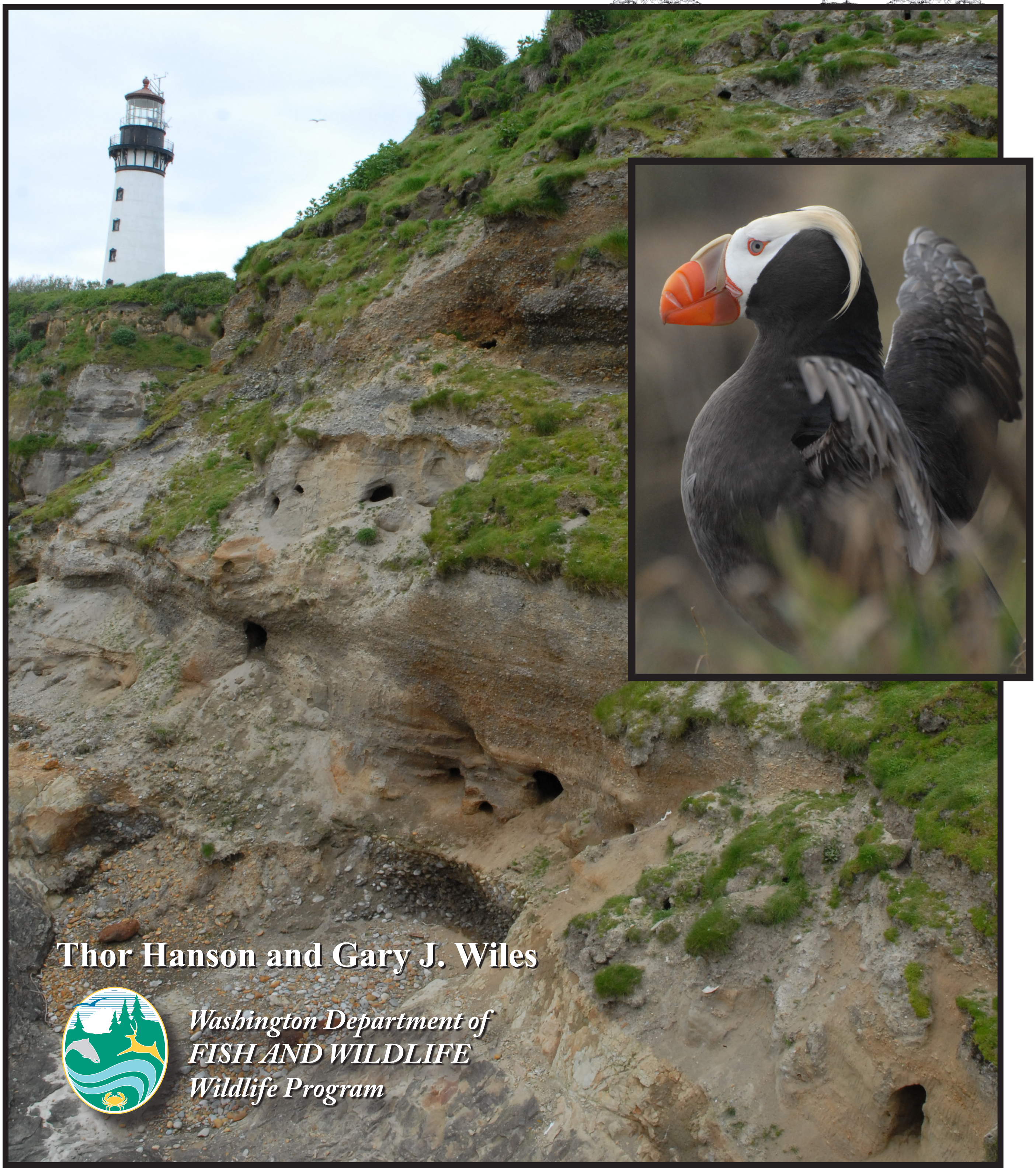
STATE OF WASHINGTON January 2015

Status Report for the Tufted Puffin



Thor Hanson and Gary J. Wiles

Washington Department of
FISH AND WILDLIFE
Wildlife Program

The Washington Department of Fish and Wildlife maintains a list of endangered, threatened, and sensitive species (Washington Administrative Codes 232-12-014 and 232-12-011, Appendix B). In 1990, the Washington Wildlife Commission adopted listing procedures developed by a group of citizens, interest groups, and state and federal agencies (Washington Administrative Code 232-12-297, Appendix B). The procedures include how species listings will be initiated, criteria for listing and delisting, public review standards, the development of recovery or management plans, and the periodic review of of listed species.

The first step in the process is to develop a preliminary species status report. The report includes a review of information relevant to the species' status in Washington and addresses factors affecting its status. The procedures then provide for a 90-day public review opportunity for interested parties to submit new scientific data relevant to the draft status report and classification recommendation. At the close of the comment period, the Department incorporates new information and prepares the final status report and listing recommendation for presentation to the Washington Fish and Wildlife Commission. The final report and recommendations are then released for public review 30 days prior to the Commission presentation.

The draft status report for Tufted Puffins was reviewed by researchers and state and federal agencies. This was followed by a 90-day public comment period from September 12–December 11, 2014. All comments received were considered during the preparation of the final status report. The Department intends to present the results of this periodic status review to the Fish and Wildlife Commission for action at the February 2015 meeting.

This report should be cited as:
Hanson, T. and G. J. Wiles. 2015. Washington state status report for the Tufted Puffin. Washington Department of Fish and Wildlife, Olympia, Washington. 66 pp.

Cover photos by Peter Hodum showing an adult Tufted Puffin and seabird burrows at Destruction Island, Washington

Washington State Status Report for the Tufted Puffin

Tufted Puffin at Tatoosh Island, Washington (Photo © Charles Bergman)

Thor Hanson
The SeaDoc Society, 942 Deer Harbor Road, Eastsound, WA 98245

Gary J. Wiles
Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-1091

Washington Department of Fish and Wildlife
Wildlife Program, Diversity Division
600 Capitol Way N
Olympia, WA 98501-1091

January 2015

TABLE OF CONTENTS

LISTS OF TABLES AND FIGURES

TABLES

FIGURES

ACKNOWLEDGMENTS

Much of the preparation of this report was funded by the SeaDoc Society, a program of the Wildlife Health Center, UC Davis School of Veterinary Medicine (www.seadocsociety.org). This work would not have been possible without financial support from private citizens, especially K. and R. McDowell, G. Georges, E. Snyder, R. Lundeen, K. and G. Keeler, A. Azous, R. and P. Henigson, and K. Allen. J. Gaydos provided important organizational support.

Internal and peer review comments were kindly provided by S. Pearson, D. Lowry, B. Tweit, H. Allen, P. Becker, B. Hoenes, D. Stinson, J. Gaydos, D. Noviello, C. Niles, L. Wargo, A. Kettle, P. Hodum, D. Bertram, L. Antrim, S. Thomas, S. Horton, S. Gremel, L. Slater, S. Stephensen, and L. Leschner. S. North offered substantive comments during the public review period. We also thank the many biologists and other professionals who contributed background information on various topics, including S. Pearson, S. Thomas, D. Stinson, I. Vilchis, A. Kettle, L. Slater, P. Hodum, J. Parrish, K. Fresh, P. Arcese, K. Stick, M. Hipfner, T. Scruton, M. Rodway, K. Koski, R. Lowe, C. Niles, L. Slater, S. Stephensen, S. Mills, J. Dolliver, L. Wargo, S. Thiesfeld, H. Reed, C. Burns, K. Henry, and others. J. Jenkerson maintained the WSDM database for Tufted Puffins at WDFW and created the breeding colony maps used in Figure 3. N. Alboucq helped significantly with the literature review.

EXECUTIVE SUMMARY

With its striking plumage and brilliant orange bill, the Tufted Puffin (*Fratercula cirrhata*) is an iconic seabird well known to native peoples, fishermen, and coastal communities throughout its range in the temperate and sub-arctic North Pacific. Though pelagic in winter, puffins gather on islands and headlands during spring and summer to breed and raise their young. They are members of the auk family, with stocky bodies adapted to "flying" underwater as they dive in pursuit of a wide range of fish and invertebrate prey. Nesting Tufted Puffins range up to 100 km from their breeding colonies to forage for their nestlings, and are famed for carrying 20 or more small fish at one time, neatly lined up and carried crosswise in their large, brightly colored bills.

Historically, 44 Tufted Puffin nesting colonies were documented in Washington and the bird was considered common in the San Juan Islands, the Strait of Juan de Fuca, and particularly along the outer coast of the Olympic Peninsula. The population along the outer coast was conservatively estimated at about 25,000 individuals in the early 1900s, and the statewide population remained in that range for much of the 20th century, with a 1978-1984 minimum estimate of 23,342 birds at 35 known sites. Recent surveys, however, found nesting birds at only 19 sites in 2007-2010 and resulted in a minimum outer coastal population estimate of 2,958 individuals in 2009. Maximum estimates once ranked nine colonies at 1,000 or more individuals each, with two reaching 10,000 or more, but no current breeding sites now hold more than a few hundred birds. Significant average annual rates of decline have been recorded on pelagic surveys west of Westport (13.6%, from 1972 to 2001) and coastal surveys from Cape Flattery to Point Grenville (8.9%, from 2001 to 2012). Taken together these studies strongly suggest that Tufted Puffins in Washington have undergone an order of magnitude population decline, which is ongoing, and a decrease in the number of occupied breeding colonies of 57% since 1886-1977 and 46% since 1978-1984. This declining trend corresponds with a broader geographic pattern of range contraction, population decline, and breeding colony disappearance noted throughout the southern portion of the species' distribution, including California, Oregon, and Japan.

Causes for the decline are unknown, but potentially include a number of historical and recent factors such as reduced prey availability, changing oceanic and climatic conditions, entrapment in fishing nets, mortality from oil spills and chemical contaminants, human disturbance of breeding colonies, impacts from introduced species, and increased Bald Eagle predation. The largest known mortality event in Washington was the 1991 *Tenyo Maru* oil spill, which killed an estimated 9% of the state's Tufted Puffin population. Rising ocean temperatures and other shifts associated with climate change are expected to reduce ocean productivity and forage fish populations throughout the North Pacific, creating a challenging environment for piscivorous birds like the Tufted Puffin.

The current conservation status and legal protections for Tufted Puffins include no specific management or recovery requirements for Washington's population. Puffins in Washington are considered a species of concern by the U.S. Fish and Wildlife Service and have been petitioned for listing under the federal Endangered Species Act, but an evaluation to list the species will not begin until 2016 or 2017. At the state level, Tufted Puffins have been a candidate for listing since 1998 and have been identified by Audubon Washington as a species at high risk from the impacts of climate change.

Given the rate of recent population decreases, widespread colony abandonment, ongoing threats from multiple factors, and the challenging ocean conditions expected for piscivorous seabirds in the years ahead, Tufted Puffins are likely to continue declining in Washington. If the current 8.9% annual rate of decline continues, the state's population could become functionally extirpated within about 40 years. For these reasons, it is recommended that the Tufted Puffin be listed as endangered in Washington.

INTRODUCTION

Tufted Puffins (*Fratercula cirrhata*) are an iconic seabird species. With their brilliant orange bills and white faces framed by golden plumes, they adorn the covers of field guides and feature regularly in wildlife films, photo collections, and animal calendars around the world. Their likeness can also be found on souvenir t-shirts, postcards, posters, figurines, stuffed animals, and jigsaw puzzles, as well as the label of an award-winning red wine from Washington state. Aquariums from Tacoma to Tokyo maintain popular live puffin exhibits, and one Northwest coastal community organizes an annual "Puffin Watch" as an alternative to fireworks on the Fourth of July.

Inhabiting a wide geographic zone across the temperate and subarctic North Pacific, Tufted Puffins spend much of the year foraging singly or in small groups far out to sea. They are considered the most pelagic and far-ranging member of the auk family (Alcidae) (Piatt and Kitaysky 2002). During spring and summer, however, the birds congregate to breed on rocky coastal islets and headlands from Japan north to Siberia, and from Alaska south as far as California. It is their habits during the breeding season that have long brought them into contact with human cultures. Salish, Tlingit, Haida, and other native peoples have hunted Tufted Puffins at their breeding colonies for at least 1,600 years (Bovy 2007, Moss 2007), consuming their meat and stitching their feathered skins into garments (Bent 1919). Puffin eggs, too, were an important traditional food source throughout the coastal Northwest, while the birds' bright bill plates provided colorful decorations for dance rattles and the fringes of ceremonial robes (Piatt and Kitaysky 2002).

Following European settlement, early commercial fishermen came to regard the species as a wily adversary. Trollers in Southeast Alaska reported Tufted Puffins following close behind their skiffs, plucking herring and other baitfish from lines as deep as 15 fathoms (Heath 1915, Willet 1915). With the advent of gillnet and driftnet fisheries, the deep-diving birds often became ensnared and drowned in nets. In the mid- to late 20th century, Tufted Puffins ranked among the most commonly caught seabirds in the salmon and squid net fisheries, with tens of thousands or even hundreds of thousands of birds killed annually (DeGange and Hay 1991, DeGange et al. 1993). These bycatch losses, combined with the birds' high vulnerability to oil spills, brought Tufted Puffins to the attention of wildlife managers and conservationists in the 1970s. At the same time, biologists began recognizing puffins and other fish-eating seabirds as important indicators for the health of marine systems (Piatt et al. 2007). Feeding high on the food chain and breeding in dense colonies, they provide a visible and highly sensitive means for gauging a range of trends, from plankton productivity to ocean warming to climate change (e.g., Hatch and Sanger 1992, Hunt et al. 2002, Hyrenbach and Veit 2003). Because their natural history is relatively well known, Tufted Puffins can signal deeper ecological patterns through subtle changes in their diet, behavior, and breeding success. Following the *Exxon Valdez* oil spill, for example, Tufted Puffin populations were studied as a potential measure of the recovery of Prince William Sound (e.g., Agler et al. 1994, 1999, Piatt et al. 1997).

While the late 20th century saw increasing public and scientific appreciation for Tufted Puffins, it also marked a steep decline in populations throughout the southern portions of their range. Puffins decreased dramatically or disappeared entirely from dozens of colonies in California, Oregon, Washington, and Japan (Piatt and Kitaysky 2002). Despite the species' prominence, information on the rate and cause of the decline remained largely anecdotal.

In Washington, concern for Tufted Puffin populations intensified in the 1990s following the abandonment of former breeding colonies in the San Juan Islands and the steady downward trend in outer coastal populations and offshore sightings (Speich and Wahl 1989, Wahl and Tweit 2000). Tufted Puffins were added to the Washington Department of Fish and Wildlife's list of candidate species in October 1998 to be reviewed for potential listing as endangered, threatened, or sensitive (per Policy 5301 [formerly Policy 6001]).

Per Washington Administrative Code (WAC) 232-12-297, the purpose of this status report is to collate the available scientific data on Tufted Puffins so that the Washington Department of Fish and Wildlife can prepare an informed state listing recommendation of endangered, threatened, or sensitive to the Washington Fish and Wildlife Commission. The report presents all known data on the historical and current status of the puffin population and its habitats in the state, as well as threats to the population.

TAXONOMY

Tufted Puffins are members of the auk family (Alcidae), a group of diving seabirds that includes puffins, auklets, murrelets, guillemots, Razorbills (*Alca torda*), and Dovekies (*Alle alle*). Alcids share the order Charadriiformes with the shorebirds and gulls. The 24 extant alcid species inhabit temperate waters of the northern oceans, with 15 species known from Washington. Alcids are stout-bodied divers specifically adapted for underwater pursuit foraging. Diversity within the family is considered a classic example of adaptive radiation, with bill and body-sizes specialized for plankton feeding, fish feeding or, in the case of puffins, an intermediate strategy that takes advantage of both (Bédard 1969). Genetic and morphological analyses divide the alcids into six major lineages, with Tufted Puffins found in a close-knit group made up of their sister species, the Horned (*F. corniculata*) and Atlantic (*F. arctica*) Puffins, as well as the Rhinoceros Auklet (*Cerorhinca monocerata*) (Friesen et al. 1996, Pereira and Baker 2008). Of these, Rhinoceros Auklets are also regular breeders in Washington waters and often use the same nesting colonies as Tufted Puffins. The close behavioral and ecological relationship between these two species has been demonstrated by exchange experiments, where adults of each species successfully raised chicks of the other to fledging (Vermeer and Cullen 1979).

The Tufted Puffin is classified in the genus *Fratercula*, from the Latin for "little brother" or "little monk," and with the specific epithet *cirrhata*, Latin for "tufted." It shares this genus with the Horned and Atlantic puffins, though until recently its larger size and distinctive plumage led taxonomists to place it in its own genus, *Lunda* (AOU 1998, Sangster et al. 2011). No subspecies are recognized. Though its breeding range overlaps with that of the closely-related Horned Puffin and Rhinoceros Auklet, no hybrids are known.

DESCRIPTION

General description. Tufted Puffins are among the largest alcids, measuring 35-40 cm (14-16 in) in length and weighing on average 775 g (1.7 lb) (Piatt and Kitaysky 2002). They share the general alcid family traits of short, stubby wings and legs set well back on a stocky body. Their characteristic rapid flight strokes and lack of maneuverability in the air stem from high wing loading, and they often require a runway of clear water for takeoffs and landings. Any awkwardness disappears beneath the surface, however, where diving puffins "fly" rapidly and gracefully underwater in pursuit of prey. Tufted Puffins have large, triangular orange bills that are laterally compressed and grooved on the upper mandible, and their orange feet are strongly clawed for aid in digging, as well as providing traction on land. Males grow slightly larger than females, but the sexes are otherwise indistinguishable in the field (Piatt and Kitaysky 2002).

Plumages and other features. The iconic image of a Tufted Puffin features the bird in its breeding plumage: jet black body feathers, with a white face framed by long golden plumes that sweep backward and down the neck. The breeding colors occur from April to September and are augmented by brilliant orange bill plates, orange rictal bristles, and a crimson ring of bare skin around the eye. The non-breeding plumage (October to March) is less familiar because the birds are usually far out at sea. Body feathers are brownish black, with a dusky black face. The golden tufts and rictal bristles are gone, and the skin around the eye becomes dark. The bright bill plates are also lost, making the bill appear smaller (though still orange).

Immature birds strongly resemble winter adults and do not develop breeding plumage until at least their second year. Bill size is proportionally smaller than in adults.

Vocalizations. Tufted Puffins are generally quiet birds, but communicate with a range of low purrs and growls at breeding sites and when gathered on the water. Although puffin vocalizations remain poorly studied, at least four distinct calls have been identified in adults (Piatt and Kitaysky 2002), while the peeping of chicks differs according to levels of hunger and stress (Gjerdrum et al. 2006).

GEOGRAPHICAL DISTRIBUTION

World

Tufted Puffins range throughout the temperate and sub-arctic North Pacific (Nettleship 1996, Piatt and Kitaysky 2002). Though vagrants have been noted as far south as Laysan Island in the Northwestern Hawaiian Islands (Clapp and Giezentanner 1979, Clapp 1986), they are generally restricted to the cool waters above 30–34°N latitude (Gould and Piatt 1993). Like other alcids, as well as penguins, Tufted Puffins rely on cold water to help dispel body heat produced by underwater "flight," and their energy requirements depend on the high prey densities found in high latitude oceans (Nettleship 1996, Van Buren and Boersma 2007). Warm, low-productivity tropical waters present a dispersal barrier to both groups (Sparks and Soper 1987, Pereira and Baker 2008).

Relatively little is known about Tufted Puffins during winter on the open seas, but individuals and small groups have been sighted on surveys throughout the central North Pacific (Gould and Piatt 1993), where they were also a common bycatch in late 20th century driftnet fisheries (DeGange et al. 1993). Sub-adults may remain at sea year-round, but breeding birds congregate on rocky coastal islands from as early as March through September. Breeding concentrations are highest around the Bering Sea, Aleutian Islands, and Gulf of Alaska, but colonies also occur along the Asian coast as far south as Hokkaido, Japan (Brazil 1991, Osa and Watanuki 2002), and in North America as far south as the Channel Islands in California (McChesney et al. 1995).

North America

Of the 1,031 nesting colonies known worldwide in about 2000, 802 (78%) occur in North America (Piatt and Kitaysky 2002). These are concentrated in Alaska, particularly in the Aleutian Islands and along the Alaskan Peninsula, where some individual colonies host more than 100,000 birds. Tufted Puffins also breed in significant numbers in Southeast Alaska and British Columbia, and less commonly in Washington, Oregon, and California.

Washington

In Washington, Tufted Puffin breeding colonies lie mainly along the outer coast from Point Grenville north to Cape Flattery (Speich and Wahl 1989, Wahl 2005). The species formerly bred in small numbers at sites throughout the San Juan Islands (e.g., Edson 1908, 1935), but nesting colonies on inland marine waters are now restricted to Protection and Smith islands in the eastern Strait of Juan de Fuca (P. Hodum, et al., unpubl. data). Table 1 lists all known former and current nesting sites in Washington. No breeding colonies were ever detected in Puget Sound.

During the winter months, Tufted Puffins migrate far offshore, but a few occur in Washington waters over the continental shelf as late as October (Wahl 1975), and birds occasionally wash up along outer coastal beaches after winter storm events (Lawrence 1892, Dawson and Bowles 1909). Puffins have been sighted between 64 and 155 km offshore in January (Wahl 2005). An early description of Tufted Puffins as common winter residents around Tacoma (Bowles 1922) was certainly in error, as nearly all the birds are far out to sea at that time of year. Casual winter sightings of Tufted Puffins in Washington waters can usually be attributed to misidentified Rhinoceros Auklets, because the two species resemble one another closely during winter when out of breeding plumage.

The species occasionally wanders south from the Strait of Juan de Fuca into northern Puget Sound (e.g., Wahl 2005, Hunn 2012). A specimen collected in the mid-19th century near Fort Steilacoom in present-day Lakewood, Pierce County, is the only confirmed occurrence from southern Puget Sound (Jewett et al. 1953).

NATURAL HISTORY

Daily Habits

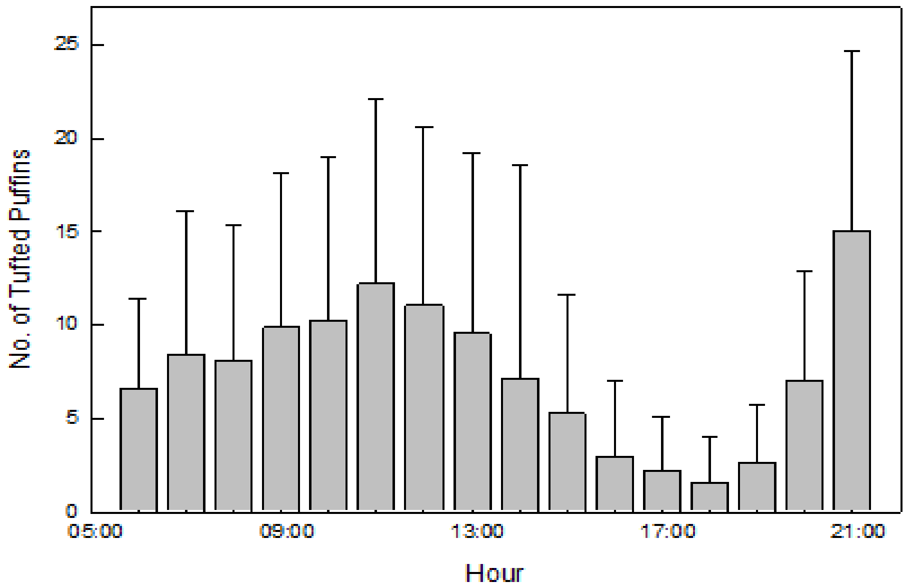
Few studies have quantified the time budget for Tufted Puffins and very little is known about the activities of birds wintering at sea. They are diurnal, however, and during the breeding season, birds show activity peaks in the morning and evening hours. At Tatoosh Island, Washington, for example, summer counts of birds in and around the colony peaked at 11 a.m. and 9 p.m., with mornings generally busier than afternoons (Figure 1; P. Hodum et al., unpubl. data). Colony attendance becomes more consistent throughout the day as the season progresses, though provisioning visits to chicks remain concentrated in the morning (Piatt and Kitaysky 2002). Provisioning trips may last several hours, during which adults forage alone, in small groups, or in mixed-species flocks. Preening and resting occurs on land or on the water, and birds generally sleep on the water near nesting sites, though burrows may also be used. During winter and for non-breeding individuals, all activities occur on the water but specific patterns are unknown. Birds winter alone or in small groups at sea.

Table 1. Name, location, and occupancy status of known Tufted Puffin breeding sites in Washington. Occupancy data for each site appear in Appendix A.

Colony name[1]	County[2]	Status[3]
Bodelteh Islands (East)	C	(1982)
Bodelteh Islands (Middle & West)	C	O
Cake Rock	C	O
Cakesosta	C	O
Carroll Island	C	O
Dhuoyautzachtahl (Petrel Rock)	C	O
Dohodaaluh	C	(1907)
Hand Rock	C	(1915)
Jagged Island (Wishalooth, Bald Is.)	C	O
James Island	C	O
Kochaauh	C	O
Seal Rock	C	(1981)
Silver Sides	C	O
Table Rock	C	(1978)
Tatoosh Island	C	O
Unnamed Rock 1	C	?(1978)
Unnamed Rock 2	C	?(1982)
White Rock	C	O
Erin's Bride	G	O
Grenville Arch	G	(1915)
Grenville Pillar	G	(1980)
Point Grenville Cliffs	G	?(1980)
Puffin Rock (Erin)	G	O
Willoughby Rock	G	O
Smith Island	I	O
Alexander Island	J	O
Destruction Island	J	O
Ghost Rock	J	?(1981)
Half Round Rock	J	(1981)
Protection Island	J	O
Rounded Island	J	O
Bare Island	SJ	(1978)
Bird Rocks	SJ	(1984)
Castle Island	SJ	(1928)
Colville Island	SJ	(1984)
Flattop Island	SJ	(1949)
Hall Island	SJ	(1990)
Matia Island	SJ	(1984)
Puffin Island	SJ	(1982)
Skipjack Island	SJ	(1936)
South Peapod	SJ	(1949)
Sucia Islands	SJ	(1886)
Viti Rocks	Sk	(1970s)
Williamson Rocks	Sk	(1985)

[1] Colony names conform to Speich and Wahl (1989). [2] C=Clallam, G=Grays Harbor, I=Island, J=Jefferson, SJ=San Juan, Sk=Skagit. [3] O=currently occupied; dates in parentheses indicate year of last confirmed occupancy; sites with question marks were not checked during the 2007-2010 surveys of P. Hodum et al., thus current status is unknown. Data are from Speich and Wahl (1989), Osborne et al. (1998), USFWS (2010; unpubl. data), P. Hodum et al. (unpubl. data), and T. Scruton (pers. comm.).

Figure 1. Hourly attendance patterns of Tufted Puffins at Tatoosh Island, Washington, from June 1 to August 24, 2005–2008, averaged across years (P. Hodum et al., unpubl. data). Data are instantaneous counts of all birds present (on colony, on water, in air).



Diet and Foraging

Tufted Puffins are diving, underwater pursuit foragers with bills adapted to take both fish and invertebrates (e.g., Bédard 1969, Baird 1991, Davies et al. 2009). Their diet includes an exceptional range of prey – one study found Tufted Puffins consuming 47 different species in the same habitat whereas the closely-related Horned Puffin took only 20 (Piatt et al. unpubl., cited in Piatt and Kitaysky 2002). However, foraging behavior and diet vary considerably from year to year, based on fluctuations in the availability of prey (e.g., Baird 1990, 1991, Hatch and Sanger 1992). Diet may also vary between colonies located near one another (Williams and Buck 2010). In general, wintering birds and breeding birds that forage over deep, oceanic habitats exhibit a broader diet, including a higher proportion of invertebrates, particularly euphausiids (i.e., krill, shrimp-like crustaceans), while breeders foraging near coastlines and over the continental shelf take more fish (Baird 1991, Piatt and Kitaysky 2002).

Fish comprise the bulk of the nestling diet, >95% in some studies, and research consistently links the type and availability of fish in nearby waters to the growth rates and fledging success of chicks (Baird 1990, Hatch and Sanger 1992, Hipfner et al. 2007, Williams and Buck 2010). At Triangle Island, British Columbia, adults exhibit a dramatic shift in habitat use and diet over the course of the nesting season. Early in the season they forage on abundant pelagic zooplankton and squid of modest quality, but switch to coastal fish species of higher nutritional quality later in the season when they are feeding growing chicks and keeping themselves fortified for long provisioning flights (Davies et al. 2009). Studies in Alaska, however, suggest that adults continue to support themselves on invertebrates while feeding fish to their nestlings (Piatt and Kitaysky 2002). Some evidence suggests that adults, particularly males, lose body mass sharply in lean years, depriving themselves of food to keep their chicks fed (Williams et al. 2007). In times of extreme scarcity, however, individual nestlings or even whole colonies may be abandoned mid-season (Vermeer and Cullen 1979, Vermeer et al. 1979, Gjerdum et al. 2003). The fidelity of nestling diets to local fish stocks is well known and has been recommended for monitoring as an indicator of forage fish availability (Hatch and Sanger 1992).

Though no dietary studies for Tufted Puffins have been conducted in Washington, research in British Columbia and Alaska has documented a range of prey species that are available to puffins nesting in Washington (e.g., Wehle 1983, Piatt et al. 1997, Gjerdum 2004, Williams and Buck 2010). Pacific Sand Lance (*Ammodytes hexapterus*) and Pacific Herring (*Clupea pallasii*) rank among the most important prey species, but the list also includes juvenile rockfish (*Sebastes* spp.), Eulachon (*Thaleichthys pacificus*), Pacific Sardine (*Sardinops sagax*), and Northern Anchovy (*Engraulis mordax*), as well as various squid, euphausiids, and other invertebrates. Puffins on the Washington coast have been spotted with bill loads containing sand lance, herring, anchovy, and smelt (Cody 1973, Frazer 1975). A number of additional fish species in Washington fall within the 20 to 200 mm size range preferred by puffins during the breeding season (Piatt and Kitaysky 2002), including Surf Smelt (*Hypomesus pretiosus*), Night Smelt (*Spirinchus starksi*), Popeye Blacksmelt (*Bathylagus ochotensis*), Whitebait Smelt (*Allosmerus elongatus*), Pacific Saury (*Cololabis saira*), Kelp Greenling (*Hexagrammos decagrammus*), and juvenile salmon (*Oncorhynchus* spp.). It is also likely that diets of puffins nesting on the outer coast vary from those nesting in inland marine waters, a pattern that has been reported for other Washington alcids. For example, the diet of Rhinoceros Auklets on Protection Island near the eastern end of the Strait of Juan de Fuca is dominated by Pacific Herring and Pacific Sand Lance while the coastal diet (Tatoosh and Destruction islands) is much more diverse and includes Northern Anchovy, Pacific Sand Lance, Pacific Herring, Whitebait and Surf Smelt, juvenile rockfish, and Pacific Saury (Pearson et al. in review).

Details of Tufted Puffin foraging behavior derive largely from studies of birds at breeding colonies. For breeding birds, the demands of a growing chick dictate their daily foraging routine. Evidence suggests that puffins will forgo high quality foraging sites in favor of areas located close to their colonies (Sealy 1973, Ostrand et al. 1998). Just what determines an individual's foraging strategy remains unclear, but site choice and target prey can vary dramatically between sub-groups within the same colony, with measurable impacts on nestling development (Hipfner et al. 2007). It's possible that individuals pattern their foraging habits after those of other puffins foraging nearby, a flocking impulse that persists regardless of foraging success (Hipfner et al. 2007). On the outer coast of Washington, adults fly an average of 4.67 km from breeding sites to feed, but sometimes venture as far as 100 km from their colonies (Cody 1973). Tufted Puffins generally forage singly or in small groups, and position themselves on the periphery when joining mixed-species flocks (Hoffman et al. 1981, Tyler et al. 1993, Ostrand et al. 1998). Most prey are probably caught within 60 m of the surface, but puffin dives to depths of 110 m have been recorded, ranking them among the deepest-diving alcids (Piatt and Kitaysky 2002). Captive birds spend more time foraging at depth than almost any other species (Duffy et al. 1987). When feeding themselves, prey items are consumed immediately, but puffins often capture and hold multiple fish when provisioning their young. Bill loads vary, but generally include five or more fish, and sometimes reach more than 20 fish (Wehle 1983). Foraging puffins on the water sometimes grow accustomed to the presence of people and boats and have been known to steal bait from fishing lines (Heath 1915, Willet 1915), and successfully "beg" for bait fish tossed to them from sport fishers (L. Slater, pers. comm.).

Dietary information for wintering birds remains poorly known because individuals disperse too widely on the open seas for practical observation. It's generally believed, however, that birds outside of the breeding season take a higher proportion of squid and euphausiids (Piatt and Kitaysky 2002).

Reproduction, Longevity, and Survival

Breeding season. The Tufted Puffin breeding season begins as early as March in California and as late as June at the northern extent of the species' range. In Washington, puffins begin returning to their nesting colonies in mid-April (Frazer 1974, 1975, Burrell 1980). Egg laying peaks from May to early June and parents remain in the vicinity of the colony provisioning their chicks until they fledge in mid-August or early September, when all birds depart for the open sea (Frazer 1975, Burrell 1980).

Breeding behavior and territoriality. Tufted Puffins become gregarious during the breeding season when they nest in colonies. Upon arrival at nesting colonies, birds spend a week or more re-establishing pair bonds and occupying or excavating burrows (Frazer 1975). They display high mate fidelity, establishing pair bonds that have been observed to last for consecutive seasons (Wehle 1980) and are thought to endure longer (Piatt and Kitaysky 2002). Courtship behaviors include billing and displaying with nesting materials, as well as chase and copulation sequences on the water where the male jerks his head rapidly while opening and closing his bright bill (Piatt and Kitaysky 2002). Individuals and pairs compete for nesting sites and defend burrow entrances, with fights and aggressive displays common during the early breeding season. Adults defend the area around their burrow entrance, but given high nest densities at some colonies (e.g., Dawson and Bowles 1909), this can amount to an area of 1.5 m^2 or less.

Nesting and brood rearing. Tufted Puffins excavate straight, curved, or branched nesting burrows in the soil on offshore islands, inaccessible headlands, or occasionally in estuaries (Gill and Sanger 1979, Piatt and Kitaysky 2002). Burrows generally range from 0.5–1.5 m deep and 13.5–19.0 cm in diameter, though depths of up to 5 m have been reported (Piatt and Kitaysky 2002). Where surface material is thin or when competition for choice nest sites is fierce, rocky crevices, overhangs, and even talus slopes may be used (e.g., Edson 1929a, Bailey and Faust 1981). Clutches consist of one whitish egg 71–74 mm long and 48–49 mm wide (Piatt and Kitaysky 2002). A replacement egg may be laid within about 21 days if the first is lost (Wehle 1980). Adults take turns incubating for about 43–46 days (range 41–53 days) (Piatt and Kitaysky 2002).

Average hatching date at Destruction Island, Washington, is July 1 (range, June 21–July 24; Burrell 1980). Adults remain with the hatchling for several days until it develops the ability to thermoregulate (Wehle 1980). Both parents provision the growing chick until it fledges, together bringing an average of four bill loads of fish per day (Piatt and Kitaysky 2002). Evidence suggests that adults adjust the number of provisioning trips based on the development and corresponding nutritional requirements of the chick, and begin reducing the amount of food sharply late in the nestling period to help induce chicks to fledge (Gjerdrum 2004). The nestling period averages about 48 days (range 38-59 days) (Wehle 1980, Piatt and Kitaysky 2002).

Chick growth and fledging. Hatchling weights and growth rates vary by colony and season, but chicks generally weigh 60–70 g at hatching and reach about 450–577 g at fledging (Piatt and Kitaysky 2002, Williams and Buck 2010). Chick development appears to favor the most important physical characters, allocating resources to wing length (necessary for the first flight to sea and subsequent foraging), and body mass (fat reserves for survival during the critical post-fledging period, while learning to feed) (Gjerdrum 2004). Fledglings with larger weights and longer wing lengths exhibit higher survival and earlier fledging dates (Morrison et al. 2009). Puffins leave the nest after six to eight weeks, an age when they still lack the ability to fly well, but are agile in the water and can make short dives in pursuit of prey (Piatt and Kitaysky 2002). Fledging generally occurs under the cover of darkness to avoid predators, with chicks walking, hopping, or flying from burrows to the water where they are immediately independent of the parents.

Fledgling survival varies markedly by year depending on food availability and corresponding condition of the chicks. A survey of multiple studies at various sites found a mean (± SD) fledging success of 64 ± 28% and a mean breeding success of 0.43 ± 0.22 chicks produced per pair (Piatt and Kitaysky 2002). On Tatoosh Island, burrow occupancy ranged from 72-91%, hatching success from 47-90%, and chick survival from 30-75% for the 19-25 burrows surveyed per year between 2005 and 2008 (P. Hodum et al., unpubl. data). Overall fledging success ranged from 23-63%. The 2005 season was anomalous because of late spring upwelling that resulted in widespread colony abandonment by other seabirds in the California Current (e.g., Sydeman et al. 2006). However, even without the 2005 data, fledging success for 2006-2008 ranged from 35-63%, which is considerably lower than that reported by Piatt and Kitaysky (2002) for a range of sites, and considerably lower than that of Rhinoceros Auklets (66-89%) nesting in burrows on the same colony during the same years (2006-2008; P. Hodum et al., unpubl. data; Pearson et al. in review).

Longevity and survival. The lifespan of wild Tufted Puffins has not been determined (Piatt and Kitaysky 2002), but captive birds regularly live 15-20 years and occasionally longer than 30 years (S. Perry, pers. comm.). Morrison et al. (2011) reported average annual survival rates of 95 ± 3% in adult females and 92 ± 4% in adult males.

Tufted Puffins comprise a small proportion of the beached (dead) seabirds found along shorelines in Washington during surveys conducted by the Coastal Observation and Seabird Survey Team (COASST) program (J. Parrish, pers. comm.). The vast majority of Tufted Puffins recorded from 2001 to 2012 were counted along the outer coast, with very few or none noted in the Strait of Juan de Fuca, the San Juan Islands, and Puget Sound. Along the outer coast, 0 to 7 beached individuals were found per year during this period, except in 2012, when 82 birds were recorded between mid-January and mid-April. This mortality event followed an extended period of stormy weather in December 2011 (S. Horton, pers. comm.). No monthly pattern in beachings was evident during other survey years.

Migration and Dispersal

Migration. Tufted Puffins migrate annually between their coastal breeding colonies and wintering areas in the North Pacific. The exact winter range of Washington's population remains unknown, but nearly all birds are absent from coastal and shelf waters off British Columbia, Washington, Oregon, and California from late fall until spring (Tyler et al. 1993, Wahl et al. 1993). Tufted Puffins have long been considered the most pelagic of the alcids (Bent 1919), but very little is known about the routes they use during migration or the extent of their winter movements. Retreats and advances in pack ice determine migratory patterns for the most northern populations, but little else is known definitively about puffin movements at sea. Attempts at radio and satellite telemetry have led to altered behaviors, nest abandonment, and even mortality in subject birds, and no tags have yielded data beyond the breeding season (Hatch et al. 2000a, 2000b, Whidden et al. 2007). Flight habits, foraging stops, flocking, and other migratory behaviors are not well understood, though mass arrivals at breeding colonies have been observed (Piatt and Kitaysky 2002).

Dispersal. Information about the dispersal of young Tufted Puffins remains scant, though fledglings probably depart for pelagic wintering areas soon after leaving their burrows (Piatt and Kitaysky 2002). Some degree of fidelity to natal nesting colonies is assumed among adults and yearlings. Investigators have speculated that large peaks in colony attendance early in the spring reflect the return of yearling, non-breeding birds to their natal colonies (Frazer 1975). Shortages of suitable nesting sites point to overcrowding at some colonies (e.g., Dawson and Bowles 1909), and seabirds are known to show higher reproductive success in less crowded conditions (Hunt et al. 1986). An ecological incentive for dispersal therefore exists, and the re-occupation of former breeding colonies has occurred (McChesney et al. 1995), but the vital questions of how often and by whom remain unanswered.

Molting

Like most other alcids, Tufted Puffins exhibit an intense and rapid molting of their flight feathers, where first the primaries and then the secondaries are dropped in rapid succession, reducing wing area by up to 40% (Bridge 2004). The rectrices (tail feathers) follow the secondaries and new growth of all three flight feather types is completed at roughly the same time (Thompson and Kitaysky 2004). This molt occurs in the spring for second-year birds (Thompson and Kitaysky 2004) and in the fall for adults (Piatt and Kitaysky 2002, Bridge 2004). Though it reduces diving efficiency and renders the birds flightless for 32-45 days (Bridge 2004, Thompson and Kitaysky 2004), the rapid molt strategy is thought to reduce the overall period of flight disruption. It is common in birds like puffins and other alcids, where high wing-loading makes the sequential feather loss of a traditional molt a far more prolonged threat to their ability to fly (Ehrlich et al. 1988). In contrast to their flight feathers, Tufted Puffins molt their body plumage over a much longer time frame twice a year, once in the late summer and fall, and again from February to April (Piatt and Kitaysky 2002).

Ecological Relationships

Competition. Though the topic has received relatively little research attention, Tufted Puffins engage in a range of competitive interactions, particularly in and around breeding colonies. They have been observed displacing Horned Puffins at nesting sites and are thought to compete aggressively with other burrow-nesting alcids as well (Piatt and Kitaysky 2002). On the other hand, Ancient Murrelets (*Synthliboramphus antiquus*), Rhinoceros Auklets, Leach's Storm-Petrels (*Oceanodroma leucorhoa*), and Fork-tailed Storm-Petrels (*O. furcata*) have all nested successfully in side-tunnels off of Tufted Puffin burrows (Frazer 1975, Piatt and Kitaysky 2002). The nocturnal habit of these species presumably reduces direct competition with puffins.

In a study of six captive alcid species, Tufted Puffins were the most aggressive underwater, chasing and stealing fish from Common Murres (*Uria aalge*), Rhinoceros Auklets, Cassin's Auklets (*Ptychoramphus aleuticus*), and Pigeon Guillemots (*Cepphus columba*), as well as conspecifics (Duffy et al. 1987). Puffins also regularly join mixed-species flocks where their diving behaviors help concentrate fish prey schools, potentially benefiting surface-feeding birds (Hoffman et al. 1981).

In general, competition among co-occurring alcids may be reduced through differences in foraging strategies (e.g., distance from nesting colony) and nesting sites (burrows vs. crevices vs. cliffs) (Cody 1973). Still, a meta-study of seabird colonies underscores the important role of intra- and interspecific competition for food and nesting sites, because birds in smaller colonies fared better in a range of reproductive measures than those breeding at large, crowded sites (Hunt et al. 1986). In California's Farallon Islands, competition for nesting sites is exacerbated by the presence of non-native European Rabbits (*Oryctolagus cuniculus*), another burrowing species (Ainley and Lewis 1974).

Predation. A number of predators are known to attack puffins. Brown Bears (*Ursus arctos*) excavate Tufted Puffin burrows and have been implicated in population declines or extirpations from several Alaskan breeding colonies (Bailey and Faust 1981). Puffin remains have been found in Bald Eagle (*Haliaeetus leucocephalus*) nests (Vermeer et al. 1976; see Factors Affecting Continued Existence – Bald Eagle Predation) and in the pellets of Snowy Owls (*Bubo scandiacus*; Williams and Frank 1979), and several authors report observing attacks by Peregrine Falcons (*Falco peregrinus*; Vermeer et al. 1976, Addison et al. 2007). River Otters (*Lontra canadensis*) eliminated the last pair of puffins nesting on Mandarte Island, British Columbia (P. Arcese, pers. comm.), and are known to take chicks and adults at East Amatuli Island, Alaska (A. Kettle, pers. comm.). River Otters have been observed entering unidentified seabird burrows on Alexander Island, Washington (S. Pearson, pers. comm.), which has one of the largest remaining colonies of Tufted Puffins in the state.

Studies of Bald Eagle predation on another alcid, the Common Murre, have revealed that the indirect effects of predation (e.g., less time spent defending eggs) can also have important consequences (Parrish et al. 2001). Puffins alter their flight patterns and activity rates in the presence of eagles and falcons (Addison et al. 2007), but the effects of raptor predation on population trends remains unclear.

The strongest documented impact of predation on Tufted Puffins comes from the introduction of non-native mammalian predators to nesting colonies. The introduction of Arctic Foxes (*Alopex lagopus*) for fur farming led to severe population declines on several Alaskan islands (Bailey 1976, Bailey and Faust 1981), while introduced Red Foxes (*Vulpes vulpes*), Arctic Ground Squirrels (*Urocitellus parryii*), and Norway Rats (*Rattus norvegicus*) have adversely impacted a number of colonies throughout the puffin's range (see summary in Piatt and Kitaysky 2002). Other documented predators of adults, nestlings, and/or eggs include Common Ravens (*Corvus corax*), Glaucous-winged Gulls (*Larus glaucescens*), Steller's Sea Eagles (*Haliaeetus pelagicus*), and Eurasian Eagle Owls (*Bubo bubo*) (Piatt and Kitaysky 2002). Several other common predators known to prey on burrow-nesting seabirds have yet to be confirmed depredating Tufted Puffins, including Black Rats (*Rattus rattus*), Raccoons (*Procyon lotor*), and American Mink (*Neovison vison*).

Kleptoparasitism. The puffin habit of carrying whole fish crosswise in their bills makes them a favored target of kleptoparasites. Glaucous-winged Gulls, Red-legged Kittiwakes (*Rissa brevirostris*), Black-legged Kittiwakes (*R. tridactyla*), and Parasitic Jaegers (*Stercorarius parasiticus*) regularly harass puffins foraging in mixed flocks, as well as during their approaches to colonies. Tufted Puffins appear to adjust their overflights and approaches to reduce the risk of kleptoparasitism (Blackburn et al. 2009), a behavior confirmed in Atlantic Puffins (Rice 1987). Glaucous-winged and Western (*Larus occidentalis*) gulls are the most common kleptoparasites at breeding colonies in Washington (Cody 1973, Frazer 1975) and at Triangle Island, British Columbia (St. Clair et al. 2001, Blackburn et al. 2009). A study at Triangle Island found that rates of kleptoparasitism varied among years, but that general incidence was low and there was no relationship between rates of kleptoparasitism and puffin breeding success (St. Clair et al. 2001). Investigators generally agree that kleptoparasitism may contribute to the challenge of provisioning chicks during difficult years, but probably doesn't constitute a major ecological constraint (Piatt and Kitaysky 2002). Similar conclusions have been reached about gull kleptoparasitism on Atlantic Puffins (Pierotti 1983, Rice 1985) and Rhinoceros Auklets (Wilson 1993), although auklet chicks in gull-free areas on Protection Island, Washington, did grow significantly faster than chicks from burrows located within a gull colony (Wilson 1993).

Diseases and Parasites

Pathogens and diseases affecting Tufted Puffins are poorly understood. No major mortality events have been attributed to outbreaks of illness, but Tufted Puffins are known to carry antibodies to the Tyuleniy virus, a tick-borne flavivirus related to West Nile virus, yellow fever, and dengue fever (Lvov et al. 1972). Parasitic nematodes have been recovered from Tufted Puffins at high enough concentrations to cause ulcerated lesions (Nagasawa et al. 1998), but the effects of worms on puffin health remain unknown. In general, Tufted Puffins support fewer numbers and species of internal parasites than other alcids (Piatt and Kitaysky 2002). Captive populations show susceptibility to a fatal form of avian mycosis, a fungal infection, but this has not been studied in the wild (Monroe et al. 1994). Ectoparasites including ticks and lice have been noted in several populations, but have not been studied in detail (Piatt and Kitaysky 2002).

HABITAT REQUIREMENTS

Nesting habitat. Tufted Puffins nest in burrows, rocky crevices, and occasionally in dense shrubbery on isolated offshore islands and inaccessible headlands (Dawson and Bowles 1909, Nettleship 1996, Piatt and Kitaysky 2002). Ideal habitat includes grassy slopes, bluffs, and plateaus with soil deep enough for burrowing in areas that are free of introduced predators (e.g., foxes, rats) and human disturbance. Rocky areas and thickets may be utilized, but are not preferred. Access to steep slopes, cliff edges, or elevated rocks is important for taking flight. In British Columbia, colony locations are characterized by lower than average rainfall intensity, lower than average air and surface water temperatures, and higher salinity in surrounding waters than sites without colonies (Kaiser and Forbes 1992). Nesting Tufted Puffins are sensitive to disturbance, generally avoiding inhabited areas (e.g., islands with manned light stations) and often abandoning nests accessed for scientific observation (e.g., Frazer 1975, Pierce and Simons 1986, Hatch et al. 2000b; see Factors Affecting Continued Existence – Human Disturbance).

Foraging habitat. During the breeding season, adult Tufted Puffins range as far as 100 km from their breeding colonies, utilizing open water foraging habitats from the nearshore to the open sea (Cody 1973, Piatt and Kitaysky 2002). Like many other seabirds, they often congregate where currents, coastline features, and other conditions concentrate schools of prey (Piatt and Kitaysky 2002, Zamon 2003). Foraging habitat during the breeding period requires access to adequate supplies of sand lance, herring, or other fish species that are fed to the young.

Wintering habitat. Tufted Puffins spend the winter at sea in the North Pacific, though they also infrequently use continental shelf waters and are occasionally spotted off of Washington's outer shores or washed up on coastal beaches (Lawrence 1892, Dawson and Bowles 1909, Alcorn 1959, Wahl 2005). Little is known about their habitat requirements in the winter months. They have little contact with people during this period, but are vulnerable to chronic oil discharges, ingested plastics, and illegal driftnet fisheries (DeGange et al. 1993).

POPULATION STATUS AND TRENDS

Observers have estimated Tufted Puffin populations using various measures, including burrow counts, burrow occupancy, colony counts from boats, on-water counts, aerial surveys, and general estimates of colony attendance (Piatt and Kitaysky 2002). Each method comes with its own set of strengths, biases, and limitations. The number of adults visible at a colony varies dramatically depending on the time of day (Figure 1), and daily activity patterns change over the course of the season. Count data are also influenced by weather and sea conditions, equipment, and observer bias that, if unaccounted for in the sampling design, can make it difficult to compare estimates across time or from different studies. Still, general patterns and trends emerge from even the most cautious examination of the available data. This report draws on published studies from throughout the range of Tufted Puffins, as well as an extensive compilation of historical and contemporary population estimates for Washington (a full list of Washington population estimates is included in Appendix A).

Global Status and Trends

Although the International Union for the Conservation of Nature (IUCN) considers the species globally secure, noting its expansive range and relatively large population (BirdLife International 2012), the steep drop in puffin numbers throughout the southern portions of their range suggests to many investigators that the species is undergoing a major range contraction (McChesney et al. 1995, Piatt and Kitaysky 2002, Gjerdrum et al. 2003). Published estimates put the total number of Tufted Puffins between 2.97 million (Piatt and Kitaysky 2002) and 3.50 million (Byrd et al. 1993). These numbers represent compilations and extrapolations of colony estimates, mostly from Alaska where >75% of the species breeds. Little historical data exist to establish long-term global trends (Byrd et al. 1993), but site-specific surveys and occupancy records show a dynamic patchwork of population gains and losses.

Even at the heart of their range, Tufted Puffins experience highly variable breeding success and corresponding changes in local populations. This pattern is typical of colonial nesting seabirds, where raising young to fledging is tightly linked to fluctuations in nearby food supplies and environmental conditions (Baird 1990). In the Gulf of Alaska, for example, Tufted Puffins declined >60% between the 1970s and 1990s, probably as a result of changing ocean conditions and related declines in forage fish availability (Piatt and Anderson 1996). Some colonies in the Aleutian Islands, however, increased by as much as 8.7% annually over the same general time period (Piatt and Kitaysky 2002, Dragoo et al. 2010). Piatt and Kitaysky (2002) assembled data from 17 published and unpublished colony surveys (Table 2) and concluded that populations were stable or increasing in the northern portion of the range, but generally declining sharply throughout the southern regions.

Regional range contraction. In California, only 13 breeding sites have been occupied in recent years (McChesney and Carter 2008) and the population of the largest colony, the South Farallon Islands, decreased from "thousands" in 1911 (Dawson 1911) to about 250 in 2012 (Warzybok et al. 2012). In Oregon, the breeding population decreased by more than an order of magnitude in 20 years, from 4,858 at 49 sites in 1988 to 142 at 15 sites in 2008 (Kocourek et al. 2009) and 146 at 12 sites in 2009 (Suryan et al. 2012). Oregon's largest colony of puffins varied in size from 74 to 143 birds during 2010-2013 (Stephensen 2014). Puffin

Table 2. Population trends of Tufted Puffins in North America (adapted and expanded from Piatt and Kitaysky 2002).

State/province area/location	Type of count[1]	No. counts	Years	Population change		Source[2]
				%/year	Probability	
Alaska						
W. Aleutians						
Nizki I.	Shoreline	4	1976-1998	+8.7	<0.05	A
Buldir I.	Burrow	5	1991-2001	+6.8	ns[3]	A
C. Aleutians						
Adak I.	Burrow	7	1988-1995	+17.9	<0.001	A
E. Aleutians						
Bogoslof I.	Burrow	8	1973-2005	+3.0	<0.001	B
Aiktak I.	Burrow	16	1989-2007	no trend	ns	B
N. Gulf of Alaska						
E. Amatuli I.	Burrow	13	1995-2007	-2.9	<0.001	B
Pr. William Sound	Pelagic	6	1972-1993	-2.9	ns	C
Pr. William Sound	Pelagic	7	1989-2000	+3.9	ns	D
SE. Alaska						
St. Lazaria I.	Burrow	11	1996-2006	-5.9	<0.05	B
British Columbia						
S. Queen Charlotte I.						
Kerouard I.	Colony	2	1977-1986	-10.6	ns	E
N. Vancouver I.						
Triangle I.	Burrow	6	1984-2009	negative trend	<0.01	F
Washington						
Strt. of Juan de Fuca						
Protection I.	Colony	8	1973-2001	-13.9	<0.05	G
N. Outer Coast						
Tatoosh I.	Bird Plot	17	1983-2001	-16.9	<0.001	H
Various	Offshore	24	2001-2012	-8.9	0.01	I
S. Outer Coast						
Westport	Pelagic	19	1983-2001	-13.6	<0.001	J
Oregon						
Oregon Coast NWRC	Shoreline	3	1979-2008	-12.4	-	K
Three Arches Rock	Colony	2	1979-1988	-3.6	ns	L
California						
N. Coast						
Castle Rock	Colony	6	1972-1999	-6.3	<0.05	M
Central Coast						
SE Farallon I.	Colony	37	1972-2012	+3.0	-	N

[1]Type of count: shoreline = bird count from colony shoreline; burrow = plot count of occupied burrows; pelagic = bird count at sea; colony = whole colony count; bird plot = bird count within plots; offshore = bird count on transects within 8 km of shore.

[2]Sources: A = J. Williams & G. V. Byrd, as cited in Piatt & Kitaysky 2002; B = Dragoo et al. 2010; C = Agler et al. 1999; D = Lance et al. 1999; E = Campbell et al. 1990; F = Rodway & Lemon 2011; G = U. Wilson, as cited in Piatt & Kitaysky 2002; H = R. T. Paine, as cited in Piatt & Kitaysky 2002; I = S. Pearson, unpubl. data; J = Wahl & Tweit 2000; K = Kocourek et al. 2009; L = Hodder 2003; M = Jaques & Strong 2001; N = Warzybok et al. 2012.

[3]ns = not significant.

numbers in Washington have also declined dramatically, as discussed in detail below. Declines have been reported from Hokkaido, Japan, where two-thirds of former breeding colonies are now unoccupied and the population declined 9–15% annually during the 1970s to 1990s to an estimated 10 remaining breeding pairs at two sites in about 2012 (Osa and Watanuki 2002, Ono 2012).

While range contraction is apparent, the causes underlying it remain unclear, and may be the result of a combination of historical and current factors (see Factors Affecting Continued Existence). Population declines during the 20th century have been attributed to oil spills, drift net and coastal gillnet fisheries (e.g., Ainley and Lewis 1974, DeGange and Day 1991), and dramatic population crashes of several important forage fish stocks (e.g., sardine, anchovy, eulachon). Links have also been found between rising ocean temperatures, food availability, and puffin breeding success (Golobuva 2002, Gjerdrum et al. 2003). Determining the exact causes of population declines can be difficult, especially for long-lived species, because there is often a lag between specific events or ecological changes and detectable population trends. This is particularly true for seabirds when reproductive success is affected, because long-lived adults returning to nesting colonies year after year can mask the lack of recruitment. A crash in Norwegian herring stocks in the 1960s, for example, led to large-scale reductions in Atlantic Puffin populations that weren't fully realized until the 1980s (Anker-Nilssen et al. 1997). It can also be challenging to determine causation if populations near the edge of a species' range (like Tufted Puffins in Washington) are bolstered by emigration from core areas. In that case, factors affecting the core population and rates of emigration may be undetectable at the fringe. Though it is also possible that reductions in Tufted Puffins in Washington, Oregon, and California may partly be due to the northward movement of some individuals to colonies in British Columbia and Alaska, this seems unlikely because of the strong fidelity to breeding sites and limited dispersal of immature birds among most puffin species (e.g., Harris and Wanless 2011).

Washington Status and Trends

Historically, ornithologists considered Tufted Puffins among the most common seabirds on the Washington coast and estimated the breeding population in the tens of thousands (e.g., Rhoads 1893, Dawson and Bowles 1909, Palmer 1927, Jewett et al. 1953, Larrison and Francq 1962, Wahl 2005). Dawson and Bowles (1909) conservatively put the number of birds along the outer Olympic Coast at about 25,000 birds in the early 1900s, an estimate that was maintained for much of the 20th century (e.g., Jewett et al. 1953, Speich and Wahl 1989). Speich and Wahl (1989) estimated the 1978-1982 nesting population at 23,342 birds, although they remarked that the population could be ≥50% larger than this number. Though colony declines and abandonment were observed in the Strait of Juan de Fuca and the San Juan Islands (Jewett et al. 1953, Speich and Wahl 1989), Tufted Puffins were still considered common in offshore surveys into the 1990s (Briggs et al. 1992, Wahl et al. 1993). More recent studies, however, point to widespread colony abandonment and a rapid order of magnitude population decline throughout Washington (e.g., Wahl and Tweit 2000; P. Hodum et al., unpubl. data). This downward trend in puffin occurrence in Washington is evident, and its strength and scale are consistent, among all three types of data used for this report: boat-based surveys, breeding colony occupancy records, and breeding colony attendance counts. Declining trends were particularly evident from the mid-1980s through the late 1990s, but continue to the present.

Boat-based surveys. Two multi-year boat-based studies contain data for Tufted Puffin populations in Washington, and both show statistically significant declines in recent decades. From 1972 to 2001, Wahl and Tweit (2000, unpubl. data) surveyed seabirds annually between July and October during more than 4,400 counts on more than 230 cruises from Westport westward to about 50 km offshore. In the early years of this period, puffins occurred on 78.6% of counts (Wahl 1975), but sightings decreased dramatically during the latter part of the study (Figure 2). The overall downward trend averaged 13.6% per year and no puffins were sighted at all during 198 counts in 1997 (Wahl and Tweit 2000).

A second set of boat-based surveys conducted annually from 2001 to 2012 for Marbled Murrelets (*Brachyramphus marmoratus*) and other seabirds from Cape Flattery to Point Grenville (made within 8 km of shore from mid-May to late July and averaging 24 transects totaling about 1,000 km per year, see Raphael et al. 2007, Falxa et al. 2011) also shows a declining trend in Tufted Puffin density, averaging a loss of 8.9% per year (Figure 2; S. Pearson, unpubl. data). Using data from the 2009 survey for an expanded area between Cape Flattery and the mouth of the Columbia River with 1,380 km of transects, S. Pearson (unpubl. data) generated a minimum breeding season population estimate of 2,958 Tufted Puffins on the water for the outer coast. This estimate does not account for individuals provisioning chicks or otherwise attending colonies, or those farther offshore.

Site occupancy records. Forty-four historical breeding locations have been documented in Washington, with 35 of them still occupied during 1978-1984 (Tables 1, 3, Figure 3, Appendix A; Speich and Wahl 1989; USFWS, unpubl. data). While this later estimate represented a 20% drop from the historical maximum number of colonies, most of the abandoned sites had previously held ≤50 birds, so the impact on the overall population was relatively small. However, surveys from 2007 to 2010, conducted mainly by P. Hodum et al. (unpubl. data), have revealed a much larger decline in site occupancy since then, with breeding birds found at only 19 sites. This represents a 46% drop in site occupancy since 1978-1984 and a 57% decline since 1886-1977. Sites that remain occupied are overwhelmingly (89%, 17 of 19) those that held larger numbers (≥100) of puffins during 1886-1977, whereas the vast majority (88%, 22 of 25) of those abandoned by 2007-2010 held fewer than 100 birds during 1886-1977.

Colony attendance counts. Multi-year land-based counts of Tufted Puffins exist for two breeding colonies in Washington, with both showing statistically significant declines. Puffin numbers fell an average of 16.9% annually at Tatoosh Island between 1983 and 2001 (Figure 2; R. Paine, unpubl. data) and an average of 13.9% annually at Protection Island between 1973 and 2001 (Figure 2; U. Wilson, unpubl. data). These rates of decline are similar to those recorded for the on-the-water population during boat-based surveys.

While time series datasets do not exist for other breeding sites, over 400 observations, counts, collections, and other records of breeding Tufted Puffins have been documented in Washington (Appendix A). These records represent a range of methodologies that do not allow for statistical comparisons; however, the data are informative for documenting large-scale changes in population. At Carroll Island, for example, the puffin population declined from estimates of 10,000 birds in 1907 (Dawson 1908a), to 2,270 birds in 1982 (Speich and Wahl 1989), to 18-211 birds observed (total number of birds seen on the water, flying, or on the colony) during repeated boat-based surveys between 2007 and 2010 (P. Hodum et al., unpubl. data). In the Strait of Juan de Fuca, combined estimates at Protection and Smith islands fell from over 1,070 puffins in the 1950s (Ainley et al. 1994) to about 60 birds in 2007-2008 (P. Hodum et al., unpubl. data). Of the 19 occupied sites surveyed along the outer coast and in the Strait of Juan de Fuca in 2007-2010, only three (Cakesota, Erin's Bride, Rounded) continued to support populations similar in size to those reported in 1978-1982 by Speich and Wahl (1989) (see Appendix A).

Nine Washington colony sites are estimated to have once supported ≥1,000 puffins each, with two (Carroll, Jagged) reaching 10,000 or more individuals (Appendix A). Of the eight currently occupied colonies (Alexander, Bodelteh Islands [all], Cake, Carroll, Dhuoyautzachtahl, Jagged, Puffin Rock, Silver Sides) that formerly held ≥1,000 birds, the maximum count at any of these sites in 2007-2010 was 211 individuals.

Future population status. Future population trends for Washington's Tufted Puffins likely depend on a range of local, regional, and global factors. Populations will be negatively affected by many of the considerations detailed below under Factors Affecting Continued Existence, some of which are beyond the control of local regulations and management practices. If the current 8.9% annual rate of decline continues, the species could become functionally extirpated from Washington in about 40 years (based on a current estimated population of 3,000-4,000 puffins falling to 100 birds).

Figure 2. Population (abundance or density) trends for Tufted Puffins in Washington from four time series datasets. These include results from two boat-based surveys (Westport offshore surveys, 1972-2001 [Wahl and Tweit 2000; T. R. Wahl and B. Tweit, unpubl. data] and coastal offshore surveys from Cape Flattery to Point Grenville, 2001-2012 [S. Pearson, unpubl. data]) and two colony attendance surveys (Tatoosh Island, 1983-2001 [R. Paine, unpubl. data] and Protection Island, 1973-2001 [U. Wilson, unpubl. data]).

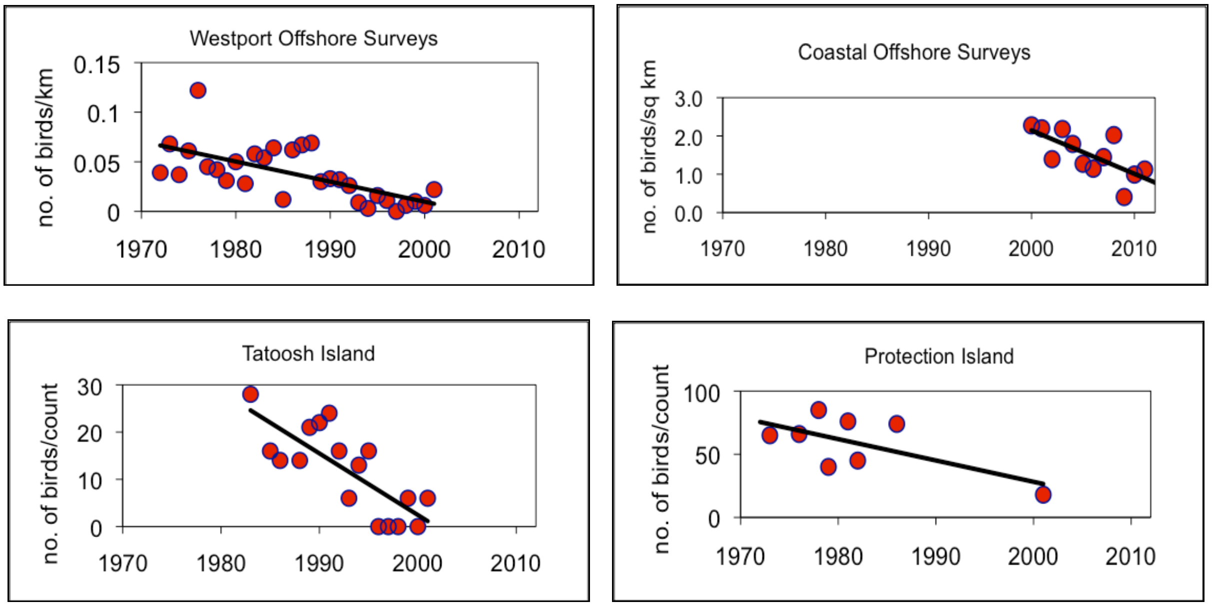
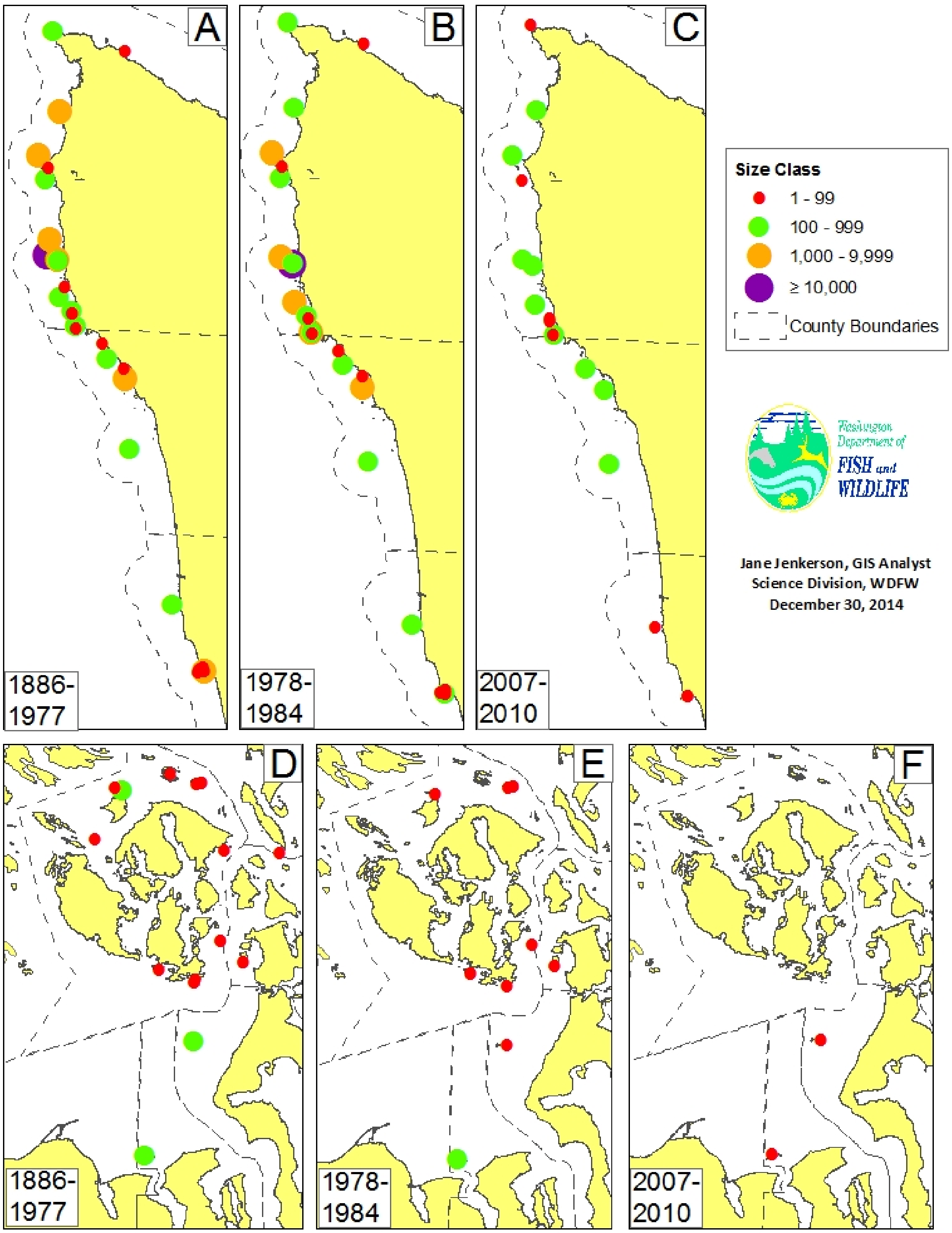


Table 3. Changes in the numbers and sizes of breeding colonies of Tufted Puffins in Washington from the late 1800s to 2007-2010.

Colony size (no. of birds)	No. of colonies per survey period		
	1886-1977	1978-1984	2007-2010
1-99	24	18	10
100-999	13	11	9
1,000-9,999	6	5	0
≥10,000	1	1	0
Total no. of occupied sites	44	35	19

Figure 3. Locations and historical maximum population estimates for 44 Tufted Puffin breeding colonies documented in Washington. Panels A-C depict colony occurrences along the outer coast from northwestern Clallam County to northern Grays Harbor County during the periods from 1886-1977, 1978-1984, and 2007-2010. Panels D-F depict colony occurrences in the San Juan Islands and eastern Strait of Juan de Fuca during the periods from 1886-1977, 1978-1984, and 2007-2010. Count data for each breeding site are presented in Appendix A.



HABITAT STATUS

This discussion of habitat status in Washington is limited to current and former areas used during the breeding season, since Tufted Puffins generally do not winter in state waters. The few birds visiting the state in winter are strays from pelagic regions of the North Pacific. The status of their winter pelagic habitat is poorly known, but that habitat is subject to large-scale trends in climate, ocean conditions, and pollutants (e.g., plastic debris).

Past

Historically, Native Americans visited Tufted Puffin colonies in Washington both to hunt birds and gather their eggs (Jones 1908a, Bovy 2007). Small islands with nesting puffins and other seabirds were also used for the rearing of dogs (Paterek 1996) and for the collection of camas (*Camassia* spp.) and other food plants (Turner 1999). Burning after the camas harvest was a common practice to reduce woody vegetation (Boyd 1999) and records indicate that Native Americans performed burns on at least two islands in Washington and British Columbia that once held nesting puffins (Waldron Island, Washington, and Mandarte Island, British Columbia; Turner 1999, Sprenger and Dunwiddie 2011). It is unclear whether or how puffin nesting habitats were affected by these activities.

Following European settlement, several important Tufted Puffin colonies were adversely impacted by construction, human habitation, farming, and other human disturbances. Tatoosh, Smith, and Destruction islands all supported manned lighthouse stations for many decades, where activities included the development and maintenance of landing sites, lighthouses, outbuildings, and other infrastructure. Protection Island was extensively farmed and at one time platted and partially developed for an 800-lot vacation home project. Flattop Island experienced use as a training range for warplanes during World War II, and other islands received occasional visits from fishermen, naturalists, and the general public until well into the 20th century. European Rabbits and dogs were introduced to several islands with nesting puffins, but impacts of these species are poorly known except on Destruction Island, where overgrazing by rabbits appears to have changed the island's grassy vegetation and caused significant soil erosion and land slippage, which reduced burrowing habitat for puffins (S. Pearson, pers. comm.). By the 1970s, virtually all former and active breeding sites in Washington had been protected by the establishment of national wildlife refuges and wilderness areas, where public access is much reduced or prohibited altogether.

Foraging areas for Tufted Puffins include vast tracts of outer coastal and inland marine waterways where the birds disperse to feed and find fish to feed their young. These areas are governed by maritime laws and fishing regulations, and more nominally by laws concerning seabird protection (Harrison et al. 1992). Following European settlement, puffin foraging habitat in these areas was adversely impacted by fishing, environmental contaminants, shipping, and increasing boat traffic.

Present and Future

Nearly all documented former and current breeding locations for Tufted Puffins in Washington are now included in the Washington Maritime National Wildlife Refuge Complex and associated wilderness areas. This group of refuges includes six distinct management units: the San Juan Islands, Protection Island, Dungeness Spit, Cape Flattery, Quillayute Needles, and Copalis national wildlife refuges. Additionally, many sites in the San Juan Islands are included in the San Juan Islands Wilderness. In most instances, light stations have been automated or decommissioned and other human activities are greatly reduced at these sites. Caretakers reside on Protection Island, and other islands receive periodic visitation from researchers and refuge managers, but the amount of human disturbance at current Washington breeding colonies is low and likely to remain so. Some of the rocks and islands formerly occupied by puffins in the San Juan Islands are not regularly patrolled and therefore may be subject to recurring human disturbance. Rabbit control measures have been proposed for Destruction Island, and current refuge management plans include an emphasis on promoting native plants and animals (e.g., USFWS 2007, 2010).

With shipping and recreational traffic on the rise, foraging habitat continues to be affected by vessel traffic, particularly in the inland marine waters. Oil spills and other environmental contaminants remain a threat to these habitats, and diminished populations of forage fish have likely reduced habitat quality in some areas. Commercial fishing in Washington has declined sharply in recent decades. Though no Tufted Puffin entanglements have been reported recently, Common Murres, Rhinoceros Auklets, and other diving seabirds continue to drown in nets, albeit in reduced numbers (e.g., Hamel et al. 2009). Derelict fishing gear also continues to be a threat in some areas (Good et al. 2009, 2010), but is currently the subject of a clean-up effort (see www.derelictgear.org) with positive early results (June and Antonelis 2009).

CONSERVATION STATUS

Federal. The U.S. Fish and Wildlife Service (USFWS) considers the Tufted Puffin a species of concern, a non-regulatory designation intended to encourage conservation action before situations become more serious. Tufted Puffins are protected under the 1918 Migratory Bird Treaty Act (and subsequent amendments), which prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, and their nests. Federal management of seabirds falls under the jurisdiction of the USFWS, and certain exceptions to the law that allow interaction with migratory birds (e.g., scientific, cultural) are governed by strict permitting requirements. In general, the law is more strictly enforced with regards to nesting colonies, but less so in terms of the "taking" of puffins as bycatch from fishing activities (Harrison et al. 1992). The Fish and Wildlife Conservation Act of 1980 is also pertinent to Tufted Puffins, requiring the USFWS to assess migratory nongame bird populations, determine the effects of human activities, and identify populations likely to become candidates for listing under the Endangered Species Act. An Executive Order implemented in 2001 (Executive Order 13186 - Responsibilities of Federal Agencies To Protect Migratory Birds) essentially expands this mandate to every federal agency whose actions are likely to impact migratory bird populations, requiring them to enter into a Memorandum of Understanding for management and monitoring purposes with the USFWS.

National marine sanctuary (NMS) regulations (15 CFR 922 Subpart O, 152(a)), which apply to the Olympic Coast NMS off the outer northwest coast of Washington, contain prohibitions on the taking and possessing of any seabird in the sanctuary, except as authorized by the Endangered Species Act and the Migratory Bird Treaty Act. The regulations also prohibit the disturbance of seabirds by aircraft flying below 610 m over waters within 1.85 km of Flattery Rocks, Quillayute Needles, and Copalis national wildlife refuges or within 1.85 km seaward from the coastal boundary of the sanctuary, with certain exceptions.

In February 2014, the USFWS was petitioned to list Tufted Puffin populations in Washington, Oregon, and California under the federal Endangered Species Act (NRDC 2014). Because of other listing priorities, the USFWS will not begin its evaluation to list the species in these states until 2016 or 2017 (D. Lynch, pers. comm.). This means that any listing decision would probably not be reached until sometime between 2018 and 2020.

Washington. Tufted Puffins are covered under several Washington laws and regulations. The species is protected under the category of "other protected wildlife" in the Washington Administrative Code (WAC 232-12-011; Appendix B). This prohibits the hunting, malicious killing, possession, and malicious destruction of Tufted Puffins and their eggs and nests, but does not protect the species from harassment. Violations of this law are a misdemeanor offense (RCW 77.15.130; Appendix B), with penalties ranging up to 90 days imprisonment, a $1,000 fine, or both. The species also receives protection under WAC 232-12-064, which prohibits the capture, importation, possession, transfer, and holding of most wildlife in the state.

The Washington Department of Fish and Wildlife (WDFW) has considered the Tufted Puffin a candidate for state listing since October 1998, though this designation does not infer any specific legal status or protections. Audubon Washington considers Tufted Puffins as an "early warning" species of concern, and one at "high risk" of negative impacts from changes in ocean and atmospheric circulation related to climate change (Audubon Washington 2004, 2009).

Other states. Tufted Puffins are listed by the California Department of Fish and Wildlife as a Priority 1 Bird Species of Special Concern (S2; McChesney and Carter 2008). The Oregon Department of Fish and Wildlife lists Tufted Puffins as Sensitive - Vulnerable, while the Oregon Natural Heritage Program ranks the breeding population as Critically Imperiled (S1B; ORBIC 2013). In Alaska, the species is considered Apparently Secure (S4; NatureServe 2014) and is not listed by the state.

International. In Canada, Tufted Puffins are protected from harvest by the federal Migratory Birds Convention Act and the province of British Columbia's Wildlife Act. They are not listed under the Species at Risk Act (federal legislation). The province has designated the breeding population of the species as being of Special Concern (S3B) and includes it on its Blue List, meaning that this population is sensitive or vulnerable to human activities or natural events (B.C. Conservation Data Centre 2014). However, the province's overall puffin population (including wintering birds) is considered Apparently Secure (S4N). In Japan, Tufted Puffins have been listed as a national and local endangered species since 1993 (Osa and Watanuki 2002).

RESEARCH, MONITORING, AND RESTORATION

Research. Research on Tufted Puffins dates back decades and covers a wide range of behavioral and ecological subjects. Breeding biology, diet, foraging habitats, and ecological relationships are now fairly well understood (Piatt and Kitaysky 2002), and new tools are opening up additional opportunities to refine existing knowledge. Stable isotope analysis has revealed the subtleties of seasonal dietary shifts (e.g., Davies et al. 2009), while population and ecological genetic tools developed for closely related alcids (Rhinoceros Auklet, Whiskered Auklet) show great promise for use in Tufted Puffins (Dawson et al. 2005, Hasegawa et al. 2005). Challenges to puffin research include the inaccessibility of many breeding sites, the dispersed nature of puffin populations in winter, and the sensitivity of the birds to research-associated disturbance. Studies have shown changes in adult and chick behaviors during nestling research (e.g., Hatch et al. 2000 a, 2000b, Gjerdrum et al. 2006), and have found that the presence of observers can negatively affect fledging success and nestling growth rates (Pierce and Simons 1986). Attempts to surgically implant satellite transmitters in Tufted Puffins have met with behavioral alteration (nest abandonment) and high mortality, and the attachment of small radio-transmitters has negatively impacted reproductive success (Whidden et al. 2007). Further refinements are necessary for these techniques to be effective and safe (Hatch et al. 2000a, 2000b).

Research needs. Though Tufted Puffins are considered one of the better-studied alcids, many important research questions remain. No data exist on gene flow or the genetic and ecological distinctiveness among populations, which are significant considerations for conservation efforts for populations near the southern edges of the species' range. Similarly, puffin distribution and habits during the winter months are largely unknown, factors that may take on increased significance if ocean conditions follow the trends predicted by climate change (e.g., Hoegh-Guldberg and Bruno 2010, Doney et al. 2012). Habitat use, diet, and survival at sea remain essentially unmonitored and there is no information on whether winter habits differ among colonies or regions, which could be particularly important for declining populations like those in Washington. More precise data on foraging range and habitat use during the nesting season would also be of great use in identifying effective management strategies for the species. In Washington, specific information on dietary habits and the relationships between breeding success and trends in forage fish remains largely speculative. Long-term, location-specific data of the type being amassed at Triangle Island, British Columbia, would be extremely pertinent for the management and conservation of Washington colonies, and it would be helpful to analyze the relative influence of both top-down (e.g., Bald Eagle predation) and bottom-up (e.g., prey availability) factors affecting the population. Additionally, more precise time series data on population trends would be helpful and a thorough assessment of threats to Washington's sites (e.g., introduced species) would help set management priorities. The extent and impacts of gull kleptoparasitism at Washington colonies should be investigated, particularly in light of increasing abundance of gulls.

Surveys and monitoring. Tufted Puffins are currently included in long-term monitoring of seabird colonies in Alaska (Dragoo et al. 2010) and at Triangle Island, British Columbia (M. Hipfner, pers. comm.). Expansion of such surveys and standardization of protocols have been called for (USFWS 2005) and would be particularly relevant for Washington and other areas where the species is declining. Regular surveys or monitoring programs specific to Tufted Puffins have never been conducted in Washington. The investigation by P. Hodum et al. in 2007-2010 was the first statewide attempt to assess the status of puffin breeding colonies in 25 years. The species is counted on the water during annual boat-based surveys focused on Marbled Murrelets (S. Pearson, pers. comm.). It also has been surveyed during the Westport Seabirds trips traveling west out of Westport, Washington, since 1972, although a change in survey protocols has prevented meaningful analyses of count data since 2002. The species is also recorded during annual boat-based surveys in the San Juan Islands National Wildlife Refuge.

Restoration potential. Restoration of Tufted Puffins at current and former breeding sites in Washington was suggested in the wake of the 1991 *Tenyo Maru* oil spill, but never acted upon (*Tenyo Maru* Trustees 2000). Though stabilizing and increasing populations at current breeding sites should receive first priority, restoration may offer a future means of expanding breeding opportunities and buffering the species against decline. Restoration has never been attempted with Tufted Puffins, but the successful reintroduction of Atlantic Puffins to islands off the coast of Maine (Kress and Nettleship 1988) indicates that it may be possible. In a worldwide review of seabird restoration, Jones and Kress (2012) found a 60% success rate for alcid species. Recent colonization of Mandarte Island, British Columbia, by Rhinoceros Auklets (P. Arcese, pers. comm.) and increased numbers of forage fish in recent trawls in the San Juan Islands (K. Fresh, pers. comm.) suggest that conditions around some former nesting sites in Washington may be opportune for either natural re-occupation or reintroduction. Site selection would require careful analysis, however, to avoid encouraging puffins to reoccupy poorly suited sites.

Projects to restore natural habitat conditions at current and former nesting islands should also be undertaken or evaluated to conserve Tufted Puffins in Washington. These would include the removal of invasive plants and animals (see Factors Affecting Continued Existence – Introduced Species) and the replanting of native vegetation. Eradication of European Rabbits on Destruction Island is already under consideration (S. Pearson, pers. comm.) and control of non-native plants at Protection Island has been proposed (USFWS 2010).

FACTORS AFFECTING CONTINUED EXISTENCE

The causes of the Tufted Puffin decline in Washington remain undetermined because of a lack of scientific study. Throughout its range, the species is adversely impacted by a wide range of natural and human factors. On the water, threats include net fisheries, oil spills, ingested plastics, and bioaccumulation of chemical pollutants, whereas breeding colonies are at risk from disturbance, predators, introduced species, disease outbreaks, and habitat loss (Tyler et al. 1993, Mahaffy et al. 1994, Piatt and Kitaysky 2002, Gill 2007). Reduced prey availability ranks as a major concern, particularly in combination with ocean surface temperature trends predicted by global climate change (Gjerdrum et al. 2003). The puffin habit of nesting in aggregations makes them particularly vulnerable to many of these threats (Gill 2007), while small, declining populations like those in Washington face increased risk of extirpation from stochastic events like disease outbreaks or oil spills (Donald 2010). These and other threats are discussed in detail below, set in the context of existing regulatory mechanisms and with particular attention to conditions in Washington.

Adequacy of Existing Regulatory Mechanisms

Federal protection. Federal laws and regulations relevant to Tufted Puffins help protect the birds from harassment and hunting (see Conservation Status), but are unevenly applied, particularly with regard to bycatch from commercial fishing (Harrison et al. 1992). The U.S. Fish and Wildlife Service has recommended several research and management initiatives for the species to be conducted by the agency and other entities, including the development of protocols for long-term monitoring and the installation of observers on commercial fishing vessels (USFWS 2005, 2009). There are no federal regulations that require proactive management steps, however, which could be important for declining populations like those in Washington.

State protection. Current state protections for Tufted Puffins resemble those offered by federal law, but do not protect the species from harassment (see Conservation Status). Results of this listing process could afford Washington's puffin population some additional legal protection under RCW 77.15.120 (Appendix B). Classification as a state endangered species would (1) protect puffins from malicious harassment, (2) increase the legal penalties associated with unlawful taking, (3) result in the preparation and implementation of a state recovery plan having conservation actions that benefit the species, (4) make puffins a high priority conservation target within WDFW, and (5) bring greater public recognition to the imperiled status of the species in Washington.

Reduced Prey Availability

Reductions in prey abundance and the timing of prey availability rank as major concerns for Tufted Puffin populations in Washington and elsewhere. A recent study found widespread reproductive failure in 14 seabird species (including Atlantic Puffins) when forage fish and krill populations were depleted below one-third of their observed maximum (Cury et al. 2011). Data on the status of prey in the puffins' winter range is limited, so the discussion below focuses on prey availability during the critical breeding period, when the birds reside in Washington waters. Because the timing and abundance of prey populations are often dependent upon ocean temperature and climatic conditions, this threat should be considered closely intertwined with ocean and climate forcing factors.

Forage fish. Populations of forage fish can vary widely in response to large-scale changes in oceanic conditions (e.g., El Niño, La Niña, decadal oscillations) (Baird 1990, Brodeur et al. 2005, Lindegren and Checkley 2013, Santora et al. 2014), as well as fishing or other human pressures (e.g., Ainley and Lewis 1974). Seabird abundance and reproductive success correlate closely with prey availability around nesting colonies, and numerous studies have linked Tufted Puffin breeding success with the availability of forage fish in nearby waters (e.g., Vermeer et al. 1979, Baird 1990, Golubova 2002, Gjerdrum et al. 2003). Nestling body mass, growth rates, fledging rates, and the timing of the first molt have all been linked to quantity and quality of fish species that adults provide their offspring (Vermeer and Cullen 1979a, Thompson et al. 2001). Reproductive failure, on the other hand, has been noted in years of forage fish shortage (e.g., Vermeer et al. 1979), or when the timing or size of prey fail to match the parents' foraging requirements (Golubova 2002). Similarly, the type of forage fish available has been correlated to chick growth and fledging success in the closely-related Rhinoceros Auklet (e.g., Hedd et al. 2006, Thayer and Sydeman 2007), which may indicate that birds have a particular efficiency for assimilating nutrition from their preferred prey (Niizuma and Yamamura 2004).

Though there have been no studies in Washington specifically focused on Tufted Puffin diet or the relationships between puffins and forage fish, several inferences can be made from available data on fish populations. During the breeding season, puffins generally feed themselves and provision their young with fish of high nutritional quality within a 20 to 200 mm size range. In Washington, these would include several well-documented puffin prey species: Pacific Herring, Pacific Sand Lance, juvenile rockfish, Eulachon, Pacific Sardine, and Northern Anchovy. Additional species within the preferred size range include Surf Smelt, Night

Smelt, Popeye Blacksmelt, Whitebait Smelt, juvenile Kelp Greenling, Pacific Saury, and juvenile salmon. Catch records, survey data, and other observations suggest that some of these species experienced significant population declines and/or loss of habitat in Washington during the 1900s through to the present, as follows:

- **Pacific Herring** – A number of herring stocks in the Georgia Basin are comprised of sizable migratory components that move to feeding grounds off the continental shelf along the outer Washington coast from March to July (Stick and Lindquist 2009), where they become available as prey for Tufted Puffins. Of 19 herring stocks in greater Puget Sound, only nine (47%) were considered healthy or moderately healthy in the latest analysis (Stick and Lindquist 2009), the lowest number of healthy stocks since tracking began in 1994. The herring population at Cherry Point, once considered Washington's largest, suffered a 95% decline between 1973 and 2000 and has shown little sign of recovery (Gustafson et al. 2006, Stick and Lindquist 2009). Recent declines in herring spawning have also been noted in the Strait of Georgia (Therriault et al. 2009). However, some relatively healthy stocks do remain in Puget Sound and elsewhere in the Georgia Basin (Gustafson et al. 2006, DFO 2014) and it's likely that both resident and migratory herring remain an important food source for Tufted Puffins in Washington. Spawning populations of herring also exist in Willapa Bay and Grays Harbor (Penttila 2007), but no long-term data are available to establish abundance trends.
- **Pacific Sand Lance** – Sand lance constitute a major part of puffin diets in British Columbia and Alaska (summarized in Piatt and Kitaysky 2002) and are known to be an important potential food source of other alcids in Washington (Leschner 1976, Wilson and Manuwal 1986, Schrimpf et al. 2012, Pearson et al. in review). Though sand lance population trends have not been monitored in Washington, the species is known to spawn in upper intertidal areas vulnerable to shoreline alterations (Penttila 2007). The impacts of shoreline modifications (e.g., armoring, nearshore fill, wetland loss, and the construction of breakwaters, jetties, and overwater structures) on sand lance abundance in Washington are unknown, but it is safe to say that spawning habitat has declined in extensively developed areas, such as Puget Sound. However, in the areas historically occupied by Tufted Puffins, shoreline modifications have been relatively modest (in the Strait of Juan de Fuca and San Juan Islands; Simenstad et al. 2011) or minimal (the outer Washington coast), thus sand lance populations in these regions may have remained relatively stable compared to historical levels.
- **Rockfish** – Juvenile rockfish can be a significant percentage of adult and nestling Tufted Puffin diets during the breeding season (e.g., Vermeer 1979), and are known to be an important food source for the closely related Rhinoceros Auklet at coastal sites in Washington (Wilson and Manuwal 1986). Rockfish populations in the interior waters of Washington have declined markedly over the past three decades, with 22% of stocks considered vulnerable or depleted, and 56% considered precautionary (reduced but apparently stable, or information lacking) (Palsson et al. 2009). Additionally, seven coastal rockfish stocks are considered depleted and have been put under severe fishing restrictions in both federal and state jurisdictions (Palsson et al. 2009). Thirteen rockfish species in Washington's inner waters are federal species of concern and three were listed as endangered or threatened under the Endangered Species Act in 2010. Thirteen rockfish species are designated as state candidates for listing (WDFW 2014). Overharvest has been a primary factor in these declines. While the species composition of the "rockfish" component of puffin diets has not been established, decreased adult abundance and stochasticity in reproductive success, perhaps exacerbated in part by climate change, have very likely made juvenile rockfish a less abundant food source for Tufted Puffins in Washington.
- **Eulachon** – Precipitous declines in Eulachon (also called Columbia River Smelt or Pacific Smelt) led the National Marine Fisheries Service to declare populations throughout Washington, Oregon, California, and British Columbia as threatened under the federal Endangered Species Act in 2010 (NMFS 2009, 2010, ODFW/WDFW 2014). Two major production areas for the species occurred in the Columbia and Fraser rivers and would once have been prolific potential food sources for puffins, but Eulachon populations in both areas have greatly declined since 1993 (NMFS 2009). Minor improvements in the Columbia River population may have occurred since 2011 (ODFW/WDFW 2014).

- **Pacific Sardine** – Sardines were among the most abundant forage fish off the outer Washington coast in the early 1900s and supported a large commercial fishery until stocks collapsed in the 1930s and 1940s coincident with a change in ocean conditions and high harvest levels (Bargmann 1998, Zwolinski and Demer 2012). The species made a partial comeback in the 1990s (Emmett et al. 2005), which has supported a limited commercial harvest since 2000. Sardine abundance along the North American west coast has shown several fluctuations since 2000, but has generally displayed a downward trend during this period (Hill et al. 2011), including the disappearance of stocks off Vancouver Island in 2013. Though the impacts of these population fluctuations on Washington's Tufted Puffins are unknown, the mid-20th century crash in sardine stocks has been suggested as a factor in coincident puffin declines in California (Ainley and Lewis 1974).
- **Northern Anchovy** – The historical abundance of anchovies off the outer Washington coast is poorly known (Bargmann 1998), although the species typically is associated with warmer water temperatures and weaker upwelling, which are ocean conditions unfavorable for Pacific Sardines and some other forage fish (Chavez et al. 2003, Santora et al. 2014). Anchovy biomass off Washington declined during the 1980s, then increased during the 2000s (Litz et al. 2008; L. Wargo, pers. comm.). Stocks currently support a limited commercial fishery primarily for the bait trade. Anchovies have also been considered abundant at times in Puget Sound (Bargmann 1998). Studies at Destruction Island note anchovies as a vital food source for nesting Rhinoceros Auklets (Wilson and Manuwal 1986, Pearson et al. in review), and they are likely an important prey species for puffins as well. In Californian waters, anchovies function as a primary food item of seabirds during periods of decline among other prey species (Santora et al. 2014).

Natural fluctuations caused by changing ocean conditions are a major influence on the abundance of forage fish in the areas of Washington inhabited by Tufted Puffins. Additionally, existing data and historical accounts make it clear that the availability of some populations of forage fish (especially Pacific Herring, Eulachon, and rockfish) used by Tufted Puffins in Washington has declined beyond what might be expected due to changes in ocean conditions (Gustafson et al. 2006, NMFS 2009, 2010, Palsson et al. 2009, Stick and Lindquist 2009, ODFW/WDFW 2014). Past overfishing has played a role in the declines of herring, rockfish, and perhaps other species (Gustafson et al. 2006, Palsson et al. 2009, Stick and Lindquist 2009). Commercial fisheries currently exist for herring, Surf Smelt, sardines, and anchovies (largely inactive), but are much reduced from their historical peaks and, barring major increases in harvest, are likely to have only a limited role in reducing current prey availability for Tufted Puffins. Pelagic fisheries for sardines and anchovies are managed by the Pacific Fishery Management Council with a priority for maintaining their ecosystem functions, primarily as a food source for seabirds, marine mammals, salmon, and other predators (PFMC 2011).

Loss or degradation of key habitats and declining water quality are other major concerns for forage fish populations, especially in highly developed regions like Puget Sound, where there is extensive industry, agriculture, and urban growth, and where widespread shoreline armoring has greatly reduced intertidal spawning habitats for species like Surf Smelt, Night Smelt, and Pacific Sand Lance (Thom et al. 1994, Rice 2006, Krueger et al. 2010). However, shoreline modifications and other coastal development have been minimal along the outer Washington coast and relatively modest in the Strait of Juan de Fuca and San Juan Islands (e.g., Simenstad et al. 2011).

In addition to the quantity, and thus availability, of forage species, prey quality also plays a role in the breeding success of Tufted Puffins. The nutritional value of potential Tufted Puffin prey varies widely among species and among age classes of the same species (Anthony and Roby 1997). Dietary shifts to less nutritious species reduce nestling growth rates in captive studies (Romano et al. 2006) and have been implicated in declines in the wild (e.g., Piatt and Anderson 1996). Recovery of seabirds, including Tufted Puffins, in the wake of the *Exxon Valdez* oil spill in Alaska was thought to be limited by the availability of high quality forage fish (sand lance, herring, and capelin; Anthony and Roby 1997). Studies of Rhinoceros

Auklets, for example, show high breeding performance when Pacific Sand Lance predominate the diet fed to chicks (e.g., Wilson and Manuwal 1986, Hedd et al. 2006, Borstad et al. 2011). During warm water events, when sand lance numbers generally decline, juvenile Pacific Saury often become more abundant in the auklet diet, resulting in reduced chick growth rates (Thayer and Sydeman 2007) and fledging success (Hedd et al. 2006). Timing of reproduction that may lead to reductions or changes in the availability of appropriately sized prey for nestlings can also be a threat. Golobuva (2002) observed mass starvation of Tufted Puffin nestlings in the Sea of Okhotsk in a year when herring were abundant, but of a size class too large for the chicks to ingest.

Marine invertebrates. No time series data exist for the populations of squid and large zooplankton that likely make up part of the Tufted Puffin diet in Washington. A critical winter food source, invertebrates can also be important adult prey items during the early breeding season (Davies et al. 2009), and some individuals, both breeders and non-breeders, appear to use them throughout the summer (Piatt and Kitaysky 2002). Though local population trends remain unstudied, zooplankton blooms in the Northeastern Pacific respond directly to ocean surface temperatures and other climatic trends, and are in turn a primary factor controlling fluctuations in forage fish numbers (e.g., Mackas et al. 2007). In general, increases in ocean temperature result in declining zooplankton biomass and changes in community composition of zooplankton (King et al. 2011), a pattern that has already been documented for euphausiids. Research on Cassin's Auklets found that warm water years altered the productivity and timing of critical euphausiid species with direct negative consequences for nestling survival and fledging weight (Bertram et al. 2001, Hipfner 2008, 2009). The availability of marine invertebrates is probably closely linked to the trends in climate and ocean temperatures discussed below.

Climate Change Effects

The locations of breeding colonies used by Tufted Puffins may make them particularly vulnerable to the effects of climate change. Shifting weather patterns and rising sea temperatures predicted by climate change models could have a dramatic impact on the productivity and occupancy of established puffin colonies, as well as the establishment of new ones.

Warming ocean and prey availability. Climate change is expected to cause a long-term rise in global ocean surface temperatures (Morgan and Siemann 2011, IPCC 2013), a trend generally associated with lower ocean productivity (e.g., Behrenfeld et al. 2006), altered availability of plankton (Hipfner 2008, Batten and Walne 2011, King et al. 2011), and corresponding changes in high-trophic communities like seabirds (e.g., Hyrenbach and Veit 2003, Frederiksen et al. 2013). Increases in ocean surface temperature have already been detected in much of the North Pacific (Thompson et al. 2012). Predicted effects for this region are widely expected to include altered food webs and faunal distributions (e.g., Fields et al. 1993, Di Lorenzo et al. 2008, Abdul-Aziz et al. 2011), and recent fluctuations in temperature and climate have been linked to prey availability and breeding success in alcids (e.g., Francis et al. 1998, Gjerdrum et al. 2003, Hedd et al. 2006, Hipfner 2008, 2009). These relationships have been called the most important factor in determining the viability of Tufted Puffin populations (Gjerdrum et al. 2003).

Previously, periodic short-term temperature increases have been linked to lower productivity, shifts in prey communities, and corresponding declines in seabird abundance, particularly for diving pursuit feeders like puffins (Ainley and Hyrenbach 2010, Miller et al. 2013). In general, piscivorous birds are thought to have greater breeding success during cold water regimes, when ocean productivity is higher and more forage fish are available to them (Hunt et al. 2002). Rises in ocean surface temperatures during El Niño events have been associated with widespread nesting failures for Tufted Puffins and other alcids (e.g., Lowe 1993, Piatt and van Pelt 1993), though adult survival can remain high during these periods (Morrison et al. 2011). Following a decadal shift in ocean temperatures and cycling in the 1970s, forage fish declined throughout the Northeastern Pacific (Francis et al 1998). This change has been implicated in corresponding declines of several piscivorous seabirds (Francis et al. 1998), including Tufted Puffins (Agler et al. 1999). Anderson and

Piatt (1999) also noted widespread declines in Tufted Puffins and other piscivorous seabirds in the Gulf of Alaska following a shift to warmer ocean temperatures, which corresponded with fewer prey (capelin and shrimp). Whether these changes represented a reduction in the overall puffin population or a shift in distribution is unclear, but the link between local numbers and ocean temperatures appears strong.

Relationships between puffins, climate, and ocean temperature have been studied intensively at Triangle Island, British Columbia, where conditions resemble those of Washington's outer coast. Gjerdrum et al. (2003) found that hatch date, chick growth, and fledging success were all affected by ocean temperature, and there appeared to be upper and lower temperature thresholds outside of which breeding success was reduced essentially to zero. The mechanisms behind these results have not been determined, but are likely related to reduced copepod abundance in warm, nutrient-poor surface waters, which in turn lead to reduced forage fish populations around nesting colonies (Gjerdrum et al. 2003). This can occur in response to widespread trends in ocean surface temperature, or when the local upwelling of cold, nutrient-rich waters is poor or late. Links between ocean temperatures, prey availability, and nesting failures have been noted previously at Triangle Island (Vermeer et al. 1979), as well as for Tufted Puffin colonies in Alaska (Agler et al. 1999) and Russia (Golubova 2002), and for Atlantic Puffins in Norway (Durant et al. 2003).

Though most studies find puffins faring poorly in warm water regimes, Kitaysky and Golubova (2000) documented increased reproductive success during high surface temperature periods in Tauyskaya Bay, Russia. They postulated that in that system, abundant meso-zooplankton in warm water attracted larger numbers of pelagic forage fish into the bay. It may be that in some cases local effects are ultimately more important than global and regional trends in the fate of individual colonies. At Triangle Island, for example, recent research on Rhinoceros Auklets suggests that large-scale weather patterns greatly complicate the link between ocean temperatures and the availability of sand lance (Borstad et al. 2011). The timing of the annual spring shift from winter to summer wind patterns determines when deep-water upwelling will bring plankton-rich waters to the island (Borstad et al. 2011). If winter storms delay that transition beyond a critical period, the plankton bloom is poor or late, juvenile sand lance fare poorly, and the birds that feed on the sand lance suffer accordingly. A large-scale study of Cassin's Auklets at sites from British Columbia to Baja California also identified highly local conditions, rather than regional or global trends, as the best predictor of colony breeding success (Wolf et al. 2009).

Thompson et al. (2012) recently reported an increased occurrence of Tufted Puffins at sea during February cruises (but not during those in June and August-September) along a 1,425-km transect west of Vancouver Island. These results suggest the possibility of regional shifts in puffin wintering distribution in the North Pacific in association with warming ocean surface temperatures.

Sea level rise. Sea level rise caused by climate change is expected to negatively impact the breeding and foraging habitats and prey populations of many coastal waterbird species (Clausen and Clausen 2014). For Tufted Puffins, it may affect the abundance of some forage fish species by altering the intertidal and subtidal habitat conditions (e.g., water depths) preferred for egg deposition and refuge (Penttila 2007, Krueger et al. 2010). This problem may be especially acute where shoreline armoring has reduced or eliminated the ability of the beach face to erode landward, a situation referred to as "coastal squeeze" (Glick et al. 2007, Krueger et al. 2010). Physical attributes of beaches within a given locale may vary significantly, leading fish to deposit proportionally more eggs on "preferred beaches" (Quinn et al. 2012). As a result, losses of beach faces at specific tidal heights at a relatively small number of spawning beaches might have a large negative effect on egg abundance (Quinn et al. 2012).

Sea level rise, combined with increasing severity of storms, also has the potential to damage or destroy some Tufted Puffin colonies through increased erosion of soil and unconsolidated bluffs used as nesting areas (Miller et al. 2013). Examples of sites in Washington that may be vulnerable to this threat include Protection, Smith, and Destruction islands (S. Pearson, pers. comm.). Jewett et al. (1953) previously described the loss of occupied nesting burrows on Smith Island caused by wave erosion.

Ocean acidification. In addition to its predicted impacts on ocean temperatures and weather patterns, climate change is also expected to alter the acidity of seawater, particularly at higher latitudes where Tufted Puffins reside. As the ocean absorbs increased levels of atmospheric carbon dioxide (CO_2) from human activities and natural processes, acidity will rise and impair the ability of marine organisms to form calcareous shells and skeletal structures (Fabry et al. 2008). This change could shift planktonic and benthic communities away from calcium-dependent species, a low-trophic re-ordering with unpredictable but potentially profound implications for marine food webs (Fabry et al. 2008, Branch et al. 2013). Where rising ocean surface temperatures are expected to lower the abundance of zooplankton (and the forage fish that consume them), rising acidity may change the composition of these communities as well (Roemmich and McGowan 1995). The consequences for high trophic feeders like Tufted Puffins remain unknown.

Other effects. The interplay between changing climate, ocean conditions, plankton blooms, and forage fish creates a dynamic environment with significant implications for Tufted Puffin reproduction. The prediction that climate change will bring increased frequency of high intensity storms (IPCC 2013) is also a consideration for Tufted Puffins during the breeding season, when fledglings have been known to die by the thousands from severe weather and wave action (Reagan 1910). Some experts also predict climate change will increase the frequency of harmful algal blooms, or "red tides" (Peperzak 2003), which can have a range of negative effects on seabirds (see below).

Environmental Contaminants

Oil spills. Oil spills have long been considered one of the major anthropogenic threats to Tufted Puffins (Ainley and Lewis 1974, Tyler et al. 1993, Piatt and Kitaysky 2002). Alcids often make up the majority of seabirds killed during spills, and may also suffer when spills adversely affect their prey populations (Irons et al. 2000). Most relevant to Washington is the particular vulnerability of Tufted Puffins during spring and summer when their populations are concentrated around breeding colonies. The *Exxon Valdez* oil spill in 1989, for example, occurred in March when puffins and other alcids were just arriving at breeding sites. It killed an estimated 250,000 seabirds, including as many as 13,000 Tufted Puffins (Piatt and Ford 1996, Denlinger 2006). Another well-documented case occurred in Washington and adjacent British Columbia, at the entrance to the Strait of Juan de Fuca. The 1991 *Tenyo Maru* oil spill took place in July at the height of the breeding season, less than 30 km from the Tufted Puffin colony at Tatoosh Island. Oil slicks affected Tatoosh and other shorelines all along the Washington coast, killing an estimated 9% of the statewide puffin population (*Tenyo Maru* Trustees 2000). Because spills are more likely to occur during severe winter conditions, puffins are probably less vulnerable during this period because of their pelagic distribution. For example, a February 1986 spill off the coast of California resulted in thousands of alcid deaths, but Tufted Puffins were only a minor component (Page et al. 1990).

In addition to the risk oil presents to birds at sea, it is important to consider that an oil spill need not reach the islands where nesting colonies occur to inflict damage to eggs and nestlings. Oil encountered by foraging adults at sea up to 100 km from the colony can be carried back to the nest, where eggs exposed to as little as 5 μl of oil can experience damage to developing embryos (Albers 1978, King and Lefever 1979).

The number and volume of oil spills increased markedly in the North Pacific during the later decades of the 20th century, corresponding with increased oil development, shipping, and industrialization of the Pacific Rim (Burger and Fry 1993). As a shipping and oil-refining hub, Washington lies at the heart of this commercial vessel traffic and experienced six major oil spills ranging from 0.1-2.3 million gallons along the outer coast and the Strait of Juan de Fuca between 1964 and 1991 (Neel et al. 2007). Increased safety measures and prevention programs since the 1990s have helped reduce the number and scale of vessel spills globally (Anderson et al. 2012, Ramseur 2012), as well as in Washington, where no spills exceeding 100,000 gallons have occurred since 1991 (Etkin and Neel 2001, Neel et al. 2007). However, the sheer volume of shipping traffic makes oil spills a persistent threat in the state. Shipping routes for major ports in Seattle, Tacoma, and Vancouver, B.C., as well as several major oil refineries and the third largest naval base in the

U.S., all traverse waters near the largest puffin colonies in Washington (Serra-Sogas 2008). Marine vessel transits in Washington numbered 7,100 in 2013, with hundreds of tank ships and tanker barges annually transporting more than 15 billion gallons of crude oil, fuel, and other chemicals (Etkin and Neel 2001, Puget Sound Action Team 2005, Neel et al. 2007, WSDOE 2014). Tanker traffic from ports in British Columbia and possibly Washington, as well as oil transport by train, is expected to increase greatly in the next several decades as oil and natural gas production expands in the interior of North America and as offshore oil and gas development off Vancouver Island likely begins (NMFS 2013, O'Neil 2013). This is expected to increase the risk of spills in Washington (Van Dorp and Merrick 2014). Barges, freighters, container ships, ferries, naval vessels, and large fishing and recreational craft also carry oil and fuel in volumes large enough to produce a significant spill. Places where spills are most likely to occur include the Strait of Juan de Fuca and the outer coast, where puffin breeding and foraging sites are concentrated.

Among the safety measures instituted to prevent marine oil spills in Washington since the 1990s is the establishment of an Area to Be Avoided (ATBA) off the northwestern coast, which encourages large vessels to stay well offshore during transit along the coast (WSDOE 2014). Additional risk mitigation is provided by a rescue tug stationed in Neah Bay that is able to respond to vessels with impaired maneuverability near the entrance to the Strait of Juan de Fuca. Use of single-hull tanker vessels, including barges, was completely phased out in the U.S. in January 2015.

Although lower in profile, the chronic discharge of waste oil at sea (e.g., from illegal releases of oily bilge water and tank flushings) represents another pervasive and continuing threat to puffins (e.g., Jewett et al. 1953). Mortality from oil discharged in shipping lanes was implicated as a factor in the early 1900s decline of Tufted Puffins at the Farallon Islands, California (Ainley and Lewis 1974). Lighthouse keeper logs and naturalist reports from the period note that oiled puffins and other birds were a common occurrence (Dawson 1911, Ainley and Lewis 1974). Near Westport, Washington, small numbers of Tufted Puffins were found with bilge oil on their feathers in 1959 (Alcorn 1959). Surveillance of small-volume oil discharges from 1997 to 2006 in British Columbia indicates that the Strait of Juan de Fuca (including the entrance and the area around Cape Flattery, Washington) and Canadian waters near the San Juan Islands are areas of relatively high chronic oil pollution and some associated seabird loss (Serra-Sogas et al. 2008, O'Hara et al. 2009).

Ingested plastics. Plastic pollution has steadily increased throughout the North Pacific in recent decades (e.g., Day and Shaw 1987, Robards et al. 1995), with some forms of plastic being most common in coastal waters (e.g., microplastics; Desforges et al. 2014). Among alcid species, those that feed extensively on zooplankton (i.e., puffins, auklets) may be most at risk of consuming plastic debris (Avery-Gomm et al. 2013). Tufted Puffins ingest both consumer debris and industrial pellets (Blight and Burger 1997). While the specific effects of plastics on puffins have not been studied, there is evidence that large plastic loads interfere with feeding and digestion in other seabirds and can release toxins directly into the bloodstream (Derraik 2002, Teuton et al. 2009). A study comparing data from two time periods (1969-1978 and 1988-1990) in Alaska found that the frequency of plastics in Tufted Puffin stomachs had increased from about 15% to 25% and the number of particles per bird had doubled (Robards et al. 1995). The most recent data are from coastal Oregon, Washington, and British Columbia, where 89% of the Tufted Puffin stomachs sampled contained plastics (Blight and Burger 1997). All studies to date have been of adult birds – chicks would need to acquire plastic from prey dropped by adults and this has not been assessed. Wehle (1982), however, found significantly higher plastic loads in the stomachs of subadult puffins and suggested that subadults may be less capable of differentiating between plastics and prey items.

Organochlorines, heavy metals, and other contaminants. During the 20th century, chlorinated hydrocarbons, also called organochlorines, were associated with population declines of numerous marine birds in the North Pacific (reviewed in Elliott and Noble 1993). Organochlorines include a wide range of chemical compounds used in industry (e.g., polychlorinated biphenyls [PCBs], dioxins) and agriculture (e.g., DDT, other pesticides, herbicides). Many of these contaminants persist in the environment for very long periods, entering the marine ecosystem through atmospheric transport, runoff, and point source pollution.

Organochlorines accumulate in fatty tissues and become amplified at higher trophic levels, where predators amass and store the contaminants ingested and assimilated by their prey. Toxicity and effects vary with species and exposure, but can include eggshell thinning, embryo mortality, skeletal deformities, wasting, and impaired chick rearing and incubation behaviors (Fry 1995). Tufted Puffins feed at a relatively high trophic level, particularly as nestlings and during the breeding season when their diet is mainly piscivorous. It follows that they are vulnerable to the bioaccumulation of organochlorines, as well as heavy metals and other compounds, and studies have confirmed generally higher levels of contaminants in puffins than in lower trophic feeders living in the same system (Burger and Gochfeld 2009a, 2009b).

Organochlorines and heavy metals have been detected in several populations of Tufted Puffins, but there is little information on whether contaminants have adversely impacted the species' health, reproduction, or behavior. Research in the Aleutian Islands has documented mercury, chromium, and other metals in Tufted Puffin tissue samples, but generally at low levels (Ricca et al. 2008, Burger and Gochfeld 2009a, 2009b). Though Honda et al. (1990) detected high levels of cadmium in puffins from the Aleutian Islands, it was unclear whether the metal was natural or anthropogenic in origin, or whether it was harming the health of the birds. Sublethal levels of PCBs and other organochlorines have also been found in puffins sampled in the Aleutian Islands and at sea (Tanaka 1989, Ricca et al. 2008). While some of these contaminants were attributed to point sources (e.g., a former military base), there was strong evidence that oceanic and atmospheric patterns, combined with the birds' wide-ranging pelagic habits, made puffins vulnerable to distant sources, including pesticide applications (Ricca et al. 2008).

The only published information on contaminant levels in Tufted Puffins in Washington comes from a single adult female found dead near Smith Island in August 2009 that had extremely high levels of organochlorines and polybrominated dipenyl ethers (PBDE) (Good et al. 2014; S. Pearson, pers. comm.). Based on pollutant concentrations in the prey of Rhinoceros Auklets in Washington (Good et al. 2014), it is likely that puffins nesting in the eastern Strait of Juan de Fuca carry higher contaminant loads than those inhabiting the outer coast. In Oregon, organochlorine levels were low in puffin eggs collected in 1979 and no discernible shell thinning was observed (Henny et al. 1982).

In analyses of bone and muscle tissue from Tufted Puffins nesting on Amchitka, an Aleutian Island exposed to underground nuclear testing from 1965-1971, no levels of radionuclides were found above the minimum detectable activity (Burger and Gochfeld 2007, Burger et al. 2007). These tests took place more than 30 years after the last underground detonation suggesting, in this instance at least, that puffin populations were little affected by point-source or global fallout radionuclide pollution (Burger and Gochfeld 2007).

Introduced Species

Introduced species rank as one of the chief threats to birds that nest on islands (Gill 2007). They have been implicated in scores of extinctions since 1500, not to mention an untold number of local extirpations and population declines (Donald 2010). Island birds tend to be naive to non-native predators, leaving themselves, their eggs, and their nestlings vulnerable to attack. Introduced animals can also compete for nesting space and food resources, alter habitat structure, or bring with them exotic parasites and diseases, while introduced plants can alter the composition and structure of nesting habitats.

Historically, Tufted Puffin populations have suffered from a range of introduced mammals, including Arctic Foxes, Norway Rats, Arctic Ground Squirrels, and European Rabbits (Piatt and Kitaysky 2002). Several islands in Alaska saw puffins decline or disappear completely following the introduction of foxes for fur farming (Bailey 1976), only to return after the foxes were removed (Piatt and Kitaysky 2002). In California's Farallon Islands, rabbits competed directly with puffins for nesting sites and are thought to have contributed to rapid puffin declines during the 20th century (Ainley and Lewis 1974). In the Queen Charlotte Islands, Raccoons introduced for their trapping potential have spread through much of the archipelago, crossing distances of up to 950 m of open water and putting an estimated 80% of the archipelago's burrowing seabirds at risk, potentially including Tufted Puffins (Hartman and Eastman 1999).

Though introduced species have never been thoroughly assessed at Tufted Puffin colonies in Washington, it's known that Native Americans raised dogs on Tatoosh Island (Paterek 1996), and that European Rabbits were introduced to a number of islands, including Destruction, Smith, Colville, Flattop, Matia, and Skipjack (Couch 1929, Aubry and West 1984). The impacts of dogs and rabbits were never studied at these sites, but puffins have disappeared from Colville, Flattop, Matia, and Skipjack islands. European Rabbits remain a particular concern because they persist on Destruction Island, which otherwise offers excellent habitat and supported hundreds of nesting pairs as recently as 1975. Rhinoceros Auklets on this island have declined by an estimated 50% since the 1970s (measured by burrow occupancy), in spite of higher hatching and fledging rates (Pearson et al. in review). Though direct evidence is lacking, Pearson et al. (in review) have seen rabbits occupying Rhinoceros Auklet burrows there, thus rabbits may have contributed to the declining trend of this species through direct competition for burrow sites, particularly in prime grassland areas. A study in Iceland's Westman Islands found that Atlantic Puffin burrow occupancy and density was markedly lower in areas occupied by rabbits (64% of puffin burrows inactive) when compared to an unoccupied area (only 4% were inactive) (Vigfusdottir 2007). The presence of rabbits and competition for burrow sites is also thought to have played a role in the decline of Tufted Puffins at California's Farallon Islands (Ainley and Lewis 1974). The impact of rabbits on burrowing seabirds has also been documented on various islands, including Ile Verte, Kerguelen Islands, South Indian Ocean, and Santa Clara Island, Juan Fernández Islands, Chile, where European Rabbits were removed in 1992 and 2003, respectively. Following their eradication, burrow occupancy by breeding pairs of Blue Petrels (*Halobaena caerulea*) increased 8-fold on Ile Verte (Brodier et al. 2011) and of Pink-footed Shearwaters (*Puffinus creatopus*) from 43% to 60% on Santa Clara Island (Hodum 2007).

Beyond the direct effect of competition, rabbits also contribute to indirect effects, including hyperpredation and reduced habitat quality for nesting. Hyperpredation can arise when the introduction of a prey species adapted to high predation pressure (like the European Rabbit) results in higher predator densities and increased predation pressure on less resilient endemic prey species (Smith and Quin 1996, Courchamp et al. 2000). On Destruction Island, overgrazing by rabbits also appears to have changed the island's grassy bluff plant communities (where nearly all puffin burrows are located) from primarily perennial bunch grasses to mainly annual grasses (S. Pearson, pers. comm.; S. Thomas, pers. comm.). This has resulted in significant soil erosion and land slippage through both the close cropping of grasses by rabbits and because annual grasses have smaller root masses to hold the soil, which in turn has caused the loss of burrowing habitat for puffins and other breeding seabirds on the island (S. Pearson, pers. comm.). No non-native animals other than the European Rabbit are currently known to occur at puffin breeding sites in Washington, but their potential introduction remains a threat, particularly for sites subject to visitation by people.

Invasive non-native plants can negatively affect seabirds by reducing or degrading nesting and roosting habitat, preventing access to nest burrows, and entrapping chicks. Introduced plant species are present at many seabird nesting sites in Washington, particularly in the San Juan Islands and Strait of Juan de Fuca. At Protection Island, for example, non-native grasses (e.g., *Bromus tectorum*) and shrubs (e.g., *Cytisus scoparius*) are common on sandy bluff habitat used by nesting Tufted Puffins and Rhinoceros Auklets (USFWS 2010). Control measures and restoration goals for up to 8 ha of bluff habitat were included in a recently adopted management plan for the site (USFWS 2010).

Commercial and Tribal Fishing Bycatch

Fisheries bycatch can be a major cause of mortality in seabirds (Žydelis et al. 2013). Historically, Tufted Puffins were a major part of the bycatch of large-scale drift net fisheries in the North Pacific, with tens of thousands or even hundreds of thousands of birds killed annually (DeGange and Hay 1991, DeGange et al. 1993). Though banned by international treaty since 1991, some illegal drift netting continues in the North

Pacific (e.g., Rosen 2011), with undocumented levels of seabird bycatch. Coastal gillnet fisheries also impact puffin populations. In Japan, Tufted Puffins made up nearly 20% of the avian bycatch in the salmon fishery in the 1970s and 1980s, with yearly totals numbering from about 10,000 to more than 30,000 birds (DeGange and Day 1991). More recently, observers at Kodiak Island, Alaska, noted an estimated 110 Tufted Puffins killed during the 2002 salmon gillnetting season (Denlinger 2006).

In Washington, bycatch from fishing activities has been suggested as a factor in the decline of Tufted Puffins (Smith et al. 1997, Wahl 2005). Current commercial fishing in Washington waters occupied by puffins includes net fisheries for salmon, sardines, shrimp, herring (in Puget Sound only), and anchovy (southern outer coast only), as well as hook-and-line and/or trawl fisheries for salmon, Pacific Halibut (*Hippoglossus stenolepis*), Albacore Tuna (*Thunnus alalunga*), and various groundfish (TCW Economics 2008). On the outer coast, net fisheries for salmon exist in Grays Harbor and Willapa Bay, which are less frequented by puffins than areas farther north that are closer to nesting colonies. Commercial gillnet fisheries also occur in some bordering areas of southern British Columbia where puffins from Washington may forage. Smaller tribal fisheries exist in Washington for some of these same species, including salmon gillnetting at Mukkaw Bay and in parts of the Strait of Juan de Fuca, trolling for salmon, longlining for halibut and Sablefish (*Anoplopoma fimbria*), trawling for other groundfish, and purse seining for sardines. There is also the potential for small-scale ceremonial and subsistence harvest of forage fish by tribes.

No comprehensive Tufted Puffin bycatch data are available, but a recent report on West Coast ground fisheries found no cases of Tufted Puffin mortality in the at-sea Pacific Hake (*Merluccius productus*) fishery, nor in several other coastal groundfish fisheries between 2002 and 2009 (NFSC 2008, Jannot et al. 2011). A study of seabird strandings associated with gillnetting activity in Washington's inland marine waters also did not document any Tufted Puffin mortalities between 1969 and 2007 (Hamel et al. 2009). Tufted Puffins were scarce in the study area, however, and Hamel et al. (2009) noted that other alcids dominated the bycatch, which added an estimated 0.2% and 2.9% to the annual mortality rates for Common Murres. Tufted Puffins also were not detected among the seabird bycatch associated with commercial purse seine fisheries for salmon in the San Juan Islands and southernmost Strait of Georgia from 2001-2012 (WDFW 2001-2012).

Some commercial fisheries in Washington operate at levels much reduced from their historical peaks in foraging habitat for Tufted Puffins along the outer coast and in the Strait of Juan de Fuca and San Juan Islands (e.g., McShane et al. 2004). Nonetheless, even minimal levels of fishing-related mortality pose a potential threat to the diminished Tufted Puffin population in Washington. Similarly, while puffins have not been documented in derelict fishing nets recovered in northern Puget Sound and the Strait of Juan de Fuca (Good et al. 2009, 2010), recovery data are considered an underestimate and even low levels of mortality may be harmful to puffin populations.

Human Disturbance

Historically, many nesting colonies of Tufted Puffins have suffered from disturbances and/or habitat loss associated with human activities including hunting, egg collection, fur farming, lighthouses, development, recreation, and habitation (Piatt and Kitaysky 2002). Studies have also demonstrated that the species is sensitive to even the small-scale disturbances associated with research activities (Frazer 1975, Pierce and Simons 1986, Hatch et al. 2000). Human disturbance (including researcher presence, recreational visitation of nesting islands, and low flying aircraft; Frazer 1974) has been, for the most part, addressed at Tufted Puffin breeding sites in Washington. All of these sites are currently under some kind of habitat protection. Puffin colonies along the Washington coast now receive only occasional visitation from scientists and federal or state land managers, and are not currently considered threatened by development. Former nesting sites in the San Juan Islands are also protected (USFWS 2010), but may be subject to more visitation because of the much greater human activity in the area and limited enforcement.

Bald Eagle Predation

Bald Eagle numbers have steadily increased in Washington since the early 1980s (Stinson et al. 2007), resulting in more potential opportunities for interactions with nesting seabirds. A long-term study at Tatoosh Island attributes the decline in Common Murre numbers to direct and indirect effects associated with increased Bald Eagle predation (Parrish et al. 2001). Eagles attacked the murres directly, but also created disturbances that allowed increased predation by Glaucous-winged Gulls (*Larus glaucescens*) and Northwestern Crows (*Corvus caurinus*) (Parrish et al. 2001). These factors contributed to complete nesting failure for the Common Murre colony in 2007 and 2008 (Schrimpf et al. 2012). A similar dynamic between surface nesting seabird populations and White-tailed Eagles (*Haliaeetus albicilla*) has been reported from northern Europe (Hipfner et al. 2012).

Bald Eagles regularly prey upon Tufted Puffins (Vermeer et al. 1976, Piatt and Kitaysky 2002) and puffins are known to alter their flight behavior in the presence of eagles, reducing or synchronizing their colony arrivals and departures to reduce the risk of attack (Addison et al. 2007). Whether or not the frequency of eagle-puffin interactions is changing or adversely affecting puffin populations in Washington remains unknown, but puffins with full bill loads appear reluctant to enter burrows when eagles are present (S. Pearson, pers. comm.). The density of eagles at puffin colonies can be high. For example, during visits to Smith Island (15 ha) in 2007 and 2008, P. Hodum et al. (unpubl. data) observed densities of 2.2 eagles/ha and 2.3 eagles/ha, respectively. Parrish et al. (2001) pointed out that the secondary effects of predation can be subtle, but that even small behavioral changes can have important implications for population trends.

Other Factors

Harmful algal blooms. Historically known as "red tides," harmful algal blooms result from rapid, temporary increases in local populations of particular dinoflagellates, protists, or other phytoplankton. Harmful algal blooms have been increasing globally in recent decades and while their underlying causes are complex and poorly understood, some laboratory experiments predict increased occurrence with climate change (Anderson 1997, Peperzak 2003, Glibert et al. 2005, Lewitus et al. 2012). Negative impacts on seabirds include mortality and morbidity from the ingestion of algae-produced toxins (e.g., domoic acid), as well as from the fouling of feathers with associated proteinaceous foam produced by the dinoflagellate *Akashiwo sanguinea* (Jessup et al. 2009). Seabirds are also known to alter their movements and foraging behavior during blooms (Shumway et al. 2003), a particular concern during sensitive breeding periods. Some ornithologists suspect that harmful algal blooms are an important and underreported cause of seabird mortality worldwide (Shumway et al. 2003).

Though the effects of harmful algae on Tufted Puffins have never been studied directly, large blooms in recent years have led to mass strandings and mortality of seabirds in Monterey Bay, California (Jessup et al. 2009), and off the outer Washington and Oregon coasts (Du et al. 2011, Phillips et al. 2011). The Washington bloom reached waters in and around major puffin breeding colonies and peaked in September at the end of the breeding season. No puffin mortalities were recorded in the aftermath, but an estimated 10,000 Surf Scoters (*Melanitta perspicillata*), White-winged Scoters (*M. fusca*), and other seabirds died when their feathers became fouled with proteinaceous foam (Welch 2009, Phillips et al. 2011). This was the first recorded bloom of *A. sanguinea* in Washington, but in 1942 over 2,000 dead seabirds stranded on the coast coincident with a bloom of *Alexandrium catenella* (McKernan and Scheffer 1942, Landsberg 2002). Other blooms that have occurred in the region include *Pseudo-nitzschia* (which produces domoic acid) and multiple species producing potent neurotoxins (saxitoxins), which are known to affect piscivorous birds by contaminating their prey base (Landsberg 2002, Lewitus et al. 2012).

Based on the increased frequency and severity of harmful dinoflagellate blooms in recent years, Jessup et al. (2009) hypothesized that the negative effects from these events could become more common in the future. If this occurs and the blooms overlap with critical breeding and fledging periods, their effect on puffin populations could be severe.

Pathogens and disease. Though the impacts of particular pathogens and diseases on Tufted Puffins remain poorly understood, the potential effects of these are likely to increase when birds are under stress from other environmental factors. The physical condition of adult male puffins, for example, is known to decline when attempting to provision offspring during periods of prey shortage (Williams et al. 2007) and could make some birds more susceptible to disease. Also, nesting in dense colonies increases the potential consequences of a major disease outbreak (Gill 2007).

Egg collection. Historically, seabird breeding colonies in Washington experienced hunting and egg collection by Native Americans, and later by Euro-American settlers, fishermen, and natural history collectors. Tufted Puffins were included in these annual hunts, and Jones (1908a) recounted Quileute egg collectors preceding his and Dawson's 1907 visit to islands near La Push: "Fortunately for our purposes, the seas prevented a landing at Carroll Islet, but the adjoining island of Wishalooth was as nearly cleaned of eggs as it was possible for them to clean it." Later confiscated by a game warden, the collectors' haul included over 250 eggs of Glaucous-winged Gulls, Common Murres, and Tufted Puffins. The impacts of such harvests were never quantified, but establishment of the coastal refuges curtailed hunting and may have contributed to a subsequent rise in Tufted Puffin numbers (Bent 1919). Currently, egg collection is prohibited by state and federal law and although the patrolling of nesting sites is limited, this threat is considered minimal.

Brown Pelican impacts. Since 2008, increasing numbers of Brown Pelicans (*Pelecanus occidentalis*) have roosted on four islands (Willoughby Rock, Erin's Bride, Grenville Arch, Grenville Pillar) currently or formerly used by nesting Tufted Puffins in Washington, with hundreds of pelicans present on each of the islands in 2014 (S. Pearson, pers. comm.). The birds have caused substantial vegetation change in their roosting areas, which could potentially result in soil erosion and a loss of nesting habitat for puffins. This impact should be monitored in the future to determine actual effects on puffins.

CONCLUSIONS AND RECOMMENDATION

Tufted Puffins are pelagic, pursuit diving seabirds that congregate annually on coastal islands and headlands to breed and raise their chicks to fledging. In Washington, small nesting colonies in the San Juan archipelago began declining as early as the 1950s, but the species was still considered a common bird along the outer coast into the 1990s. However, Tufted Puffin sightings declined by 13.9% per year in pelagic surveys off Westport, Washington, between 1983 and 2001 and 8.9% per year in offshore surveys along the outer Washington coast from Cape Flattery to Point Grenville from 2001 to 2012. Colony visits from 2007 to 2010 noted widespread abandonment and an apparent order of magnitude population decline since the last summary assessment from 1978-1984. Overall, 57% of the 44 historically documented puffin breeding sites in Washington are no longer active. Maximum estimates once ranked nine colonies at 1,000 or more individuals, with two reaching 10,000 or more birds, but none of the 19 remaining breeding sites now contains more than a few hundred birds. In combination, of the 44 once-documented breeding sites, 39 have either been abandoned or experienced an order of magnitude decline. Puffins in Washington's inland marine waters are at particular risk, with only two active breeding sites now remaining, both in the eastern Strait of Juan de Fuca, that together contain a total population of a few dozen individuals.

Washington's population trends fit a larger geographic pattern for Tufted Puffins, which appear to be undergoing a range contraction. Though apparently stable in the northern portion of their range in Alaska and Siberia, puffins have been declining throughout the southern extent of their range, including California, Oregon, and Japan. Causes for the decline in Washington are not known, but may stem from a number of current and historical threats, including reduced prey availability, changing ocean conditions, entrapment in fishing nets, mortality from oil spills and chemical contaminants, human disturbance of breeding colonies, impacts from introduced species, and increased Bald Eagle predation. Predicted shifts in ocean surface temperature, ocean acidity, and weather patterns associated with climate change are expected to make conditions challenging for piscivorous seabirds across the North Pacific, including Tufted Puffins. If the current 8.9% annual rate of decline continues, the Washington population could become functionally extirpated within about 40 years. Based on recent and continuing dramatic population declines and widespread colony abandonment, and with conditions expected to worsen for this species in Washington and throughout the North Pacific in the years ahead, it is recommended that the Tufted Puffin be listed as endangered in Washington.

LITERATURE CITED

Abdul-Aziz, O. I., N. J. Mantua, and K. W. Myers. 2011. Potential climate change impacts on thermal habitats of Pacific salmon (*Oncorhynchus* spp.) in the North Pacific Ocean and adjacent seas. Canadian Journal of Fisheries and Aquatic Sciences 68:1660-1680.

Addison, B., R. C. Ydenberg, and B. D. Smith. 2007. Tufted puffins (*Fratercula cirrhata*) respond to predation danger during colony approach flights. Auk 124:63-70.

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 a climatic regime shift. Waterbirds 22:98-103.

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 *Exxon Valdez* oil spill. Restoration Project No. 93405, Final Report, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Ainley, D. G., and K. D. Hyrenbach. 2010. Top-down and bottom-up factors affecting seabird population trends in the California current system (1985–2006). Progress in Oceanography 84:242–254.

Ainley, D. G., and T. J. Lewis. 1974. The history of Farallon Island marine bird populations, 1854-1972. Condor 76:432-446.

Ainley, D. G., W. J. Sydeman, S. A. Hatch, and U. Wilson. 1994. Seabird population trends along the west coast of North America: causes and the extent of regional accordance. *In* J. R. Jehl, Jr., and N. K. Johnson, editors. A century of avifaunal change in western North America. Studies in Avian Biology 15:119-133.

Albers, P. H. 1978. The effects of petroleum on different stages of incubation in bird eggs. Bulletin of Environmental Contamination and Toxicology 19:624-630.

Alcorn, G. D. 1959. Puffins on the south Grays Harbor beaches. Murrelet 40:21.

Anderson, C. M., M. Mayes, and R. LaBelle. 2012. Update of occurrence rates for offshore oil spills. OCS Report, BOEM 2012-069, BSEE 2012-069, Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement, Department of the Interior, Herndon, Virginia.

Anderson, D. M. 1997. Turning back the harmful red tide. Nature 388:513-514.

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.

Anker-Nilssen, T., R. T. Barrett, and J. V. Krasnov. 1997. Long and short-term responses of seabirds in the Norwegian and Barents Seas to changes in stocks of prey fish. Pages 683-698 *in* Forage fishes in marine ecosystems: proceedings of the international symposium on the role of forage fishes in marine ecosystems. Alaska Sea Grant College Program AK-SG-97-01, University of Alaska, Fairbanks, Alaska.

Anthony, J. A., and D. D. Roby. 1997. Variation in lipid content of forage fishes and its effect on energy provisioning rates to seabird nestlings. Pages 725-729 *in* Forage fishes in marine ecosystems: proceedings of the international symposium on the role of forage fishes in marine ecosystems. Alaska Sea Grant College Program AK-SG-97-01, University of Alaska, Fairbanks, Alaska.

AOU (American Ornithologists' Union). 1998. Check-list of North American birds. 7th edition. American Ornithologists' Union, Washington, D.C.

Aubry, K. B., and S. D. West. 1984. The status of native and introduced mammals on Destruction Island, Washington. Murrelet 65:80-83.

Audubon Washington. 2004. State of the birds. Audubon Washington, Seattle, Washington.

Audubon Washington. 2009. State of the birds. Audubon Washington, Seattle, Washington.

Avery-Gomm, S., J. F. Provencher, K. H. Morgan, and D. F. Bertram. 2013. Plastic ingestion in marine-associated bird species from the eastern North Pacific. Marine Pollution Bulletin 72:257-259.

Bailey, E. P. 1976. Breeding bird distribution and abundance in the Barren Islands, Alaska. Murrelet 57:2-12.

Bailey, E. P., and N. H. Faust. 1981. Summer distribution and abundance of marine birds and mammals between Mitrofania and Sutwik Islands south of Alaska Peninsula. Murrelet 62:34-42.

Baird, P. H. 1990. Influence of abiotic factors and prey distribution on diet and reproductive success of three seabird species in Alaska. Ornis Scandinavica 21:224-235.

Baird, P. H. 1991. Optimal foraging and intraspecific competition in the Tufted Puffin. Condor 93:503-515.

Bargmann, G. 1998. Forage fish management plan. Washington Department of Fish and Wildlife, Olympia, Washington. 77 pp.

Batten, S. D., and A. W. Walne. 2011. Variability in northwards extension of warm water copepods in the NE Pacific. Journal of Plankton Research 33:1643-1653.

B.C. Conservation Data Centre. 2014. BC species and ecosystems explorer. British Columbia Ministry of

Environment, Victoria, British Columbia. http://a100.gov.bc.ca/pub/eswp/ [accessed December 18, 2014]

Bédard, J. 1969. Adaptive radiation in the Alcidae. Ibis 111:19-98.

Behrenfeld, M. J., R. T. O'Malley, D. A. Siegel, C. R. McClain, J. L. Sarmiento, et al. 2006. Climate-driven trends in contemporary ocean productivity. Nature 444:752-755.

Bent, A. C. 1919. Life history of North American diving birds. Dover Publications, New York, New York (1963 reprint).

Bertram, D. F., D. L. Mackas, and S. M. McKinnell. 2001. The seasonal cycle revisited: interannual variation and ecosystem consequences. Progress in Oceanography 49:283-307.

BirdLife International. 2012. *Fratercula cirrhata*. *In* IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/ [accessed on December 19, 2014]

Blackburn, G. S., J. M. Hipfner, and R. C. Ydenberg. 2009. Evidence that Tufted Puffins *Fratercula cirrhata* use colony overflights to reduce kleptoparasitism risk. Journal of Avian Biology 40:412-418.

Blight, L. K., and A. E. Burger. 1997. Occurrence of plastic particles in seabirds from the Eastern North Pacific. Marine Pollution Bulletin 34:323-325.

Borstad, G., W. Crawford, J. M. Hipfner, R. Thomson, and K. Hyatt. 2011. Environmental control of the breeding success of Rhinoceros Auklets at Triangle Island, British Columbia. Marine Ecology Progress Series 424:285–302.

Bovy, K. 2007. Prehistoric human impacts on waterbirds at Watmough Bay, Washington, USA. Journal of Island and Coastal Archaeology 2:210-230.

Bowles, J. H. 1922. Birds of Tacoma and vicinity. Murrelet 3:14-16.

Boyd, R. 1999. Indians, fire and the land in the Pacific Northwest. Oregon State University Press, Corvallis, Oregon.

Branch, T. A., B. M. DeJoseph, L. J. Ray, and C. A. Wagner. 2013. Impacts of ocean acidification on marine seafood. Trends in Ecology & Evolution 28:178-186.

Brazil, M. A. 1991. The birds of Japan. Smithsonian Institution Press, Washington, D.C. 448 pp.

Bridge, E. S. 2004. The effects of intense wing molt on diving in alcids and potential influences on the evolution of molt patterns. Journal of Experimental Biology 207:3003-3014.

Briggs, K. T., D. H. Varaoujen, W. W. Williams, R. G. Ford, M. L. Bonnell, and J. N. Casey. 1992. Seabirds of the Oregon and Washington OCS, 1989-1990. Pages 3.142-3.145 *in* J. J. Brueggeman, editor. Oregon and Washington marine mammal and seabird surveys: final report. Pacific OCS Region, Minerals Management Service, U.S. Department of the Interior, Los Angeles, California.

Brodeur, R. D., J. P. Fisher, R. L. Emmett, C. A. Morgan, and E. Casillas. 2005. Species composition and community structure of pelagic nekton off Oregon and Washington under variable oceanographic conditions. Marine Ecology Progress Series 298:41-57.

Brodier, S., B. Pisanu, A. Villers, E. Pettex, M. Lioret, J.-L. Chapuis, and V. Bretagnolle. 2011. Responses of seabirds to the rabbit eradication on Ile Verte, sub-Antarctic Kerguelen Archipelago. Animal Conservation 14:459-465.

Burger, A. E., and D. M. Fry. 1993. Effects of oil pollution on seabirds in the Northeast Pacific. Pages 254-263 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.

Burger, J., and M. Gochfeld. 2007. Metals and radionuclides in birds and eggs from Amchitka and Kiska Islands in the Bering Sea/Pacific Ocean ecosystem. Environmental Monitoring and Assessment 127:105-117.

Burger, J., and M. Gochfeld. 2009a. Comparison of arsenic, cadmium, chromium, lead, manganese, mercury and selenium in feathers in Bald Eagle (*Haliaeetus leucocephalus*), and comparison with Common Eider (*Somateria mollissima*), Glaucous-winged Gull (*Larus glaucescens*), Pigeon Guillemot (*Cepphus columba*), and Tufted Puffin (*Fratercula cirrhata*) from the Aleutian chain of Alaska. Environmental Monitoring and Assessment 152:357-367.

Burger, J., and M. Gochfeld. 2009b. Mercury and other metals in feathers of Common Eider (*Somateria mollissima*) and Tufted Puffin (*Fratercula cirrhata*) from the Aleutian chain of Alaska. Archives of Environmental Contamination and Toxicology 56:596-606.

Burger, J., M. Gochfeld, D. Kosson, C. W. Powers, et al. 2007. Radionuclides in marine fishes and birds from Amchitka and Kiska Islands in the Aleutians: establishing a baseline. Health Physics 92:265-279.

Burrell, G. C. 1980. Some observations on nesting Tufted Puffins, Destruction Island, Washington. Murrelet 61:92-94.

Byrd, G. V., E. C. Murphy, G. W. Kaiser, A. Y. Kondratyev, and Y. V. Shibaev. 1993. Status and ecology of offshore fish-feeding alcids (murres and puffins) in the North Pacific. Pages 176-186 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, and M. C. E. McNall. 1990. The birds of British Columbia. Volume 2: diurnal birds of prey through woodpeckers. Royal British Columbia Museum, Victoria, British Columbia.

Carter, H. R., and S. G. Sealy. 2011. Historical breeding records of four species of alcid in British Columbia and southeastern Alaska, 1858–1910. Northwestern Naturalist 92:37-49.

Clapp R. B. 1986. A summary of alcid records from Hawaii. Colonial Waterbirds 9:104-107.

Clapp, R. B. and J. B. Giezentanner. 1979. Tufted Puffin from Laysan – first occurrence in the tropical Pacific. 'Elepaio 40:120-121.

Clausen, K. K., and P. Clausen. 2014. Forecasting future drowning of coastal waterbird habitats reveals a major conservation concern. Biological Conservation 171:177-185.

Cody, M. L. 1973. Coexistence, coevolution and convergent evolution in seabird communities. Ecology 54:31-44.

Couch, L. K. 1929. Introduced European Rabbits in the San Juan Islands, Washington. Journal of Mammalogy 10:334-336.

Courchamp, F., M. Langlais, and G. Sugihara. 2000. Rabbits killing birds: modeling the hyperpredation process. Journal of Animal Ecology 69:154-164.

Crowell, J. B., Jr., and H. B. Nehls. 1975. The nesting season: northern Pacific Coast region. American Birds 29:1020-1025.

Cury, P. M., I. L. Boyd, S. Bonhommeau, T. Anker-Nilssen, R. J. M. Crawford, et al. 2011. Global seabird response to forage fish depletion – one-third for the birds. Science 334:1703-1706.

Davies, W. E., J. M. Hipfner, K. A. Hobson, and R. C. Ydenberg. 2009. Seabird seasonal trophodynamics: isotopic patterns in a community of Pacific alcids. Marine Ecology Progress Series 382:211-219.

Dawson, D. A., F. M. Hunter, J. Pandhal, R. Buckland, A. Parham, et al. 2005. Assessment of 17 new Whiskered Auklet (*Aethia pygmaea*) microsatellite loci in 42 seabirds identifies 5–15 polymorphic markers for each of nine Alcinae species. Molecular Ecology Notes 5:289–297.

Dawson, W. L. 1908a. The new reserves on the Washington Coast. Condor 10:45-49.

Dawson, W. L. 1908b. The bird colonies of the Olympiades. Auk 25:153-166.

Dawson, W. L. 1911. Another fortnight on the Farallones. Condor 13:171-83.

Dawson, W. L. and J. H. Bowles. 1909. The birds of Washington: a complete scientific and popular account of the 372 species of birds found in the state. Occidental Publishing Company, Seattle, Washington.

Day, R. H., and D. G. Shaw. 1987. Patterns in the abundance of pelagic plastic and tar in the North Pacific Ocean, 1976–1985. Marine Pollution Bulletin 18:311-316.

DeGange, A. R., and R. H. Day. 1991. Mortality of seabirds in the Japanese land-based gillnet fishery for salmon. Condor 93:251-258.

DeGange, A. R., R. H. Day, J. E. Takekawa, and V. M. Mendenhall. 1993. Losses of seabirds in gill nets in the North Pacific. Pages 204-211 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.

Denlinger, L. M. 2006. Alaska seabird information series. Migratory Bird Management, Nongame Program, U.S. Fish and Wildlife Service, Anchorage, Alaska. 92 pp.

Derraik, J. G. B. 2002. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44:842-852.

De Santo, T. L., and S. K. Nelson. 1995. Comparative reproductive ecology of the auks (family Alcidae). Pages 33-47 *in* C. J. Ralph, G. L. Hunt Jr., M. G. Raphael, and J. F. Piatt, editors. Ecology and conservation of the Marbled Murrelet. General Technical Report PSW-GTR-152, USDA Forest Service, Pacific Southwest Research Station, Albany, California. 420 pp.

Desforges, J.-P., M. Galbraith, N. Dangerfield, and P. S. Ross. 2014. Widespread distribution of microplastics in subsurface seawater in the NE Pacific Ocean. Marine Pollution Bulletin 79:94-99.

DFO (Fisheries and Oceans Canada). 2014. Stock assessment and management advice for British Columbia Pacific Herring: 2013 status and 2014 forecast. DFO Canadian Science Advisory Secretariat, Science Advisory Report 2014/003.

Dickerman, R. W. 1960. Possible nesting interference of Tufted Puffins by Glaucous-winged Gulls. Murrelet 41:16.

Di Lorenzo, E., N. Schneider, K. M. Cobb, P. J. S. Franks, K. Chhaket, et al. 2008. North Pacific Gyre Oscillation links ocean climate and ecosystem change. Geophysical Research Letters 35, L08607, doi:10.1029/2007GL032838.

Donald, P. 2010. Facing extinction: the world's rarest birds and the race to save them. T. & A. D. Poyser, London, United Kingdom.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate change impacts on marine ecosystems. Annual Review of Marine Science 4:11-37.

Dragoo, D. E., G. V. Byrd, and D. B. Irons. 2010. Breeding status, population trends and diets of seabirds in Alaska, 2007. U.S. Fish and Wildlife

Service Report AMNWR 2010/08, U.S. Fish and Wildlife Service, Homer, Alaska.

Du, X., W. Peterson, A. McCulloch, and G. Liu. 2011. An unusual bloom of the dinoflagellate *Akashiwo sanguinea* off the central Oregon, USA, coast in autumn 2009. Harmful Algae 10:784-793.

Duffy, C. D., F. S. Todd, and W. R. Siegfried. 1987. Submarine foraging behavior of alcids in an artificial environment. Zoo Biology 6:373-378.

Durant, J. M., T. Anker-Nilssen, and N. C. Stenseth. 2003. Trophic interactions under climate fluctuations: the Atlantic Puffin as an example. Proceedings of the Royal Society of London B 270:1461–1466.

Edson, J. M. 1908. Birds of the Bellingham Bay region. Auk 25:425-439.

Edson, J. M. 1929a. Afield and afloat with Dawson (part I). Murrelet 10:1-6.

Edson, J. M. 1929b. Afield and afloat with Dawson (part II). Murrelet 10:27-33.

Edson, J. M. 1935. Some records supplementary to the distributional check-list of the birds of the state of Washington. Murrelet 16:11-14.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The birder's handbook. Simon and Schuster, New York, New York.

Elliott, J. E., and D. G. Noble. 1993. Chlorinated hydrocarbon contaminants in marine birds of the temperate North Pacific. Pages 241-253 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.

Emmett, R. L., R. D. Brodeur, T. W. Miller, S. S. Pool, P. J. Bentley, G. K. Krutzikowsky, and J. McCrae. 2005. Pacific sardine (*Sardinops sagax*) abundance, distribution, and ecological relationships in the Pacific Northwest. California Cooperative Oceanic Fisheries Investigations Report 46:122-143.

Etkin, D. S., and J. Neel. 2001. Investing in spill prevention-has it reduced vessel spills and accidents in Washington state? Pages 47-56 *in* Proceedings of 2001 International Oil Spill Conference. American Petroleum Institute, Washington, D.C.

Fabry, V. J., B. A. Seibel, R. A. Feely, and J. C. Orr. 2008. Impacts of ocean acidification on marine fauna and ecosystem processes. ICES Journal of Marine Science 65:414–432.

Falxa, G., J. Baldwin, D. Lynch, S. L. Miller, S. K. Nelson, S. F. Pearson, M. G. Raphael, C. Strong, T. Bloxton, B. Galleher, B. Hogoboom, M. Lance, and R. Young. 2011. Marbled Murrelet effectiveness monitoring, Northwest Forest Plan: 2009 and 2010 summary report. 26 pp.

Fields, P. A., J. B. Graham, R. H. Rosenblatt, and G. N. Somero. 1993. Effects of expected global climate change on marine faunas. Trends in Ecology and Evolution 8:361–366.

Francis, R. C., S. R. Hare, A. B. Hollowed, and W. S. Wooster. 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific. Fisheries Oceanography 7:1-21.

Frazer, D. A. 1974. Breeding biology of the Tufted Puffin on Destruction Island: a brief summary of the 1974 field season. University of Washington, Seattle, Washington.

Frazer, D. A. 1975. Breeding biology of the Tufted Puffin (*Lunda cirrhata*): a review. M.S. thesis, University of Washington, Seattle, Washington.

Frederiksen, M., T. Anker-Nilssen, G. Beaugrand, and S. Wanless. 2013. Climate, copepods and seabirds in the boreal Northeast Atlantic – current state and future outlook. Global Change Biology 19:364-372.

Friesen, V. L., A. J. Baker, and J. F. Piatt. 1996. Phylogenetic relationships within the Alcidae (Charadriiformes: Aves) inferred from total molecular evidence. Molecular Biology and Evolution 13:359-367.

Fry, D. M. 1995. Reproductive effects in birds exposed to pesticides and industrial chemicals. Environmental Health Perspectives 103:165-171.

Galusha, J. G., B. Vorvick, M. R. Opp, and P. T. Vorvick. 1987. Nesting season censuses of seabirds on Protection Island, Washington. Murrelet 68:103-107.

Gill, F. 2007. Ornithology. 3rd edition. W. H. Freeman and Co., New York, New York.

Gill, R. E., Jr., and G. A. Sanger. 1979. Tufted Puffins nesting in estuarine habitat. Auk 96:792-794.

Gjerdrum, C. 2004. Parental provisioning and nestling departure decisions: a supplementary feeding experiment in Tufted Puffins (*Fratercula cirrhata*) on Triangle Island, British Columbia. Auk 121:463-472.

Gjerdrum, C., A. M. J. Vallée, C. C. St. Clair, D. F. Bertram, J. L. Ryder, and G. S. Blackburn. 2003. Tufted Puffin reproduction reveals ocean climate variability. Proceedings of the National Academy of Sciences 100:9377-9382.

Gjerdrum, C., G. M. Yanega, and D. F. Bertram. 2006. Bill harnesses on nestling Tufted Puffins influence adult provisioning behavior. Journal of Field Ornithology 77:329-334.

Glibert, P. M., D. M. Anderson, P. Gentien, E. Graneli, and K. G. Sellner. 2005. The global, complex phenomena of harmful algal blooms. Oceanography 18:135-147.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-level rise and coastal habitats in the Pacific Northwest: an analysis for Puget Sound, southwestern Washington, and northwestern Oregon. Seattle, WA: National Wildlife Federation. 106 pp.

Golovkin, A. 2001. Seabird harvest in Russia. Pages 44–46 *in* L. Denlinger and K. Wohl, editors. Seabird harvest regimes in the circumpolar nations.

Conservation of Arctic Flora and Fauna, Technical Report No. 9, CAFF International Secretariat, Akureyri, Iceland.

Golubova, E. Y. 2002. The state of food resources and reproductive success of Tufted and Horned Puffins in the northern Sea of Okhotsk. Ekologiya 5:378-387.

Good, T. P., J. A. June, M. A. Etnier, and G. Broadhust. 2009. Ghosts of the Salish Sea: threats to marine birds in Puget Sound and the Northwest Straits from derelict fishing gear. Marine Ornithology 37:67–76.

Good, T. P., J. A. June, M. A. Etnier, and G. Broadhurst. 2010. Derelict fishing nets in Puget Sound and the Northwest Straits: patterns and threats to marine fauna. Marine Pollution Bulletin 60:39–50.

Good, T. P., S. F. Pearson, P. Hodum, D. Boyd, B. F. Anulacion, and G. M. Ylitalo. 2014. Persistent organic pollutants in forage fish prey of rhinoceros auklets breeding in Puget Sound and the northern California Current. Marine Pollution Bulletin 86:367-378.

Gould, P. J., and J. F. Piatt. 1993. Seabirds of the central North Pacific. Pages 27-38 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.

Gustafson, R. G., J. Drake, M. J. Ford, J. M. Myers, E. E. Holmes, and R. S. Waples. 2006. Status review of Cherry Point Pacific Herring (*Clupea pallasii*) and updated status review of the Georgia Basin Pacific Herring distinct population segment under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-76, U.S. Department of Commerce, Seattle Washington. 182 pp.

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

Harris, M. P., and S. Wanless. 2011. The puffin. T. & A.D. Poyser, London, United Kingdom.

Harrison, C. S., H. Fen-Qi, K. S. Choe, and Y. V. Shibaev. 1992. The laws and treaties of the North Pacific Rim nations that protect seabirds on land and at sea. Colonial Waterbirds 15:264-277.

Hartman, L. H., and D. S. Eastman. 1999. Distribution of introduced Raccoons *Procyon lotor* on the Queen Charlotte Islands: implications for burrow-nesting seabirds. Biological Conservation 88:1-13.

Hasegawa, O., Y. Ishibashi, and S. Abe. 2005. Polymorphic microsatellite DNA markers for the Rhinoceros Auklet (*Cerorhinca monocerata*). Molecular Ecology Notes 5:637-638.

Hatch, S. A., and G. A. Sanger. 1992. Puffins as samples of juvenile pollock and other forage fish in the Gulf of Alaska. Marine Ecology Progress Series 80:1-14.

Hatch, S. A., P. M. Meyers, D. M. Mulcahy, and D. C. Douglas. 2000a. Performance of implantable satellite transmitters in diving seabirds. Waterbirds 23:84-94.

Hatch, S. A., P. M. Meyers, D. M. Mulcahy, and D. C. Douglas. 2000b. Seasonal movements and pelagic habitat use of murres and puffins determined by satellite telemetry. Condor 102:145-154.

Heath, H. 1915. Birds observed on Forrester Island, Alaska, during the summer of 1913. Condor 17:20–41.

Hedd, A., D. F. Bertram, J. L. Ryder, and I. J. Jones. 2006. Effects of interdecadal climate variability on marine trophic interactions: Rhinoceros Auklets and their fish prey. Marine Ecology Progress Series 309:263-278.

Henny, C. J., L. J. Blus, and R. M. Pouty. 1982. Organochlorine residues and shell thinning in Oregon seabird eggs. Murrelet 63:15-21.

Hill, K.T., P. R. Crone, N. C. H. Lo, B. J. Macewicz, E. Dorval, J. D. McDaniel, and Y. Gu. 2011. Assessment of the Pacific sardine resource in 2011 for U.S. management in 2012. NOAA Technical Memorandum NMFS-SWFSC-487.

Hipfner, J. M. 2008. Matches and mismatches: ocean climate, prey phenology and breeding success in a zooplanktivorous seabird. Marine Ecology Progress Series 368:295–304.

Hipfner, J. M. 2009. Euphausiids in the diet of a North Pacific seabird: annual and seasonal variation and the role of ocean climate. Marine Ecology Progress Series 390:277–289.

Hipfner, J. M., L. K. Blight, R. W. Lowe, S. I. Wilhelm, G. J. Robertson, et al. 2012. Unintended consequences: how the recovery of sea eagle *Haliaeetus* spp. populations in the northern hemisphere is affecting seabirds. Marine Ornithology 40:39–52.

Hipfner, J. M., M. R. Charette, and G. S. Blackburn. 2007. Subcolony variation in breeding success in the Tufted Puffin (*Fratercula cirrhata*): association with foraging ecology and implications. Auk 124:1149-1157.

Hodder, J. 2003. Tufted Puffin *Fratercula cirrhata*. Pages 298-299 *in* D. B. Marshall, M. G. Hunter, and A. L. Contreras, editors. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, Oregon.

Hodum, P. J. 2007. Respuesta de la fardela blanca (*Puffinus creatopus*) a la erradicación de conejos en Isla Santa Clara. CONAF Technical Report.

Hoegh-Guldberg, O. and J. F. Bruno. 2010. The impact of climate change on the world's marine ecosystems. Science 328:1523-1528.

Hoffman, W., D. Heinemann, and J. A. Weins. 1981. The ecology of seabird feeding flocks in Alaska. Auk 98:437-456.

Honda, K., J. E. Marcovecchio, S. Kan, R. Tatsukawa, and H. Ogi. 1990. Metal concentrations in pelagic

seabirds from the North Pacific Ocean. Environmental Contamination Toxicology 19:704-711.
Hunn, E. S. 2012. Birding in Seattle and King County: site guide and annotated list. Seattle Audubon Society, Seattle, Washington.
Hunt, G. L., Jr., Z. A. Eppley, and D. C. Schneider. 1986. Reproductive performance of seabirds: the importance of population and colony size. Auk 103:306-317.
Hunt, G. L., Jr., P. J. Stabeno, G. E. Walters, H. Sinclair, R. Brodeur, J. Napp, and N. Bond. 2002. Climate change and control of the southeastern Bering Sea pelagic ecosystem. Deep Sea Research II: Topical Studies in Oceanography 49:5821-5853.
Hyrenbach, K. D., and R. R. Veit. 2003. Ocean warming and seabird communities of the southern California Current System (1987–98): response at multiple temporal scales. Deep Sea Research II: Topical Studies in Oceanography 50:2537–2565.
IPCC (Intergovernmental Panel on Climate Change). 2013. Summary for policymakers. *in* T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley, editors. Climate change 2013: the physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom.
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.
Jannot, J., E. Heery, M. A. Bellman, and J. Majewski. 2011. Estimated bycatch of marine mammals, seabirds, and sea turtles in the US west coast commercial groundfish fishery, 2002-2009. National Marine Fisheries Service, Seattle, Washington.
Jaques, D., and C. S. Strong. 2001. Seabird status at Castle Rock National Wildlife Refuge, 1997-1999. Humboldt Bay National Wildlife Refuge, U.S. Fish and Wildlife Service, Loleta, California.
Jessup, D. A, M. A. Miller, J. P. Ryan, H. M. Nevins, H. A. Kerkering, et al. 2009. Mass stranding of marine birds caused by a surfactant-producing red tide. PLoS ONE 4:e4550. doi:10.1371/journal.pone.0004550.
Jewett, S. G., W. P. Taylor, W. T. Shaw, and J. W. Aldrich. 1953. Birds of Washington state. University of Washington Press, Seattle, Washington.
Jones, H. P., and S. W. Kress. 2012. A review of the world's active seabird restoration projects. Journal of Wildlife Management 76:2–9.
Jones, L. 1908a. June with the birds of the Washington coast. Wilson Bulletin 20:189-199.
Jones, L. 1908b. June with the birds of the Washington coast: down the coast to Destruction. Wilson Bulletin 20:57-62.
Jones, L. 1909. June with the birds of the Washington coast. Wilson Bulletin 21:2-15.
June, J. and K. Antonelis. 2009. Marine habitat recovery of five derelict fishing gear removal sites in Puget Sound, Washington. Natural Resources Consultants, Seattle, Washington. 19 pp.
Kaiser, G. W., and L. S. Forbes. 1992. Climatic and oceanographic influences on island use in four burrow-nesting alcids. Ornis Scandinavica 23:1-6.
Kenyon, K. W., and V. B. Scheffer. 1961. Wildlife surveys along the northwest coast of Washington. Murrelet 42:29-37.
King, J. R., V. N. Agostini, C. J. Harvey, G. A. McFarlane, M. G. G. Foreman, J. E. Overland, E. Di Lorenzo, N. A. Bond, and K. Y. Aydin. 2011. Climate forcing and the California Current ecosystem. ICES Journal of Marine Science 68:1199-1216.
King, K. A., and C. A. Lefever. 1979. Effects of oil transferred from incubating gulls to their eggs. Marine Pollution Bulletin 10:319-321.
Kitaysky, A. S., and E. G. Golubova. 2000. Climate change causes contrasting trends in reproductive performance of planktivorous and piscivorous alcids. Journal of Animal Ecology 69:248-262.
Kocourek, A. L., S. W. Stephensen, K. J. So, A. J. Gladics, and J. C. Ziegler. 2009. Burrow-nesting seabird census of the Oregon Coast National Wildlife Refuge Complex, June – August 2008. U.S. Fish and Wildlife Service, Newport, Oregon. 63 pp.
Kress, S. W., and D. N. Nettleship. 1988. Re-establishment of Atlantic Puffins (*Fratercula arctica*) at a former breeding site in the Gulf of Maine. Journal of Field Ornithology 59:161-170.
Krueger, K. L., K. B. Pierce, Jr., T. Quinn, and D. E. Penttila. 2010. Anticipated effects of sea level rise in Puget Sound on two beach-spawning fishes. Pages 171-178 *in* H. Shipman, M. N. Dethier, G. Gelfenbaum, K. L. Fresh, and R. S. Dinicola, editors. Puget Sound shorelines and the impacts of armoring—proceedings of a state of the science workshop. U.S. Geological Survey Scientific Investigations Report 2010–5254. 262 pp.
Lance, B. K., D. B. Irons, S. J. Kendall, and L. L. McDonald. 1999. Marine bird and sea otter population abundance of Prince William Sound, Alaska: trends following the T/V *Exxon Valdez* oil spill, 1989-98. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Project 98159), U.S. Fish and Wildlife Service, Anchorage, Alaska.
Landsberg, J. H. 2002. The effects of harmful algal blooms on aquatic organisms. Reviews in Fisheries Science 10:113-390.

Larrison, E. J., and E. N. Francq. 1962. Field guide to the birds of Washington state. Seattle Audubon Society, Seattle, Washington.

Lawrence, R. H. 1892. A preliminary list of the birds of the Grays Harbor region, Washington. Auk 9:38-47.

Leschner, L. L. 1976. The breeding biology of the Rhinoceros Auklet on Destruction Island. M.S. thesis. University of Washington, Seattle, Washington.

Lewitus, A. J., R. A. Horner, D. A. Caron, E. Garcia-Mendoza, B. M. Hickey, M. Hunter, D. D. Huppert, R. M. Kudela, G. W. Langlois, J. L. Largier, E. J. Lessard, R. RaLonde, J. E. J. Rensel, P. G. Strutton, V. L. Trainer, and J. F. Tweddle. 2012. Harmful algal blooms along the North American west coast region: history, trends, causes, and impacts. Harmful Algae 19:133-159.

Lindegren, M., and D. M. Checkley, Jr. 2013. Temperature dependence of Pacific sardine (*Sardinops sagax*) recruitment in the California Current Ecosystem revisited and revised. Canadian Journal of Fisheries and Aquatic Sciences 70:245–252.

Litz, M. N. C., R. L. Emmett, S. S. Heppell, and R. D. Brodeur. 2008. Ecology and distribution of the northern subpopulation of Northern Anchovy (*Engraulis mordax*) off the U.S. west coast. California Cooperative Oceanic Fisheries Investigations Report 49:167-182.

Lowe, R. 1993. El Nino hard on Oregon seabirds. Pacific Seabird Group Bulletin 20:62.

Lvov, D. K., V. I. Chervonski, I. N. Gostinschikova, A. S. Zemit, V. L. Gromashevski, Y. M. Tsyrkin, and O. V. Veselovskaya. 1972. Isolation of Tyuleniy virus from ticks *Ixodes* (*Ceratixodes*) *putus* Pick.-Camb. 1878 collected on Commodore Islands. Archiv für die Gesamte Virusforschung 38:139-142.

Mackas D. L., S. Batten, and M. Trudel. 2007. Effects on zooplankton of a warmer ocean: recent evidence from the Northeast Pacific. Progress in Oceanography 75:223-252.

Mahaffy, M. S., D. R. Nysewander, K. Vermeer, T. R. Wahl, and P. E. Whitehead. 1994. Status, trends and potential threats related to birds in the Strait of Georgia, Puget Sound and Juan de Fuca Strait. Pages 256-28 *in* R. C. H. Wilson, R. J. Beamish, F. Aitkins, and J. Bell, editors. Review of the marine environment and biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait. Proceedings of the BC/Washington Symposium on the Marine Environment, January 13 and 14, 1994. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1948.

McChesney, G. J., and H. R. Carter. 2008. Tufted Puffin (*Fratercula cirrhata*). Pages 213-217 *in* W. D. Shuford and T. Gardali, editors. California bird species of special concern: a ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1, Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California.

McChesney, G. J., H. R. Carter, and D. L. Whitworth. 1995. Reoccupation and extension of southern breeding limits of Tufted Puffins and Rhinoceros Auklets in California. Waterbirds 18:79-90.

McKernan, D. L., and V. B. Scheffer. 1942. Unusual numbers of dead birds on the Washington coast. Condor 44:264-266.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the Marbled Murrelet in Washington, Oregon, and California. Unpublished report, EDAW, Inc. Seattle, Washington.

Miller, I. M., C. Shishido, L. Antrim, and C. E. Bowlby. 2013. Climate change and the Olympic Coast National Marine Sanctuary: interpreting potential futures. Marine Sanctuaries Conservation Series ONMS-13-01, Office of National Marine Sanctuaries, National Oceanic and Atmospheric Administration, Silver Spring, Maryland.

Miller, R. C. 1936. Minutes of club meetings. Murrelet 17:59-60.

Miller, R. C., E. D. Lumley, and F. S. Hall. 1935. Birds of the San Juan Islands, Washington. Murrelet 16:51-65.

Monroe, A., P. Noah, and S. Brown. 1994. Comparison of medical treatment regimes for aspergillosis in captive Tufted Puffins (*Lunda cirrhata*). Penguin Conservation 7:1-5.

Morgan, E., and D. Siemann. 2011. Climate change effects on marine and coastal habitats in Washington state. Washington Department of Fish and Wildlife, Olympia, Washington, and National Wildlife Federation, Seattle, Washington.

Morrison, K. W., M. Hipfner, G. S. Blackburn, and D. J. Green. 2011. Effects of extreme climate events on adult survival of three Pacific auks. Auk 128:707−715.

Morrison, K. W., M. J. Hipfner, C. Gjerdrum, and D. J. Green. 2009. Wing length and mass at fledging predict local juvenile survival and age at first return in Tufted Puffins. Condor 111:433-441.

Moss, M. L. 2007. Haida and Tlingit use of seabirds from the Forrester Islands, Southeast Alaska. Journal of Ethnobiology 27:28-45.

Nagasawa, K., V. Barus, and H. Ogi. 1998. Description of larval *Contracaecum variegatum* (Rudolphi, 1809) and adult *Contracaecum* sp. (Nematoda: Anisakidae) collected from seabirds of the Bering Sea. Journal of the Yamashina Institute for Ornithology 30:22-30.

NatureServe. 2014. NatureServe explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer [accessed December 18, 2014]

Neel, J., C. Hart, D. Lynch, S. Chan, and J. Harris. 2007. Oil spills in Washington state: a historical analysis (revision of 1997 report). Publication No. 97-252, Washington State Department of Ecology, Olympia, Washington. 51 pp.

Nettleship, D. 1996. Family Alcidae (alcids). Pages 678-722 *in* J. del Hoyo, A. Elliott, and J. Sargatal, editors. Handbook of the birds of the world. Vol. 3. Hoatzin to auks. Lynx Edicions, Barcelona, Spain.

NFSC (Northwest Fisheries Science Center). 2008. Report on the bycatch of marine mammals and seabirds by the US West Coast groundfish fleet. Northwest Fisheries Science Center, NOAA Fisheries, Seattle, Washington.

Niizuma, Y., and O. Yamamura. 2004. Assimilation efficiency of Rhinoceros Auklet (*Cerorhinca monocerata*) chicks fed Japanese Anchovy (*Engraulis japonicus*) and Japanese Sand Lance (*Ammodytes personatus*). Comparative Biochemistry and Physiology, Part A: Molecular and Integrative Physiology 139:97-101.

NMFS (National Marine Fisheries Service). 2009. Endangered and threatened wildlife and plants: proposed threatened status for southern distinct population segment of Eulachon. Federal Register 74(48):10857-10876.

NMFS (National Marine Fisheries Service). 2010. Endangered and threatened wildlife and plants: threatened status for southern distinct population segment of Eulachon. Federal Register 75(52):13012-13024.

NMFS (National Marine Fisheries Service). 2013. Status review of the eastern distinct population segment of Steller Sea Lion (*Eumetopias jubatus*). National Marine Fisheries Service, Juneau, Alaska.

NRDC (Natural Resources Defense Council). 2014. Petition to list the contiguous U.S. distinct population segment of Tufted Puffin (*Fratercula cirrhata*) under the Endangered Species Act. Natural Resources Defense Council, New York, New York.

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

ODFW/WDFW (Oregon Department of Fish and Wildlife/Washington Department of Fish and Wildlife). 2014. 2014 joint staff report concerning stock status and fisheries for sturgeon and smelt. Oregon Department of Fish and Wildlife, Salem, Oregon, and Washington Department of Fish and Wildlife, Olympia, Washington. 47 pp.

O'Hara, P. D., P. Davidson, and A. E. Burger. 2009. Aerial surveillance and oil spill impacts based on beached bird survey data collected in southern British Columbia. Marine Ornithology 37:61-65.

O'Neil, P. 2013. Ottawa's oil-spill plan for B.C. can't cope with coming supertankers. Vancouver Sun, February 6, 2013. http://www.vancouversun.com/news/Ottawa+spill+plan+cope+with+coming+supertankers/7920670/story.html [accessed April 25, 2013]

Ono, K. 2012. Tufted Puffin conservation in Japan: trials on gillnet mitigation measures. Presentation abstract, page 28 *in* Birdlife International Workshop Report on Seabird Bycatch in Gillnet Fisheries, 3-4 May 2012, Berlin, Germany.

ORBIC (Oregon Biodiversity Information Center). 2013. Rare, threatened and endangered species of Oregon. Institute for Natural Resources, Portland State University, Portland, Oregon. 111 pp.

Osa, Y., and Y. Watanuki. 2002. Status of seabirds breeding in Hokkaido. Journal of the Yamashina Institute for Ornithology 33:107-141.

Osborne, R. W., R. E. Tallmon, K. Koski, and K. Meyer. 1998. San Juan Islands National Wildlife Refuge 1997 inventory. The Whale Museum, Friday Harbor, Washington. 283 pp.

Ostrand, W. D., K. O. Coyle, G. S. Drew, J. M. Maniscalco, and D. B. Irons. 1998. Selection of forage-fish schools by murrelets and Tufted Puffins in Prince William Sound, Alaska. Condor 100:286-297.

Page, G. W., H. R. Carter, and R. G. Ford. 1990. Numbers of seabirds killed or debilitated in the 1986 *Apex Houston* oil spill in central California. Studies in Avian Biology 14:164–174.

Palmer, R. H. 1927. Birds of the Olympic Peninsulaof Washington. Part I. Murrelet 8:35-42.

Palsson, W. A., T.-S. Tsou, G. G. Bargmann, R. M. Buckley, J. E. West, M. L, Mills, Y. W. Cheng, and R. E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound. Washington Department of Fish and Wildlife, Olympia, Washington. 208 pp.

Parrish J. K., M. Marvier, and R. T. Paine. 2001. Direct and indirect effects: interactions between Bald Eagles and Common Murres. Ecological Applications 11:1858-1869.

Paterek, J. 1996. Encyclopedia of Native American costume. W.W. Norton & Co., New York, New York.

Pearson, S. F., P. J. Hodum, T. P. Good, M. Schrimpf, and S. M. Knapp. 2013. A model approach for estimating colony size, trends, and habitat associations of burrow-nesting seabirds. Condor 115:356-365.

Pearson, S. F., P. Hodum, M. Schrimpf, J. K. Parrish, T. Good, and J. Dolliver. In review. Variation in seabird diet and reproduction across oceanographic regimes, time periods, and environmental conditions.

Penttila, D. 2007. Marine forage fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03, U.S. Army Corps of Engineers, Seattle, Washington.

Peperzak, L. 2003. Climate change and harmful algal blooms in the North Sea. Acta Oecologica 24:S139-S144.

Pereira, S. L., and A. J. Baker. 2008. DNA evidence for a Paleocene origin of the Alcidae (Aves: Charadriiformes) in the Pacific and multiple dispersals across northern oceans. Molecular Phylogenetics and Evolution 46:430–445.

PFMC (Pacific Fishery Management Council). 2011. Status of the Pacific coast coastal pelagic species fishery and recommended acceptable biological catches: stock assessment and fishery evaluation, 2011. Pacific Fishery Management Council, Portland, Oregon.

Phillips, E. M., J. E. Zamon, H. M. Nevins, C. M. Gibble, R. S. Duerr, and L. H. Kerr. 2011. Summary of birds killed by a harmful algal bloom along the south Washington and north Oregon coasts during October 2009. Northwestern Naturalist 92:120-126.

Piatt, J. F., and P. J. Anderson. 1996. Response of Common Murres to the *Exxon Valdez* oil spill and long-term changes in the Gulf of Alaska marine ecosystem. American Fisheries Society Symposium 18:720-737.

Piatt, J. F., and R. G. Ford. 1996. How many seabirds were killed by the *Exxon Valdez* oil spill? American Fisheries Society Symposium 18:712-719.

Piatt, J. F., and A. S. Kitaysky. 2002. Tufted Puffin *Fratercula cirrhata*. Birds of North America 708:1-31.

Piatt, J. F., and T. van Pelt. 1993. Common Murre die-off in Alaska. Pacific Seabirds 20:61.

Piatt, J. F., D. D. Roby, L. Henkel, L., and K. Neuman. 1997. Habitat use, diet and breeding biology of Tufted Puffins in Prince William Sound, Alaska. Northwestern Naturalist 78:102-109.

Piatt J. F., W. J. Sydeman, and F. Wiese. 2007. Introduction: a modern role for seabirds as indicators. Marine Ecology Progress Series 352:199–204.

Pierce, D. J., and T. R. Simons. 1986. The influence of human disturbance on Tufted Puffin breeding success. Auk 103:214-216.

Pierotti, R. 1983. Gull-puffin interactions on Great Island, Newfoundland. Biological Conservation 26:1-14.

Puget Sound Action Team. 2005. State of the Sound 2004. Puget Sound Action Team, Olympia, Washington.

Quinn, T., K. Krueger, K. Pierce, D. Penttila, K. Perry, T. Hicks, and D. Lowry. 2012. Patterns of Surf Smelt, *Hypomesus pretiosus*, intertidal spawning habitat use in Puget Sound, Washington State. Estuaries and Coasts 5:1214-1228.

Ramseur, J. L. 2012. Oil spills in U.S. coastal waters: background and governance. Congressional Research Service 7-5700.

Raphael, M. G., J. Baldwin, G. A. Falxa, M. H. Huff, M. Lance, S. L. Miller, S. F. Pearson, C. J. Ralph, C. Strong, and C. Thompson. 2007. Regional population monitoring of the Marbled Murrelet: field and analytical methods. General Technical Report PNW-GTR-716, Pacific Northwest Research Station, USDA Forest Service, Portland, Oregon. 70 pp.

Reagan, A. B. 1910. Destruction of young water birds by a storm. Auk 27:92.

Rhoads, S. N. 1893. The birds observed in British Columbia and Washington during spring and summer, 1892. Proceedings of the Academy of Natural Sciences of Philadelphia 45:21-65.

Ricca, M. A., A. K. Miles, and R. G. Anthony. 2008. Sources of organochlorine contaminants and mercury in seabirds from the Aleutian archipelago of Alaska: inferences from spatial and trophic variation. Science of the Total Environment 406:308-323.

Rice, C. A. 2006. Effects of shoreline modification on a northern Puget Sound beach: microclimate and embryo mortality in Surf Smelt (*Hypomesus pretiosus*). Estuaries and Coasts 29:63-71.

Rice, J. 1985. Interactions of variation in food supply and kleptoparasitism levels on the reproductive success of Common Puffins (*Fratercula arctica*). Canadian Journal of Zoology 63:2743-2747.

Rice, J. 1987. Behavioural responses of Common Puffins to kleptoparasitism by Herring Gulls. Canadian Journal of Zoology 65:339-347.

Richardson, F. 1961. Breeding biology of the Rhinoceros Auklet on Protection Island, Washington. Condor 63:456-473.

Robards, M. D., J. F. Piatt, and K. D. Wohl. 1995. Increasing frequency of plastic particles ingested by seabirds in the subarctic North Pacific. Marine Pollution Bulletin 30:151-157.

Rodway, M. S., and M. J. F. Lemon. 2011. Use of permanent plots to monitor trends in burrow-nesting seabird populations in British Columbia. Marine Ornithology 39:243-253.

Roemmich, D., and J. McGowan. 1995. Climatic warming and the decline of zooplankton in the California Current. Science 267:1324-1326.

Romano, M. D., J. F. Piatt, and D. D. Roby. 2006. Testing the junk-food hypothesis on marine birds: effects of prey type on growth and development. Waterbirds 29:407-414.

Rosen, Y. 2011. Rogue drift-net fishing vessel seized in North Pacific. Reuters, September 30, 2011.

Sangster, G., J. M. Collinson, P.-A. Crochet, A. G. Knox, D. T. Parkin, et al. 2011. Taxonomic recommendations for British birds: seventh report. Ibis 153:883–892.

Santora, J. A., I. D. Schroeder, J. C. Field, B. K. Wells, and W. J. Sydeman. 2014. Spatio-temporal dynamics of ocean conditions and forage taxa reveal regional structuring of seabird-prey relationships. Ecological Applications 24:1730-1747.

Schrimpf, M. B., J. K. Parrish, and S. F. Pearson 2012. Trade-offs in prey quality and quantity revealed through the behavioral compensation of breeding seabirds. Marine Ecology Progress Series 460:247–259.

Sealy, S. G. 1973. Interspecific feeding assemblages of marine birds off British Columbia. Auk 90:796-802.

Serra-Sogas, N., P. D. O'Hara, R. Canessa, P. Keller, and R. Pelot. 2008. Visualization of spatial patterns and temporal trends for aerial surveillance of illegal oil discharges in western Canadian marine waters. Marine Pollution Bulletin 56:

Shumway, S. E., S. M. Allen, and P. D. Boersma. 2003. Marine birds and harmful algal blooms: sporadic victims or under-reported events? Harmful Algae 2:1-17.

Simenstad, C., M. Ramirez, J. Burke, M. Logsdon, H. Shipman, et al. 2011. Historical change and impairment of Puget Sound shorelines: atlas and interpretation of Puget Sound Nearshore Ecosystem Project change analysis. Report No. 2011-01, Puget Sound Nearshore Ecosystem Project, Washington Department of Fish and Wildlife, Olympia, Washington, and U.S. Army Corps of Engineers, Seattle, Washington.

Smith, A. P., and D. G. Quin. 1996. Patterns and causes of extinction and decline in Australian conilurine rodents. Biological Conservation 77:243-267.

Smith, M. R., P. W. Mattocks, Jr., and K. M. Cassidy. 1997. Breeding birds of Washington state: location data and predicted distributions. Volume 4. Washington State Gap Analysis – Final Report. Publications in Zoology No. 1, Seattle Audubon Society, Seattle, Washington. 538 pp.

Sparks, J., and T. Soper. 1987. Penguins. 2nd edition. David & Charles, Newton Abbot, United Kingdom.

Speich, S. M, and T. R. Wahl. 1989. Catalog of Washington seabird colonies. U.S. Fish and Wildlife Service Biological Report 88(6), U.S. Fish and Wildlife Service, Washington, D.C., and Minerals Management Service, Los Angeles, California. 510 pp.

Sprenger, C. B., and P. W. Dunwiddie. 2011. Fire history of a Douglas-Fir-Oregon White Oak woodland, Waldron Island, Washington. Northwest Science 85:108-119.

St. Clair, C. C., R. C. St. Clair, and T. D. Williams. 2001. Does kleptoparasitism by Glaucous-winged Gulls limit the reproductive success of Tufted Puffins? Auk 118:934-943.

Stephensen, S. W. 2014. Tufted Puffin monitoring study at Haystack Rock, Cannon Beach, Oregon 2010-2013. U.S. Fish and Wildlife Service, Newport, Oregon.

Stick, K. C., and A. Lindquist. 2009. 2008 Washington state herring stock status report. Washington Department of Fish and Wildlife, Olympia, Washington. 100 pp.

Stinson, D. W., J. W. Watson, and K. R. McAllister. 2007. Washington state status report for the Bald Eagle. Washington Department of Fish and Wildlife, Olympia, Washington. 86 pp.

Suryan, R. M., E. M. Phillips, K. J. So, J. E. Zamon, R. W. Lowe, and S. W. Stephensen. 2012. Marine bird colony and at-sea distributions along the Oregon coast: Implications for marine spatial planning and information gap analysis. Report 2, Northwest National Marine Renewable Energy Center, Corvallis, Oregon.

Sydeman, W. J., R. W. Bradley, P. Warzybok, C. L. Abraham, J. Jahncke, K. D. Hyrenbach, V. Kousky, J. M. Hipfner, and M. D. Ohman. 2006. Planktivorous auklet *Ptychoramphus aleuticus* responses to ocean climate, 2005: unusual atmospheric blocking? Geophysical Research Letters 33:L22S09.

Tanaka, H. 1989. Biology and bioaccumulation of PCBs in Tufted Puffins *Lunda cirrhata* of the northern North Pacific. Journal of the Yamashina Institute for Ornithology 21:1-41.

TCW Economics. 2008. Economic analysis of the non-treaty commercial and recreational fisheries in Washington state. TCW Economics, Sacramento, California.

Tenyo Maru Trustees. 2000. Final restoration plan and environmental assessment for the *Tenyo Maru* oil spill. U.S. Fish and Wildlife Service, Lacey, Washington. 70 pp. http://www.darrp.noaa.gov/northwest/tenyo/admin.html [accessed December 18, 2014]

Teuten, E. L., J. M. Saquing, D. R. U. Knappe, M. A. Barlaz, S. Jonsson, et al. 2009. Transport and release of chemicals from plastics to the environment and to wildlife. Philosophical Transactions of the Royal Society B (2009) 364:2027–2045.

Thayer, J. A., and W. J. Sydeman. 2007. Spatio-temporal variability in prey harvest and reproductive ecology of a piscivorous seabird, *Cerorhinca monocerata*, in an upwelling system. Marine Ecology Progress Series 329:253-265.

Therriault, T. W., D. E. Hay, and J. F. Schweigert. 2009. Biological overview and trends in pelagic forage fish abundance in the Salish Sea (Strait of Georgia, British Columbia). Marine Ornithology 37:3-8.

Thom, R. M., D. K. Schreffler, and K. Macdonald. 1994. Shoreline armoring effects on coastal ecology and

biological resources in Puget Sound, WA. Coastal Erosion Management Studies, Volume 7, Washington Department of Ecology, Olympia, Washington.
Thompson, C. W., and A. S. Kitaysky. 2004. Polymorphic flight-feather molt sequence in Tufted Puffins (*Fratercula cirrhata*): a rare phenomenon in birds. Auk 121:35-45.
Thompson, C. W., S. A. Kitaysky, and R. Westra. 2001. Tufted Puffin flight feather molt and effects of food availability. Pacific Seabirds 28:55-56.
Thompson, S. A., W. J. Sydeman, J. A. Santora, K. H. Morgan, W. Crawford, and M. T. Burrows. 2012. Phenology of pelagic seabird abundance relative to marine climate change in the Alaska Gyre. Marine Ecology Progress Series 454:159-170.
Thorsen, A. C. 1980. Diurnal land visitations by Rhinoceros Auklets. Western Birds 11:154.
Thorsen, A. C. 1981. Midsummer occurrence of the Horned Puffin in Rosario Strait, Washington. Western Birds 12:56.
Thorsen, A. C., and J. G. Galusha. 1971. A nesting population study of some islands in the Puget Sound area. Murrelet 52:20-23.
Turner, N. J. 1999. Time to burn: traditional use of fire to enhance resource production by aboriginal peoples in British Columbia. Pages 185-218 *in* R. Boyd, editor. Indians, fire, and the land in the Pacific Northwest. Oregon State University Press, Corvallis, Oregon.
Tyler, W. B., K. T. Briggs, D. B. Lewis, and R. G. Ford. 1993. Seabird distribution and abundance in relation to oceanographic processes in the California Current System. Pages 48-60 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.
USFWS (U.S. Fish and Wildlife Service). 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Portland, Oregon. 264 pp.
USFWS (U.S. Fish and Wildlife Service). 2007. Washington Islands National Wildlife Refuges, Flattery Rocks, Quillayute Needles, and Copalis National Wildlife Refuges: comprehensive conservation plan and environmental assessment. U.S. Fish and Wildlife Service, Port Angeles, Washington.
USFWS (U.S. Fish and Wildlife Service). 2009. Alaska seabird conservation plan. U.S. Fish and Wildlife Service, Anchorage, Alaska. 136 pp.
USFWS (U.S. Fish and Wildlife Service). 2010. Protection Island and San Juan Islands National Wildlife Refuges comprehensive conservation plan and San Juan Islands Wilderness stewardship plan. U.S. Fish and Wildlife Service, Seattle, Washington. 557 pp.
Van Buren, A. N., and P. D. Boersma. 2007. Humboldt Penguins (*Spheniscus humboldti*) in the Northern Hemisphere. Wilson Journal of Ornithology 119:284-288.
Van Dorp, J. R. and J. Merrick. 2014. VTRA 2010 final report: preventing oil spills from large ships and barges in northern Puget Sound & Strait of Juan de Fuca. George Washington University, Washington, D.C., and Virginia Commonwealth University, Richmond, Virginia. http://www.psp.wa.gov/VTRA.php [accessed December 18, 2014]
Vermeer, K. 1979. Nesting requirements, food and breeding distribution of Rhinoceros Auklets, *Cerorhinca monocerata*, and Tufted Puffins *Lunda cirrhata*. Ardea 67:101-110.
Vermeer, K., and L. Cullen. 1979. Growth of Rhinoceros Auklets and Tufted Puffins, Triangle Island, British Columbia. Ardea 67:22-27.
Vermeer, K., L. Cullen, and M. Porter 1979. A provisional explanation of the reproductive failure of Tufted Puffins (*Lunda cirrhata*) on Triangle Island. Ibis 121:348-354.
Vermeer, K., K. R. Summers, and D. S. Bingham. 1976. Birds observed at Triangle Island, British Columbia, 1974 and 1975. Murrelet 57:35-42.
Vigfusdottir, F. 2007. Vinur eða vágestur? Áhrif kanína á lundabyggð á Heimaey. Natturufraedingurinn: volume and page numbers unavailable.
Wahl, T. R. 1975. Seabirds in Washington's off-shore zone. Western Birds 6:117-134.
Wahl, T. R. 2005. Tufted Puffin. Pages 205-206 *in* T. R. Wahl, B. Tweit, and S. G. Mlodinow, editors. Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.
Wahl, T. R., and B. Tweit. 2000. Seabird abundances off Washington, 1972-1998. Western Birds 31:69-88.
Wahl, T. R., K. H. Morgan, and K. Vermeer. 1993. Seabird distribution of British Columbia and Washington. Pages 39-47 *in* K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication, Ottawa, Ontario.
Warzybok, P.M., R. W. Berger, and R. W. Bradley. 2012. Status of seabirds on Southeast Farallon Island during the 2012 breeding season. PRBO Conservation Science, Petaluma, California.
WDFW (Washington Department of Fish and Wildlife). 2001-2012. Puget Sound area commercial and recreational salmon fisheries and their effects on ESA-threatened Marbled Murrelets. Washington Department of Fish and Wildlife, Olympia, Washington.
WDFW (Washington Department of Fish and Wildlife). 2014. Washington state species of concern lists. Washington Department of Fish and Wildlife,

Olympia, Washington. http://www.wdfw.wa.gov/conservation/endangered/All/ [accessed December 18, 2014]
Wehle, D. H. S. 1980. The breeding biology of the puffins: Tufted Puffin (*Lunda cirrhata*), Horned Puffin (*Fratercula corniculata*), Common Puffin (*F. arctica*), and Rhinoceros Auklet (*Cerorhinca monocerata*). PhD dissertation, University of Alaska, Fairbanks, Alaska.
Wehle, D. H. S. 1982. Food of adult and subadult Tufted and Horned Puffins. Murrelet 63:51-58.
Wehle, D. H. S. 1983. The food, feeding, and development of young Tufted and Horned Puffins in Alaska. Condor 85:427-442.
Welch, C. 2009. Trying to crack an ocean mystery: what caused killer algal blooms? Seattle Times, November 29, 2009. http://seattletimes.com/html/localnews/2010378956_algalbloom29m.html [accessed December 19, 2014]
Whidden, S. E., C. T. Williams, A. R. Breton, and C. L. Buck. 2007. Effects of transmitters on the reproductive success of Tufted Puffins. Journal of Field Ornithology 78:206-212.
Wiese, F. K., and G. J. Robertson. 2004. Assessing seabird mortality from chronic oil discharges at sea. Journal of Wildlife Management 68:627–638.
Willett, G. 1915. Summer birds of Forrester Island, Alaska. Auk 32:295–305.
Williams, C. T., and C. L. Buck. 2010. Spatial and temporal variation in Tufted Puffin (*Fratercula cirrhata*) nestling diet quality and growth rates. Marine Ornithology 38:41-48.
Williams, C. T., S. D. Kildaw, and C. L. Buck. 2007. Sex-specific differences in body condition indices and seasonal mass loss in Tufted Puffins. Journal of Field Ornithology 78:369-378.
Williams, P. L., and L. G. Frank. 1979. Diet of the Snowy Owl in the absence of small mammals. Condor 81:213-214.
Wilson, U. W. 1993. Rhinoceros Auklet burrow use, breeding success, and chick growth: gull-free vs. gull-occupied habitat. Journal of Field Ornithology 64:256-261.
Wilson, U. W. and D. A. Manuwal. 1986. Breeding biology of the Rhinoceros Auklet in Washington. Condor 88:143-155.
Wolf, S. G., W. J. Sydeman, J. M. Hipfner, C. L. Abraham, B. R. Tershy, and D. A. Croll. 2009. Range-wide reproductive consequences of ocean climate variability for the seabird Cassin's Auklet. Ecology 90:742–753.
WSDOE (Washington State Department of Ecology). 2014. Vessel entries and transits for Washington waters, VEAT 2013. Publication 14-08-004, Washington State Department of Ecology, Olympia, Washington.
Zamon, J. E. 2003. Mixed species aggregations feeding upon herring and sandlance schools in a nearshore archipelago depend on flooding tidal currents. Marine Ecology Progress Series 261:243-255.
Zwolinski, J. P. and D. A. Demer. 2012. A cold oceanographic regime with high exploitation rates in the Northeast Pacific forecasts a collapse of the sardine stock. Proceedings of the National Academy of Sciences 109:4175-4180.
Žydelis, R., C. Small, and G. French. 2013. The incidental catch of seabirds in gillnet fisheries: a global review. Biological Conservation 162:76-88.

PERSONAL COMMUNICATIONS AND SOURCES OF UNPUBLISHED DATA

Peter Arcese
University of British Columbia
Vancouver, British Columbia

Kurt Fresh
Northwest Fisheries Science Center
Seattle, Washington

Mark Hipfner
Pacific Wildlife Research Center
Environment Canada
Delta, British Columbia

Peter Hodum
University of Puget Sound
Tacoma, Washington

Scott Horton
Washington State Department of Natural Resources
Forks, Washington

Arthur Kettle
Alaska Maritime National Wildlife Refuge
Homer, Alaska

Deanna Lynch
U.S. Fish and Wildlife Service
Lacey, Washington

Robert Paine
University of Washington (retired)
Seattle, Washington

Julia Parrish
University of Washington
Seattle, Washington

Scott Pearson
Washington Department of Fish and Wildlife
Olympia, Washington

Sara Perry
Seattle Aquarium
Seattle, Washington

Tony Scruton
The San Juan Preservation Trust
Waldron Island, Washington

Leslie Slater
Alaska Maritime National Wildlife Refuge
Homer, Alaska

Sue Thomas
Washington Maritime National Wildlife Refuge Complex
Sequim, Washington

Bill Tweit
Washington Department of Fish and Wildlife
Olympia, Washington

Terence Wahl
Bellingham, Washington

Lorna Wargo
Washington Department of Fish and Wildlife
Montesano, Washington

Ulrich Wilson
Washington Maritime National Wildlife Refuge Complex (retired)
Sequim, Washington

Appendix A. Counts of Tufted Puffins at breeding sites and other locations in Washington, 1886-2013.

Colony Name	County	Year	Count	Observer	Reference
Bodelteh Island East	Clallam	1978	20	Pitman	Speich & Wahl 1989
Bodelteh Island East	Clallam	1979	7	Graybill	Speich & Wahl 1989
Bodelteh Island East	Clallam	1979	10	Pitman	Speich & Wahl 1989
Bodelteh Island East	Clallam	1982	6	Wilson	Speich & Wahl 1989
Bodelteh Island East	Clallam	2008	0	Hodum et al.	Hodum et al., unpubl.
Bodelteh Island Middle	Clallam	1978	Breeding	Speich	Speich & Wahl 1989
Bodelteh Island Middle	Clallam	1978	Breeding	Pitman	Speich & Wahl 1989
Bodelteh Island Middle	Clallam	1979	250	Pitman	Speich & Wahl 1989
Bodelteh Island Middle	Clallam	1982	8	Wilson	Speich & Wahl 1989
Bodelteh Island Middle	Clallam	2008	28	Hodum et al.	Hodum et al., unpubl.
Bodelteh Island Middle	Clallam	2009	11	Hodum et al.	Hodum et al., unpubl.
Bodelteh Island Middle	Clallam	2010	4	Hodum et al.	Hodum et al., unpubl.
Bodelteh Island West	Clallam	1978	150-200	Speich	Speich & Wahl 1989
Bodelteh Island West	Clallam	1978	Breeding	Pitman	Speich & Wahl 1989
Bodelteh Island West	Clallam	1979	130	Pitman	Speich & Wahl 1989
Bodelteh Island West	Clallam	1979	Breeding	Speich	Speich & Wahl 1989
Bodelteh Island West	Clallam	1982	10	Wilson	Speich & Wahl 1989
Bodelteh Island West	Clallam	2008	51	Hodum et al.	Hodum et al., unpubl.
Bodelteh Island West	Clallam	2009	0	Hodum et al.	Hodum et al., unpubl.
Bodelteh Island West	Clallam	2010	59	Hodum et al.	Hodum et al., unpubl.
Bodelteh Islands (all)	Clallam	1907	500-1,000	Dawson	Dawson 1908b
Bodelteh Islands (all)	Clallam	1959	20	Kenyon & Scheffer	Kenyon & Scheffer 1961
Bodelteh Islands (all)	Clallam	1978	1,000-2,000	Pitman	Speich & Wahl 1989
Bodelteh Islands (all)	Clallam	2007	19[1]	Hodum et al.	Hodum et al., unpubl.
Bodelteh Islands (all)	Clallam	2007	3[1]	Hodum et al.	Hodum et al., unpubl.
Bodelteh Islands (all)	Clallam	2008	81[1,2]	Hodum et al.	Hodum et al., unpubl.
Bodelteh Islands (all)	Clallam	2010	0[1]	Hodum et al.	Hodum et al., unpubl.
Bodelteh Islands (all)	Clallam	2010	20[1]	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	1907	500	Dawson	Dawson 1908b
Cake Rock	Clallam	1959	30	Kenyon & Scheffer	Kenyon & Scheffer 1961
Cake Rock	Clallam	1967	Breeding	Hancock	Speich & Wahl 1989
Cake Rock	Clallam	1968-1969	Breeding	Cody	Cody 1973
Cake Rock	Clallam	1978	1,000	Speich	Speich & Wahl 1989
Cake Rock	Clallam	1978	480+	Speich	Speich & Wahl 1989
Cake Rock	Clallam	1978	500-1,000	Pitman	Speich & Wahl 1989
Cake Rock	Clallam	1981	70	Wilson	Speich & Wahl 1989
Cake Rock	Clallam	2007	17	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	2007	0	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	2008	98[2]	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	2009	60	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	2010	74	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	2010	50	Hodum et al.	Hodum et al., unpubl.
Cake Rock	Clallam	2010	47	Hodum et al.	Hodum et al., unpubl.
Cakesosta	Clallam	1907	500	Dawson	Dawson 1908b

Colony Name	County	Year	Count	Observer	Reference
Cakesosta	Clallam	1978	60-80	Speich	Speich & Wahl 1989
Cakesosta	Clallam	1981	125+	Wilson	Speich & Wahl 1989
Cakesosta	Clallam	1982	6+	Wilson	Speich & Wahl 1989
Cakesosta	Clallam	2008	82[2]	Hodum et al.	Hodum et al., unpubl.
Cakesosta	Clallam	2009	2	Hodum et al.	Hodum et al., unpubl.
Carroll Island	Clallam	1907	10,000	Dawson	Dawson 1908a
Carroll Island	Clallam	1907	Breeding	Jones	Jones 1909
Carroll Island	Clallam	1907	Breeding[3]	Jones	Speich & Wahl 1989
Carroll Island	Clallam	1907	5,000	Dawson	Dawson 1908b
Carroll Island	Clallam	1909	5,000-10,000	Dawson	Dawson and Bowles 1909
Carroll Island	Clallam	1967	100s	Hancock	Speich & Wahl 1989
Carroll Island	Clallam	1968-1969	Breeding	Cody	Cody 1973
Carroll Island	Clallam	1978	100s	Speich	Speich & Wahl 1989
Carroll Island	Clallam	1978	1,000-2,000	Pitman	Speich & Wahl 1989
Carroll Island	Clallam	1978	4,000	Pitman	Speich & Wahl 1989
Carroll Island	Clallam	1978	8,000	Speich	Speich & Wahl 1989
Carroll Island	Clallam	1979	2,000	Pitman	Speich & Wahl 1989
Carroll Island	Clallam	1979	Breeding	Speich	Speich & Wahl 1989
Carroll Island	Clallam	1979	6,800	Speich	Speich & Wahl 1989
Carroll Island	Clallam	1981	250	Wilson	Speich & Wahl 1989
Carroll Island	Clallam	1982	2,270	Wilson	Speich & Wahl 1989
Carroll Island	Clallam	2008	40	Hodum et al.	Hodum et al., unpubl.
Carroll Island	Clallam	2009	136	Hodum et al.	Hodum et al., unpubl.
Carroll Island	Clallam	2010	115	Hodum et al.	Hodum et al., unpubl.
Carroll Island	Clallam	2010	18	Hodum et al.	Hodum et al., unpubl.
Carroll Island	Clallam	2010	211	Hodum et al.	Hodum et al., unpubl.
Dhuoyautzachtahl (Petrel Rock)	Clallam	1907	300	Dawson	Dawson 1908b
Dhuoyautzachtahl (Petrel Rock)	Clallam	1919	Specimen	Albrecht	Speich & Wahl 1989
Dhuoyautzachtahl (Petrel Rock)	Clallam	1954	Breeding	Alcorn, Eddy	Speich & Wahl 1989
Dhuoyautzachtahl (Petrel Rock)	Clallam	1979	1,100	Speich	Speich & Wahl 1989
Dhuoyautzachtahl (Petrel Rock)	Clallam	1981	25	Wilson	Speich & Wahl 1989
Dhuoyautzachtahl (Petrel Rock)	Clallam	2007	64	Hodum et al.	Hodum et al., unpubl.
Dhuoyautzachtahl (Petrel Rock)	Clallam	2008	41	Hodum et al.	Hodum et al., unpubl.
Dhuoyautzachtahl (Petrel Rock)	Clallam	2009	3	Hodum et al.	Hodum et al., unpubl.
Dhuoyautzachtahl (Petrel Rock)	Clallam	2009	4	Hodum et al.	Hodum et al., unpubl.
Dohodaaluh	Clallam	1907	40	Dawson	Dawson 1908b
Hand Rock	Clallam	1914-1915	5,000	Cantwell	Jewett et al. 1953
Hand Rock	Clallam	1978	0	Pitman	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1907	1,000	Dawson	Dawson 1908b
Jagged Island (Wishalooth, Bald I.)	Clallam	1907	Breeding	Dawson	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1907	Breeding	Jones	Jones 1908a

Colony Name	County	Year	Count	Observer	Reference
Jagged Island (Wishalooth, Bald I.)	Clallam	1959	30	Kenyon & Scheffer	Kenyon & Scheffer 1961
Jagged Island (Wishalooth, Bald I.)	Clallam	1967	Breeding	Hancock	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1978	10,000	Pitman	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1978	Breeding	Speich	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1979	1,000s	Pitman	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1979	Breeding	Speich	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1979	12,000	Speich	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1981	950+	Wilson	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	1982	7,800	Wilson	Speich & Wahl 1989
Jagged Island (Wishalooth, Bald I.)	Clallam	2005	768	Hodum et al.	Hodum et al., unpubl.
Jagged Island (Wishalooth, Bald I.)	Clallam	2005	159	Hodum et al.	Hodum et al., unpubl.
Jagged Island (Wishalooth, Bald I.)	Clallam	2007	1	Hodum et al.	Hodum et al., unpubl.
Jagged Island (Wishalooth, Bald I.)	Clallam	2008	206	Hodum et al.	Hodum et al., unpubl.
Jagged Island (Wishalooth, Bald I.)	Clallam	2009	117	Hodum et al.	Hodum et al., unpubl.
Jagged Island (Wishalooth, Bald I.)	Clallam	2010	29	Hodum et al.	Hodum et al., unpubl.
Jagged Island (Wishalooth, Bald I.)	Clallam	2010	36	Hodum et al.	Hodum et al., unpubl.
James Island	Clallam	1975	Breeding	Chappell	Speich & Wahl 1989
James Island	Clallam	2007	13	Hodum et al.	Hodum et al., unpubl.
James Island	Clallam	2007	30	Hodum et al.	Hodum et al., unpubl.
James Island	Clallam	2007	12	Hodum et al.	Hodum et al., unpubl.
James Island	Clallam	2007	0	Hodum et al.	Hodum et al., unpubl.
Kochaauh	Clallam	1954	Breeding	Eddy	Speich & Wahl 1989
Kochaauh	Clallam	1967	Breeding	Hancock	Speich & Wahl 1989
Kochaauh	Clallam	1978	200-400	Speich	Speich & Wahl 1989
Kochaauh	Clallam	2007	30	Hodum et al.	Hodum et al., unpubl.
Kochaauh	Clallam	2008	24	Hodum et al.	Hodum et al., unpubl.
Kochaauh	Clallam	2009	1	Hodum et al.	Hodum et al., unpubl.
Kochaauh	Clallam	2010	0	Hodum et al.	Hodum et al., unpubl.
Kochaauh	Clallam	2010	33	Hodum et al.	Hodum et al., unpubl.
Ozette Island	Clallam	1979	0	Speich	Speich & Wahl 1989
Ozette Island	Clallam	2007	0	Hodum et al.	Hodum et al., unpubl.
Quillayute Needles Group[4]	Clallam	1954	Specimen	Anonymous	Speich & Wahl 1989
Quillayute Needles Group[4]	Clallam	1959	25	Kenyon & Scheffer	Kenyon & Scheffer 1961
Quillayute Needles Group[4]	Clallam	1968-1969	Breeding	Cody	Cody 1973
Quillayute Needles Group[4]	Clallam	2007	39	Hodum et al.	Hodum et al., unpubl.
Quillayute Needles Group[4]	Clallam	2007	63	Hodum et al.	Hodum et al., unpubl.
Quillayute Needles Group[4]	Clallam	2007	0	Hodum et al.	Hodum et al., unpubl.
Quillayute Needles Group[4]	Clallam	2010	35	Hodum et al.	Hodum et al., unpubl.
Quillayute Needles Group[4]	Clallam	2010	5	Hodum et al.	Hodum et al., unpubl.
Seal Rock	Clallam	1976	Breeding	Chappell	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Seal Rock	Clallam	1978	25	Speich	Speich & Wahl 1989
Seal Rock	Clallam	1978	36	Harrington-Tweit	Speich & Wahl 1989
Seal Rock	Clallam	1978	24	Harrington-Tweit	Speich & Wahl 1989
Seal Rock	Clallam	1978	41	Wahl	Speich & Wahl 1989
Seal Rock	Clallam	1978	Breeding	Chappell	Speich & Wahl 1989
Seal Rock	Clallam	1981	8	Wilson	Speich & Wahl 1989
Seal Rock	Clallam	2008	0	Hodum et al.	Hodum et al., unpubl.
Silver Sides	Clallam	1907	1,000	Dawson	Dawson 1908b
Silver Sides	Clallam	1978	Breeding	Pitman	Speich & Wahl 1989
Silver Sides	Clallam	1978	200	Speich	Speich & Wahl 1989
Silver Sides	Clallam	2008	81[2]	Hodum et al.	Hodum et al., unpubl.
Table Rock	Clallam	1978	Breeding	Speich	Speich & Wahl 1989
Table Rock	Clallam	2009	0	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	1907	Breeding	Dawson	Dawson 1908b
Tatoosh Island	Clallam	1914	Breeding	Cantwell	Speich & Wahl 1989
Tatoosh Island	Clallam	1959	50	Kenyon & Scheffer	Kenyon & Scheffer 1961
Tatoosh Island	Clallam	1968	Breeding	WA Dept. of Game	Speich & Wahl 1989
Tatoosh Island	Clallam	1970	200	Paulson	Speich & Wahl 1989
Tatoosh Island	Clallam	1971	20	Willapa NWR	Speich & Wahl 1989
Tatoosh Island	Clallam	1973	60	Frazer	Speich & Wahl 1989
Tatoosh Island	Clallam	1973	50+	Leschner	Speich & Wahl 1989
Tatoosh Island	Clallam	1975	Breeding	Leschner	Speich & Wahl 1989
Tatoosh Island	Clallam	1978	100+	Boersma	Speich & Wahl 1989
Tatoosh Island	Clallam	1978	300	Pitman	Speich & Wahl 1989
Tatoosh Island	Clallam	2005	55	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2005	146	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2005	40	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2008	24	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2008	45	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2009	1	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2009	1	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2009	7	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2010	9	Hodum et al.	Hodum et al., unpubl.
Tatoosh Island	Clallam	2010	36	Hodum et al.	Hodum et al., unpubl.
Unnamed Rock 1	Clallam	1978	60	Pitman	Speich & Wahl 1989
Unnamed Rock 2	Clallam	1978	200	Pitman	Speich & Wahl 1989
Unnamed Rock 2	Clallam	1982	110	Wilson	Speich & Wahl 1989
White Rock	Clallam	1907	200-500	Dawson	Dawson 1908b
White Rock	Clallam	1959	10	Kenyon & Scheffer	Kenyon & Scheffer 1961
White Rock	Clallam	1978	150	Pitman	Speich & Wahl 1989
White Rock	Clallam	1979	Breeding	Speich	Speich & Wahl 1989
White Rock	Clallam	2007	3	Hodum et al.	Hodum et al., unpubl.
White Rock	Clallam	2007	0	Hodum et al.	Hodum et al., unpubl.
White Rock	Clallam	2008	65	Hodum et al.	Hodum et al., unpubl.
White Rock	Clallam	2009	1	Hodum et al.	Hodum et al., unpubl.
Erin's Bride	Grays Harbor	1976	Breeding	Hunn	Speich & Wahl 1989
Erin's Bride	Grays Harbor	1978	16+	Harrington-Tweit	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Erin's Bride	Grays Harbor	2007	32	Hodum et al.	Hodum et al., unpubl.
Erin's Bride	Grays Harbor	2008	6	Hodum et al.	Hodum et al., unpubl.
Grenville Arch	Grays Harbor	1915	Breeding	Cantwell	Jewett et al. 1953
Grenville Arch	Grays Harbor	2007	0	Hodum et al.	Hodum et al., unpubl.
Grenville Arch	Grays Harbor	2009	0	Hodum et al.	Hodum et al., unpubl.
Grenville Arch	Grays Harbor	2009	0	Hodum et al.	Hodum et al., unpubl.
Grenville Pillar	Grays Harbor	1980	3	Harrington-Tweit	Speich & Wahl 1989
Grenville Pillar	Grays Harbor	2007	0	Hodum et al.	Hodum et al., unpubl.
Grenville Pillar	Grays Harbor	2009	0	Hodum et al.	Hodum et al., unpubl.
Point Grenville Cliffs	Grays Harbor	pre-1921	Breeding	Fletcher	Speich & Wahl 1989
Point Grenville Cliffs	Grays Harbor	1980	10-12	Smith	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1973	100	Leschner	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1974	80	Hoge & Morris	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1974	40-50	Hoge & Hoge	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1975	20	Crowell & Nehls	Crowell & Nehls 1975
Point Grenville Rocks[5]	Grays Harbor	1976	64	Hoge & Hoge	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1977	Breeding	Harrington-Tweit	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1979	Breeding	Hoge & Hoge	Speich & Wahl 1989
Point Grenville Rocks[5]	Grays Harbor	1980	Breeding	Harrington-Tweit	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1907	2,000	Dawson	Dawson 1908b
Puffin Rock (Erin)	Grays Harbor	1973	98	Frazer	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1976	Breeding	Hunn	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1978	16	Harrington-Tweit	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1978	200	Speich	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1979	42	Speich	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1980	62	Harrington-Tweit	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1981	50	Wilson	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	1982	15	Wilson	Speich & Wahl 1989
Puffin Rock (Erin)	Grays Harbor	2007	38	Hodum et al.	Hodum et al., unpubl.
Puffin Rock (Erin)	Grays Harbor	2010	22	Hodum et al.	Hodum et al., unpubl.
Puffin Rock (Erin)	Grays Harbor	2010	23	Hodum et al.	Hodum et al., unpubl.
Puffin Rock (Erin)	Grays Harbor	2010	25	Hodum et al.	Hodum et al., unpubl.
Split Rock	Grays Harbor	2009	0	Hodum et al.	Hodum et al., unpubl.
Split Rock	Grays Harbor	2009	0	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	1907	500	Dawson	Dawson 1908b
Willoughby Rock	Grays Harbor	1977	Breeding	Harrington-Tweit	Speich & Wahl 1989
Willoughby Rock	Grays Harbor	1979	28	Speich	Speich & Wahl 1989
Willoughby Rock	Grays Harbor	1981	120+	Wilson	Speich & Wahl 1989
Willoughby Rock	Grays Harbor	2007	27	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	2007	39	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	2008	23	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	2009	6	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	2010	3	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	2010	0	Hodum et al.	Hodum et al., unpubl.
Willoughby Rock	Grays Harbor	2010	7	Hodum et al.	Hodum et al., unpubl.
Smith Island	Island	1914	Breeding	Cantwell	Speich & Wahl 1989
Smith Island	Island	1914	500	Cantwell	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Smith Island	Island	1915	150	Cantwell	Speich & Wahl 1989
Smith Island	Island	1916	150	Cantwell	Speich & Wahl 1989
Smith Island	Island	1917	150	Cantwell	Speich & Wahl 1989
Smith Island	Island	1973	1	Manuwal	Speich & Wahl 1989
Smith Island	Island	1979	44	Nisqually NWR	Speich & Wahl 1989
Smith Island	Island	1982	8	Nisqually NWR	Speich & Wahl 1989
Smith Island	Island	1983	1	WMNWRC	WMNWRC, unpubl.[6]
Smith Island	Island	1983	6	WMNWRC	WMNWRC, unpubl.[6]
Smith Island	Island	1984	10	WMNWRC	WMNWRC, unpubl.[6]
Smith Island	Island	1985	3	WMNWRC	WMNWRC, unpubl.[6]
Smith Island	Island	1986	6	WMNWRC	WMNWRC, unpubl.[6]
Smith Island	Island	2007	21	Hodum et al.	Hodum et al., unpubl.
Smith Island	Island	2007	11	Hodum et al.	Hodum et al., unpubl.
Smith Island	Island	2007	15	Hodum et al.	Hodum et al., unpubl.
Smith Island	Island	2008	25	Hodum et al.	Hodum et al., unpubl.
Smith Island	Island	2008	18	Hodum et al.	Hodum et al., unpubl.
Smith Island	Island	2009	5	Thomas	S. Thomas, pers. comm.
Smith Island	Island	2010	4	Thomas	S. Thomas, pers. comm.
Alexander Island	Jefferson	1907	5,000	Dawson	Dawson 1908b
Alexander Island	Jefferson	1907	Breeding	Jones	Jones 1908b
Alexander Island	Jefferson	1914-1915	5,000	Cantwell	Speich & Wahl 1989
Alexander Island	Jefferson	1974	Breeding	Hoffman	Speich & Wahl 1989
Alexander Island	Jefferson	1974	300-400	Nysewander	Speich & Wahl 1989
Alexander Island	Jefferson	1977	80	Harrington-Tweit	Speich & Wahl 1989
Alexander Island	Jefferson	1978	600-1,000	Pitman	Speich & Wahl 1989
Alexander Island	Jefferson	1978	400	Speich	Speich & Wahl 1989
Alexander Island	Jefferson	1978	4,000	Speich	Speich & Wahl 1989
Alexander Island	Jefferson	1981	45+	Wilson	Speich & Wahl 1989
Alexander Island	Jefferson	2005	117	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2005	706	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2005	123	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2007	145	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2007	158	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2008	136	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2009	116	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2010	11	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2010	63	Hodum et al.	Hodum et al., unpubl.
Alexander Island	Jefferson	2010	6	Hodum et al.	Hodum et al., unpubl.
Destruction Island	Jefferson	pre-1921	Present	Lien	Rathbun, unpubl.[7]
Destruction Island	Jefferson	1963	Specimens	Hudson	Speich & Wahl 1989
Destruction Island	Jefferson	1963	Specimen	LaFave	Speich & Wahl 1989
Destruction Island	Jefferson	1963	Breeding	LaFave	Speich & Wahl 1989
Destruction Island	Jefferson	1967	Breeding	Hancock	Speich & Wahl 1989
Destruction Island	Jefferson	1968-1969	Breeding	Cody	Cody 1973
Destruction Island	Jefferson	1973	550	Leschner	Speich & Wahl 1989
Destruction Island	Jefferson	1973	100s	Hoffman	Speich & Wahl 1989
Destruction Island	Jefferson	1973	400	Frazer, Reick	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Destruction Island	Jefferson	1975	650-700	Frazer	Speich & Wahl 1989
Destruction Island	Jefferson	1976	Specimen	Anonymous	Speich & Wahl 1989
Destruction Island	Jefferson	1976	Specimen	Welch	Speich & Wahl 1989
Destruction Island	Jefferson	1979	Breeding	Speich	Speich & Wahl 1989
Destruction Island	Jefferson	2007	92[2]	Hodum et al.	Hodum et al., unpubl.
Destruction Island	Jefferson	2008	52	Hodum et al.	Hodum et al., unpubl.
Destruction Island	Jefferson	2010	30	Hodum et al.	Hodum et al., unpubl.
Destruction Island	Jefferson	2010	19	Hodum et al.	Hodum et al., unpubl.
Ghost Rock	Jefferson	1981	25	Wilson	Speich & Wahl 1989
Half Round Rock	Jefferson	1974	1	Hoffman	Speich & Wahl 1989
Half Round Rock	Jefferson	1978	20	Speich	Speich & Wahl 1989
Half Round Rock	Jefferson	1981	2+	Wilson	Speich & Wahl 1989
Half Round Rock	Jefferson	2007	0	Hodum et al.	Hodum et al., unpubl.
Half Round Rock	Jefferson	2009	0	Hodum et al.	Hodum et al., unpubl.
Half Round Rock	Jefferson	2009	0	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	1923	80-100	Pennington	Speich & Wahl 1989
Protection Island	Jefferson	1955	140	Eddy	Speich & Wahl 1989
Protection Island	Jefferson	1956-1959	Breeding	Richardson	Richardson 1961
Protection Island	Jefferson	1966	Breeding	Wahl	Speich & Wahl 1989
Protection Island	Jefferson	1967	Breeding	Wahl	Speich & Wahl 1989
Protection Island	Jefferson	1968	Breeding	Wahl	Speich & Wahl 1989
Protection Island	Jefferson	1971	0	Wahl	Speich & Wahl 1989
Protection Island	Jefferson	1973	60-70	Frazer	Speich & Wahl 1989
Protection Island	Jefferson	1975-1976	66	Wilson	Speich & Wahl 1989
Protection Island	Jefferson	1976	33	Thompson	Galusha et al. 1987
Protection Island	Jefferson	1978	70-100	Pitman	Speich & Wahl 1989
Protection Island	Jefferson	1979	40	Speich	Speich & Wahl 1989
Protection Island	Jefferson	1980	76	Hirsch	Speich & Wahl 1989
Protection Island	Jefferson	1980	32	Galusha et al.	Galusha et al. 1987
Protection Island	Jefferson	1982	45	Galusha et al.	Galusha et al. 1987
Protection Island	Jefferson	1984	50	Galusha et al.	Galusha et al. 1987
Protection Island	Jefferson	1984	89	WMNWRC	WMNWRC, unpubl.[6]
Protection Island	Jefferson	1986	25	WMNWRC	WMNWRC, unpubl.[6]
Protection Island	Jefferson	1988	45	WMNWRC	WMNWRC, unpubl.[6]
Protection Island	Jefferson	1989	40	WMNWRC	WMNWRC, unpubl.[6]
Protection Island	Jefferson	1995	26	Wilson	Smith et al. 1997
Protection Island	Jefferson	2007	40	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	2007	14	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	2007	35	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	2007	4	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	2008	37	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	2008	23	Hodum et al.	Hodum et al., unpubl.
Protection Island	Jefferson	2011	23	WMNWRC	WMNWRC, unpubl.[6]
Protection Island	Jefferson	2012	20	WMNWRC	WMNWRC, unpubl.[6]
Protection Island	Jefferson	2013	22	WMNWRC	WMNWRC, unpubl.[6]
Rounded Island	Jefferson	1907	500	Dawson	Dawson 1908b
Rounded Island	Jefferson	1978	150	Speich	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Rounded Island	Jefferson	1981	20	Wilson	Speich & Wahl 1989
Rounded Island	Jefferson	2007	115	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2007	65	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2008	26	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2009	2	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2009	45	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2010	50	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2010	14	Hodum et al.	Hodum et al., unpubl.
Rounded Island	Jefferson	2010	12	Hodum et al.	Hodum et al., unpubl.
Bare Island[8]	San Juan	1903	Breeding[3]	Edson	Speich & Wahl 1989
Bare Island[8]	San Juan	1905	40	Edson	Edson 1929b
Bare Island[8]	San Juan	1933-1935	Breeding	Miller et al.	Miller et al. 1935
Bare Island[8]	San Juan	1936	Breeding	Miller	Miller 1936
Bare Island[8]	San Juan	1937	100	Jewett	Speich & Wahl 1989
Bare Island[8]	San Juan	1949	16	Hudson	Speich & Wahl 1989
Bare Island[8]	San Juan	1956	Breeding	Richardson	T. Scruton, pers. comm.
Bare Island[8]	San Juan	1957	Present	Eddy	Speich & Wahl 1989
Bare Island[8]	San Juan	1959	Breeding	Bakus	Speich & Wahl 1989
Bare Island[8]	San Juan	1959	<40	Dickerman	Dickerman 1960
Bare Island[8]	San Juan	1962	20	Nisqually NWR	Speich & Wahl 1989
Bare Island[8]	San Juan	1962	14	Eddy	Speich & Wahl 1989
Bare Island[8]	San Juan	1963	2	Nisqually NWR	Speich & Wahl 1989
Bare Island[8]	San Juan	1963	1	Hauser & Monson	Speich & Wahl 1989
Bare Island[8]	San Juan	1967	5	Scruton	T. Scruton, pers. comm.
Bare Island[8]	San Juan	1973-1975	4	Manuwal	Speich & Wahl 1989
Bare Island[8]	San Juan	1973	18	Manuwal	Speich & Wahl 1989
Bare Island[8]	San Juan	1974	3	Eddy	Speich & Wahl 1989
Bare Island[8]	San Juan	1976	Present	Games	Speich & Wahl 1989
Bare Island[8]	San Juan	1978	4	Speich & Wahl	Speich & Wahl 1989
Bare Island[8]	San Juan	2007	0	Hodum et al.	Hodum et al., unpubl.
Bare Island[8]	San Juan	2007	0	Hodum et al.	Hodum et al., unpubl.
Bare Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Bare Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Bird Rocks[8]	San Juan	1905	6	Edson	Edson 1929a
Bird Rocks[8]	San Juan	1937	2	Jewett	Speich & Wahl 1989
Bird Rocks[8]	San Juan	1942	Breeding[3]	Bushnell	Speich & Wahl 1989
Bird Rocks[8]	San Juan	1984	1	WMNWRC	WMNWRC, unpubl.[6]
Bird Rocks[8]	San Juan	2009	0	WMNWRC	WMNWRC, unpubl.[6]
Bird Rocks[8]	San Juan	2010	0	WMNWRC	WMNWRC, unpubl.[6]
Castle Island[8]	San Juan	1928	4	Rathbun	Rathbun, unpubl.[7]
Castle Island[8]	San Juan	1961	0	Eddy	Speich & Wahl 1989
Castle Island[8]	San Juan	2007	0	Hodum et al.	Hodum et al., unpubl.
Colville Island[8]	San Juan	1957	6+	Eddy	Speich & Wahl 1989
Colville Island[8]	San Juan	1961	2	Eddy	Speich & Wahl 1989
Colville Island[8]	San Juan	1962	6	Nisqually NWR	Speich & Wahl 1989
Colville Island[8]	San Juan	1967	0	Wahl	Speich & Wahl 1989
Colville Island[8]	San Juan	1968	Breeding	Wahl	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Colville Island[8]	San Juan	1970	0	Wahl	Speich & Wahl 1989
Colville Island[8]	San Juan	1978	20-30	Pitman	Speich & Wahl 1989
Colville Island[8]	San Juan	1979	5	Wahl	Speich & Wahl 1989
Colville Island[8]	San Juan	1983	9	WMNWRC	WMNWRC, unpubl.[6]
Colville Island[8]	San Juan	1984	5	WMNWRC	WMNWRC, unpubl.[6]
Colville Island[8]	San Juan	2007	0	Hodum et al.	Hodum et al., unpubl.
Colville Island[8]	San Juan	2007	0	Hodum et al.	Hodum et al., unpubl.
Colville Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Colville Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Flattop Island[8]	San Juan	1904	Specimen	MacKay	Speich & Wahl 1989
Flattop Island[8]	San Juan	1905	4-6	Edson	Edson 1929b
Flattop Island[8]	San Juan	1905	2	Edson	Edson 1929b
Flattop Island[8]	San Juan	1949	Specimen	Hudson	Speich & Wahl 1989
Flattop Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Flattop Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Goose Island	San Juan	1937	0	Jewett	Speich & Wahl 1989
Goose Island	SanJuan	2007	0	Hodum et al.	Hodum et al., unpubl.
Hall Island[8]	San Juan	1978	10	WMNWRC	WMNWRC, unpubl.[6]
Hall Island[8]	San Juan	1990	1	WMNWRC	WMNWRC, unpubl.[6]
Hall Island[8]	San Juan	2009	0	WMNWRC	WMNWRC, unpubl.[6]
Hall Island[8]	San Juan	2010	0	WMNWRC	WMNWRC, unpubl.[6]
Matia Island[8]	San Juan	1984	10	WMNWRC	WMNWRC, unpubl.[6]
Matia Island[8]	San Juan	2009	0	WMNWRC	WMNWRC, unpubl.[6]
Matia Island[8]	San Juan	2010	0	WMNWRC	WMNWRC, unpubl.[6]
Mummy Rocks	San Juan	1989	1	WMNWRC	WMNWRC, unpubl.[6]
Mummy Rocks	San Juan	1990	2	WMNWRC	WMNWRC, unpubl.[6]
North Pacific Rock	San Juan	1990	1	WMNWRC	WMNWRC, unpubl.[6]
Puffin Island[8]	San Juan	1938	Breeding[3]	Ray	Speich & Wahl 1989
Puffin Island[8]	San Juan	1957	4	Richardson	Speich & Wahl 1989
Puffin Island[8]	San Juan	1957	8+	Eddy	Speich & Wahl 1989
Puffin Island[8]	San Juan	1963	2	Nisqually NWR	Speich & Wahl 1989
Puffin Island[8]	San Juan	1963	7	Hauser & Monson	Speich & Wahl 1989
Puffin Island[8]	San Juan	1982	1	WMNWRC	WMNWRC, unpubl.[6]
Puffin Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Puffin Island[8]	San Juan	2008	0	Hodum et al.	Hodum et al., unpubl.
Secar Rock	San Juan	1982	0	Wahl	Speich & Wahl 1989
Secar Rock	San Juan	1985	1	WMNWRC	WMNWRC, unpubl.[6]
Shark Reef	San Juan	1978	1	WMNWRC	WMNWRC, unpubl.[6]
Skipjack Island[8]	San Juan	1905	Present	Edson	Edson 1929b
Skipjack Island[8]	San Juan	1933-1935	Breeding	Miller et al.	Miller et al. 1935
Skipjack Island[8]	San Juan	1936	Breeding	Miller	Miller 1936
South Peapod[8]	San Juan	1949	Breeding	Hudson	Speich & Wahl 1989
Sucia Islands[8]	San Juan	1886	Breeding[3]	Randolph, Johnson	Speich & Wahl 1989
The Sisters	San Juan	1963	2	Hauser & Monson	Speich & Wahl 1989
The Sisters (Little Sister)	San Juan	1976	1	WMNWRC	WMNWRC, unpubl.[6]
Turn Island	San Juan	1939	Specimen	Anonymous	Speich & Wahl 1989
Turn Island	San Juan	1979	0	Wahl	Speich & Wahl 1989

Colony Name	County	Year	Count	Observer	Reference
Unnamed (NWR Island 14)	San Juan	1980	6	WMNWRC	WMNWRC, unpubl.[6]
Waldron Island	San Juan	1895	Specimen	Edson	Speich & Wahl 1989
Waldron Island	San Juan	1949	Specimens	Hudson	Speich & Wahl 1989
Waldron Island	San Juan	1975	0	Eddy	Speich & Wahl 1989
Whale Rocks	San Juan	2007	0	Hodum et al.	Hodum et al., unpubl.
Viti Rocks	Skagit	1927	Specimen	Booth	Speich & Wahl 1989
Viti Rocks	Skagit	1949	4?	Hudson	Speich & Wahl 1989
Viti Rocks	Skagit	1975	0, 4 old burrows	Eddy	Speich & Wahl 1989
Williamson Rocks	Skagit	1905	12	Edson	Edson 1929a
Williamson Rocks	Skagit	1928	Breeding[3]	Booth	Speich & Wahl 1989
Williamson Rocks	Skagit	1928	Several	Booth	Speich & Wahl 1989
Williamson Rocks	Skagit	1930	Breeding[3]	Booth	Speich & Wahl 1989
Williamson Rocks	Skagit	1930	Several	Booth	Speich & Wahl 1989
Williamson Rocks	Skagit	1957	16	Thorsen & Booth	Speich & Wahl 1989
Williamson Rocks	Skagit	1957-1976	Breeding	Thorsen	Thorsen 1981
Williamson Rocks	Skagit	1963	8	Thorsen & Galusha	Thorsen & Galusha 1971
Williamson Rocks	Skagit	1963	1	Hauser & Monson	Speich & Wahl 1989
Williamson Rocks	Skagit	1967	5	Nisqually NWR	Speich & Wahl 1989
Williamson Rocks	Skagit	1975	1	Eddy	Speich & Wahl 1989
Williamson Rocks	Skagit	1977	6+	Thorsen	Thorsen 1980, 1981
Williamson Rocks	Skagit	1985	2	WMNWRC	WMNWRC, unpubl.[6]
Williamson Rocks	Skagit	2008	0	Hodum et al.	Hodum et al., unpubl.
Williamson Rocks	Skagit	2008	0	Hodum et al.	Hodum et al., unpubl.

[1] No puffins were detected on Bodelteh East.
[2] Colony size was estimated at ≥100 puffins (S. Pearson, pers. comm.).
[3] Breeding was determined by the collection of one or more eggs, which are held as museum specimens (Speich and Wahl 1989).
[4] The Quillayute Needles Group is comprised of various rocks and small islands, including Cakesota, Dhuoyautzachtahl, and Table Rock (Speich and Wahl 1989), which are listed individually elsewhere in this appendix.
[5] The Point Grenville Rocks are comprised of various rocks and small islands, including Erin's Bride, Grenville Arch, Grenville Pillar, and Puffin Island, as well as the Point Grenville Cliffs (Speich and Wahl 1989), which are listed individually elsewhere in this appendix.
[6] WMNWRC, Washington Marine National Wildlife Refuge Complex.
[7] Unpublished field notes of S. F. Rathbun held at the Burke Museum, University of Washington, Seattle, Washington.
[8] Classified here as a former breeding island. Speich and Wahl (1989) listed 11 San Juan Islands as current or former breeding sites for Tufted Puffins, but we consider their supporting evidence as insufficient for three islands (The Sisters, Turn Island, Waldron Island). We instead used the following criteria to establish an island as a breeding site in the San Juans: (1) records of breeding, including collected egg specimens, are documented for the island in Speich and Wahl (1989), or (2) ≥3 puffins were observed at least once at the island, and descriptions and photographs of the island (USFWS 2010) suggest that potentially suitable habitat for breeding occurs there. Based on these criteria, we continue to classify 11 San Juan Islands as former breeding sites. This includes two islands (Hall Island, Matia Island) where use was documented by the Washington Marine National Wildlife Refuge Complex (unpubl. data) and one island (Castle Island) where breeding was documented by S. F. Rathbun (unpubl. notes); use of these three islands was not reported in Speich and Wahl (1989).

Appendix B. Washington Administrative Codes 232-12-011, 232-12-014, and 232-12-297 and Revised Codes of Washington 77.15.120 and 77.15.130.

WAC 232-12-011 Wildlife classified as protected shall not be hunted or fished.

Protected wildlife are designated into three subcategories: threatened, sensitive, and other.

(1) Threatened species are any wildlife species native to the state of Washington that are likely to become endangered within the foreseeable future throughout a significant portion of their range within the state without cooperative management or removal of threats. Protected wildlife designated as threatened include:

Common Name	**Scientific Name**
Mazama pocket gopher	*Thomomys mazama*
western gray squirrel	*Sciurus griseus*
Steller (northern) sea lion	*Eumetopias jubatus*
North American lynx	*Lynx canadensis*
Aleutian Canada goose	*Branta canadensis leucopareia*
bald eagle	*Haliaeetus leucocephalus*
ferruginous hawk	*Buteo regalis*
marbled murrelet	*Brachyramphus marmoratus*
green sea turtle	*Chelonia mydas*
loggerhead sea turtle	*Caretta caretta*
sage grouse	*Centrocercus urophasianus*
sharp-tailed grouse	*Phasianus columbianus*

(2) Sensitive species are any wildlife species native to the state of Washington that are vulnerable or declining and are likely to become endangered or threatened in a significant portion of their range within the state without cooperative management or removal of threats. Protected wildlife designated as sensitive include:

Common Name	**Scientific Name**
gray whale	*Eschrichtius gibbosus*
common Loon	*Gavia immer*
peregrine falcon	*Falco peregrinus*
Larch Mountain salamander	*Plethodon larselli*
pygmy whitefish	*Prosopium coulteri*
margined sculpin	*Cottus marginatus*
Olympic mudminnow	*Novumbra hubbsi*

(3) Other protected wildlife include:

Common Name	**Scientific Name**
cony or pika	*Ochotona princeps*
least chipmunk	*Tamius minimus*
yellow-pine chipmunk	*Tamius amoenus*
Townsend's chipmunk	*Tamius townsendii*
red-tailed chipmunk	*Tamius ruficaudus*
hoary marmot	*Marmota caligata*
Olympic marmot	*Marmota olympus*
Cascade golden-mantled ground squirrel	*Spermophilus saturatus*
golden-mantled ground squirrel	*Spermophilus lateralis*
Washington ground squirrel	*Spermophilus washingtoni*
red squirrel	*Tamiasciurus hudsonicus*
Douglas squirrel	*Tamiasciurus douglasii*
northern flying squirrel	*Glaucomys sabrinus*
Wolverine	*Gulo gulo*
painted turtle	*Chrysemys picta*
California mountain kingsnake	*Lampropeltis zonata*

All birds not classified as game birds, predatory birds or endangered species, or designated as threatened species or sensitive species; all bats, except when found in or immediately adjacent to a dwelling or other occupied building; mammals of the order Cetacea, including whales, porpoises, and mammals of the order Pinnipedia not otherwise classified as endangered species, or designated as threatened species or sensitive species. This section shall not apply to hair seals and sea lions which are threatening to damage or are damaging commercial fishing gear being utilized in a lawful manner or when said mammals are damaging or threatening to damage commercial fish being lawfully taken with commercial gear.

[Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 06-04-066 (Order 06-09), § 232-12-011, filed 1/30/06, effective 3/2/06; 04-11-036 (Order 04-98), § 232-12-014, filed 5/12/04, effective 6/12/04. Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 02-11-069 (Order 02-98), § 232-12-011, filed 5/10/02, effective 6/10/02. Statutory Authority: RCW 77.12.047. 02-08-048 (Order 02-53), § 232-12-011, filed 3/29/02, effective 5/1/02; 00-17-106 (Order 00-149), § 232-12-011, filed 8/16/00, effective 9/16/00. Statutory Authority: RCW 77.12.040, 77.12.010, 77.12.020, 77.12.770. 00-10-001 (Order 00-47), § 232-12-011, filed 4/19/00, effective 5/20/00. Statutory Authority: RCW 77.12.040, 77.12.010, 77.12.020, 77.12.770, 77.12.780. 00-04-017 (Order 00-05), § 232-12-011, filed 1/24/00, effective 2/24/00. Statutory Authority: RCW 77.12.020. 98-23-013 (Order 98-232), § 232-12-011, filed 11/6/98, effective 12/7/98. Statutory Authority: RCW 77.12.040. 98-10-021 (Order 98-71), § 232-12-011, filed 4/22/98, effective 5/23/98. Statutory Authority: RCW 77.12.040 and 75.08.080. 98-06-031, § 232-12-011, filed 2/26/98, effective 5/1/98. Statutory Authority: RCW 77.12.020. 97-18-019 (Order 97-167), § 232-12-011, filed 8/25/97, effective 9/25/97. Statutory Authority: RCW 77.12.040, 77.12.020, 77.12.030 and 77.32.220. 97-12-048, § 232-12-011, filed 6/2/97, effective 7/3/97. Statutory Authority: RCW 77.12.020. 93-21-027 (Order 615), § 232-12-011, filed 10/14/93, effective 11/14/93; 90-11-065 (Order 441), § 232-12-011, filed 5/15/90, effective 6/15/90. Statutory Authority: RCW 77.12.040. 89-11-061 (Order 392), § 232-12-011, filed 5/18/89; 82-19-026 (Order 192), § 232-12-011, filed 9/9/82; 81-22-002 (Order 174), § 232-12-011, filed 10/22/81; 81-12-029 (Order 165), § 232-12-011, filed 6/1/81.]

WAC 232-12-014 Wildlife classified as endangered species. Endangered species include:

Common Name	**Scientific Name**
pygmy rabbit	*Brachylagus idahoensis*
Fisher	*Martes pennanti*
gray wolf	*Canis lupus*
grizzly bear	*Ursus arctos*
sea otter	*Enhydra lutris*
sei whale	*Balaenoptera borealis*
fin whale	*Balaenoptera physalus*
blue whale	*Balaenoptera musculus*
humpback whale	*Megaptera novaeangliae*
black right whale	*Balaena glacialis*
sperm whale	*Physeter macrocephalus*
killer whale	*Orcinus orca*
Columbian white-tailed deer	*Odocoileus virginianus leucurus*
woodland caribou	*Rangifer tarandus caribou*
American white pelican	*Pelecanus erythrorhynchos*
brown pelican	*Pelecanus occidentalis*
sandhill crane	*Grus canadensis*
snowy plover	*Charadrius alexandrinus*
upland sandpiper	*Bartramia longicauda*
spotted owl	*Strix occidentalis*
Streaked horned lark	*Eremophila alpestris strigata*
western pond turtle	*Clemmys marmorata*
leatherback sea turtle	*Dermochelys coriacea*
mardon skipper	*Polites mardon*
Oregon silverspot butterfly	*Speyeria zerene hippolyta*
Taylor's checkerspot	*Euphydryas editha taylori*
Oregon spotted frog	*Rana pretiosa*
northern leopard frog	*Rana pipiens*

[Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 06-04-066 (Order 06-09), § 232-12-014, filed 1/30/06, effective 3/2/06. Statutory Authority: RCW 77.12.047, 77.12.655, 77.12.020. 02-11-069 (Order 02-98), § 232-12-014, filed 5/10/02, effective 6/10/02. Statutory Authority: RCW 77.12.040, 77.12.010, 77.12.020, 77.12.770, 77.12.780. 00-04-017 (Order 00-05), § 232-12-014, filed 1/24/00, effective 2/24/00. Statutory Authority: RCW 77.12.020. 98-23-013 (Order 98-232), § 232-12-014, filed 11/6/98, effective 12/7/98; 97-18-019 (Order 97-167), § 232-12-014, filed 8/25/97, effective 9/25/97; 93-21-026 (Order 616), § 232-12-014, filed 10/14/93, effective 11/14/93. Statutory Authority: RCW 77.12.020(6). 88-05-032 (Order 305), § 232-12-014, filed 2/12/88. Statutory Authority: RCW 77.12.040. 82-19-026 (Order 192), § 232-12-014, filed 9/9/82; 81-22-002 (Order 174), § 232-12-014, filed 10/22/81; 81-12-029 (Order 165), § 232-12-014, filed 6/1/81.

WAC 232-12-297 Endangered, threatened, and sensitive wildlife species classification.

PURPOSE

1.1 The purpose of this rule is to identify and classify native wildlife species that have need of protection and/or management to ensure their survival as free-ranging populations in Washington and to define the process by which listing, management, recovery, and delisting of a species can be achieved. These rules are established to ensure that consistent procedures and criteria are followed when classifying wildlife as endangered, or the protected wildlife subcategories threatened or sensitive.

<u>DEFINITIONS</u>

For purposes of this rule, the following definitions apply:

2.1 "Classify" and all derivatives means to list or delist wildlife species to or from endangered, or to or from the protected wildlife subcategories threatened or sensitive.

2.2 "List" and all derivatives means to change the classification status of a wildlife species to endangered, threatened, or sensitive.

2.3 "Delist" and its derivatives means to change the classification of endangered, threatened, or sensitive species to a classification other than endangered, threatened, or sensitive.

2.4 "Endangered" means any wildlife species native to the state of Washington that is seriously threatened with extinction throughout all or a significant portion of its range within the state.

2.5 "Threatened" means any wildlife species native to the state of Washington that is likely to become an endangered species within the forseeable future throughout a significant portion of its range within the state without cooperative management or removal of threats.

2.6 "Sensitive" means any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened in a significant portion of its range within the state without cooperative management or removal of threats.

2.7 "Species" means any group of animals classified as a species or subspecies as commonly accepted by the scientific community.

2.8 "Native" means any wildlife species naturally occurring in Washington for purposes of breeding, resting, or foraging, excluding introduced species not found historically in this state.

2.9 "Significant portion of its range" means that portion of a species' range likely to be essential to the long term survival of the population in Washington.

<u>LISTING CRITERIA</u>

3.1 The commission shall list a wildlife species as endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available, except as noted in section 3.4.

3.2 If a species is listed as endangered or threatened under the federal Endangered Species Act, the agency will recommend to the commission that it be listed as endangered or threatened as specified in section 9.1. If listed, the agency will proceed with development of a recovery plan pursuant to section 11.1.

3.3 Species may be listed as endangered, threatened, or sensitive only when populations are in danger of failing, declining, or are vulnerable, due to factors including but not restricted to limited numbers, disease, predation, exploitation, or habitat loss or change, pursuant to section 7.1.

3.4 Where a species of the class Insecta, based on substantial evidence, is determined to present an unreasonable risk to public health, the commission may make the determination that the species need not be listed as endangered, threatened, or sensitive.

<u>DELISTING CRITERIA</u>

4.1 The commission shall delist a wildlife species from endangered, threatened, or sensitive solely on the basis of the biological status of the species being considered, based on the preponderance of scientific data available.

4.2 A species may be delisted from endangered, threatened, or sensitive only when populations are no longer in danger of failing, declining, are no longer vulnerable, pursuant to section 3.3, or meet recovery plan goals, and when it no longer meets the definitions in sections 2.4, 2.5, or 2.6.

<u>INITIATION OF LISTING PROCESS</u>

5.1 Any one of the following events may initiate the listing process.

5.1.1 The agency determines that a species population may be in danger of failing, declining, or vulnerable, pursuant to section 3.3.

5.1.2 A petition is received at the agency from an interested person. The petition should be addressed to the director. It should set forth specific evidence and scientific data which shows that the species may be failing, declining, or vulnerable, pursuant to section 3.3. Within 60 days, the agency shall either deny the petition, stating the reasons, or initiate the classification process.

5.1.3 An emergency, as defined by the Administrative Procedure Act, chapter 34.05 RCW. The listing of any species previously classified under emergency rule shall be governed by the provisions of this section.

5.1.4 The commission requests the agency review a species of concern.

5.2 Upon initiation of the listing process the agency shall publish a public notice in the Washington Register, and notify those parties who have expressed their interest to the department, announcing the initiation of the classification process and calling for scientific information relevant to the species status report under consideration pursuant to section 7.1.

<u>INITIATION OF DELISTING PROCESS</u>

6.1 Any one of the following events may initiate the delisting process:

6.1.1 The agency determines that a species population may no longer be in danger of failing, declining, or vulnerable, pursuant to section 3.3.

6.1.2 The agency receives a petition from an interested person. The petition should be addressed to the director. It should set forth specific evidence and scientific data which shows that the species may no longer be failing, declining, or vulnerable, pursuant to section 3.3. Within 60 days, the agency shall either deny the petition, stating the reasons, or initiate the delisting process.

6.1.3 The commission requests the agency review a species of concern.

6.2 Upon initiation of the delisting process the agency shall publish a public notice in the Washington Register, and notify those parties who have expressed their interest to the department, announcing the initiation of the delisting process and calling for scientific information relevant to the species status report under consideration pursuant to section 7.1.

<u>SPECIES STATUS REVIEW AND AGENCY RECOMMENDATIONS</u>

7.1 Except in an emergency under 5.1.3 above, prior to making a classification recommendation to the commission, the agency shall prepare a preliminary species status report. The report will include a review of information relevant to the species' status in Washington and address factors affecting its status, including those given under section 3.3. The status report shall be reviewed by the public and scientific community. The status report will include, but not be limited to an analysis of:

7.1.1 Historic, current, and future species population trends.

7.1.2 Natural history, including ecological relationships (e.g., food habits, home range, habitat selection patterns).

7.1.3 Historic and current habitat trends.

7.1.4 Population demographics (e.g., survival and mortality rates, reproductive success) and their relationship to long term sustainability.

7.1.5 Historic and current species management activities.

7.2 Except in an emergency under 5.1.3 above, the agency shall prepare recommendations for species classification, based upon scientific data contained in the status report. Documents shall be prepared to determine the environmental consequences of adopting the recommendations pursuant to requirements of the State Environmental Policy Act (SEPA).

7.3 For the purpose of delisting, the status report will include a review of recovery plan goals.

<u>PUBLIC REVIEW</u>

8.1 Except in an emergency under 5.1.3 above, prior to making a recommendation to the commission, the agency shall provide an opportunity for interested parties to submit new scientific data relevant to the status report, classification recommendation, and any SEPA findings.

8.1.1 The agency shall allow at least 90 days for public comment.

<u>FINAL RECOMMENDATIONS AND COMMISSION ACTION</u>

9.1 After the close of the public comment period, the agency shall complete a final status report and classification recommendation. SEPA documents will be prepared, as necessary, for the final agency recommendation for classification. The classification recommendation will be presented to the commission for action. The final species status report, agency classification recommendation, and SEPA documents will be made available to the public at least 30 days prior to the commission meeting.

9.2 Notice of the proposed commission action will be published at least 30 days prior to the commission meeting.

PERIODIC SPECIES STATUS REVIEW

10.1 The agency shall conduct a review of each endangered, threatened, or sensitive wildlife species at least every five years after the date of its listing. This review shall include an update of the species status report to determine whether the status of the species warrants its current listing status or deserves reclassification.

10.1.1 The agency shall notify any parties who have expressed their interest to the department of the periodic status review. This notice shall occur at least one year prior to end of the five year period required by section 10.1.

10.2 The status of all delisted species shall be reviewed at least once, five years following the date of delisting.

10.3 The department shall evaluate the necessity of changing the classification of the species being reviewed. The agency shall report its findings to the commission at a commission meeting. The agency shall notify the public of its findings at least 30 days prior to presenting the findings to the commission.

10.3.1 If the agency determines that new information suggests that classification of a species should be changed from its present state, the agency shall initiate classification procedures provided for in these rules starting with section 5.1.

10.3.2 If the agency determines that conditions have not changed significantly and that the classification of the species should remain unchanged, the agency shall recommend to the commission that the species being reviewed shall retain its present classification status.

10.4 Nothing in these rules shall be construed to automatically delist a species without formal commission action.

RECOVERY AND MANAGEMENT OF LISTED SPECIES

11.1 The agency shall write a recovery plan for species listed as endangered or threatened. The agency will write a management plan for species listed as sensitive. Recovery and management plans shall address the listing criteria described in sections 3.1 and 3.3, and shall include, but are not limited to:

11.1.1 Target population objectives.

11.1.2 Criteria for reclassification.

11.1.3 An implementation plan for reaching population objectives which will promote cooperative management and be sensitive to landowner needs and property rights. The plan will specify resources needed from and impacts to the department, other agencies (including federal, state, and local), tribes, landowners, and other interest groups. The plan shall consider various approaches to meeting recovery objectives including, but not limited to regulation, mitigation, acquisition, incentive, and compensation mechanisms.

11.1.4 Public education needs.

11.1.5 A species monitoring plan, which requires periodic review to allow the incorporation of new information into the status report.

11.2 Preparation of recovery and management plans will be initiated by the agency within one year after the date of listing.

11.2.1 Recovery and management plans for species listed prior to 1990 or during the five years following the adoption of these rules shall be completed within five years after the date of listing or adoption of these rules, whichever comes later. Development of recovery plans for endangered species will receive higher priority than threatened or sensitive species.

11.2.2 Recovery and management plans for species listed after five years following the adoption of these rules shall be completed within three years after the date of listing.

11.2.3 The agency will publish a notice in the Washington Register and notify any parties who have expressed interest to the department interested parties of the initiation of recovery plan development.

11.2.4 If the deadlines defined in sections 11.2.1 and 11.2.2 are not met the department shall notify the public and report the reasons for missing the deadline and the strategy for completing the plan at a commission meeting. The intent of this section is to recognize current department personnel resources are limiting and that development of recovery plans for some of the species may require significant involvement by interests outside of the department, and therefore take longer to complete.

11.3 The agency shall provide an opportunity for interested public to comment on the recovery plan and any SEPA documents.

CLASSIFICATION PROCEDURES REVIEW

12.1 The agency and an ad hoc public group with members representing a broad spectrum of interests, shall meet as needed to accomplish the following:

12.1.1 Monitor the progress of the development of recovery and management plans and status reviews, highlight problems, and make recommendations to the department and other interested parties to improve the effectiveness of these processes.

12.1.2 Review these classification procedures six years after the adoption of these rules and report its findings to the commission.

AUTHORITY

13.1 The commission has the authority to classify wildlife as endangered under RCW 77.12.020. Species classified as endangered are listed under WAC 232-12-014, as amended.

13.2 Threatened and sensitive species shall be classified as subcategories of protected wildlife. The commission has the authority to classify wildlife as protected under RCW 77.12.020. Species classified as protected are listed under WAC 232-12-011, as amended. [Statutory Authority: RCW 77.12.020. 90-11-066 (Order 442), § 232-12-297, filed 5/15/90, effective 6/15/90.]

RCW 77.15.120 Endangered fish or wildlife – Unlawful taking – Penalty.

(1) A person is guilty of unlawful taking of endangered fish or wildlife in the second degree if the person hunts, fishes, possesses, maliciously harasses or kills fish or wildlife, or maliciously destroys the nests or eggs of fish or wildlife and the fish or wildlife is designated by the commission as endangered, and the taking has not been authorized by rule of the commission.

(2) A person is guilty of unlawful taking of endangered fish or wildlife in the first degree if the person has been:

(a) Convicted under subsection (1) of this section or convicted of any crime under this title involving the killing, possessing, harassing, or harming of endangered fish or wildlife; and

(b) Within five years of the date of the prior conviction the person commits the act described by subsection (1) of this section.

(3)(a) Unlawful taking of endangered fish or wildlife in the second degree is a gross misdemeanor.

(b) Unlawful taking of endangered fish or wildlife in the first degree is a class C felony. The department shall revoke any licenses or tags used in connection with the crime and order the person's privileges to hunt, fish, trap, or obtain licenses under this title to be suspended for two years.

[2000 c 107 § 236; 1998 c 190 § 13.]

RCW 77.15.130 Protected fish or wildlife — Unlawful taking — Penalty.

(1) A person is guilty of unlawful taking of protected fish or wildlife if:

(a) The person hunts, fishes, possesses, or maliciously kills protected fish or wildlife, or the person possesses or maliciously destroys the eggs or nests of protected fish or wildlife, and the taking has not been authorized by rule of the commission; or

(b) The person violates any rule of the commission regarding the taking, harming, harassment, possession, or transport of protected fish or wildlife.

(2) Unlawful taking of protected fish or wildlife is a misdemeanor.

[1998 c 190 § 14.]

Appendix C. WDFW responses to public comments received during both the 90-day public review period for the draft *Washington State Status Report for the Tufted Puffin* conducted from September 12 to December 11, 2014, and the 14-day public review period for the final report conducted under the State Environmental Policy Act (SEPA) from January 9-23, 2015. The comments presented here are summaries of the remarks provided by one or more people.

Report Section	Comment and Response
General comments	1. I support the listing of Tufted Puffins as state endangered in Washington for the reasons provided in the status report.
	WDFW is recommending that Tufted Puffins be added to the state endangered species list because of substantial scientific evidence indicating that the species has experienced a major decline in abundance in Washington since about the 1970s. Tufted Puffin sightings declined on average by 13.9% per year in pelagic surveys off Westport, Washington, between 1983 and 2001, and 8.9% per year in offshore surveys along the outer Washington coast from Cape Flattery to Point Grenville from 2001 to 2012. Colony visits from 2007 to 2010 noted widespread abandonment and an apparent order of magnitude population decline since the last summary assessment from 1978-1984. Overall, 57% of the 44 historically documented puffin breeding sites in Washington are no longer active. Maximum estimates once ranked nine colonies at 1,000 or more individuals, with two reaching 10,000 or more birds, but none of the 19 remaining breeding sites now contains more than a few hundred birds. In combination, of the 44 once-documented breeding sites, 39 have either been abandoned or experienced an order of magnitude decline. Puffins in Washington's inner marine waters are at particular risk, with only two active breeding sites now remaining, both in the eastern Strait of Juan de Fuca, that together contain a population of a few dozen individuals. None of the 11 historically known breeding colonies in the San Juan Islands remain active.
	2. I oppose the listing of Tufted Puffins as state endangered in Washington.
	Comment noted. By law (WAC 232-12-297), species listings and delistings by the state must be based solely on the biological status of the species and its continued existence in the state.
	3. There are concreate actions that can be taken in Washington to recover Tufted Puffins, in particular doing more to restore prey fish. A plan should be formulated to stop the decline of this species.
	If the Washington Fish and Wildlife Commission classifies Tufted Puffins as a state endangered species, WDFW will prepare a recovery plan for the species as required in WAC 232-12-297, Section 11.1, which will describe different actions that can be taken to recover puffins in Washington. These activities may include, for example, expanded research on the species to determine the cause(s) of its decline; expanded monitoring of prey fish trends; eradication of European rabbits from Destruction Island, where puffins nest; management of invasive plants on nesting islands; and continued planning to avoid oil spills in Washington's marine waters.
	4. The Washington State Department of Natural Resources hopes to collaborate with WDFW in developing management actions for puffins on its aquatic reserves and other aquatic lands in the state.

Report Section	Comment and Response
	WDFW appreciates this offer for collaboration and looks forward to working with the Washington State Department of Natural Resources on puffin recovery planning and conservation implementation in the future.
	5. The puffin report's conclusions and recommendation are completely unwarranted and unsupported by the data available and presented. The report fails to adequately make a case for listing Tufted Puffins as endangered in Washington. I want to see good, documentable, applicable, verifiable, and real science that supports legitimate, not pre-determined and ideological conclusions.
	WDFW disagrees with this comment and believes the Washington State Status Report for the Tufted Puffin was prepared using the best available scientific information on the species. Draft versions of the report were reviewed by scientists and knowledgeable staff within WDFW and numerous scientists and species experts outside of the agency. The final status report reflects their suggested edits. None of these reviewers questioned the report's conclusions and recommendations, or its use of the science.
	6. I used to see lots of sea ducks from Whidbey Island to Port Angeles in the 1970s and 1980s, and enjoyed hunting them. From what I read in your report, there is not enough of a population to support harvesting puffins, therefore I support protecting them.
	WDFW has never had a hunting season on Tufted Puffins. The status report does not mention the hunting of puffins except during historical times, when tribal harvest of eggs and birds was conducted.
Natural History	7. It might be useful to also cite the publication by Tyler et al. (1993), which states that Tufted Puffins forage in fairly low densities.
	This information was added to the status report (page 6).
	8. Data confirming monogamy and long-term pair-bonding in this species are extremely limited. We suggest using language indicating high mate fidelity, as opposed to monogamy.
	This correction was made in the status report (page 7).
	9. The report notes that females lay only one egg, with a possible second egg being laid if the first is lost. This naturally low reproductive rate should be discussed as a biological factor causing Tufted Puffins to be particularly vulnerable to nest failure when disturbances are present.
	This information was not added to the status report because the authors were unable to confirm in the scientific literature whether single-egg clutches do indeed make Tufted Puffins more vulnerable to nest failure from disturbance.
	10. We suggest including a reference by Peterson (1982) documenting Red Fox predation on adults in Alaska.
	This citation was not added to the status report because predation by Red Foxes was already noted in the report.

Report Section	Comment and Response
	11. We appreciate the inclusion of useful comparative data from related species on the potential impact of gull kleptoparasitism. We have received anecdotal information that these species also prey upon young Tufted Puffins. We suggest this as an area requiring further research (to be added to the Research Needs section), particularly in light of increasing abundance of gulls.
	A statement about needing more information on gull kleptoparasitism was added to the Research Needs section (page 20).
Population Status and Trends	12. Table 2 in the status report shows that making comparisons between data sets is problematic. For example, comparing Protection Island with Westport is difficult because the former includes 10 years prior to the latter (with 1.5 times as many years measured). We recommend finding a way to standardize years used for comparison across sites. It would be helpful to see the data provided in Table 2 (separated out by sites) plotted on one graph with time on the X-axis and percent population change on the Y-axis.
	This change was not made. Much of the information appearing in the table for locations outside of Washington was taken from Piatt and Kitaysky (2002) and WDFW does not have access to the data. Population trends for the four data sets in Washington are depicted in greater detail in Figure 2 of the status report.
Conservation Status	13. The report mistakenly states that the U.S. Fish and Wildlife Service will decide whether or not to federally list the Tufted Puffin in Washington, Oregon, and California in 2016 or 2017. In fact, this is when their listing evaluation will be initiated. A final listing decision will likely not be made until 2018-2020.
	This correction was made in the status report (pages v and 18).
Research, Monitoring, and Restoration	14. The Restoration Potential section should also include information on habitat restoration activities that could be done at current and former puffin breeding islands in Washington.
	This information was added to the status report (page 20).
Factors Affecting Continuing Existence	15. The section on Adequacy of Existing Regulatory Mechanisms should clarify what protections will be afforded to puffins through state listing as endangered.
	This information was added to the status report (page 21).
	16. I believe that the lack of sufficient small forage fish is very likely causing the decrease in puffins and other marine waterbirds in Washington. WDFW and the Washington Fish and Wildlife Commission have not done enough to reduce the harvest of forage fish in the state.
	The causes of the Tufted Puffin decline in Washington remain undetermined because of a lack of scientific information. The status report includes a section on reduced prey availability that discusses changes in forage fish populations in the state and how this might affect Tufted Puffins. Harvest of several forage fish species in Washington have been reduced in recent years in response to concerns about declining abundance of those species. In addition, pelagic fisheries for sardines and anchovies are managed by the Pacific Fishery Management Council (of which WDFW is a member) with a priority for maintaining their ecosystem functions, primarily as a food source for seabirds, marine mammals, salmon, and other predators.

Report Section	Comment and Response
	17. In the Reduced Prey Availability section, we suggest citing a recent scientific paper by Santora et al. (2014) that describes the relationships among prey species and seabirds in California.
	This reference was added to the status report (pages 21 and 23).
	18. The section on oil spills should mention that the use of single-hull tanker vessels will be completely phased out in the U.S. in January 2015.
	This information was added to the status report (page 27).
	19. In the Environmental Contaminants section, we suggest citing a recent scientific paper by Desforges et al. (2014) that describes the occurrence of microplastics in coastal British Columbia and adjacent waters of Washington.
	Information from this reference was added to the status report (page 27).
	20. Please prevent human disturbance at all remaining nesting sites for Tufted Puffins that are under WDFW's jurisdiction.
	Nearly all current and former puffin breeding sites in Washington are managed by the U.S. Fish and Wildlife Service (USFWS) as parts of their national wildlife refuges. These islands are visited only occasionally by scientists and land managers, and are off-limits to the general public. However, some former nesting sites in the San Juan Islands may be subject to unlawful visitation by kayakers and boaters. If WDFW prepares a recovery plan for puffins (see response to Comment 3), an action would likely be included to work with the USFWS to minimize this type of visitation.
	21. Is it possible that the growing cormorant population is crowding puffins out of their traditional breeding sites?
	There is no evidence of this occurring. The Double-crested Cormorant population has greatly increased in Washington in recent years, but it is no longer known to breed on any puffin nesting islands in the state. Pelagic and Brandt's Cormorants nest on some of the islands occupied by Tufted Puffins, but both species nest in areas separate from puffins and thus do not compete for space with puffins. In addition, WDFW biologists have never observed aggressive interactions between puffins and cormorants on these islands, which can be an indication of competitive interactions.

Washington State Status Reports, Periodic Status Reviews, Recovery Plans, and Conservation Plans

Status Reports

2015	Tufted Puffin
2007	Bald Eagle
2005	Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot
2005	Aleutian Canada Goose
2004	Killer Whale
2002	Peregrine Falcon
2000	Common Loon
1999	Northern Leopard Frog
1999	Olympic Mudminnow
1999	Mardon Skipper
1999	Lynx Update
1998	Fisher
1998	Margined Sculpin
1998	Pygmy Whitefish
1998	Sharp-tailed Grouse
1998	Sage-grouse
1997	Aleutian Canada Goose
1997	Gray Whale
1997	Olive Ridley Sea Turtle
1997	Oregon Spotted Frog
1993	Larch Mountain Salamander
1993	Lynx
1993	Marbled Murrelet
1993	Oregon Silverspot Butterfly
1993	Pygmy Rabbit
1993	Steller Sea Lion
1993	Western Gray Squirrel
1993	Western Pond Turtle

Periodic Status Reviews

2015	Steller Sea Lion

Recovery Plans

2012	Columbia Sharp-tailed Grouse
2011	Gray Wolf
2007	Western Gray Squirrel
2006	Fisher
2004	Sea Otter
2004	Greater Sage-Grouse
2003	Pygmy Rabbit: Addendum
2002	Sandhill Crane
2001	Pygmy Rabbit: Addendum
2001	Lynx
1999	Western Pond Turtle
1996	Ferruginous Hawk
1995	Pygmy Rabbit
1995	Upland Sandpiper
1995	Snowy Plover

Conservation Plans

2013	Bats

Reports, reviews, and plans are available on the Washington Department of Fish and Wildlife website at: http://wdfw.wa.gov/publications/search.php

*Tufted Puffin near Smith Island, Washington (*Photo © Bill Hoglund*)*