiak Density (otters/km^2) (SE) 2013
June	Nearshore	3.35 (0.55)	0.09 (0.04)	4.63 (0.80)	5.93 (1.75)
	Offshore	2.07 (0.66)	0.19 (0.18)	2.94 (1.28)	2.89 (1.43)
August	Nearshore	3.94 (0.63)	0.24 (0.14)	7.00 (1.26)	4.23 (0.91)
	Offshore	3.07 (1.05)	1.85 (2.18)	4.30 (1.69)	2.59 (0.91)

Table 51. Counts of Sea Otter pups and adults from the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska, 2012-2013. In 2011, when East Kodiak was surveyed, only 233 Sea Otters were counted and pups were not recorded.

Year - Region	Month	Count of Sea Otter Pups	Count of Sea Otter Adults	Pup:Adult Ratio
2012 - Afognak	June	52	1249	0.042
	August	33	1643	0.020
2013 – West Kodiak	June	32	843	0.038
	August	12	501	0.024

Table 52. Sea Otter population estimates with lower and upper 95% confidence limits (LCL-UCL) based on transect density from the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	14,573 (11,314-17,831)	562 (-27-1,151)	8,573 (6,160-10,985)	5,438 (3,328-7,548)
August	22,932 (14,422-31,442)	5,099 (-1,721-11,918)	13,319 (8,559-18,080)	4,514 (2,711-6,316)

Table 53. Comparison of Sea Otter population estimates from the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska, 2011-2013, with estimates from aerial surveys from 1994-2014 using the methods of Bodkin and Udevitz (1999).

Year	Season/Dates	Population Estimate	Survey Type	Source
1994	July - August	9,817	aerial	USFWS 2013
2001	June	5,893	aerial	USFWS 2013
2004	Summer	11,005	aerial	USFWS 2013
2011-2013	June	14,573	boat	Current survey
2011-2013	August	22,932	boat	Current survey
2014	2 July - 1 August	13,274	aerial	M. Cobb, unpublished data

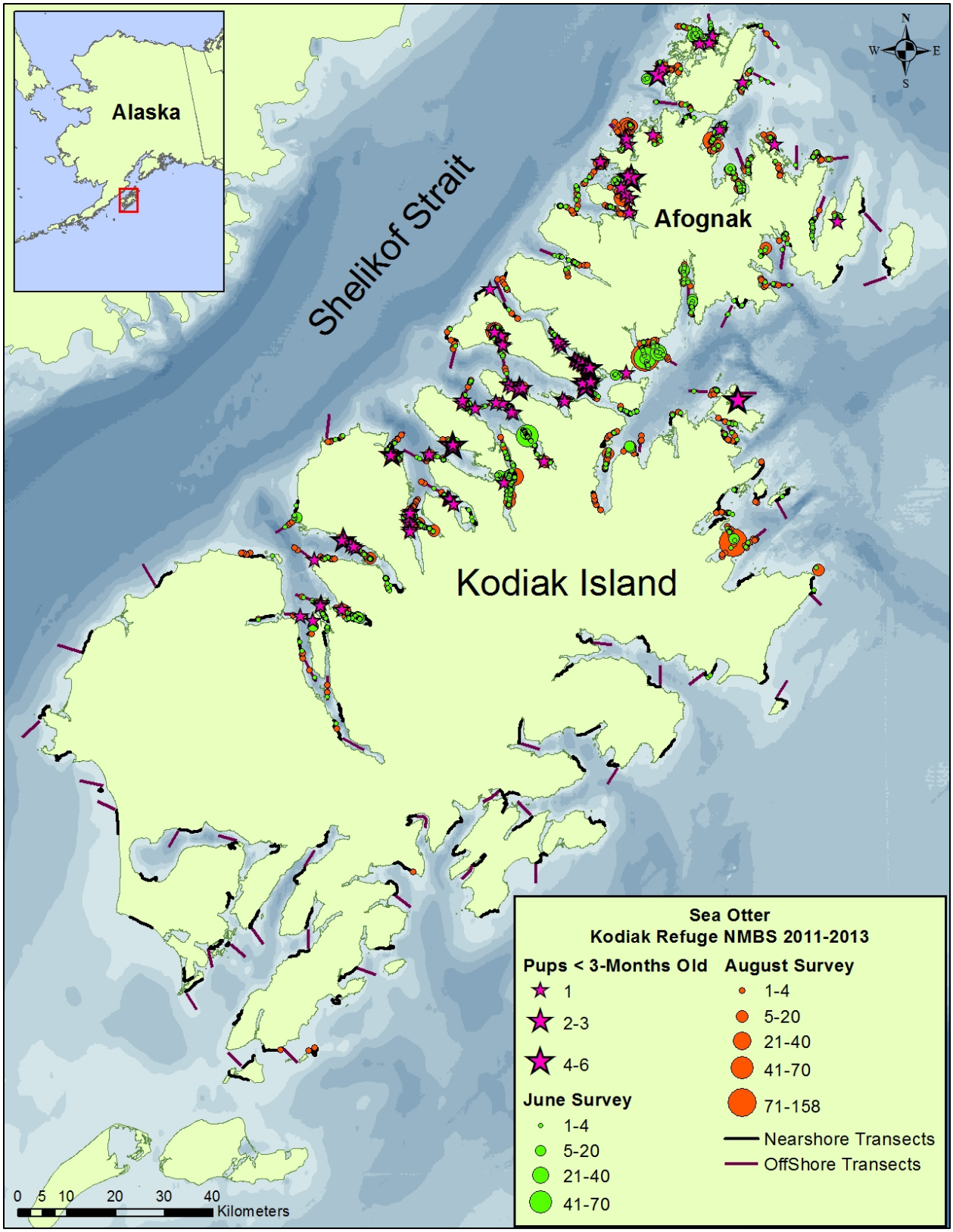

Figure 35. Sea Otter numbers (n = 4,598) and locations on marine bird and mammal survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Harbor Seal

The Alaska Harbor Seal population is estimated at approximately 205,090 based on aerial survey data collected during 1998-2011(Muto et al. 2016). Harbor Seals are listed as an Alaska Species of Special Concern, defined as any species or subspecies native to Alaska that has entered a long-term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance. Dramatic declines in Harbor Seal numbers have been documented in Alaska, including a decline from approximately 11,000 seals to 1,000 seals during 1976-1988 on Tugidak Island near Kodiak – a site previously considered to host one of the largest concentrations of Harbor Seals in the world (Jemison et al. 2006). That decline resulted in the listing of Alaskan Harbor Seals as a species of special concern by the Marine Mammal Commission. A 63% decline in Harbor Seal numbers also occurred in PWS during 1984-1997. Although seal numbers in the Kodiak area have been steadily increasing since the early 1990s and seal numbers in PWS began to stabilize and show signs of increase in 2002, both populations remain severely depressed compared to pre-decline population levels (Muto et al. 2016).

During the current nearshore marine bird survey, 839 Harbor Seals were counted in June, and 1,294 were counted in August over three field seasons 2011-2013 (Figure 36). Seals were counted at both haul-out sites and in the water. Harbor Seals were recorded on 41% of all transects in June and 45% of transects in August. Harbor Seal density was significantly higher in the nearshore survey zone within 400 m of the tide line, than in the offshore zone > 500 m from shore (Table 54).

Harbor Seal abundance estimates for the Kodiak region based on 2011 aerial surveys were 8,321 (SE = 1,619) for North Kodiak, and 19,199 (SE = 2,429) for South Kodiak (Muto et al. 2016). These estimates were significantly higher than either the June or August estimate from the current skiff-based survey (Table 55). However, these aerial surveys included areas not surveyed by the current nearshore survey including the Barren Islands to the north of the Archipelago, and the Trinity Islands southwest to Chirikof Island in the south.

Table 54. Harbor Seal density (birds/ km^2) and standard error (SE) estimates based on transects from the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska, 2011-2013.

Month	Transect Type	Kodiak Archipelago Density (seals/km^2) (SE) 2011-2013	East Kodiak Density (seals/km^2) (SE) 2011	Afognak Density (seals/km^2) (SE) 2012	West Kodiak Density (seals/km^2) (SE) 2013
June	Nearshore	2.18 (0.94)	1.04 (0.59)	2.98 (2.06)	2.41 (1.46)
	Offshore	0.30 (0.12)	0.05 (0.03)	0.43 (0.25)	0.37 (0.26)
August	Nearshore	3.48 (1.75)	5.32 (4.47)	1.02 (0.35)	5.58 (2.39)
	Offshore	0.51 (0.21)	0.08 (0.05)	0.98 (0.47)	0.28 (0.08)

Table 55. Harbor Seal population estimates with 95% lower and upper confidence limits (LCL-UCL) from the Kodiak Archipelago nearshore marine bird and mammal survey, Alaska, 2011-2013.

	Kodiak Archipelago Population Estimate (LCL-UCL) 2011-2013	East Kodiak Population Estimate (LCL-UCL) 2011	Afognak Population Estimate (LCL-UCL) 2012	West Kodiak Population Estimate (LCL-UCL) 2013
June	**3,960 (2,883-5,036)**	**728 (305-1,150)**	**1,984 (1,205-2,764)**	**1,247 (638-1,857)**
August	**7,175 (4,723-9,627)**	**2,365 (535-4,194)**	**2,814 (1,460-4,168)**	**1,996 (1,084-2,908)**

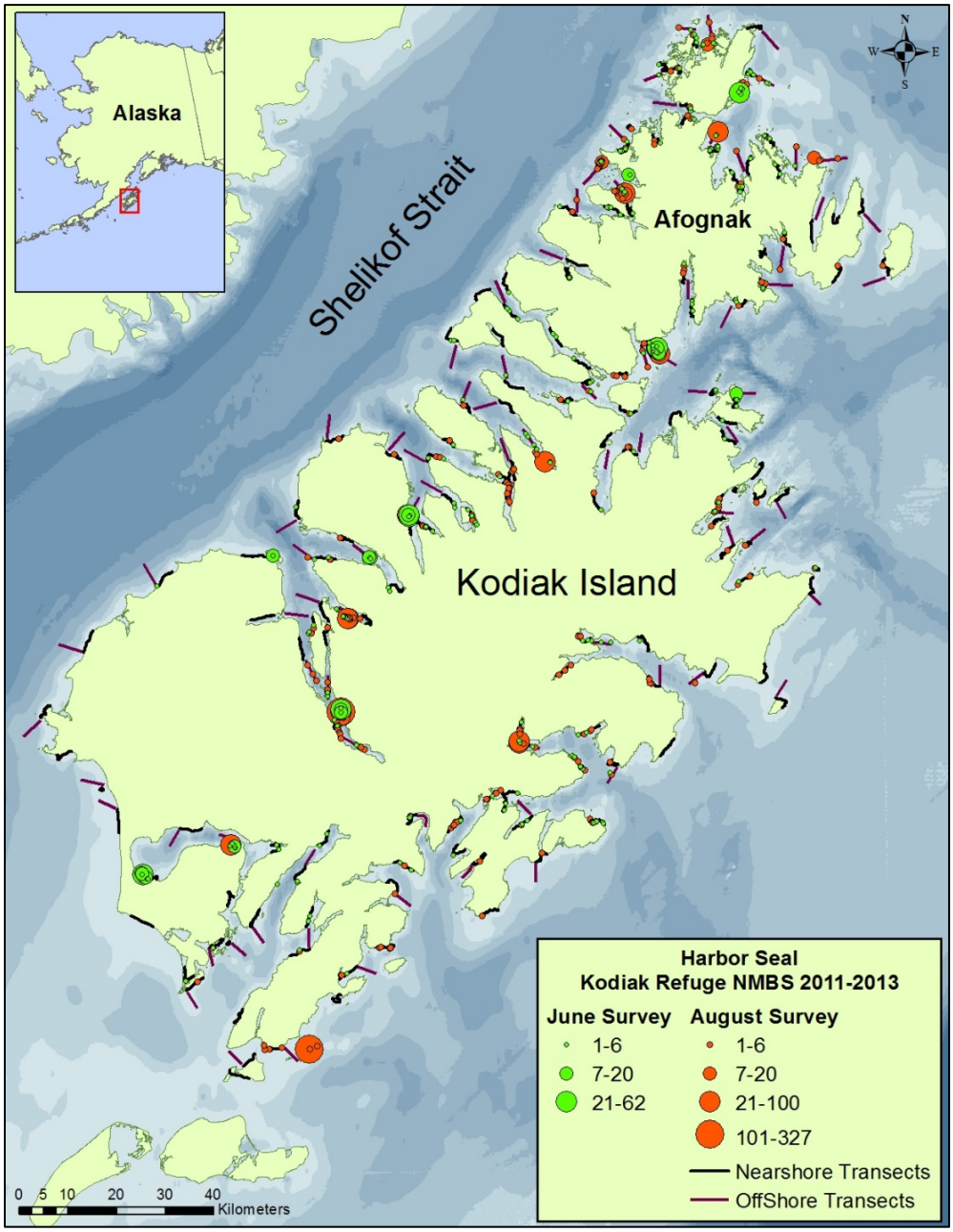

Figure 36. Harbor Seal numbers (n = 2,133) and locations on marine bird and mammal survey transects in June and August 2011-2013, Kodiak Archipelago, Alaska.

Acknowledgements

Many people were instrumental in the completion of this survey including dedicated full-time volunteers: Pauline Hsieh, Deanna Russell, Katie Studholme, Rhia Pulizzi, Marie McCann, Jenny Helm, Stacey Waldrup, and Tamara Payton. Jenna Cragg also provided assistance across several seasons. Dave Sinnett, Rich MacIntosh, and Michelle LeBeau assisted with several survey efforts. This work would not have been possible without the Kodiak Refuge research vessel Ursa Major II and captain Jeff Lewis. Much needed logistical support was provided by refuge personal Lecita Monzon, Cinda Childers, Gerri Castonguay, and Kevin VanHatten. Refuge volunteer coordinator Lisa Hupp was indispensable in volunteer recruitment and training. We thank Dr. Katherine Kuletz of the Region 7, U.S. Fish and Wildlife Service, Migratory Birds Division, and Dr. John Piatt and Dr. Rebecca Taylor of the USGS Alaska Science Center, for comments on an earlier draft of this report. We are grateful to the USFWS National Inventory and Monitoring Program for providing funding for surveys in 2013.

Literature Cited

Agler, B.A., P.E. Seiser, S.J. Kendall, and D.B. Irons. 1994. Marine bird and sea otter populations of Prince William Sound. Alaska: population trends following the T/V Exxon Valdez oil spill. Exxon Valdez Oil Spill Restoration Final Report, Exxon Valdez Oil Spill Trustee Council, Anchorage, AK.

Agler, B.A., S.J. Kendall, D.B. Irons, and S.P. Klosiewski. 1999. Declines in marine bird populations in Prince William Sound, Alaska coincident with climatic regime shift. Waterbirds 22:98-103.

Ainley, D.G., D.N. Nettleship, H.R. Carter, and A.E. Storey. 2002. Common Murre (*Uria aalge*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/commur; DOI: 10.2173/bna.666

Anderson P. J. and J.F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series 189:117-123.

Andres, B. A. and G.A. Falxa. 1995. Black Oystercatcher (*Haematopus bachmani*), 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/bna/species/155; DOI: 10.2173/bna.155

Bertram, D.F., C.A. MacDonald, P.D. O'Hara, J.L. Cragg, M.H. Janssen, M. McAdie, and W.S. Boyd. 2016. Marbled Murrelet *Brachyramphus marmoratus* movements and marine habitat use near proposed tanker routes to Kitimat, BC, Canada. Marine Ornithology 44: 3–9.

Blejwas, K.M. and S.K. Wright. 2012. Bycatch of Kittlitz's murrelet (*Brachyramphus brevirostris*) in commercial salmon gillnet fisheries in the Gulf of Alaska: A qualitative risk assessment. Wildlife Research Report ADF&G/DWC/WRR-2012-8. Alaska Department of Fish and Game, Juneau, Alaska.

Blight, L.K., M.C. Drever, and P. Arcese. 2015. A century of change in Glaucous-winged Gull (*Larus glaucescens*) populations in a dynamic coastal environment. Condor 117:108-120.

Bodkin, J.L. and M.S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. Pages 13-26 in G.W.Garner et al., editors. Marine Mammal Survey and Assessment Methods. Balekema, Rotterdam, Netherlands.

Bowman, T.D., E.D. Silverman, S.G. Gilliland, and J.B. Leirness. 2015. Status and trends of North American sea ducks: reinforcing the need for better monitoring. pp. 1-27 in J.-P.L. Savard, D.V. Derksen, D. Esler and J.M. Eadie, editors. Ecology and conservation of North American sea ducks. Studies in Avian Biology, CRC Press, New York, NY.

Carter, H.R., M.L.C. McAllister, and M.E.P. Isleib. 1995. Mortality of Marbled Murrelets in gill nets in North America. In Ecology and conservation of the Marbled Murrelet., edited by C. J. Ralph, Jr G. L. Hunt, M. G. Raphael and J. F. Piatt, 271-284. Albany, CA: USDA For. Serv. Gen. Tech. Rep. PNW-152.

Caughley, G. 1977. Sampling in aerial survey. Journal of Wildlife Management 41:605-615.

Clarke ED, L.B. Spear, M.L. McCracken, F.F.C Marques, D.L. Borchers, S.T. Buckland, and D.G. Ainley. 2003. Validating the use of generalized additive models and at-sea surveys to estimate size and temporal trends of seabird populations. Journal of Applied Ecology 40:278−292

Cochran, W.G. 1977. Sampling Techniques. John Wiley and Sons, New York.

Coletti, H.A., T.A. Dean, K.A. Kloecker, and B.E. Ballachey. 2014. Nearshore marine vital signs monitoring in the Southwest Alaska Network of National Parks: 2012. Natural Resource Technical Report NPS/SWAN/NRTR—2014/843. National Park Service, Fort Collins, CO.

Corcoran, R.M. 2012. Aleutian Tern counts from seabird colony and nearshore marine bird surveys in the Kodiak Archipelago, Alaska 1975-2012. Unpubl. Refuge Report 01-12. U.S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak, Alaska. https://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_2/Kodiak/PDF/Kodiak%20Aleutian%20Tern%20Counts%201975-2012.pdf

Corcoran, R.M. 2013. Seabird Colony Report, Kodiak Archipelago, Alaska 1975-2011. Unpubl. Refuge Report 02-13. U.S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak, AK. 83pp. http://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_2/Kodiak/PDF/Kodiak%20Seabird%20Colony%20Report%202013.pdf

Day, R.H., K.J. Kuletz, and D.A. Nigro. 1999. Kittlitz's Murrelet (*Brachyramphus brevirostris*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/kitmur: DOI: 10.2173/bna.435

Dean, T. A., and J. L Bodkin. 2006. Sampling protocol for the nearshore restoration and ecosystem monitoring (N-REM) program. *Exxon Valdez* Restoration Project //0750. Draft Final Report. *Exxon Valdez* Restoration Office, Anchorage, AK.

Dean, T. A., and J. L. Bodkin. 2011. Protocol narrative for marine nearshore ecosystem monitoring in the Southwest Alaska Network of National Parks: Version 1.0. Natural Resource Report NPS/SWAN/NRR—2011/449. National Park Service, Fort Collins, CO. 85pp.

Denlinger, L.M. 2006. Alaska Seabird Information Series. Unpubl. Rept., U.S. Fish and Wildlife Service, Migratory Bird Management, Nongame Program, Anchorage, AK. 92pp.

Dragoo, D. E., G. V. Byrd, and D. B. Irons. 2003. Breeding status, population trends and diets of seabirds in Alaska, 2001. U.S. Fish and Wildlife Service Report AMNWR 03/05.

Dragoo, D. E., H. M. Renner, and D. B. Irons. 2013. Breeding status and population trends of seabirds in Alaska, 2012. U.S. Fish and Wildlife Service Report AMNWR 2013/05. Homer, AK.

Dragoo, D. E. 2014. Breeding status and population trends of seabirds in Alaska, 2013. U.S. Fish and Wildlife Service Report AMNWR 2014/03. Homer, AK.

Eadie, J.M., J-P.L. Savard, and M.L. Mallory. 2000. Barrow's Goldeneye (*Bucephala islandica*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/bargol; DOI: 10.2173/bna.548

Ewins, P.J. 1993. Pigeon Guillemot (*Cepphus columba*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/piggui; DOI: 10.2173/bna.49

Federal Register. 2013. 12-Month finding on a petition to list Kittlitz's murrelet as an endangered or threatened species. United States Department of Interior Fish and Wildlife Service Federal Register 78:1-39.

Ford, G. 2009. Program Description and Users Manual *V* 1.0 R.G. Ford Consulting Co. dLOG3 Software for Biological Surveys: Data Entry and Real-time Mapping Program for Windows®. R.G. Ford Consulting Co., 2735 NE Weidler Street, Portland, OR.

Galusha, J. G. and J. L. Hayward. 2002. Bald Eagle activity at a gull colony and seal rookery on Protection Island, Washington. Northwestern Naturalist no. 83:23-25.

Haney, J.C. and A.R. Solow. 1992. Testing for resource use and selection by marine birds. Journal of Field Ornithology 63:43-52.

Harney, J.N., and M. Morris. 2007. ShoreZone coastal habitat mapping data summary report: Kodiak Archipelago. Report prepared for the Cook Inlet Regional Citizens' Advisory Council (CIPCAC). 112pp.

Harney, J.N., M. Morris, and J.R. Harper. 2008. ShoreZone coastal habitat mapping protocol for the Gulf of Alaska. Prepared for the Nature Conservancy, NOAA-NMFS, and Alaska State Department of Natural Resources, Juneau, AK. Coastal & Oceans Resources Inc, Sidney, BC, 137pp.

Hatch, S.A., G.J. Robertson and P.H. Baird. 2009. Black-legged Kittiwake (*Rissa tridactyla*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/bklkit; DOI: 10.2173/bna.92

Hickey, C., W. D. Shuford, G. W. Page, and S. Warnock. 2003. Version 1.1. The Southern Pacific Shorebird Conservation Plan: a strategy for supporting California's Central Valley and coastal shorebird populations. PRBO Conservation Science, Stinson Beach, CA.

Hollowed, A. B., M. Barange, R.J. Beamish, K. Brander, K. Cochrane, K. Drinkwater, M. Foreman, J. Hare, J. Holt, S-I. Ito, S. Kim, J. King, H. Loeng, B. MacKenzie, F. Mueter, T. Okey, M. A. Peck, V. Radchenko, J. Rice, M. Schirripa, A. Yatsu, and Y. Yamanaka. 2013. Projected impacts of climate change on marine fish and fisheries. – ICES Journal of Marine Science, doi:10.1093/icesjms/fst081.

Irons, D.B., S.J. Kendall, W.P. Erickson, L.L. McDonald, and B.K. Lance. 2000. Nine years after the Exxon Valdez oil spill: Effects on marine bird populations in Prince William Sound, Alaska. Condor 102:723-737.

IUCN. 2008. 2008 IUCN Red List of Threatened Species. http://www.iucnredlist.org

Jemison, L. A., G. W. Pendleton, C. A. Wilson, and R. J. Small. 2006. Long-term trends in harbor seal numbers at Tugidak Island and Nanvak Bay, Alaska. Mar. Mammal Sci. 22:339-360.

Johnson, J.M., P. Clarkson, M.I. Goldstein, S.M. Haig, R.B. Lanctot, D.F. Tessler, D. Zwiefelhofer. 2010, Seasonal movements, winter range use, and migratory connectivity of the black oystercatcher: The Condor 112:731-743.

Kissling, M.L. 2011. Foreword: Population status and trends of the Kittlitz's Murrelet *Brachyramphus brevirostris*. Marine Ornithology 39:2.

Klosiewski, S.P. and K.K. Laing. 1994. Marine bird populations of Prince William Sound, Alaska, before and after the Exxon Valdez oil spill. NRDA Bird Study No. 2. Unpubl. Rep., U.S. Fish and Wildlife Service, Anchorage, AK.

Knudson, T.W., R.M. Corcoran, J.R. Lovvorn, J.L. Piatt, and W.H. Pyle. 2016. Breeding Ecology and Behavior of Kittlitz's Murrelet in Kodiak National Wildlife Refuge, Alaska: 2015 Progress Report. Refuge report 2016.3, Kodiak National Wildlife Refuge, U.S. Fish and Wildlife Service, Kodiak, AK.

Kuletz, K. J., D. K. Marks, N. L. Naslund, N. J. Goodson, and M. B. Cody. 1995. Inland habitat suitability for the Marbled Murrelet in southcentral Alaska. Pages 141–149 in C. J.Ralph, G. L.Hunt, M. G.Raphael, and J. F.Piatt, editors. Ecology and conservation of the Marbled Murrelet. General technical report PSW-GTR-152. U.S. Forest Service, Albany, CA.

Kuletz, K. J., and S. J. Kendall. 1998. A productivity index for marbled murrelets in Alaska based on surveys at sea. Journal of Wildlife Management 62:446–460.

Kuletz, K. J., and J.F. Piatt. 1999. Juvenile Marbled Murrelets nurseries and the productivity index. Wilson Bulletin 111:257-261.

Lawonn, M.J. 2012. Breeding ecology and nest site selection of Kittlitz's murrelets on Kodiak Island, Alaska. M.S. Thesis, Oregon State University, Corvallis.

Little, B. and R. W. Furness. 1985. Long-distance moult migration by British Goosanders *Mergus merganser*. Ring. Migrat. No. 6:77-82.

Lougheed, C., L. W. Lougheed, F. Cooke, and S. Boyd. 2002. Local survival of adult and juvenile Marbled Murrelets and their importance for estimating reproductive success. Condor104:309–318.

Lyons, J.E., J.A. Royle, S.M. Thomas, E. Elliott-Smith, J.R. Evenson, E.G. Kelly, R.L. Milner, D.R. Nysewander, and B.R. Andres. 2012. Large-scale monitoring of shorebird populations using count data and N-mixture models: Black oystercatcher (*Haematopus bachmani*) surveys by land and sea. Auk 129:645-652.

Madison, E.N., J.F. Piatt, M. Arimitsu, M.D. Romano, T.I. Van Pelt, S.K. Nelson, J.C. Williams, and A.R. Degange. 2011. Status and distribution of Kittlitz's Murrelet *Brachyramphus brevirostris* along the Alaska Peninsula and Kodiak and Aleutian Islands, Alaska. Marine Ornithology 39:111-122.

Manly, B. F. J., L. L. McDonald, D. L. Thomas, T. L. McDonald, and W. P. Erickson. 2002. Resource selection by animals: statistical analysis and design for field studies. Second Edition. Kluwer, Boston, Massachusetts, USA. Pages 50-59.

Manly, B.F.J. 2007. Incidental take and interactions of marine mammals and birds in the Kodiak Island salmon set gillnet fishery, 2002 and 2005. Final Report to NMFS Alaska Region. https://alaskafisheries.noaa.gov/sites/default/files/kodiakreport02_05.pdf

Monson, D.H., J.A. Estes, J.L. Botkin, and D.B. Siniff. 2000. Life history plasticity and population regulation in sea otters. Oikos 90:457-468.

Moskoff, W. and Louis R. Bevier. 2002. Mew Gull (*Larus canus*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/mewgul; DOI: 10.2173/bna.687

Muto, M.M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2016. Alaska marine mammal stock assessments, 2015. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-323, 300 p. doi:10.7289/V5/TM-AFSC-323. Document available: http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-323.pdf

Ohlendorf, H. M., J. C. Bartonek, G. J. Divoky, E. E. Klaas and A. J. Krynitski. 1982. Organochlorine residues in eggs of Alaska seabirds. U.S. Fish and Wildlife Service Spec. Sci. Rep. no. 245.

Patten, Jr., S. M., T. Crowe, R. Gustin, R. Hunter, P. Twait and C. Hastings. 1998. Assessment of injury to sea ducks from hydrocarbon uptake in Prince William Sound and the Kodiak archipelago, Alaska, following the *Exxon Valdez* oil spill. Bird Study 11. Alaska Dept. Fish Game, Anchorage: *Exxon Valdez* Oil Spill Natural Resource Damage Assessment Final Rep.

Pearce, J. M., D. Zwiefelhofer, and N. Maryanski. 2009. Mechanisms of population heterogeneity among molting Common Mergansers on Kodiak Island, Alaska: Implications for genetic assessments of migratory connectivity. Condor no. 111:283-293.

Pearce, J., M.L. Mallory, and K. Metz. 2015. Common Merganser (*Mergus merganser*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/commer; DOI: 10.2173/bna.442

Peery, M. Z., B. H. Becker, AND S. R. Beissinger. 2007. Age ratios as estimators of productivity: testing the assumptions on a threatened seabird, the Marbled Murrelet (*Brachyramphus marmoratus*). Auk 124:224–240.

Piatt, J. F., C. J. Lensink, W. Butler, M. Kendziorek, and D. R. Nysewander. 1990. Immediate impact of the *Exxon Valdez* oil spill on marine birds. Auk 107:387-397.

Piatt, J.F., and R. G. Ford. 1993, Distribution and abundance of Marbled Murrelets in Alaska. Condor 95:662-669.

Piatt, J. F. and P. Anderson. 1996. Response of Common Murres to the *Exxon Valdez* oil spill and long-term changes in the Gulf of Alaska marine ecosystem. Am. Fish. Soc. Symp. no. 18:720-737.

Piatt, J. F. and R. G. Ford. 1996. How many birds were killed by the *Exxon Valdez* oil spill? Pages 712-719 in S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.

Piatt, J.F. and A.S. Kitaysky. 2002a. Tufted Puffin (*Fratercula cirrhata*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/tufpuf; DOI: 10.2173/bna.708

Piatt, J.F. and A.S. Kitaysky. 2002b. Horned Puffin (*Fratercula corniculata*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/horpuf; DOI: 10.2173/bna.603

Piatt J.F., A.M.A. Harding, M. Shultz, S.G. Speckmann, T.I. Van Pelt, G.S. Drew, A.B. Kettle. 2007a. Seabirds as indicators of marine food supplies: Cairns revisited. Marine Ecology Progress Series 352:221–234.

Piatt, J.F., K.J. Kuletz, A.E. Burger, S.A. Hatch, V.L. Friesen, T.P.Birt, M.L. Arimitsu, G.S. Drew, A.M.A. Harding, and K.S. Bixler. 2007b. Status review of the Marbled Murrelet (*Brachyramphus marmoratus*) in Alaska and British Columbia: U.S. Geological Survey Open-File Report 2006-1387, 258 pp.

Plafker, G. and R. Kachadoorian. 1966. Geologic effects of the March 1964 earthquake and associated seismic sea waves on Kodiak and nearby Islands Alaska. U.S. Department of the Interior, Geological Survey Professional Paper 543-D. Washington, D.C. 46pp.

Pollock, K.H., J.D. Nichols, T.R. Simons, G.L. Farnsworth, L.L. Bailey, and J.R. Sauer. 2002. Large scale wildlife monitoring studies: Statistical methods for design and analysis. Envirometrics 13:105-119.

Reid, W.V. 1988. Population dynamics of the Glaucous-winged Gull. Journal of Wildlife Management 52:763-770.

Renner, H.M., M.D. Romano, M. Renner, S. Pyare, M.I. Goldstein, and Y. Arthukin. 2015. Assessing the breeding distribution and population trends of the Aleutian Tern *Onychoprion aleuticus*. Marine Ornithology 43:179-187.

Robertson, G. J. and R.I. Goudie. 1999. Harlequin Duck (*Histrionicus histrionicus*), The Birds of North America (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from

the Birds of North America: https://birdsna.org/Species-Account/bna/species/harduc, DOI: 10.2173/bna.466

Rothe, T. C., P. I. Padding, L. C. Naves, and G. J. Robertson. 2015. Harvest of sea ducks in North America: A Contemporary Summary. In J.-P.L. Savard, D.V. Derksen, D. Esler and J.M. Eadie (editors). Ecology and conservation of North American sea ducks. Studies in Avian Biology 46, CRC Press, New York, NY.

Spies, R. B., S. D. Rice, D. A. Wolfe, and B. A. Wright. 1996. The effects of the *Exxon Valdez* oil spill on the Alaskan marine environment. Pages 1-16 in S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* oil spill symposium. American Fisheries Society Symposium 18.

Stenhouse, I. J., S. Studebaker, and D. Zwiefelhofer. 2008. Kittlitz's murrelet *Brachyramphus brevirostris* in Kodiak Archipelago, Alaska. Marine Ornithology 36:59–66.

Stephensen, S.W., D.B. Irons, S.J. Kendall, B.K. Lance, and L.L. MacDonald. 2001. Marine bird and sea otter population abundance of Prince William Sound, Alaska: Trends following the *T/V Exxon Valdez* oil spill 1989-200. *Exxon Valdez* Oil Spill Restoration project Annual Report (Restoration Project 00159). U.S. Fish and Wildlife Service, Anchorage, AK. 144pp.

Stephensen, S.W., D.C. Zwiefelhofer, and R.J. Howard. 2002. Seabird colony survey of south and east Kodiak Island, Alaska, June 2001. U.S. Fish and Wildlife Service Report. Migratory Bird Management, Anchorage, AK. 23pp.

Stephensen, S.W., D.C. Zwiefelhofer, and L. Slater. 2003. Seabird colony survey of north and west Kodiak Island, Alaska, June 2002. U.S. Fish and Wildlife Service Report. Migratory Bird Management, Anchorage, AK. 34pp.

Sullivan, T. M., S. L. Hazlitt and M. J. F. Lemon. 2002. Population trends of nesting Glaucous-winged Gulls, Larus glaucescens, in the southern Strait of Georgia, British Columbia. Canadian Field-Naturalist no. 116:603-606.

Tessler, D. F., J. A. Johnson, B. A. Andres, S. Thomas, and R. B. Lanctot. 2007. Black Oystercatcher (*Haematopus bachmani*) conservation action plan. International Black Oystercatcher Working Group, Alaska Department of Fish and Game, Anchorage, AK.

Thomas L., S.T. Buckland, E.A. Rexstad, J.L. Laake, S. Strindberg, S. L. Hedley, J.R.B. Bishop, T.A. Marques, and K.P. Burnham. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47:5–14.

Troyer, W.A. and R.J. Hensel. 1965. Nesting and productivity of Bald Eagles on Kodiak National Wildlife Refuge, Alaska. Auk 82:636-638.

U.S. Fish and Wildlife Service (USFWS). 1999. Manual for censusing seabird colonies. Beringian Seabird Colony Calatog. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK. 24pp.

U.S. Fish and Wildlife Service (USFWS). 2008a. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php

U. S. Fish and Wildlife Service (USFWS). 2008b. Revised Comprehensive Conservation Plan Kodiak National Wildlife Refuge: U.S. Fish and Wildlife Service, Region 7, Anchorage, AK.

U.S. Fish and Wildlife Service (USFWS). 2011. Land protection plan for Alaska Maritime National Wildlife Refuge, Homer, Alaska. United States Department of Interior, Fish and Wildlife Service, Region 7, Anchorage, AK. 122pp.

U.S. Fish and Wildlife Service (USFWS). 2012. Alaska Coastal Program Strategic Plan, 2012-2016. United States Department of Interior, Fish and Wildlife Service, Conservation Partnerships Program, Anchorage, AK. 29 pp.

U.S. Fish and Wildlife Service (USFWS). 2013. Southwest Alaska Distinct Population Segment of the Northern Sea Otter (*Enhydra lutris kenyoni*) – Recovery Plan. U.S. Fish and Wildlife Service, Region 7, Alaska. 171 pp.

U.S. Shorebird Conservation Plan (USSCP). 2004. High priority shorebirds—2004. U.S. Fish and Wildlife Service, Arlington, VA.

Williams, B. K., J. D. Nichols, and M. J. Conroy. 2002. Analysis and Management of Animal Populations. Academic Press, San Diego, California, USA.

Wong, S.N.P., R.A. Ronconi, A.E. Burger, and B. Hansen. 2008. Marine distribution and behavior of juvenile and adult Marbled Murrelets off southwest Vancouver Island, British Columbia: applications for monitoring. Condor 110:306-315.

Zador, S. (ed.). 2012. Ecosystem considerations 2012. North Pacific Fishery Management Council Groundfish Plan Team Document, November 2012. NOAA, AFSC, 7600 Sand Point Way, N.E., Seattle, WA.

Zwiefelhofer, D. 2007a. Comparison of Bald Eagle (*Haliaeetus leucocephalus*) nesting and productivity at Kodiak National Wildlife Refuge, Alaska 1963-2002. Journal of Raptor Research 41:1-9.

Zwiefelhofer, D. 2007b. Kodiak National Wildlife Refuge 2007 Bald Eagle nesting and productivity survey. Annual Report (unpubl). 19pp.

Zwiefelhofer, D. C., J. H. Reynolds, and M. J. Keim. 2008. Population trends and annual density estimates for select wintering seabird species on Kodiak Island, Alaska. U.S. Fish and Wildlife Service Region 7 Draft Technical Report.

Zydelis, R., C. Small, G. French. 2013. The incidental catch of seabirds in gillnet fisheries: A global review. Biological Conservation 162:76-88.

Appendix A. Species list with number counted for all marine birds and mammals sighted on June and August surveys in the Kodiak Archipelago, Alaska, 2011-2013.

		2011		2012		2013		2011-2013
Species	**Scientific Name**	**June**	**August**	**June**	**August**	**June**	**August**	**Grand Total**
LOONS & GREBES								
Red-throated Loon	*Gavia stellata*	7	2	29	39	4	9	90
Pacific Loon	*Gavia pacifica*	8	1	6	3		5	23
Common Loon	*Gavia immer*	4	2	24	34	1	3	68
Yellow-billed Loon	*Gavia adamsii*			1	1			2
Unidentified Loon		4		11	2	1		18
Red-necked Grebe	*Podiceps grisegena*		16		4		4	24
Horned Grebe	*Podiceps auritus*				3		2	5
PETRELS & SHEARWATERS								
Northern Fulmar	*Fulmarus glacialis*	2	4	11	37	5	1	60
Sooty Shearwater	*Puffinus griseus*	207	598	4	1,988	5	138	2,940
Fork-tailed Storm Petrel	*Oceanodroma furcata*		3					3
CORMORANTS								
Double-crested Cormorant	*Phalacrocorax auritus*	30	9	68	80	3		190
Red-faced Cormorant	*Phalacrocorax urile*	165	292	30	21	2		510
Pelagic Cormorant	*Phalacrocorax pelagicus*	126	254	777	274	50	33	1,514
Unidentified Cormorant		58	89	5	44			196
RAPTORS								
Sharp-shined Hawk	*Accipiter striatus*				12			12
Northern Goshawk	*Accipiter gentilis*			1			2	3
Rough-legged Hawk	*Buteo lagopus*		5			1		6
Bald Eagle Adult	*Haliaeetus leucocephalus*	222	168	274	210	203	145	1,222
Bald Eagle Subadult		20	18	69	42	11	15	175
Merlin	*Falco columbarius*				4			4
Peregrine Falcon	*Falco peregrinus*		3	2	1			6

Appendix A. (Continued)

		2011		2012		2013		2011-2013
Species	**Scientific Name**	**June**	**August**	**June**	**August**	**June**	**August**	**Grand Total**
WATERFOWL								
Tundra Swan	*Cygnus columbianus*	4						4
Canada Goose (Vancouver)	*Branta canadensis*			16	16			32
Black Brant	*Branta bernicla*						1	1
Greater White-fronted Goose	*Anser albifrons*				47			47
Mallard	*Anas platyrhynchos*	21	51	18	21	2		113
Northern Pintail	*Anas acuta*		169		1			170
American Wigeon	*Anas americana*	2	1	12	8	9		32
Northern Shovelor	*Anas clypeata*				2			2
Green-winged Teal	*Anas crecca*	2	2	2	7		13	26
Common Eider	*Somateria mollissima*		4	2	1			7
Harlequin Duck	*Histrionicus histrionicus*	884	1,395	618	1,707	191	506	5,301
Long-tailed Duck	*Clangula hyemalis*			1				1
Surf Scoter	*Melanitta perspicillata*	9	24		16		79	128
Black Scoter	*Melanitta americana*	5	1	2			1	9
White-winged Scoter	*Melanitta fusca*	46	41	6	22	3	144	262
Unidentified Scoter			275					275
Barrow's Goldeneye	*Bucephala islandica*	24	188	23	37	10	148	430
Common Merganser	*Mergus merganser*	180	374	13	132	280	142	1,121
Red-breasted Merganser	*Mergus serrator*	114	90	162	90	50		506
Unidentified Merganser		2	8	1	12	10	30	63
SHOREBIRDS								
Black Oystercatcer	*Haematopus bachmani*	59	275	197	386	62	42	1,021
Wandering Tattler	*Tringa incana*	1	16		22		8	47
Greater Yellowlegs	*Tringa melanoleuca*				1			1
Spotted Sandpiper	*Actitis macularius*		1		4			5
Whimbrel	*Numenius phaeopus*			22	3			25

Appendix A. (Continued)

		2011		2012		2013		2011-2013
Species	**Scientific Name**	**June**	**August**	**June**	**August**	**June**	**August**	**Grand Total**
SHOREBIRDS (continued)								
Black Turnstone	*Arenaria melanocephala*		105		27			132
Surfbird	*Calidris virgata*	14	61			19		94
Rock Sandpiper	*Calidris ptilocnemis*				87			87
Least Sandpiper	*Calidris minutilla*		2					2
Unidentified Peep					21			21
Unidentified Dowitcher		1			1			2
Red-necked Phalarope	*Phalaropus lobatus*	12	9		3,240		133	3,394
Unidentified Phalarope			7		17			24
JAEGERS, GULLS, & TERNS								
Parasitic Jaeger	*Stercorarius parasiticus*	10	16	5	1	14	18	64
Pomarine Jaeger	*Stercorarius pomarinus*		4	1	5		10	20
Bonaparte's Gull	*Chroicocephalus philadelphia*				2			2
Mew Gull	*Larus canus*	148	1,264	300	1,429	74	1,899	5,114
Herring Gull	*Larus argentatus*		7	2	3		8	20
Glaucous Gull	*Larus hyperboreus*	1						1
Glaucous-winged Gull	*Larus glaucescens*	2,605	5,101	4,706	4,553	1,288	1,927	20,180
Slaty-backed Gull	*Larus schistisagus*				1			1
Black-legged Kittiwake	*Rissa tridactyla*	8,079	16,761	4,870	9,829	4,230	5,300	49,069
Unidentified Gull		143	119	13	21	8		304
Arctic Tern	*Sterna paradisaea*	145	116	240	132	154	247	1,034
Aleutian Tern	*Onychoprion aleuticus*	104	30	7	5	2		148
Unidentified Tern		4	2	5	1			12
ALCIDS								
Common Murre	*Uria aalge*	2,186	1,806	56	346	628	428	5,450
Thick-billed Murre	*Uria lomvia*			1				1
Pigeon Guillemot	*Cepphus columba*	1,195	1,281	1,479	1,774	567	495	6,791
Ancient Murrelet	*Synthliboramphus antiquus*		38	10	78	5	2	133

Appendix A. (Continued)

		2011		2012		2013		2011-2013
Species	**Scientific Name**	**June**	**August**	**June**	**August**	**June**	**August**	**Grand Total**
ALCIDS (continued)								
Kittlitz's Murrelet	*Brachyramphus brevirostris*	1	6	1	16	1	12	37
Marbled Murrelet	*Brachyramphus marmoratus*	838	1,460	1,809	4,508	1,241	1,346	11,202
Unidentified *Brachyramphus*		23	5		25	29	3	85
Cassin's Auklet	*Ptychoramphus aleuticus*			2	2			4
Parakeet Auklet	*Aethia psittacula*		1	218	23		2	244
Rhinocerous Auklet	*Cerorhinca monocerata*	41	15	40	43			139
Tufted Puffin	*Fratercula cirrhata*	8,642	1,830	1,919	2,086	370	415	15,262
Horned Puffin	*Fratercula corniculata*	317	1,755	450	894	134	223	3,773
Unidentified Alcid		7		21	9	5	1	43
OTHER BIRDS								
Belted Kingfisher	*Megaceryle alcyon*	1	14	4		4		23
Bank Swallow	*Riparia riparia*			40		82	2	124
MARINE MAMMALS								
Orca	*Orcinus orca*	5	3		7			15
Harbor Porpoise	*Phocoena phocoena*		12	14	23	17	20	86
Dall's Porpoise	*Phocoenoides dalli*			11	20	5		36
Humpback Whale	*Megaptera novaeangliae*	15	6	6	31	3		61
Fin Whale	*Balaenoptera physalus*			10	13	6		29
Harbor Seal	*Phoca vitulina*	167	561	394	292	278	441	2,133
Steller's Sea Lion	*Eumetopias jubatus*	124	57	33	23	13		250
Sea Otter	*Enhydra lutris*	30	203	1,301	1,676	875	513	4,598
LAND MAMMALS								
River Otter	*Lontra canadensis*	8	20	24	25	2	6	85
Red Fox	*Vulpes vulpes*	27	10	15	12	13	3	80
Kodiak Brown Bear	*Ursus arctos middendorffi*	9	8	3	3	5	4	32
Beaver	*Castor canadensis*			1	1			2