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Conservation Plan for the Eastern Pacific Stock of Northern Fur Seal (Laaqudax̂)

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Cover photos

Top: Mike Williams (Alaska Regional Office), bottom left: Jamie Musbach (Alaska Sea Grant), bottom right: Mike Williams

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Abbreviations, acronyms, and terms

ABC	Acceptable biological catch
ACLIM	Alaska Climate Integrated Modeling Project
ACSPI	Aleut Community of St. Paul Island
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center (NMFS)
AMMC	Aleut Marine Mammal Commission
AMMOP	Alaska Marine Mammal Observer Program
ANO	Alaska Native Organization
ANSEP	Alaska Native Science and Engineering Program
Barabara	Semi-submerged sod house
BOEM	Bureau of Ocean Energy Management
BSAI	Bering Sea and Aleutian Islands
CFR	Code of Federal Regulations
Conservation Plan	Northern Fur Seal Conservation Plan
DDT	Dichlorodiphenyltricholoethane
DMRs	Discharge Monitoring Reports
ECO	Ecosystem Conservation Office
EEZ	U.S. Exclusive Economic Zone
EM	Electronic monitoring
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FMP	Fishery Management Plan
FR	Federal Register
FSA	Fur Seal Act of 1966
HAB	Harmful algal bloom
Iggadaagix̂	Unangax̂ historical figure who discovered the Pribilof Islands and their fur seal rookeries
Iqyax̂	Traditional Unangax̂ kayak
Isugin	Harbor seals
Laaqudax̂	Northern fur seal
Laaqudan	Northern fur seals
MML	Marine Mammal Laboratory (part of the AFSC)
MMPA	Marine Mammal Protection Act
MNPL	Maximum net productivity level (50–70 percent of OSP)
NAB	North Aleutian Basin
NBSCRA	Northern Bering Sea Climate Resiliency Area
NPDES	National Pollutant Discharge and Elimination System
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fishery Management Council
NPFSC	North Pacific Fur Seal Commission
NOAA	National Oceanic and Atmospheric Administration

OCP	Organochlorines
OFL	Overfishing level
OLE	NOAA Office of Law Enforcement
OSP	Optimum sustainable population
PBDE	Polybrominated diphenyl ethers
PBR	Potential biological removal
PCB	Polychlorinated biphenyls
PDV	Phocine distemper virus, now known as phocine morbillivirus
POP	Persistent organic pollutants
Pribilofs	Pribilof Islands; a collective term for St. Paul Island, St. George Island, Walrus Island, and Otter Island
Qawan	Steller sea lions
TAC	Total allowable catch
Tanam Amgiĝnaan	Indigenous Sentinel Network
Tanax̂ Amix̂	"Land of Mother's Brother", traditional Unangam tunuu name for the Pribilof Islands, currently used to refer to St. Paul Island
TCSGI	Traditional Council of St. George Island
U.S.C.	United States Code
UAS	Uncrewed Aircraft Systems
Unangan	Plural of Unangax̂
Unangam Tunuu	Language of the Unangax̂ of the Aleutian and Pribilof Islands
Unangax̂	People of the Sea, Aleut Peoples (singular), singular person
USFWS	U.S. Fish and Wildlife Service
VHF	Very High Frequency radio signals (type of tag)
ZMRG	Zero mortality rate goal

Executive Summary

In 1988, the northern fur seal (*Callorhinus ursinus*) or “laaqudax̂” in Unangam Tunuu (the language of the Indigenous Peoples of the Pribilof Islands) was designated as depleted on the Pribilof Islands (Pribilofs), Alaska, under the Marine Mammal Protection Act (MMPA) of 1972. The MMPA defines a species, population, or stock as depleted if it is below its optimum sustainable population (OSP) level, or is listed as endangered or threatened under the Endangered Species Act (ESA). The lower bound of OSP for northern fur seals is estimated to be at least 60 percent of the carrying capacity level. The northern fur seals on the Pribilofs were designated as depleted because they had declined to less than 50 percent of levels observed in the 1950s, and no compelling evidence suggested that carrying capacity had changed substantially since that time (53 FR 17888, May 18, 1988).

Amendments to the MMPA on November 23, 1988, directed the Secretary of Commerce to develop a Northern Fur Seal Conservation Plan (hereafter, Conservation Plan) for the purpose of "conserving and restoring the species or stock to its optimum sustainable population" (16 United States Code (U.S.C.) 1383b(b)). The Plan was required to include information on the status of northern fur seals on the Pribilofs, possible causes of declines, threats to the species, critical information gaps, and research and management recommendations for meeting the objectives of the Plan (listed below). Accordingly, the National Marine Fisheries Service (NMFS) published its first Conservation Plan for the Pribilof Islands population of northern fur seals in 1993 (NMFS 1993).

In 1995, NMFS published the first stock assessment reports (per MMPA section 117), and described the Eastern Pacific stock of northern fur seals to include the population on Bogoslof Island (Small and DeMaster 1995). The Eastern Pacific stock is distinguished from populations on islands in the western Bering Sea, Sea of Okhotsk, and Pacific Ocean using the phylogeographic stock definition. After having acquired substantial new information and with the greater inclusion of the Tribal Governments in management of the stock, NMFS published a revised version of the Conservation Plan in 2007 (NMFS 2007a).

Significant marine ecosystem changes are occurring, including increased air and sea surface temperature and changes to distribution and thickness of annual sea ice. These physical oceanographic characteristics influence primary and secondary biological oceanographic processes that impact recruitment and distribution of important fur seal prey (Siddon 2022; Wildes et al. 2022). Since the revision of the Conservation Plan in 2007, studies regarding numerous aspects of the biology, physiology, and ecology of northern fur seals have advanced our understanding of the stock and addressed many of the conservation actions previously identified. The advancements of bio-logging (for example, location tracking via tagging) technology and biogeochemistry analysis have given researchers the ability to map marine foraging areas, characterize aspects of diving behavior, and assess relationships to northern fur seal diet. These studies have improved our understanding of the potential and known interactions with and effects of commercial fisheries and other human activities on the habitat used by fur seals. Management changes since the publication of the revised Plan in 2007 include significant regulatory modifications in 2014 (79 FR 65327, November 4, 2014) and 2019 (84 FR 52372, October 2, 2019) to the management of subsistence use of northern fur seals on the Pribilofs, and advances through co-management partnerships to collectively address in-season subsistence use decisions with our Tribal partners. Other examples of co-management activities that have advanced since 2007 include marine debris clean-ups and prevention, entanglement response, and monitoring human use of fur seal habitat.

NMFS Alaska Regional Office strives to review the content of the Conservation Plan every five years and determine whether a revision is necessary. In 2013, NMFS determined that the changes to the subsistence use regulations for St. George and St. Paul were a higher staff priority than revision to the Conservation Plan. Those regulatory changes were completed in 2020 and thereafter, NMFS began the process to revise the Conservation Plan. Substantial new information in this current revision reflects the continued evolution of Tribal co-management relationships, identification and interpretation of research, and continued management of human activities that are thought to affect the Eastern Pacific stock. NMFS has prepared this revised Conservation Plan with valuable input from our Tribal co-managers—the Aleut Community of St. Paul Island (ACSPI) and the Traditional Council of St. George Island (TCSGI). As northern fur seals and culture surrounding their subsistence use are paramount to Pribilovian Unangax̂ (Indigenous Peoples of the Pribilof Islands) identity, we place great emphasis on incorporating Unangax̂ Indigenous and Traditional Knowledge to strengthen our collective understanding and management of the species. We have incorporated Unangam Tunuu language in relation to northern fur seals and Pribilovian Unangax̂ culture into the Plan, and will strive to continue and expand this practice in management documents moving forward. This document should serve as a guide to assist in the implementation of conservation actions.

Commercial exploitation of female northern fur seals played a significant role in the major declines in historic abundance of the population in the Pribilofs (Roppel and Davey 1965; York and Hartley 1981). However, commercial exploitation ended in 1984, four years before the depleted designation, and the Eastern Pacific stock has continued to decline in recent decades. The latest population estimate in the 2021 Stock Assessment Report was 626,618 seals, or 28 percent of carrying capacity (Muto et al. 2022). The stock decline has been largely driven by a population decline on St. Paul Island, as the St. George Island and Bogoslof Island populations have been stable or increasing over the past two decades. In addition to overall stock and island trends, rookeries in close geographic proximity with similar diet and foraging patterns have been suggested as possible relevant units of the population (i.e., rookery complex, Robson et al. 2004; Zeppelin and Ream 2006) that exhibit distinct trends in abundance.

This revised Conservation Plan reviews and assesses the known and possible threats to northern fur seals in Alaska. Natural threats include trauma and starvation, disease and parasitism, predation, and environmental change. Human-related threats that may influence the population include direct and indirect effects of commercial fishing, marine debris, vessel activity, aircraft traffic, construction, pollution (or environmental contaminants), seafood processing discharges, and oil and gas activities. Since 1985, subsistence harvest levels have been well below the historic commercial harvest levels and well below the potential biological removal (PBR) level specified under the MMPA for the northern fur seal stock (Muto et al. 2022).

As discussed in the revised Conservation Plan in 2007, four objectives are proposed to conserve and restore the Eastern Pacific stock of northern fur seals to its OSP level, consistent with the 1988 amendments to the MMPA:

1. Identify and reduce human-caused mortality of the Eastern Pacific stock of northern fur seals.
2. Assess and avoid or mitigate adverse effects of human-related activities on or near the Pribilof Islands and other habitat essential to the survival and recovery of the Eastern Pacific stock of northern fur seals.
3. Continue and, as necessary, expand research and management programs to monitor trends and detect natural or human-related causes of change in the Eastern Pacific stock of northern fur seals and habitats essential to its survival and recovery.
4. Coordinate and assess the implementation of the Conservation Plan.

The primary goal of the 2024 revised Conservation Plan is to facilitate conserving and restoring the Eastern Pacific stock of northern fur seals until the population abundance levels are above OSP (16 U.S.C. 1383b(b)(2)). NMFS recognizes that as of the writing of this Plan, the stock is declining, and that stopping this decline is of the utmost importance. Meeting the goal of restoring northern fur seals above OSP and declassification from depleted status may take many decades. The shared resources and cooperative involvement of federal and state agencies, ACSPI, TCSGI, fishing industry representatives, academia, non-governmental organizations, and other stakeholders will be required to rebuild the northern fur seal populations.

Introduction

NMFS designated the Pribilof Islands northern fur seal population depleted on 18 May 1988 (53 FR 17888, May 18, 1988) because it had declined to less than 50 percent of levels observed in the 1950s and no compelling evidence suggested that the northern fur seal carrying capacity of the Bering Sea had changed substantially since the 1950s. The MMPA defines the term "depletion" or "depleted" (16 U.S.C. 1362(1)) as meaning any case in which:

A. The Secretary of Commerce, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under [the MMPA], determines that a species or population stock is below its optimum sustainable population;
B. A State, to which authority for the conservation and management of a species or population stock is transferred under section 1379 of [the MMPA], determines that such species or stock is below its optimum sustainable population; or
C. A species or population stock is listed as an endangered species or a threatened species under the Endangered Species Act of 1973 (16 U.S.C. 1531–1544).

OSP is defined as a range of population levels from the largest supportable within the ecosystem (i.e., carrying capacity) to the population level that results in maximum net productivity (50 CFR 216.3). Maximum net productivity is the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth minus losses due to natural mortality (50 CFR 216.3). Amendments to the MMPA on November 23, 1988 (Public Law 100-711) directed the Secretary of Commerce to develop a Conservation Plan for what was then the North Pacific fur seal (*Callorhinus ursinus*). Conservation Plans identify specific management actions that must be taken to ensure that the species of concern is restored to the point that it is no longer depleted. Conservation Plans also serve as advisory documents to identify conservation threats and to recommend research and management actions for the purpose of conserving and restoring the species or stock to its OSP. The Senate report accompanying the 1998 amendments (Senate 100-592, October 7, 1998) further stated that Conservation Plans include the following essential elements:

1. An assessment of the status of the species or stock and its essential habitat;
2. A description of the causes of any population declines or loss of essential habitat, which include rookeries, beaches, and offshore foraging habitats;
3. An assessment of existing and possible threats to the species and its habitat;
4. A discussion of critical information gaps;
5. A description of research and management to be undertaken to meet the objectives of the plan; and
6. An implementation schedule of the research and management actions identified in the Plan.

NMFS published the first Conservation Plan for the Northern Fur Seal in 1993 (NMFS 1993). In 2007, NMFS revised the Plan to incorporate substantial new information and account for changes in the management structure to include co-management agreements with the Tribal Governments of St. Paul and St. George (72 FR 73766, December 28, 2007). NMFS has now prepared this second revision to include substantial additional new information and recent changes in subsistence harvest regulations. The Plan will continue to be revised at regular intervals as new information is accumulated, management actions are evaluated, and population status changes.

The decline in northern fur seal abundance that has occurred since the 1950s is similar to the decline in qawax̂, or Steller sea lion (*Eumetopias jubatus*), abundance throughout the Gulf of Alaska and Bering Sea (Merrick et al. 1987; Sease and Gudmundson 2002) in that causes cannot be easily identified due to the ecological complexity of the problem and lack of a continuous time-series of relevant biological data (e.g., population vital rates). Changing trends in fur seal abundance cannot be explained solely as a result of past commercial sealing practices or other known sources of human-caused mortality (Fowler 1985; Trites and Larkin 1989; Trites 1992; Towell 2007). Some of the decline can be explained by on-land harvesting by the U.S. government in the 1950s–1970s specifically intended to reduce the female population, as well as at-sea sealing conducted for scientific study (York and Hartley 1981). This Plan details our efforts since the publication of the 2007 revision of the Conservation Plan to understand other factors that may be contributing to this decline.

Northern fur seals are colonial breeding pinnipeds that exhibit strong site fidelity and currently breed on a few islands in the North Pacific Ocean and Bering Sea. They have a long life span, delayed reproductive maturity, segregation and philopatry, high density aggregations, no individual markings, and complicated site-specific foraging strategies. Research and management of northern fur seals is constrained by their specific life history and ecology. Northern fur seals spend the majority of their lives on the high seas and understanding their interactions with human activities at sea is challenging. Many of our management actions have focused on the terrestrial portion of their life cycle, because we have greater management control and understanding of the land-based activities and interactions. Fur seal life history at sea is largely unknown, and interactions between fur seals and human activities at sea are largely unobserved. The lack of observations and difficulty monitoring at-sea interactions confounds efforts to implement effective management actions that would restore fur seals to their OSP.

Today about 45 percent of the worldwide population of northern fur seals is found on the Pribilof Islands (Gelatt et al. 2015), which has decreased from 74 percent in 1995 (Small and DeMaster 1995). Global population estimates have remained relatively constant from 1.1 to 1.3 million since the 1990s (Loughlin 1994; Gelatt et al. 2015) indicating that there has likely been a redistribution of northern fur seals worldwide. Regular abundance estimation is critical to identifying individual population trends and understanding fur seal distribution. The integration of comprehensive population abundance estimates with concurrent behavioral and ecological studies gives researchers and managers the opportunity to gain insight into the mechanisms that may be influencing changes in the distribution and abundance of the entire population. Fur seal population vital rate studies on the Pribilof Islands were initiated in 2008, but our understanding is still incomplete. The long life of northern fur seals necessitates long-term studies to estimate age- and sex-specific survival. Historic estimates of survival and reproduction by sex and age class are not appropriate to use on a declining population with low on-land mortality rates. Maintaining ongoing, regular estimates of survival and reproduction of breeding and non-breeding fur seals is an important aspect of evaluating possible mechanisms underlying the current population decline on St. Paul Island and increase on St. George Island.

To evaluate the trends and status of the Eastern Pacific stock of northern fur seals, NMFS has counted adult males annually in mid-July since 1909 and estimated the number of pups born every other year on St. Paul and St. George Islands to create a significant data record. The population breeding on Bogoslof Island has been monitored and studied intermittently since fur seals were first observed breeding there in 1980, which has provided unique insight into the potential growth of a segment of the stock. The marine and terrestrial habitat used by fur seals breeding on Bogoslof Island (an active submarine stratovolcano sitting at the continental shelf break) is different than that used by fur seals breeding on the Pribilof Islands (situated further from the continental shelf break). NMFS has also studied various aspects of the life history of fur seals in San Miguel, and these studies and have contributed to our understanding fur seal ecology across the range of habitats where they reside. Fur seal populations breeding in the western Pacific Ocean and Bering Sea have also been studied and help us understand the full diversity of fur seal ecology and the potential for recovery of the Eastern Pacific stock. It is important that fur seal data from these varied populations be analyzed and reported, or otherwise made available to other researchers, managers, and the public in order to advance fur seal management and science as a whole.

NMFS and its Tribal co-management partners manage numerous human activities known or suspected to influence northern fur seals on the Pribilof Islands. Commercial fishery interactions, entanglement in marine debris, and subsistence use are the primary manageable or quantifiable sources of human-caused mortality to the northern fur seal population. Fishery interactions can include direct bycatch, while examples of indirect effects include prey competition, entanglement in derelict fishing gear, or modified behavior due to noise pollution, which are more difficult to detect. Since the cessation of the commercial harvest of fur seals on the Pribilof Islands (in 1972 on St. George Island and 1984 on St. Paul Island), local residents have harvested and hunted fur seals to meet their subsistence needs. Pribilovians from both islands collectively have taken fewer than 1,000 juvenile male fur seals annually since 2000, with annual takes of less than 400 animals since 2016. Other manageable human caused possible threats include oil or chemical spills, chronic pollution, vessel collisions, habitat degradation, and harassment.

Environmental factors such as pollution or climate change may also influence fur seal health and behavior, and ultimately their survival and reproductive rates.

Appropriate management is predicated on understanding the contribution of human and natural influences on the Eastern Pacific stock of northern fur seals, and on managing those human influences using the best available science. NMFS recommends continuation of ongoing research and development of new programs designed to improve our understanding of fur seal ecology. Co-management with Alaska Native Organizations and fisheries management that includes quantitative estimates of fish biomass necessary to maintain and restore northern fur seals and other marine mammal populations as functioning elements of the ecosystem will provide a basis for future management actions. Monitoring the response of fur seals to those management actions will assist us in identifying successful or new conservation actions.

Description

Taxonomy

Laaqudax̂ or the northern fur seal (*Callorhinus ursinus*) belongs to the Order Carnivora, Suborder Pinnipedia, Family Otariidae, and Subfamily Otariinae. The family contains the extant genera *Arctocephalus, Callorhinus, Eumetopias, Neophoca, Otaria, Phocarctos*, and *Zalophus*. The genus *Callorhinus* contains one species, the northern fur seal (Rice 1998). Little evidence of genetic differentiation among breeding sites has been found (Rice 1998; Ream 2002; Dickerson et al. 2010), but for management purposes, 5 stocks (populations) of northern fur seals are recognized that breed on at least 6 island groups in the North Pacific: 1) the Eastern Pacific stock which includes the Pribilof Islands and Bogoslof Island; 2) the California stock located off the coast of southern California on San Miguel Island; 3) the Commander Islands stock (Russia); 4) the Kuril Islands stock (Russia); 5) and the Tyuleny (formerly Robben) Island stock in the Okhotsk Sea (Russia) (Figure 1). Stock designation is based principally on geographic separation during the breeding season (Dizon et al. 1992), but considerable interchange of individuals takes place among rookeries; therefore, northern fur seals are considered one biological species. This Conservation Plan pertains to the Eastern Pacific stock, with relevant information from other stocks included. Unless noted otherwise, all references to fur seals in this document are to northern fur seals.

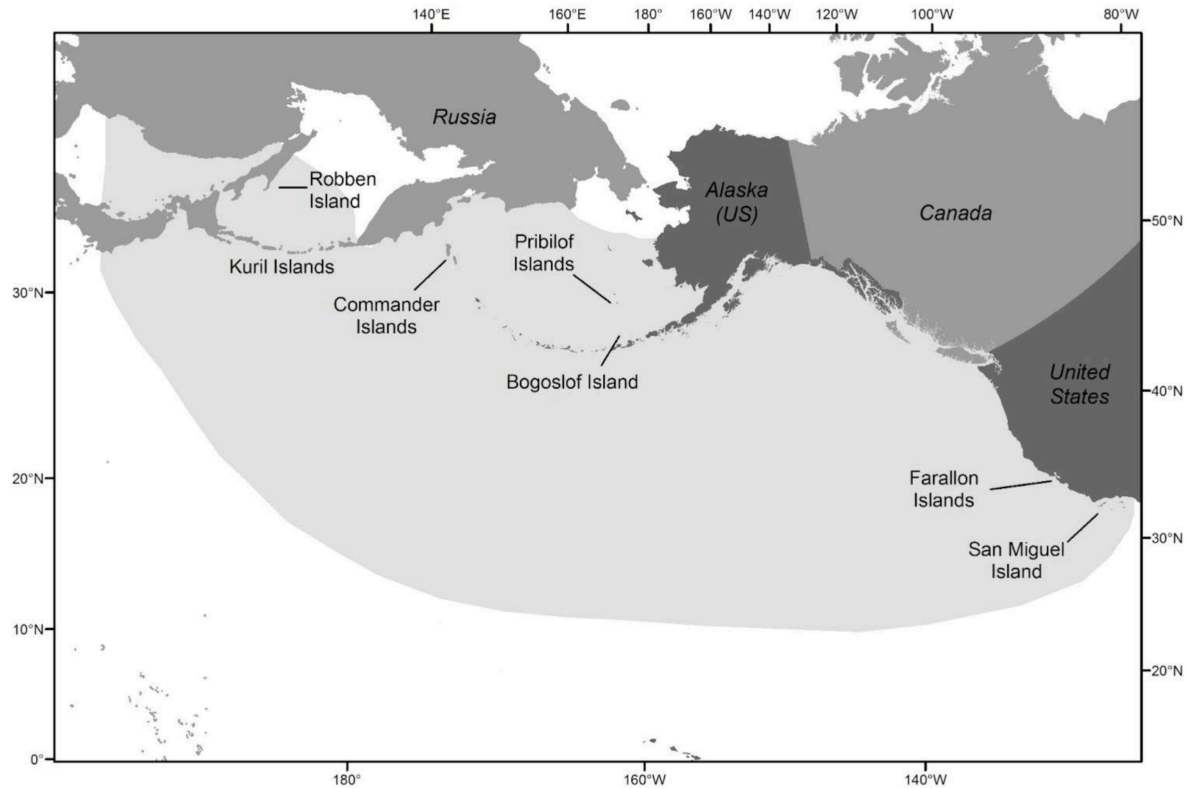

Figure 1. Wintertime range and breeding sites of northern fur seals. The southern boundary of their range extends across the Pacific Ocean between southern California and Japan. The northern boundary is in the Bering Sea. Northern fur seals seasonally breed on the Pribilofs (St. Paul Island, St. George Island, and Sea Lion Rock), Bogoslof Island, San Miguel Island, South Farallon Islands, the Commander Islands, the Kuril Islands, and Tyuleny (previously Robben) Island.

Appearance

Northern fur seals have a stocky body, small head, very short snout, and extremely dense fur (46,500 fibers/cm²) that ends at the wrist lines of their flippers (Scheffer 1962). Their flippers are the longest in the Otariidae family. Their hind flippers can measure up to one-fourth of their total body length. Their fore flippers are incredibly strong allowing them to walk or run on all four flippers. Northern fur seals exhibit sexual dimorphism, such that adult males are 2–4 times larger than adult females (Gentry 1998). The average mature male is 6.5 feet (2.0 m) long and weighs 410 pounds (186 kg), while the average female is 4.2 feet (1.3 m) long and weighs 91 pounds (41.3 kg) (Scheffer and Wilke 1953). At birth, pups weigh 3–4 pounds (1.4–1.8 kg) and are 12–14 inches (30–36 cm) long (Elliott 1882).

Pups are uniformly black until they molt to a silver-gray at around three months old. Adult males range in color from red to dark brown to black, and adult females are dark gray or brown on their backs and light gray, silver, or cream on their throat, chest, and stomach. They have whiskers on their snout, known as vibrissae. Pups are born with black vibrissae that grow throughout their lives and progressively turn white as they age. Adults have prominent white vibrissae.

Life History

Where they live

Northern fur seals primarily occupy two types of habitat: open ocean where they spend most of the year, and rocky or sandy beaches on islands where they seasonally haul out to rest, reproduce, and molt. In the United States, they seasonally breed on six islands in the eastern North Pacific Ocean (San Miguel and Farallon Islands in California) and the Bering Sea (St. Paul Island, Bogoslof Island, St. George Island, and Sea Lion Rock in Alaska) (Gentry 1998; Gelatt et al. 2015). They also breed on the Kuril Islands, Tyuleny (formerly Robben Island), and the Commander Islands in Russia (Gentry 1998, Gelatt et al. 2015). About half of the world's population of northern fur seals breeds at St. Paul Island, St. George Island, and Sea Lion Rock in the Pribilofs (Gentry 1998; Gelatt and Gentry 2018). Non-breeding northern fur seals also haul out on Walrus and Otter islands in the Pribilof Islands.

Reproduction and Lifespan

Males

A male's ability to mate depends on several factors such as body size, fighting ability, size and location of the chosen breeding territory, and skill at interacting with females. Males do not leave the breeding territory to feed, so their ability to fast is crucial. Males remain on their territories an average of 38–46 days (Gentry 1998; Gelatt and Gentry 2018) losing an average of 32 percent of their body mass during that time (Gentry 1998). Those that are successful at breeding are typically at least 10 years old and are able to maintain female breeding partners within their territories. Dominant males are typically capable of competing for breeding opportunities for about one and a half seasons before they are replaced by new males (Gentry 1998). Male northern fur seals may live up to 17 years (Johnson 1968).

Northern fur seals are polygynous; relatively few adult males mate with the available females (Gentry 1998). Very few adult males are required to maintain adequate pregnancy rates across the various breeding areas (Smith and Polacheck 1984), which is why management efforts to support healthy female populations have been of higher priority.

Females

Females generally have their first pup at 4–6 years of age, are in their reproductive prime between the ages of 8 and 13, and are known to be reproductive until at least 23 years of age (Lander 1981; York 1983). They are not selective in their choice of mate, but they do demonstrate preference for specific breeding sites (Gelatt and Gentry 2018). Females will give birth to a single pup within two days of arriving on shore, and mate 3–8 days after that (Peterson 1965; Holt 1986; Gentry 1998). Female fur seals undergo embryonic diapause, meaning the embryo does not immediately implant in the uterus. Implantation is thought to be delayed until after lactation or weaning of her current pup (York and Scheffer 1997). Females nurse their newborn pup for the first 5–7 days (Gentry and Kooyman 1986), go to sea to forage, and then return and find their pup using vocal recognition (Insley 2000). Females nurse their pups during one to two day visits between foraging trips and continue to cycle between land and sea for the remainder of the nursing period (Loughlin et al. 1987). Pups are nursed for about four months until weaning, at which time they leave the breeding site before their mothers to begin foraging independently (Macy 1982, Gentry 1998).

Migration Patterns

Northern fur seals make extensive winter migrations. In the winter and spring, they are pelagic, occupying the Bering Sea, North Pacific Ocean, and Okhotsk Sea. The southern boundary of the fur seal range extends across the Pacific Ocean, between southern California and Honshu Island, Japan, but they are found as far north as the Bering Sea (Figure 1; Kenyon and Wilke 1953). In the open ocean, concentrations of fur seals may occur near oceanographic features such as eddies, convergence-divergence zones, and frontal boundaries because of enhanced primary production in these areas that aggregates important fur seal prey (Ream et al. 2005; Pelland et al. 2014; Sterling et al. 2014).

Annually in the spring, most fur seals migrate north to breeding colonies in the Bering Sea. Each sex and age class differs in their on-land arrival and departure times to the islands (Figure 2). Beginning in May, adult male seals return to the breeding islands (Peterson 1965). Pregnant females arrive next to give birth around mid-June, followed by non-pregnant females (Bartholomew and Hoel 1953; Gentry and Holt 1986; Gentry 1998). Juveniles arrive later in the season (Gentry 1998). Most yearlings remain pelagic and do not return to the breeding islands until they are two years old (Kenyon and Wilke 1953; Gentry 1998).

Territorial males are the first to abandon their breeding sites in August and migrate to their winter foraging grounds in the Bering Sea and North Pacific Ocean along the Aleutian Islands (Bartholomew and Hoel 1953; Kajimura 1984; Loughlin et al. 1999). Pregnant adult females begin their winter migration in November and generally travel to either the central North Pacific Ocean or to offshore areas along the west coast of North America to forage throughout the winter and spring months (Lander and Kajimura 1982;

Bigg 1990; Ream et al. 2005). By about 125 days old, pups have weaned and they begin to leave the Pribilofs between late October and early November (Ragen et al. 1995; Goebel 2002; Baker 2007; Lea et al. 2009; Pelland et al. 2014; Zeppelin et al. 2019). The small proportion of yearlings that do return to the Pribilofs during the breeding season depart in mid-November (Zeppelin et al. 2019). By December, almost all fur seals have left the Pribilofs for the season and will repeat this migration annually. Understanding these migration patterns is key to identifying the evolutionary (ultimate) and physiological (proximate) causes of the observed pup production trends, because the observed mortality of pups, juveniles, and adults on land, both natural and anthropogenic, is insufficient to explain the most recent declines of Pribilof Islands (Young et al. 2023). Furthermore, evidence to date suggests that current female reproductive and pregnancy rates are sufficient for population growth (see Vital Rates; Gentry 1998; Testa et al. 2010; Testa 2016). This relatively low on-land mortality coupled with no apparent reduction in pregnancy rate suggests that the majority of the mortality among newly weaned pups, juveniles, and/or adults is unobserved, at sea, and is likely occurring during the winter migration. However, intensive satellite tracking studies from 2005–2007 on female seals from each of the Eastern Pacific stock islands indicate that female pups, female juveniles, and female adults from each of the islands forage in the same region over the winter months (Appendix IV Figure 1). This is unlike what has been observed during the summer breeding season where there is consistent foraging habitat segregation between islands and within rookery complexes on the same island (Figure 6; Robson et al. 2004; Kuhn et al. 2014b). This suggests that northern fur seals from each respective island are exposed to similar extrinsic factors throughout the majority of the migratory phase. The only winter migration difference among the islands is during the initial migratory dispersal phase, whereby St. Paul Island seals have the farthest distance to travel to reach their winter foraging grounds.

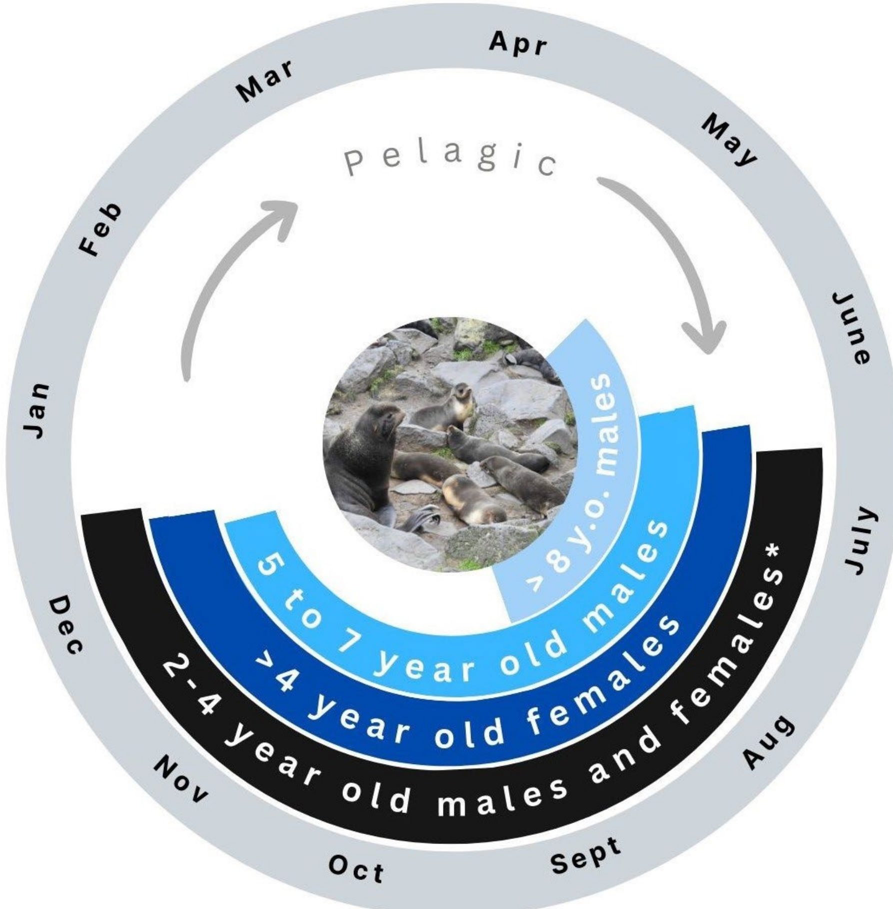

Figure 2. Arrival, departure, and on land periods by age class for northern fur seals on the Pribilof Islands. In general, one-year-old males and females remain pelagic and do not return to the Pribilofs until 2 years of age. * indicates that females in this age class arrive approximately 30 days later than males (Bigg 1986); we have no data regarding their departure for winter migration.

Habitat Use

The Pribilof Islands and Bogoslof Island are currently important terrestrial habitats for northern fur seal populations, where they congregate for about six months each year for pupping, mating, and rearing of pups. Fur seals often return to the site where they were born (Baker et al. 1995) and segregate into either breeding or resting areas (Gentry 1998).

Areas that are used for breeding are called rookeries and areas that are used for resting (non-breeding) are called hauling grounds. There are 13 rookeries on St. Paul Island (Figure 3) and 6 on St. George Island (Figure 4, Gentry 1998). The number and location of rookeries on Bogoslof Island, an active volcanic island, have varied over time due to its ever changing geology (Figure 5). Drastic geological changes were seen after the most recent eruptions that began in late 2016 and ended by September 2017 (Waythomas et al. 2020). The activity dramatically increased the terrain and size of the island, as well as the distribution of fur seals on it (Towell and Ream 2019).

Adult males, or bulls, arrive at the islands to occupy and defend prime breeding territories before the females arrive (Bartholomew and Hoel 1953; Gentry 1998). The typical structure of fur seal terrestrial habitat includes a central area occupied by breeding males and females, surrounded by territorial adult males without females (Bartholomew and Hoel 1953). Adult males exclude juvenile males from the breeding areas. Instead, these juveniles congregate in separate areas on land called hauling grounds, typically behind or adjacent to the breeding areas (Bartholomew and Hoel 1953; Gentry 1998). Once the territorial males abandon their breeding sites, non-territorial males may occupy these same areas, although the vast majority of adult females have already mated (Bartholomew and Hoel 1953).

During the summer breeding season, fur seals from the Eastern Pacific stock (including the Pribilofs and Bogoslof) rely on prey resources in the surrounding waters, including the Bering Sea basin and continental shelf habitats. Diet and telemetry studies found that rookeries on the Pribilofs are grouped into rookery complexes based on differing foraging habitat (Figure 6 and Figure 7; Robson 2001; Robson et al. 2004; Zeppelin and Ream 2006; Call et al. 2008; Kuhn et al. 2014b). Foraging areas can extend over 600 km from the rookery with juvenile males and non-lactating females traveling further than females with dependent pups (Loughlin et al. 1987; Goebel et al. 1991; Sterling and Ream 2004). Prior to the winter migration but after abandoning territories, adult males will also spend some time foraging in the Bering Sea, concentrating in shelf waters ranging from 100 to 250 m (Loughlin et al. 1999; Sterling et al. 2014). Increased foraging effort is often found to be associated with oceanographic features that are known to concentrate prey, including fronts, strong thermoclines, and eddies (Sterling 2009; Kuhn 2011; Nordstrom et al. 2013a). Diving behavior, which ranges from short shallow dives (<10 m) to longer, deep dives to the bottom (>100 m), is influenced by foraging location, prey species, and the distribution and abundance of prey (Gentry and Kooyman 1986; Goebel et al. 1991; Gentry 1998; Goebel 2002; Sterling and Ream 2004; Kuhn et al. 2014a; Kuhn et al. 2014b).

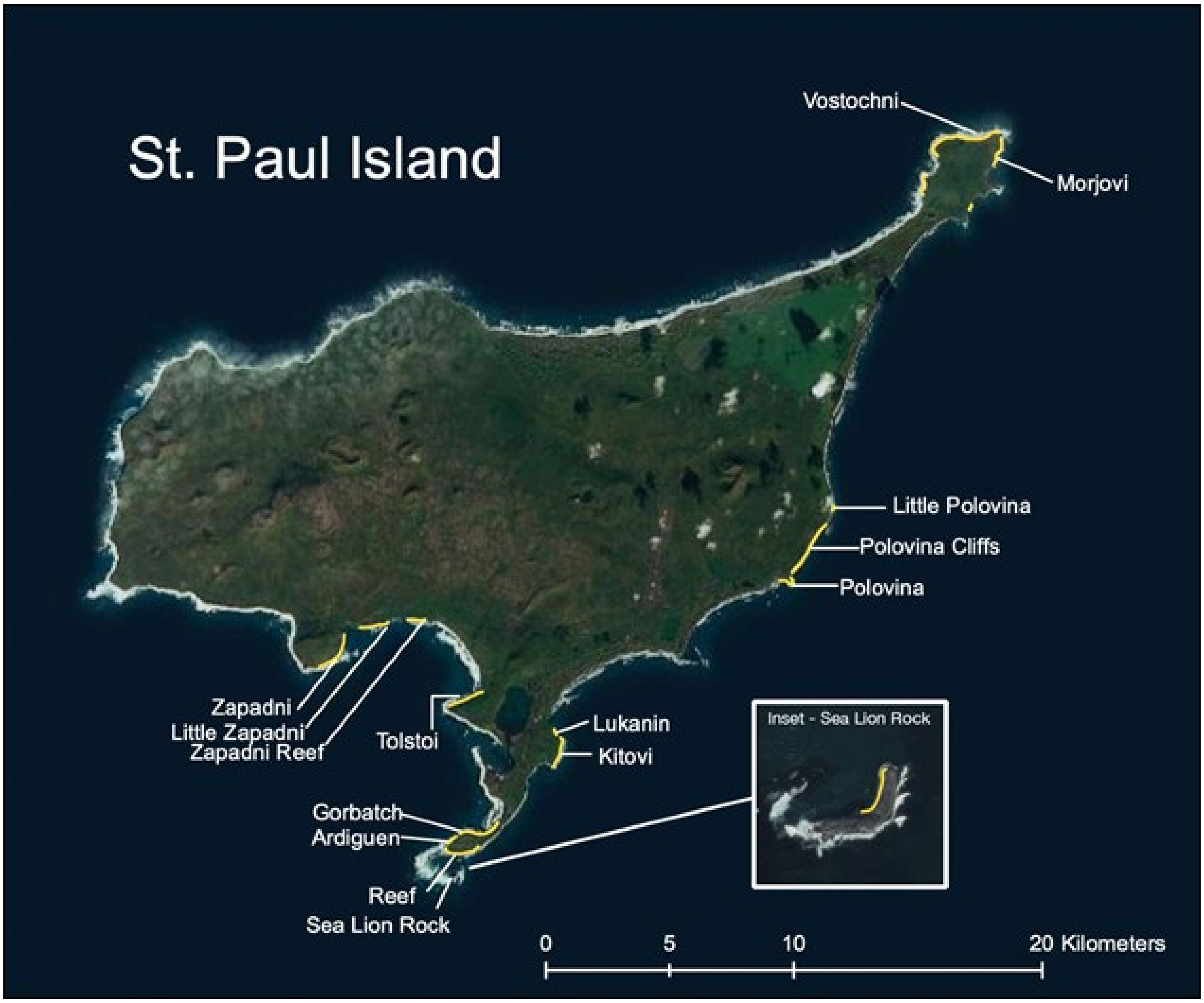

Figure 3. Northern fur seal rookeries on St. Paul Island and Sea Lion Rock (inset). Since 2012 no pups have been born at Little Polovina rookery.

Figure 4. Northern fur seal rookeries on St. George Island.

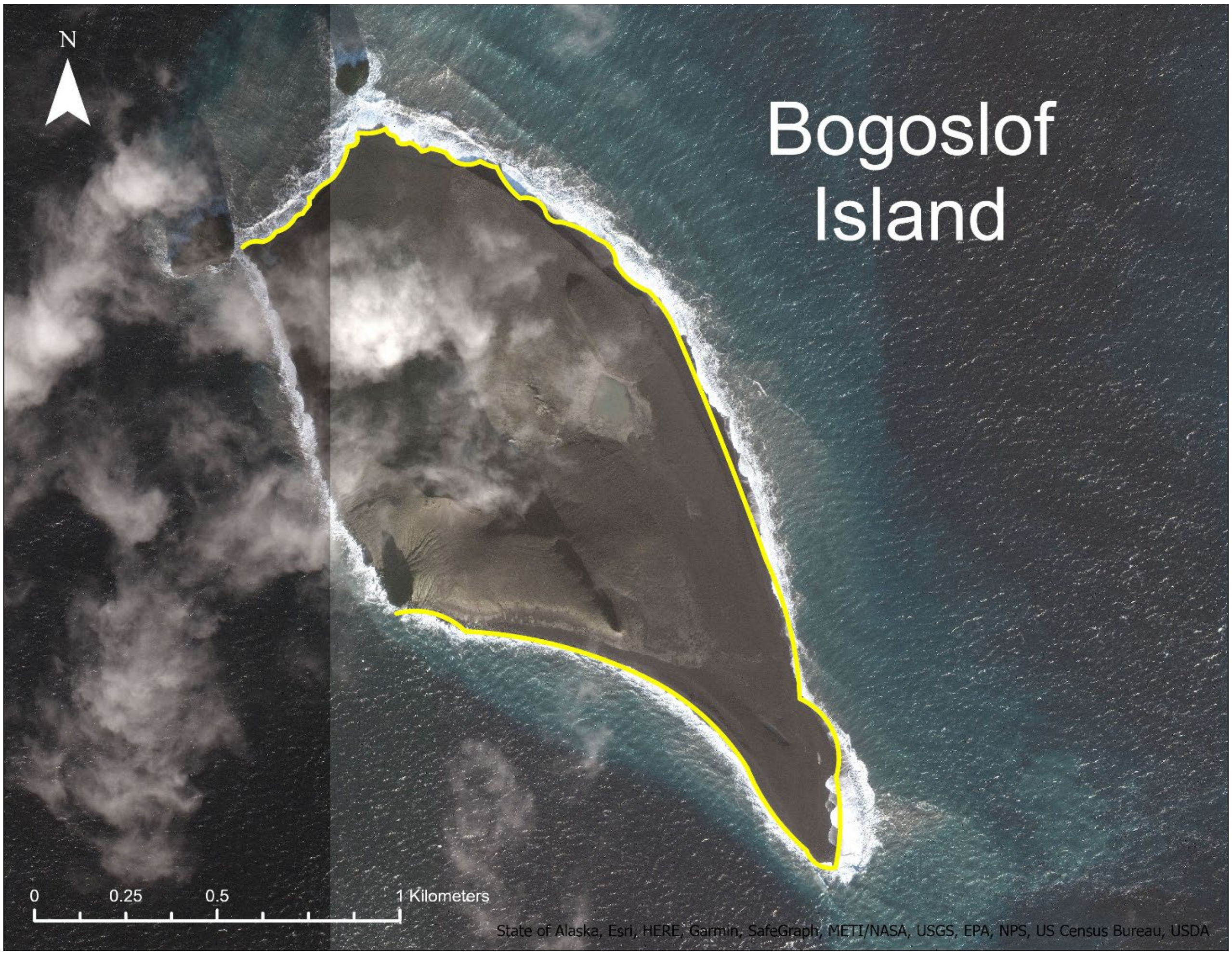

Figure 5. Northern fur seal rookeries on Bogoslof Island.

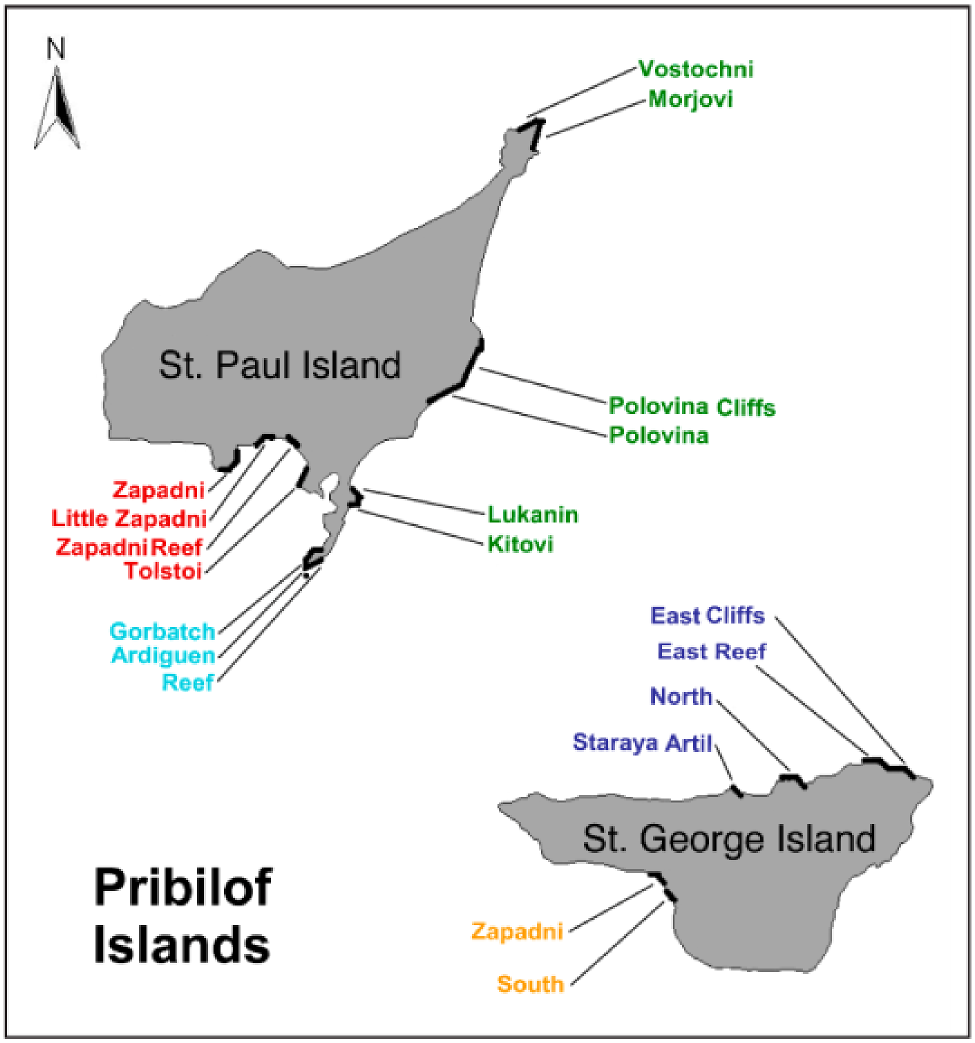

Figure 6. Designation of rookery complexes. Rookeries labeled in the same color are a part of the same rookery complex (figure from Zeppelin and Ream 2006 used with permission). Note that SP East = Vostochni, Morjovi, Polovina Cliffs, Polovina, Lukanin, and Kitovi (St. Paul); SP Reef Point = Gorbatch, Ardiguen, and Reef (St. Paul); SP English Bay = Zapadni, Little Zapadni, Zapadni Reef, and Tolstoi (St. Paul); SG South = Zapadni and South (St. George); SP North = East Cliffs, East Reef, North, and Staraya Artil (St. George).

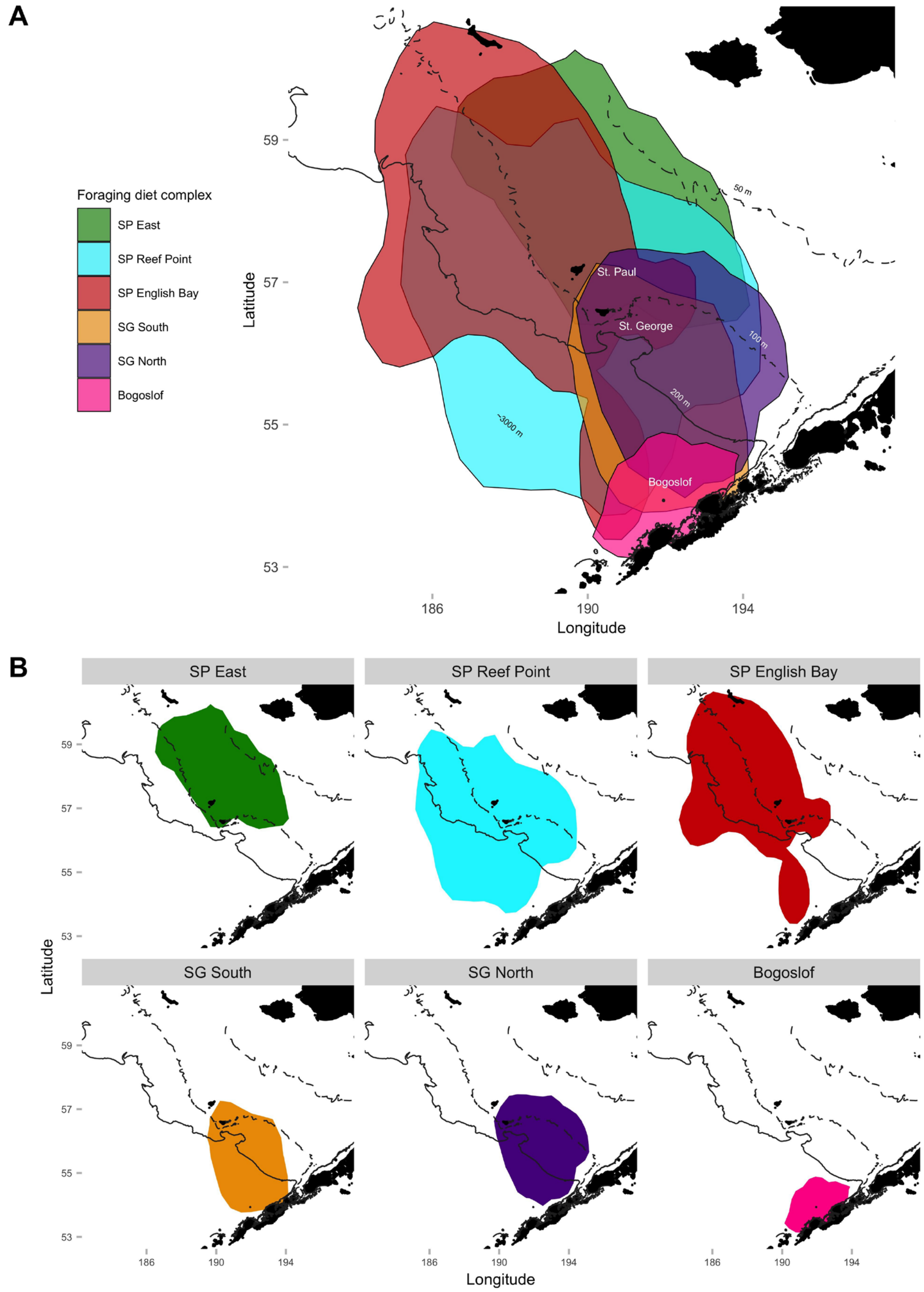

Figure 7. (A) Foraging area home ranges of Eastern Pacific stock rookery complexes as described in Zeppelin and Ream (2006) with Bogoslof rookery complex added. (B) Individual rookery complex foraging area home ranges shown with 90% kernel density. Note that SP East = Vostochni, Morjovi, Polovina Cliffs, Polovina, Lukanin, and Kitovi (St. Paul); SP Reef Point = Gorbatch, Ardiguen, and Reef (St. Paul); SP English Bay = Zapadni, Little Zapadni, Zapadni Reef, and Tolstoi (St. Paul); SG South = Zapadni and South (St. George); SP North = East Cliffs, East Reef, North, and Staraya Artil (St. George).

Diet

Most of the historic fur seal diet information comes from prey identified in the stomachs of fur seals collected during pelagic and scientific sealing operations in the Bering Sea and North Pacific Ocean. Early published descriptions of fur seal diet in the Bering Sea found that fur seals consumed walleye pollock (*Gadus chalcogrammus*; hereafter pollock), squid, and northern smoothtongue (*Leuroglossus schmidti*, also called "seal fish") (Lucas 1899a). Annual collections of hundreds to thousands of fur seals from 1958 to 1974 revealed variation in diet across the geographic range of the Eastern Pacific stock (Kajimura 1984; Perez and Bigg 1986). In the southeast Bering Sea, when seals were collected on the Bering Sea shelf their stomachs contained mostly pollock, gonatid squids (family Gonatidae), and capelin (*Mallotus villosus*). When seals were collected offshore on the Bering Sea slope or offshore in deep pelagic waters deep-sea smelts (family Bathylagidae) and squids were often found in their stomachs. During winter, fur seal diet transitioned from primarily Pacific herring (*Clupea pallasii*) in the Gulf of Alaska, British Columbia, and Washington to northern anchovy (*Engraulis mordax*) in California.

Diet information is currently obtained using a variety of methods including identification of prey hard parts (e.g., otoliths, bones, squid beaks) recovered from fecal samples (scats) and regurgitations (spews), stable isotopes, fatty acids, and genetic analysis (Antonelis et al. 1997; Goebel 2002; Gudmundson et al. 2006; Zeppelin and Ream 2006; Zeppelin and Orr 2010; Jeanniard-du-Dot et al. 2017). Recent collections have primarily focused on adult females during the summer months at all three breeding islands (St. Paul, St. George, and Bogoslof) in Alaska. Studies indicate that sub-adult male diet is consistent with that of adult females (Call et al. 2008). Adult males are thought to fast during the summer until they abandon their territories in August (Loughlin et al. 1999), and pups may not begin independent foraging until they depart on their first winter migration (Macy 1982). Primary prey species of adult females include juvenile and adult pollock, gonatid squid, northern smoothtongue, Pacific sandlance (*Ammodytes hexapterus*), and salmonids (*Oncorhynchus* spp.) (Zeppelin and Ream 2006; Zeppelin and Orr 2010). The occurrence of these prey species varies by island and rookery complex (Figure 8). In addition to hard part analysis, stable isotope and fatty acid analysis of fur seal tissues also indicate differences in prey consumption and habitat use among female fur seals breeding at colonies from each rookery complex sampled (i.e., St. Paul East, St. Paul Reef, and Bogoslof) and similarities within the rookery complexes (i.e., Vostochni and Morjovi rookeries from St. Paul East and Reef and Gorbatch rookeries from St. Paul Reef) (Zeppelin et al. 2015). Differences in diet are associated with the physical environment surrounding the islands (Antonelis et al. 1997). Pollock is the predominant prey species for St. Paul fur seals that forage over the Bering Sea shelf, while Bogoslof and St. George fur seals foraging in the Bering Sea basin consume less pollock and higher concentrations of northern smoothtongue and gonatid squid (Zeppelin and Ream 2006; Zeppelin and Orr 2010). Within St. Paul and St. George islands, diet differences between rookery complexes indicate further partitioning of prey resources (Zeppelin and Ream 2006).

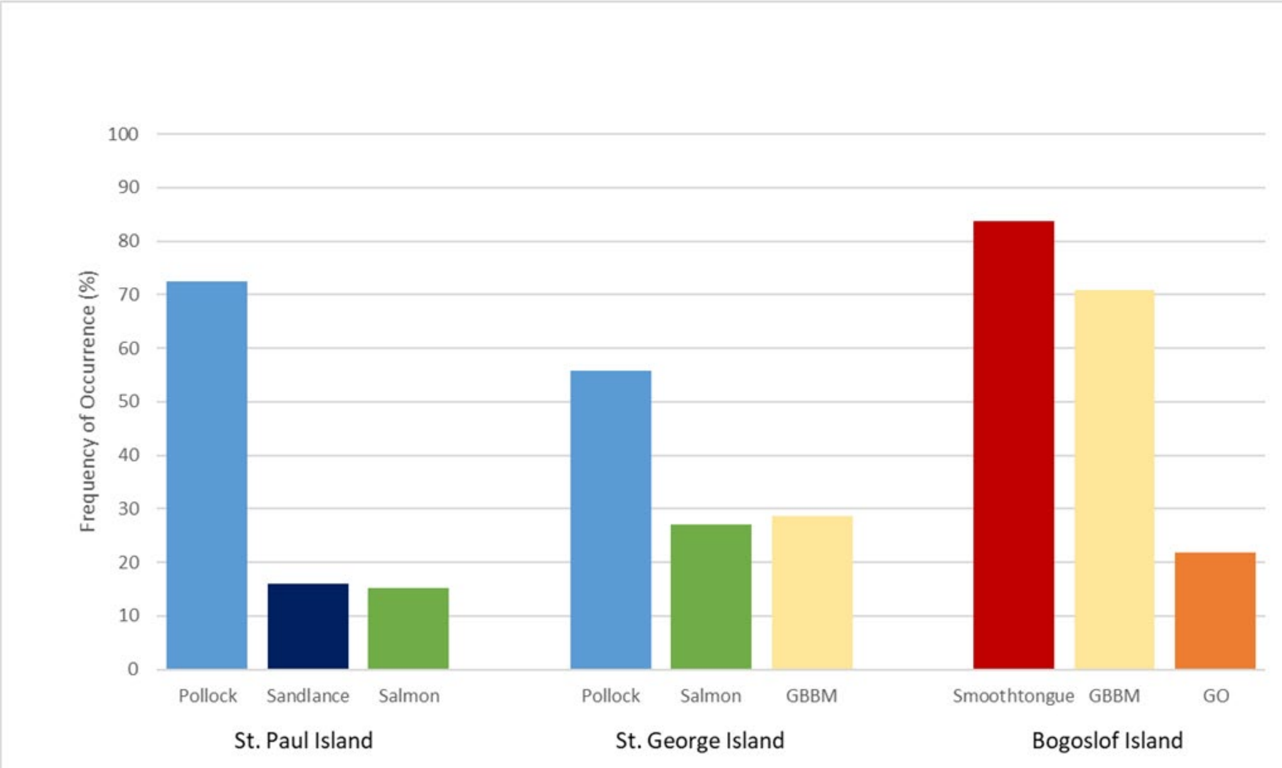

Figure 8. Frequency of occurrence (%) of the top three prey items found in scat and spew samples collected from rookeries on St. Paul (n = 1,612), St. George (n = 630), and Bogoslof (n = 306) Islands from 2001–2012 (MML, unpublished data). GBBM = *Gonatopsis borealis/Berryteuthis magister* sp. (squid) and GO = *Gonatus onyx* (squid).

Current Trends

Abundance Summary

In 1988, the Pribilof Islands population of northern fur seals was designated as a depleted stock under the MMPA because it had declined by more than 50 percent from its estimated population peak of 2.2 million seals in the 1950s (53 FR 17888, May 18, 1988). By 1995, using the phylogeographic stock definition approach proposed by Dizon et al. (1992), NMFS combined the Pribilof Islands and Bogoslof Island populations of fur seals into the Eastern Pacific stock as distinct from the San Miguel Island stock based on distributional and population response data (Small and DeMaster 1995). The fur seal population breeding on Bogoslof Island has dramatically increased since that time (Loughlin and Miller 1989; Kuhn et al. 2014a; Towell and Ream 2019; Muto et al. 2022). Despite continued growth at Bogoslof and a relatively stable population at St. George, declines at St. Paul have continued to drive an overall stock decline for the past 15 years.

The most recent estimates, however, provide some indication that the overall stock decline may be slowing. The most recent abundance estimate for the Eastern Pacific stock in the 2021 Stock Assessment Report was 626,618 seals (Muto et al. 2022).

Pup Production

The northern fur seal population is estimated biennially on St. Paul and St. George, and less frequently on Bogoslof Island (Figure 5) and Sea Lion Rock (Figure 3). Estimates are based on the number of pups born (pup production). Pups are more reliable to count than adults because they remain on land until they are old enough to begin swimming and spending more time at sea in late August. A sample of pups are marked, allowed to mix with unmarked pups, and then NMFS researchers count samples of pups to estimate the total number of pups (York and Kozloff 1987). The majority of pups are born on St. Paul, followed by Bogoslof, and St. George. NMFS estimates pup production by sampling rookeries and combines those estimates to derive abundance by island. Rookery complexes have been identified (Robson et al. 2004; Zeppelin and Ream 2006) and exhibit distinct trends, providing greater resolution to our understanding of broader stock trends. Trends in pup production differ between islands, rookery complexes, and rookeries (see Habitat Use section for more details on rookery complexes).

Pup production on the Pribilofs began declining for unknown reasons in the late 1990s (see Towell et al. 2006; NMFS 2007a for details and prior history). Since the depleted designation in 1988, pup production estimates across the Pribilofs have declined at a rate of 2.02 percent per year through 2022 (Figure 9, blue line). From 2007 through 2022 (i.e., the period of the current Conservation Plan) the rate of decline slowed to 0.75 percent (Figure 9; red line). St. George pup production declined at a rate of 0.43 percent from 1988–2022, (Figure 10, blue line); however, from 2007–2022 pup production has increased at a rate of 2.83 percent (Figure 10, red line). Pup production on St. Paul, however, has declined at an overall rate of 3.43 percent per year since 1988, slowing only slightly to 3.13 percent from 2007–2022 (Figure 10, blue and red lines, respectively).

In contrast to the Pribilofs, pup production at Bogoslof has grown at an exponential rate since 1988 (Towell and Ream 2012; Kuhn et al. 2014a; Towell and Ream 2019; Muto et al. 2022). Pup production at Bogoslof Island grew at 9.52 percent between 1988 and 2007, but then slowed to 4.83 percent between 2007 and 2022 (Figure 10; red line). Pup production is estimated biennially on the Pribilofs, and opportunistically at irregular intervals on Bogoslof Island. Due to the significantly larger size of the population at St. Paul, declines in pup production there have continued to drive the overall stock estimate down over the long term (Muto et al. 2022), although as noted above, this rate of decline has slowed in recent years (Figure 9; red line).

Examining pup production rates at the rookery complex level provides greater resolution regarding these trends. The North and South rookery complexes on St. George have demonstrated similarly stable trends from 1988–2022 (Figure 11). Pup production at all three St. Paul rookery complexes is declining, but with some apparent variation in trends among complexes (Figure 11).

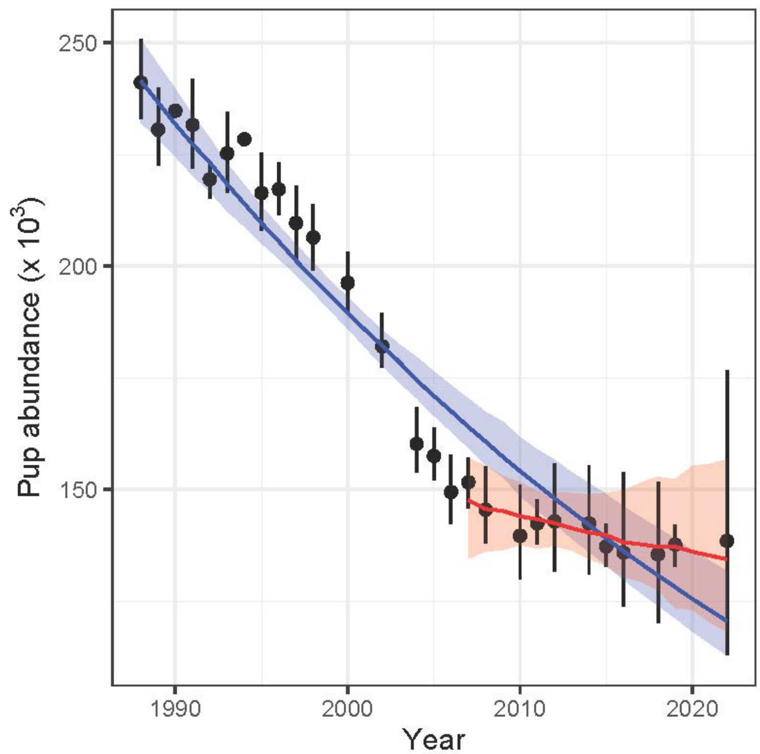

Figure 9. Estimated pup production for the Eastern Pacific stock of northern fur seals from 1988–2022. Estimated pup production (dots) with 95% credible interval (bars), average decline for the whole period (blue line), average decline from 2007–2022 (red line), and 95% credible interval for the fitted average decline in each year (shading).

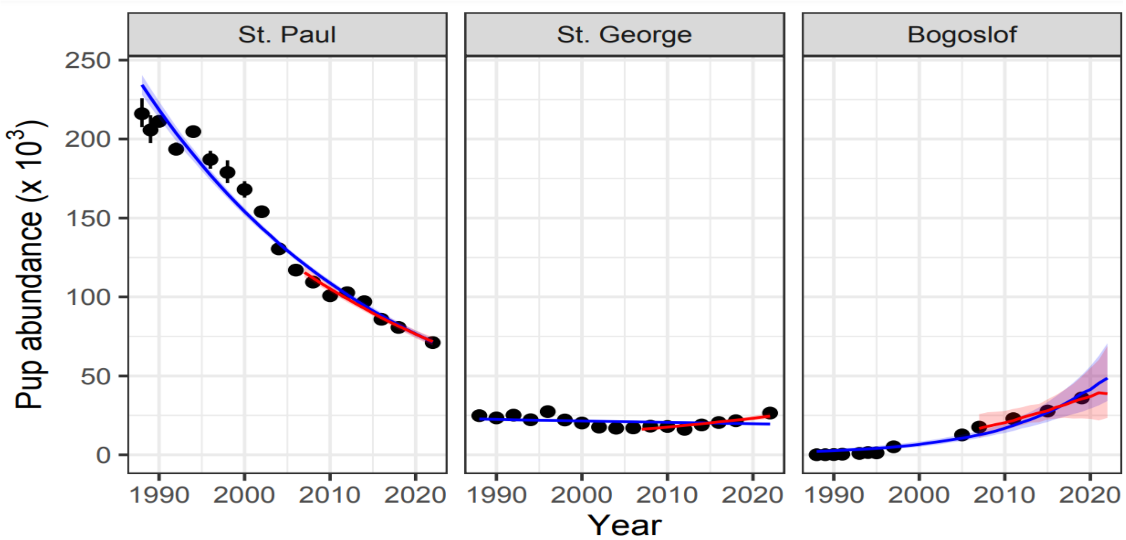

Figure 10. Estimated northern fur seal pup production by island from 1988–2022. Estimated pup production (dots) with 95% credible interval (bars), average trend for the whole period (blue line), average trend from 2007–2022 (red line), and 95% credible interval for the fitted average decline in each year (shading).

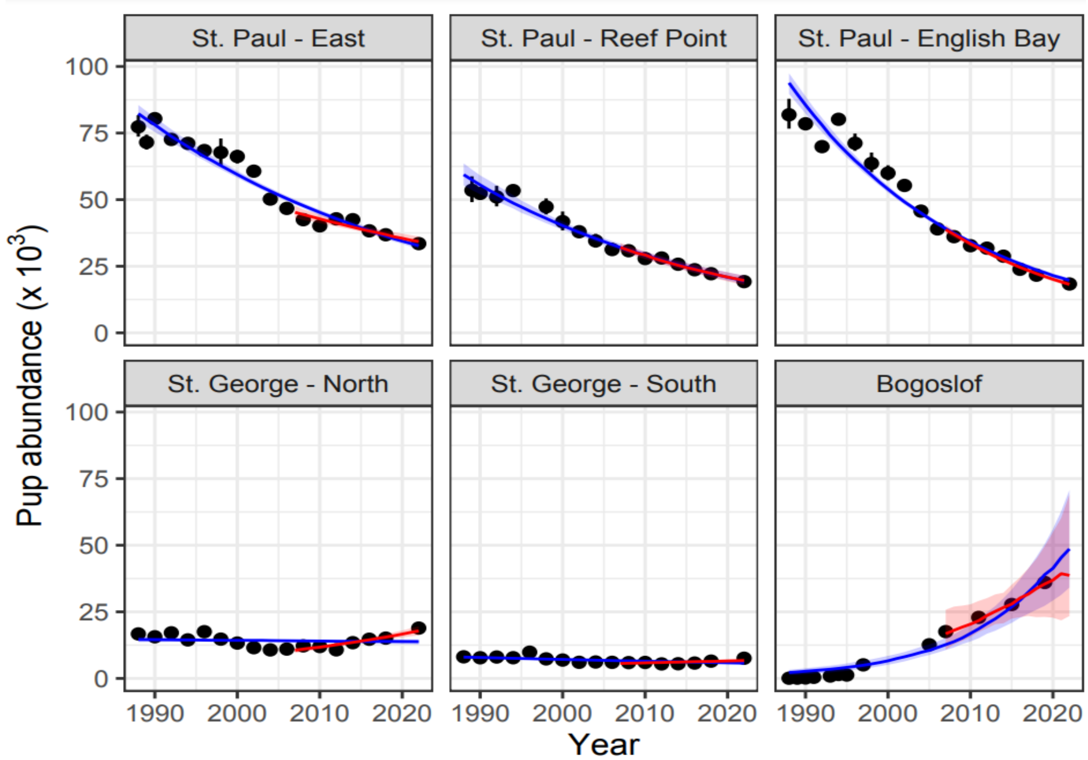

Figure 11. Estimated northern fur seal pup production by rookery complex from 1988–2022. Estimated pup production (dots), with 95% credible interval (bars), average trend for the whole period (blue line), average trend from 2007–2022 (red line), and 95% credible interval for the fitted average decline in each year (shading).

Pup Mortality

Pup mortality is an important indicator of the reproductive capacity of the northern fur seal population and has been observed periodically on the Pribilof Islands during periods of population recovery and decline since 1908. During population assessments, NMFS counts dead pups to calculate pup mortality rates when pups are about one month of age or around the third week of August. After the Fur Seal Treaty of 1911, on-land pup mortality rates exhibited density dependence by increasing as the population grew to its designated carrying capacity of 2.2 million seals in the 1950s (Fowler 1990; NMFS 1993). Following this period of peak population size, Pribilof Island pup production began to decline as a result of the adult female culling (1956–1968; see Commercial Exploitation section), which had lasting population consequences through to 1980 (York and Hartley 1981). Consistent with the population decline, the Pribilof Islands on-land pup mortality rates at each rookery declined up until the early 1980s where they have remained between 0.76–12.5 percent (Appendix IV). On Bogoslof Island, pup mortality has also remained low between approximately 2–3 percent from 2005–2019 (Towell and Ream 2012; Kuhn et al. 2014a; Towell et al. 2016; Towell and Ream 2019). Consistent with density-dependent responses seen on the Pribilof Islands, Bogoslof Island pup mortality has also slowly increased with its increasing population size, growing from less than one percent mortality in 1997 to three percent in 2019 (Kuhn et al. 2014a; Towell and Ream 2019).

The primary causes of early on-land pup mortality have remained consistent with the exception of hookworm caused mortality which was shown to be highly prevalent in the 1960s (NMFS 1970) but almost non-existent during studies from 1986–2006 (Spraker and Lander 2010). Starvation is the primary cause of early on-land pup mortality followed by trauma, perinatal mortality, and infectious diseases (Calambokidis and Gentry 1985; Spraker and Lander 2010). Starvation of pups has either been categorized as emaciation or malnutrition in these previous investigations and could be the result of any number of mechanisms.

While the relatively low on-land pup mortality rates are insufficient to explain the decline after the effects of the adult female harvest subsided, they do align with the observed complex specific pup production rates (Figure 10). Pribilof Island complexes experiencing the greatest rate of decline also exhibit the highest on-land pup mortality rates and vice versa (Appendix IV Table 1 and Appendix IV Figure 3A). Of the five complexes, St. Paul Island's English Bay complex has the highest estimated average annual pup mortality and is significantly higher than both Bogoslof Island and St. George Island's North rookery complex from 1988–2022. St. Paul Island's Reef complex has the second highest estimate of average annual pup mortality and is significantly different from Bogoslof Island (Appendix IV Table 1 and Appendix IV Figure 3A). There were no significant differences between St. George Island's North and South complexes and Bogoslof Island (Appendix IV Table 1 and Appendix IV Figure 3A). Also, there are no significant differences between St. Paul Island's East complex and St. George Island's North and South complexes and

Bogoslof Island (Appendix IV Table 1 and Appendix IV Figure 3A). For the entire period since the depleted designation (1988–2022) the general pattern of pup mortality (though not all complexes are significantly different) is lowest at Bogoslof Island followed in order of increasing mortality by rookery foraging complex: North St. George, South St. George, East St. Paul, Reef Point St. Paul, and English Bay St. Paul (Appendix IV Table 1 and Appendix IV Figure 3A). NMFS continues to monitor pup mortality rates and is investigating factors that may explain year-to-year variability.

Vital Rates

Vital rates include reproductive, survival, and growth rates. Reproductive and survival rates in the Pribilofs are discussed below; growth rates are discussed within the Pup Health section. Ongoing studies are designed to estimate reproductive and survival rates by marking or tagging individual seals as pups and then observing them throughout their lifetime. NMFS began studying fur seal vital rates through a tag and re-sight effort on the Pribilofs in 2007. Three rookeries are used for tagging and visually re-sighting individual seals, including Polovina Cliffs and Zapadni Reef rookeries on St. Paul (Figure 3), and South rookery on St. George (Figure 4). These rookeries were chosen as representative examples of the population trends, as well as for their accessibility and other logistical considerations. Reproductive and survival rates have not been measured on Bogoslof Island.

In 2017, NMFS began to investigate the influence of emigration on estimates of juvenile and adult survival from the tagging sites on St. Paul and St. George Island. In 2020, the ACSPI Ecosystem Conservation Office (ECO) was funded to tag adult female fur seals with very high frequency (VHF) transmitter tags to investigate fur seal responses to disturbance at Vostochni and Morjovi rookeries and surrounding areas (Figure 3). This project was initiated as a five-year collaboration with NMFS to develop fur seal research capacity within ECO and to share data collected from those tagged seals to increase sample sizes for the emigration study.

Reproductive Rates

To understand female reproduction rates, pupping rates are studied. Pupping rates are calculated as the proportion of adult females seen annually associated with pups. Estimated pupping rates for studied sites from 2008 through 2014 were high, and comparable to the highest historic estimates (Lander 1981; Testa et al. 2016). At Polovina Cliffs rookery, pupping rates ranged from 0.8–0.9 from 2008–2014, with a significant downward trend. At South rookery, rates from 2010–2014 ranged from 0.80–0.88 with no significant trend (Testa et al. 2016). Testa et al. (2010) used ultrasonography to determine that pregnancy rates prior to the winter migration were also high, estimated at 0.85–0.92. These data suggest that female reproductive rates are not likely contributors to population decline. No additional analyses on female reproductive rates have been conducted since 2016.

Survival Rates

Estimation of fur seal survival rates based on age class are underway, based on tagging initiated in 2010–2011. Early unpublished results suggested little difference in survival between St. George and St. Paul rookeries. These results are incongruous with the divergent abundance trends between islands and highlight the need for additional investigation of model assumptions.

Pup Health

Pup health measurements, such as weight and growth rates, are important indicators of fur seal population health, and in turn can provide insight into broader population trends. Additionally, they can reflect an indirect measure of local feeding conditions: with greater food availability and/or quality of prey, the time spent foraging by pup-provisioning mothers and fasting of their pups is reduced, leading to a greater number of suckling or feeding events, and to heavier and faster growing pups (Lunn et al. 1993; McCafferty et al. 1998; Croxall et al. 1999; Beauplet et al. 2005; McHuron et al. 2022). The end result is that their survival, influenced by body condition at the time of independence, is greater (Calambokidis and Gentry 1985; Doidge and Croxall 1989; Baker and Fowler 1992; Baker et al. 1994). Within the Eastern Pacific stock, linkages between northern fur seal maternal foraging behavior and pup growth and mass show that longer foraging trips adversely affect pup growth, resulting in slower-growing pups (Springer et al. 2010; McHuron et al. 2020). In years with longer adult female trip durations, cross-sectionally sampled pups weighed in the same year tended to weigh less compared to years with shorter trip durations (Merrill et al. 2021). Inter-island comparison research between Bogoslof Island (which at the time of the study had population growth of more than 11 percent per year) and St. Paul Island (which was declining over 3 percent per year) found that pup growth was faster on Bogoslof Island than St. Paul Island (Springer et al. 2010). The differences in pup growth rates were attributed to longer maternal foraging trips and subsequently fewer foraging bouts by St. Paul Island adult females, as compared to Bogoslof Island adult females.

Northern fur seal pup weights have been measured since 1957 on the Pribilof Islands during the months of August, September, and October because of the implications of mass for pup health. NMFS standardized its sampling of pup weights during the third week of August when pups are approximately 45 days old and during the period when pup production is estimated (NMFS 2007a). Results indicate that males tend to be heavier than females on both St. Paul and St. George, and both male and female pups tend to be significantly heavier on St. George than St. Paul (Towell et al. 2016). Pribilof Island rookery complex-specific female pup weights, sampled between the years 1988–2022, show there were no significant differences in female pup weights between the two St. George Island complexes (Appendix IV Table 1 and Appendix IV Figure 3B). However, female pup weights at both of the St. George rookery complexes are significantly greater than all three of the St. Paul Island rookery complexes (Appendix IV

Table 1 and Appendix IV Figure 3B). When grouped by island, St. George Island female pup weights, sampled over the entire sampling period (1988–2022), were significantly greater than St. Paul Island (Appendix IV Table 1 and Appendix IV Figure 3B). During the years 2007–2022, the St. George Island point estimate was greater, but not significantly greater than St. Paul Island (Appendix IV Table 1 and Appendix IV Figure 3B). NMFS does not routinely weigh pups on Bogoslof Island.

Trends in pup weight and growth rate on St. George, St. Paul, and Bogoslof Islands mirror the abundance trends among the three islands, with lower female pup mass on St. Paul Island than St. George Island, and lower pup growth rates on St. Paul Island than Bogoslof Island (Appendix IV Table 1). Continuing to monitor pup morphometrics will be an important factor in working toward a better understanding of the declining status of the Eastern Pacific stock of northern fur seals.

Foraging Trip Durations

Elliot (1882) observed marked reproductive fur seals in 1872 and stated in reference to a pup nursing, "It does not seem to nurse more than once every two or three days…" This was at a time when the Pribilof Islands northern fur seal population was estimated to be over three million seals. Three quarters of a century later, fur seal management recognized the need for quantitative behavioral data. In 1951, small groups of known individual seals were monitored at Kitovi rookery on St. Paul Island as part of a larger observational study. Bartholomew and Hoel (1953) reported the durations of the first 1–4 foraging trips of 12 reproductive females. The mean of the first foraging trip to sea after the perinatal period was six days, and overall female foraging trip durations averaged just over seven days. Peterson (1962) and later Gentry (1998) reported on reproductive fur seal foraging trip durations in the early 1960s, 1970s, and 1980s. The results from their studies demonstrated density dependence and environmental forcing, given that the observed decline in adult female trip durations was consistent with the Pribilof Island fur seal population decline. An observed further reduction in trip durations aligned with several large recruiting events of the Pribilof Island fur seal's primary prey, pollock (Gentry 1998). Cross-sectional and longitudinal studies mentioned above (also see Pup Health) are consistent with the hypothesis that shorter foraging trips result in heavier and faster growing pups (Goebel 2002; Springer et al. 2010; Kuhn et al. 2014b; Merrill 2019; Merrill et al. 2021). Modeling foraging trip durations suggests that closer prey patch distances and higher energy densities align with shorter trips based on optimal foraging theory, however direct observations of foraging trip durations, prey patches, and pup mass have not been made to confirm these model results (Goebel 2002; Springer et al. 2010; Kuhn et al. 2014b; Merrill 2019; Merrill et al. 2021; McHuron et al. 2022).

The variability in adult female foraging trip durations likely reflects variable feeding conditions and, as a result, long-term monitoring can help guide research that will lead to better understanding of the biological and physiological causes of the observed variation. Currently, observed variability in foraging trip durations among the three Eastern Pacific stock islands align with the observed island-specific pup production trends – that is, the reported Bogoslof Island foraging trip durations (Springer et al. 2010; Kuhn et al. 2014b) are the shortest in duration and its pup production is increasing, while St. Paul Island foraging trip durations are the longest in duration and its pup production is decreasing (Appendix IV Table 1; Goebel 2002; Call et al. 2008; Kuhn et al. 2014b; Towell and Ream 2019; Merrill et al. 2021; Towell et al. 2023). Both foraging trip durations and population growth rate for St. George Island fall in the middle between St. Paul and Bogoslof Islands (Merrill et al. 2021; Towell et al. 2023).

NMFS has compiled and standardized the majority of northern fur seal trip duration studies dating back to the 1950s. For the years 1988–2022, NMFS examined adult female trip durations occurring in both the months of July and August to capture the known seasonal changes that typically occur from July to August and to align with the period of sampling dead pups and pup weights (Appendix IV Table 1 and Appendix IV Figure 3C) (Springer et al. 2010; Merrill et al. 2021). Consistent with the previous studies mentioned above (Springer et al. 2010; Kuhn et al. 2014b), Bogoslof Island has significantly shorter trip durations compared to the other complexes of both St. Paul and St. George Islands (Appendix IV Table 1 and Appendix IV Figure 3C). There were no significant differences among the Pribilof Island rookery complexes over the 1988–2022 sampling period, however, the general pattern of foraging trip duration is shortest at Bogoslof Island followed by increasing trip durations by rookery complex: North St. George, South St. George, East St. Paul, Reef Point St. Paul, and English Bay St. Paul (Appendix IV Table 1 and Appendix IV Figure 3C). However, when examining the 2007–2022 sampling period, differences between St. Paul and St. George Islands and among their complexes show foraging trips to be significantly longer on St. Paul Island compared to St. George Island (Appendix IV Table 1 and Appendix IV Figure 3C).

Similar to trends in pup mortality and pup weight and growth, July and August adult female trip durations mirror the abundance trends among the three Eastern Pacific stock islands, with longer adult female trip durations occurring on St. Paul Island and among its foraging complexes as compared to St. George Island (Appendix IV Table 1). The shortest trip durations occurred on Bogoslof Island where the pup production is growing at the fastest rate (Appendix IV Table 1). NMFS is continuing to monitor adult female trip durations within the Eastern Pacific stock of northern fur seals.

Optimum Sustainable Population

The MMPA (16 U.S.C. 1362(3)(9)) defines Optimum Sustainable Population (OSP) as:

> *"[T]he number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element."*

NMFS regulations (50 CFR 216.3) define OSP as:

> *"[A] population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity. Maximum net productivity is the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality."*

The MMPA states that marine mammal species, populations, and stocks should not be permitted to fall below their OSP level (16 U.S.C. 1361(2)). The upper bound of the OSP range is the largest supportable within the ecosystem (50 CFR 216.3); and was subsequently clarified in the depleted designation as carrying capacity (53 FR 17888, May 18, 1988). Carrying capacity represents the largest population size that the environment can support under conditions of no harvest (Gerrodette and Demaster 1990). The maximum net productivity level (MNPL) is the lower bound of OSP. NMFS determined that MNPL was best expressed as a range of values (generally 50–70 percent of carrying capacity), determined theoretically by estimating what stock size, among the observed population sizes during a sufficiently long period of increase, will produce the maximum net increase in population size (42 FR 12015, March 1, 1977). MNPL for marine mammals is at least 50 percent of carrying capacity (Eberhardt and Siniff 1977), and later estimates suggested it may be as high as 80 percent (Fowler 1981; Fowler 1988).

In the 1980s, NMFS estimated that the highest sustained population size was reached in 1955 and 1956 for the Pribilof Islands stock of northern fur seals (Table 7 in Briggs and Fowler 1984). NMFS subsequently determined that the estimate of 2.2 million represented carrying capacity (53 FR 17888, May 18, 1988) as the population estimates ranged from 2.0 to 2.2 million from 1951 through 1958 (Briggs and Fowler 1984). The MNPL for the Pribilof Islands stock was determined to be 60 percent of carrying capacity (50 FR 9232, March 6, 1985) or 1.3 million fur seals (53 FR 17888, May 18, 1988). Since both the upper and lower bound of the OSP range are defined by carrying capacity, determining if the stock is above or below its MNPL of 1.3 million northern fur seals is critical. The preliminary estimate from 1986 was about 800,000 at the time of the proposed depleted designation (51 FR 47156, December 30, 1986), which is 36 percent of carrying capacity. The most recent estimate for the Eastern Pacific stock was 626,818 fur seals (Muto et al. 2022) or 28 percent of carrying capacity.

Since the depleted designation, there are have been studies and analyses that could inform the estimates of OSP, carrying capacity, and MNPL, and NMFS now understands that these estimates in part relied on assumptions that have not stood the test of time, as explained below; however, the current OSP, carrying capacity, and MNPL still provide the best available estimates in the absence of further evaluation or the development of new methods. Ragen (1995) used St. Paul pup production and age specific survival data to estimate MNPL at just under one million seals for fur seals breeding on St. Paul Island. This work indicated shortcomings of the MNPL modelling are confounded due to assumptions that the survival estimates from the 1950s as the population reached carrying capacity were representative of those in the 1940s where there were no pup production estimates and survival was back-calculated from age-specific male kill data and an assumed relationship between the number of harem males and pups born. In addition, confounding the interpretation of MNPL is the occurrence of one or more of simultaneous changes in factors such as growth, mortality, or reproduction and a quantitative measure of population size in fur seals (Fowler 1990). Finally, the models do not account for how the commercial kill of juvenile males could significantly influence the estimate of MNPL (Ragen 1995). Similar MNPL estimates for fur seals breeding on St. George and Bogoslof Islands have not been completed for the Eastern Pacific stock due to lack of data. Whether NMFS' estimate of 1.3 million seals (53 FR 17888, May 18, 1988) as MNPL for the Pribilof Islands stock could be revised for what is now the Eastern Pacific stock using data from St. George and Bogoslof based on the methods used by Ragen (1995) has not been evaluated, nor has it been evaluated whether new methods need to be developed. Regardless, of whether the methods used in Ragen (1995) could be used to estimate the additional MNPL increment to account for the breeding fur seals on St. George and Bogoslof with the limited available data above the MPNL estimate for St. Paul; the Eastern Pacific stock is well below the lower bound of OSP indicating depleted designation continues to be supported.

The primary analysis of whether the Pribilof Islands stock was below OSP relied on adult male counts, estimates of pup production, and commercial kill data from St. Paul and St. George from 1941 through 1984. In addition, the OSP analyses estimated age-specific reproductive rates from females killed during both pelagic research and island-specific kills from 1955–1974. Due to data limitations, many assumptions were made regarding data from one island being representative of both. For example, survival was estimated for male fur seals from St. Paul and assumed to apply to St. George (Lander 1980). In addition, St. George Island pup production was estimated from live pup data from just eight years of that 43-year period (i.e., 1949, 1966, 1970, 1973, 1977, 1978, 1981, and 1983). St. Paul Island pup production was estimated from live pup data from 23 of the 43 years during that same period. Until the mid-1980s, it was the accepted practice to estimate pup production on St. Paul and then derive the St. George pup production estimate by multiplying the St. Paul estimate by either 0.25 (before 1973) or 0.193 (after 1973; see Lander 1980). NMFS has still not evaluated the implications of these past assumptions regarding historic estimates of St. George pup production, the different juvenile male harvest regimes for St. George and St. Paul, or estimates of OSP for the entire Eastern Pacific stock all together (which now includes pup production from Bogoslof, which exceeds pup production on St. George).

Further complicating our understanding of the Eastern Pacific stock and the associated island population dynamics is that the majority of the analyses and modeling considered in the depleted designation and subsequent analyses used data exclusively from St. Paul Island because it was more comprehensive and assumed to also represent seals breeding on St. George Island. Furthermore, most analyses were completed prior to the re-definition of the Pribilof Islands stock to include seals breeding on Bogoslof Island and rename the stock the Eastern Pacific Stock. Since the 2007 revision of the Conservation Plan, studies have shown consistent differences in foraging behavior, diet, and segregation of marine foraging habitat by rookery complex. The trends in pup production also show differences consistent with the rookery complex segregation on St. Paul, St. George, and Bogoslof Islands.

In addition, the cessation of the commercial harvest of juvenile males on St. George in 1973 and St. Paul in 1985 resulted in annual recruitment of about 5,000 (St. George) and 25,000 (St. Paul) more males into older age classes in the population. Both islands showed significant increases in counts of adult males after accounting for 5–7 year lags for those males to reach maturity. At that time, the North Pacific Fur Seal Commission (NPFSC) believed that these additional surviving males from St. Paul Island would not compromise the breeding structure or change terrestrial mortality (NPFSC 1984; Gentry 1998). However, not until 2004 (Sterling and Ream 2004) did we understand that juvenile male foraging behavior is spatially and temporally similar to that of lactating females. We have since additionally learned that there is significant dietary niche overlap between juvenile males and lactating females (Call and Ream 2012). It follows that some competition between juvenile males and lactating females must occur, but it has not been quantitatively estimated.

Gerrodette and Demaster (1990) used Goodman's dynamic response analysis (Goodman 1988) and a condition index to evaluate northern fur seal population status relative to OSP. They determined that the population was below OSP, consistent with the depleted designation (53 FR 17888, May 18, 1988), and that carrying capacity was unchanged in the 1980s relative to the 1950s. Had carrying capacity been reduced in the 1980s relative to the peak, we would have predicted to see reduced body size, reduced growth rates and increased on-land pup mortality; however, the opposite was observed (53 FR 17888, May 18, 1988). Fowler and Siniff (1992) used a variant of the approach used by Gerrodette and Demaster (1990) to suggest that carrying capacity might be reduced by 13 percent based on a proportional reduction of mortality estimates from 1911–1990.

While these analyses were being conducted, lactating females from 1985 onward likely experienced a significant increase in competition with juvenile males who had previously been removed from the population during July and early August due to the cessation of the commercial harvest on St. George and St. Paul. Furthermore, the development of the directed foreign commercial pollock fishery began in 1964, and increased rapidly to a catch of 1.9 million tons of pollock in 1972, and by 1988 the pollock catch was harvested exclusively by U.S. vessels, with annual catch limits of around 1 million tons (Ianelli et al. 2023). The interactions between fur seals and fisheries were a recurring topic in the annual reports of the NPFSC (1984) until the lapse of the Convention in 1985. Early evaluations of competition indicated that the pollock fishery would be beneficial to fur seals, because it was believed that adult pollock and fur seals only competed for 0–1 age class pollock, and fur seal consumption of adult pollock was limited (Swartzman and Haar 1983; Livingston 1989). While fur seals do consume significant 0–1 age class pollock, they also consume significantly more adult pollock than previously estimated (Gudmundson et al. 2006; McHuron et al. 2020).

As noted above, we now know that juvenile male fur seals are important competitors and have significant niche overlap with lactating adult females (Call and Ream 2012). Furthermore, McHuron et al. (2020) estimated that adult males had the highest net energy intake of any segment of the northern fur seal population. The annual consumption of prey for the entire Eastern Pacific stock of fur seals in the five years investigated (1995, 1996, 2004, 2006, 2010) ranged from 255,232–500,039 tons (McHuron et al. 2020). This level of prey consumption by the stock is significantly higher than previous estimates (Perez and McAlister 1993), largely due to recent advances in telemetry, diet, and wild and captive energetic studies.

Carrying capacity estimates for other seasonal occupants of the Bering Sea may provide independent measures to validate the estimated carrying capacity of the Eastern Pacific stock. A review of pollock fisheries data for the Bering Sea during a similar timeframe concluded that an increase of juvenile walleye pollock may have resulted in an increase of total pollock, potentially benefiting foraging northern fur seals (Swartzman and Haar 1983; Swartzman and Haar 1985). A re-evaluation of pollock catch data from 1964–1980 indicated that fishing mortality rates for the Eastern Bering Sea (EBS) pollock stock were above maximum sustained yield (F_{MSY}) until about 1980 (Ianelli et al. 2023). Since that time, the levels of fishing mortality have averaged about 35 percent of the F_{MSY} level (see Fig. 57, *in* Ianelli et al. 2023). If no fishing had occurred since 1978, the 2022 EBS spawning stock size would be 62 percent larger (Table 27, *in* Ianelli et al. 2023). This would suggest that the pollock stock has been altered by fishing since 1964 and as a keystone species in the EBS (Aydin et al. 2002) a reduction of the pollock stock would alter the abundance of other species in the ecosystem.

Schell (2000) suggested that carbon and nitrogen isotope ratios in whale baleen indicated a reduction in primary and secondary production in the Bering Sea during 1980s and 1990s and that the overall carrying capacity of Bering Sea was reduced. However, analysis of carbon and nitrogen isotopes ratios in northern fur seal teeth from three-year-old males spanning from 1950–2000 suggested that declining carbon isotope ratios were indicative of an increase of anthropogenic carbon into the atmosphere and ocean surface and the assumptions of Schell (2000) of reduced primary and secondary productivity in the Bering Sea were unsupported by the fur seal data (Newsome et al. 2007).

Springer et al. (2003) hypothesized that commercial whaling altered predator-prey interactions between mammal-eating killer whales and large whales in the Bering Sea, resulting in sequential megafauna collapse of pinniped and sea otter (*Enhydra lutris*) stocks. While subsequent studies have disagreed on the accuracy of this hypothesis (DeMaster et al. 2006; Mizroch and Rice 2006; Trites et al. 2007; Wade et al. 2007; Springer et al. 2008; Wade et al. 2009), there is little doubt that commercial whaling through the early 1970s removed significant biomass and altered the ecosystem. However, how these ecosystem changes may have influenced carrying capacity for top level predators like northern fur seals has not been investigated.

Humans have impacted all ecosystems (Reid et al. 2005), including the Eastern Bering Sea and North Pacific Ocean. Alterations to ecosystems stemming from climate change, pollution, marine debris, and fishing are all factors that influence whether the ecosystem is resilient and capable of supporting historic abundance of higher trophic level species such as fur seals. More recent estimates of consumption of both juvenile and adult pollock indicate a more dynamic relationship between adult and juvenile pollock, other important fish species, and fur seals than was previously understood (McHuron et al. 2020). The carrying capacity for any species is an ecosystem feature determined, in part, by the combined effects of many factors.

In summary, it is clear based on recent advances in our understanding of northern fur seals and their role in the Bering Sea ecosystem that estimates of OSP in the 1980s relied on assumptions that have not stood the test of time. These unsupported assumptions include: 1) that no intraspecific competition exists between juvenile males and adult females in the Bering Sea; 2) that fur seals don’t consume adult pollock in the Bering Sea; and 3) that northern fur seal diet and foraging behavior are consistent across breeding locations on the Pribilof Islands. In addition, the assumption that the commercial harvest of juvenile males would not affect estimates of maximum net productivity level or carrying capacity is likely unsupported. Regardless, the current stock size (626,618 seals; Muto et al. 2022) is well below the threshold of 1.3 million fur seals, and there are no new analyses to reevaluate how previous assumptions might change this threshold. Analysis of populations with different trends within the stock may shed light on the stock status relative to OSP and whether there are other management actions to be taken to increase the stock above the lower bound of OSP.

Commercial Exploitation

The commercial exploitation of fur seals began within a few years of Gavriil Pribylov’s arrival on the Pribilof Islands in June 1786. Details of the fur seal harvest and management under Russian occupation can be found in numerous references including Roppel (1984), Roppel and Davey (1965), Gentry (1998), and Scheffer et al. (1984). In summary, from Russian arrival until 1799 individual vessels and crews operated independently on St. Paul and St. George. In 1799, the individual crews were consolidated under the monopoly of the Russian American Company and land-based harvests of fur seals were primarily of pups (Roppel 1984). Within a few decades, “management” measures were implemented (albeit inconsistently) to avoid females, bachelors (i.e., nonbreeding males), and adult males (Roppel 1984). Records from this period are scarce and sometimes conflicting, but during the Russian occupation about 2–4 million fur seals may have been harvested (Roppel 1984; Hanna 2008).

The fur seal population was reportedly thriving and was sustaining an annual commercial harvest of several thousand nonbreeding aged-males when the United States purchased Alaska in 1867 (York and Hartley 1981). Following the purchase of Alaska by the United States, the fur seal commercial harvest ensued from 1868–1869 without restrictions similar to the first 15 years of Russian occupation. Multiple companies arrived on the Pribilof Islands for the 1868 and 1869 seasons and as many as 329,000 seals were killed for their pelts during those two years. In 1869, the Pribilof Islands were set aside as a special reservation for the protection of fur seals as a result of the near unrestricted harvest.

In 1870, the U.S. government issued a 20-year sealing lease to the Alaska Commercial Company. The lease arrangements caused the remaining sealing companies to focus their operations at sea where U.S. jurisdiction was in dispute across the fur seal migratory range. The first lease (1870–1889) was marked by high quotas on land (100,000 males per year) and growth of the pelagic fleet and their catch. In 1880, the U.S. government issued a subsequent 20-year lease to a new lessee, the North American Commercial Company. During the second 20-year lease (1890–1909), northern fur seals were overharvested, pelagic sealing catches exceeded the land-based harvest, and the pelagic catch was primarily adult females (Hanna 2008). The North American Commercial Company never reached the annual land-based pelt quotas (60,000 per year) in the lease due to significant population declines. The history of pelagic sealing (1868–1909), its impact on the fur seal population, and a subsequent treaty that banned pelagic sealing is detailed in Roppel and Davey (1965), Gentry (1998), and Hanna (2008). At the peak of pelagic sealing (1891 to 1900), more than 42,000 fur seals, mostly lactating females, were killed annually in the Bering Sea (Scheffer et al. 1984). The pelagic fleet sold 279,396 skins from 1872–1889 (Rogers 1976). However, the number of skins sold does not account for the total number of seals killed because it is unknown how many seals were struck and lost.

The Fur Seal Treaty of 1911 prohibited pelagic sealing in the North Pacific Ocean by the signatory countries of Great Britain (also signing for Canada), Japan, the United States, and Russia. As a result of the treaty, commercial land-based exploitation was banned by Congress from 1911 to 1917, the lease program was terminated, and the U.S. government took over direct management and operation. At this time, a general seal quota was set and subsequently changed so that only non-breeding males were harvested. In the absence of a pelagic quota, land-based exploitation increased from 15,862 animals in 1923 to 95,016 animals in 1941 (Roppel 1984). No commercial season took place in 1942 due to World War II and the Unangax̂ evacuation and internment in camps at Funter Bay, Alaska (Kohlhoff 1995). In 1943, Unangax̂ sealers were brought back to fill seal pelt quotas on the Pribilof Islands during the summer and then returned to internment camps in Funter Bay. The commercial exploitation from 1943–1955 averaged about 70,000 non-breeding male fur seals per year (Roppel 1984). The U.S. continued direct oversight and management of the commercial season under the terms of the Interim Convention on Conservation of North Pacific Fur Seals of 1957 (Convention) between signatories from Canada, Japan, Russia, and the United States) and the Fur Seal Act of 1966 after Alaska Statehood in 1959. The State of Alaska received 70 percent of the net proceeds of the sale of fur seal skins annually from 1959–1984.

The Convention signed in 1957 established a four-member North Pacific Fur Seal Commission (Commission) and a six-year cooperative research program to determine measures necessary to achieve maximum sustained yield from the fur seal population. The Convention established both a directed herd reduction program focused on the killing of females and the continuation of the killing of non-breeding males for skins on the Pribilof Islands (NPFSC 1965; NPFSC 1969; NMFS 1970; NPFSC 1971). The Commission prescribed annual limits on the length of females to be killed and on whether those kills could occur at the breeding areas or at non-breeding hauling grounds (NPFSC 1965). Estimates of pup production declined immediately in response to the killing of females. Non-breeding males and adult males also declined, consistent with the herd reduction plan through 1968 when female kills on land were suspended and the juvenile male kill continued (York and Hartley 1981; Trites and York 1993). The continued decline after 1971 was not anticipated, and pelagic kills for research purposes were suspended in 1974. In total, about 315,000 female fur seals were killed on land as part of this effort from 1956–1968 (Figure 12; York and Hartley 1981).

Trites and York (1993) detected a reduction in pregnancy rates of 8 to 13-year-old females as well as an increase in the age at first birth during the decline through 1974; those results were contrary to the density-dependent predictions of the herd reduction program, which had intended to increase pregnancy rates to achieve maximum sustained yield. The herd size predicted to result in maximum sustained productivity was reached in 1962, but by 1972 the population had not responded with the increased yield of non-breeding males for harvest (Gentry 1998). The Commission then began the St. George Island Research Program (described in more detail below in the Subsistence Use and Co-Management section) in 1972 (Figure 12) to coordinate investigations of on-land behavior, population dynamics, and relationships between fur seals and fishery resources in response to cessation of the commercial harvest of seals for pelts on St. George Island (Gentry 1998). The Convention continued to provide the authority to fund and initiate research into the causes of the decline through 1984, but formal international research was discontinued due to lack of funding after the commercial harvest on St. Paul Island stopped in 1985 (Gentry 1998).

The U.S. government managed the domestic responsibilities under the Treaty and subsequent conventions through multiple federal agencies starting with the Department of Treasury, Department of Commerce and Labor, Department of Interior, Bureau of Commercial Fisheries, and then Department of Commerce, NMFS. In 1960, the Marine

Mammal Resource Program was created and subsequently became the Pribilof Islands Program to manage federal activities related to the international conventions and domestic implementation of the provisions of the Fur Seal Act (Scheffer et al. 1984). The Pribilof Islands Program responsibilities were transferred from the NMFS Northwest Regional Office to the Alaska Regional Office in the 1980s as the federal phase out plan was negotiated among the State of Alaska and Pribilof Island representatives due to a steep reduction in the revenue, domestic legislation, and renegotiation of the Fur Seal Convention (USDOC 1985). In 1984, NMFS contracted the Tanadgusix Corporation to kill fur seals for their skins (NMFS 1985), resulting in the Tanadgusix Corporation killing 22,066 fur seals for commercial sale on behalf of the U.S. that year. In total, more than 7 million northern fur seals were killed for commercial use under the U.S. control of the Pribilof Islands. The last commercial harvest occurred in 1984 on St. Paul Island. In 1985, NMFS issued an emergency interim rule under the authority of section 105(a) of the Fur Seal Act to authorize the harvest of fur seals for the 1985 season for subsistence uses (50 FR 27914, July 8, 1985). The subsistence use of fur seals by the Unangax̂ on the Pribilof Islands continues to be regulated under the Fur Seal Act and is currently managed cooperatively under section 119 of the MMPA (16 U.S.C. 1388(a)) (see Subsistence Use and Co-Management section for details).

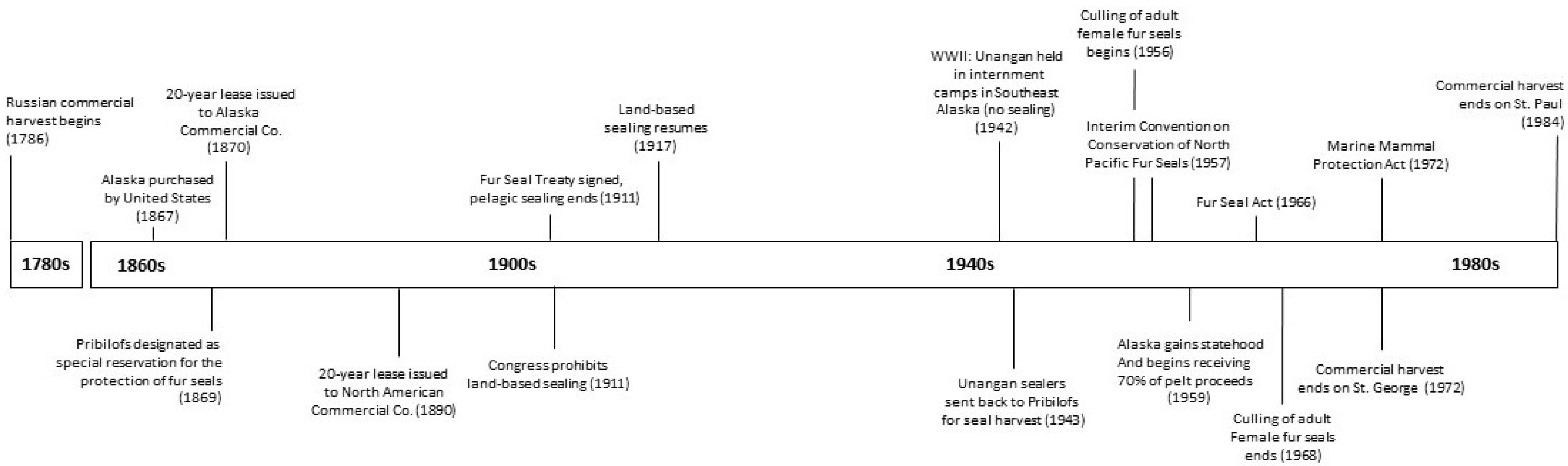

Figure 12. Timeline of events related to the commercial harvest of northern fur seals in the Pribilofs.

People of the Seal

Unangax̂ (the People of the Sea, or the Aleut Peoples) connections to the marine mammal resources in the Pribilof Islands marine ecosystem predate historic records. The bounty of diversity and richness found in the area has sustained Unangax̂ throughout the Bering Sea region for millennia. Prehistoric culture across the Aleutian Islands, the original home of Pribilovian Unangax̂, was based almost entirely on marine resources, including hunting every kind of sea mammal found around the Aleutian chain and Pribilof Islands, fishing the offshore and coastal waters, foraging for fish and shellfish on the rocky reefs, and hunting birds on land and sea. This wealth of resources supported dense human populations expressing a rich, strong culture. This prehistoric culture created the world's most specialized and successful maritime hunter-gatherer traditions, lasting from roughly 4,000 years ago until the time of Russian contact with the Aleutian villages in 1741 (Dall 1877; Dall 1878; Jochelson 1925; Hrdlička 1945; Lantis 1970; Laughlin 1980; Lantis 1984; McCartney 1984; Veniaminov 1984). The fur seal industry as it would become would not have existed or prospered without the forced labor of the Unangax̂. The history of fur seal management and conservation is inextricably linked to Unangax̂ who were enslaved to labor in the industry under the Russian and U.S. governments.

Russian fur traders arrived in the Aleutians in the mid-1700s in pursuit of sea otters, which they forced Unangax̂ to hunt on their behalf. As sea otter catches waned throughout the Aleutians, the Unangan hunters in the Russian fur trade began to explore other opportunities. Russian traders and explorers heard Unangan speak of "the island with laaqudan (northern fur seals)" and the story of Iggadaagix̂. Iggadaagix̂ was the son of a chief from Unimak Island who was caught in a storm, unable to return to land, and blown to the north in his iqyax̂ (traditional kayak). After days lost at sea, Iggadaagix̂ heard the sounds of laaqudan in the fog. When he followed the sound, he saw tens of thousands of northern fur seals on land. Up until this point, Unangan only knew fur seals at sea. Iggadaagix̂ stayed on this island for about a year when, at one point, he was at the highest part of the island and saw the mountains of the Aleutian Chain. He took his iqyax̂ and paddled home. Iggadaagix̂ recounted his story of the island of seals to Unangan in his village. The head shaman said that they should take a hunting party to these islands. When they arrived, the shaman felt the power of the place, and shared that humans were not to live there but only to visit as hunting parties. He called the islands the Tanax̂ Amix̂, or "Land of Mother's Brother." Today, St. Paul is known to community members as Tanax̂ Amix̂.

Gerasim Pribylov was first mate and navigator on the sloop, *St. George*, from 1783 to 1786 (Elliott 1886). Fur traders had been searching north and south of the Aleutians looking for the breeding or predicted wintering grounds of fur seals. Pribylov believed the Unangan story of Iggadaagix̂ and Tanax̂ Amix̂ and searched north of the Aleutians, where in 1786, he found an island he named "St. George" after their vessel. Some of the crew were left on the island for the winter, and Pribylov and the remaining crew of the *St.*

George returned to Unalaska with fur seal and sea otter pelts. Upon Pribylov's return to St. George in the spring of 1787, other competing Russian fur traders followed. The overwintering crew had observed another island they named St. Paul. The various competing fur trade companies kidnapped and enslaved Unangax̂ hunters and their families from the Aleutians to kill sea otters, foxes, and fur seals on the islands that would become known as the Pribilofs.

There was no oversight, organization, or control of the harvest or harvest practices during the first 20 years of the Russian occupation of St. George and St. Paul. The Russian fur trading companies forced Unangan to live on the islands in sealing "villages" near the densest aggregations of seals. Unangan believed that people were not to live permanently on the islands and the islands were to be kept clean of human energies. Once the sea otters were extirpated from the islands from over harvest, Unangan men were forced to kill tens of thousands of fur seals every year on land; women were forced to process and dry fur seal pelts. Unangan were often referred to as "hunters" in these early records, though their independence and social status were clearly the lowest class in the communities based on the wages or credit identified by the limited company records. Whether Unangax̂ social status changed when the Russian government began to institute harvest rules and limits is unknown, but those changes did allow the fur seal population to increase until the U.S. purchase of Alaska.

The purchase of Alaska was accomplished through the Treaty of Cession between the United States and Russia in 1867. The United States continued the administrative policies for Unangax̂ labor, but removed the Russian harvest management policies when it assumed control of the islands (see Commercial Exploitation). After the second lease arrangement between the U.S. government and commercial sealing companies expired and the North Pacific Fur Seal Treaty was signed in 1911, the administration on each island transitioned from a "company town" run by the lessee to a "government town." The federal government appointed an "island agent" from the U.S. Treasury to live on each island. These island agents had ultimate control over all aspects of life on the islands and disproportionately on Unangan. The U.S. government moved Unangan from their barabaras (semi-submerged sod houses) into wooden construction homes, government vessels transported everyone to and from the islands, and the government provided for the education and health of all residents. The government owned and operated the store, and rather than pay Unangan wages they were provided credit to purchase clothing, household items, and groceries. The transportation, health, education, and credit system were used as leverage against Unangan families by withholding credit and thus the ability to purchase basic necessities. Use of Unangax̂ language, dance, and song were prohibited. This generational trauma and cultural erosion included jail, threats of deportation from the islands, and pre-approval for off-island travel on government vessels. Marriages and other social events were controlled by the government agent. Unangax̂ labor was used to harvest seals, clean and remove blubber from fur seal skins, collect and process carcasses, and participate in fur seal research for the U.S. government under the Fur Seal Treaty.

In 1942, Japan bombed Unalaska and Dutch Harbor and invaded Kiska and Attu islands in the Aleutians. The U.S. War Department forcibly evacuated St. George and St. Paul residents (and remaining Aleutian Island village residents) from their homes with only 24 hours' notice. Approximately 450 residents of St. Paul and St. George were interned in an abandoned cannery and mine in Funter Bay, Southeast Alaska, where they were forced to survive in horrific and inhumane conditions for the duration of the war. There was no fur seal harvest in 1942, and in 1943 and 1944 Unangax̂ men were transported from Funter Bay back to the Pribilofs to harvest seals and process seal skins. When surviving residents were allowed to return to St. George and St. Paul in mid-1945, they found their homes ransacked by the U.S. military, and many of their prized church icons were stolen. The atrocities of World War II internments against Unangan were acknowledged by the United States more than 40 years later in the Aleutian and Pribilof Islands Restitution Act of 1988. Through the mid-1960s, Pribilovian Unangax̂ continued to be treated as "wards of the government" even though Alaska Natives in other communities earned wages and had basic rights and freedoms not afforded to Pribilovians.

Today, the Tribal communities of St. George and St. Paul self-identify as 'People of the Seal' and live with the knowledge that, "If they're [seals] not here, then we won't be either" (A.D. Lestenkof as quoted in Goldman et al. 2020). The current subsistence use of fur seals provides a sense of ceremony and deep appreciation for marine animals and all life. Unangax̂ stewardship responsibilities speak often of global forces impacting their existence in a rapidly changing climate and marine ecosystem, and stewardship over marine mammals is exceedingly important at the individual and collective levels.

Aniqdun ngiin aqaaĝan aĝnangin qulingiin akux̂ gumalgakux̂.

(For the coming generations that we don't see yet, for their time here.)

Subsistence Use and Co-Management

Unangax̂ Cultural Subsistence Values

Though many different definitions exist, the word "subsistence" approximates a concept in the culture of Unangax̂ and other Indigenous Peoples that encompasses the use of plants, fish, and other wildlife (including access to, and the process of, obtaining them) to fulfill not only survival needs, but also social and spiritual needs and values. Subsistence, for Unangax̂ of both the past and present, describes a relationship with the environment that lies at the core of identity, culture, and way of life. Unfortunately, Indigenous subsistence has historically been incorrectly interpreted by western society, as well as state and federal governments, to mean only the harvesting of natural resources in order to obtain food (e.g., "meat" in the case of fur seals). Understanding this misalignment between Unangax̂ subsistence values and the more literal interpretation of the word is important for understanding the history of northern fur seal subsistence in the Pribilofs.

Historically (i.e., prior to permanent settlement of the Pribilof Islands), Unangax̂ hunted fur seals for subsistence use throughout the Aleutian Islands. Archaeological evidence suggests fur seals were used for subsistence in this region for almost 4,000 years (Veltre and Veltre 1987). Hunting was conducted at sea, as fur seals rarely haul out in the Aleutians; it occurred throughout the year as seals were available, and was not limited to a particular season. The meat of pups was preferred (Veltre and Veltre 1981; Eldridge 2016). Pups were typically harvested in the late fall; the Unangam tunuu word for November is “Kimadgim tugida”, meaning time of fur seal hunting. Unangax̂ hunters killed mostly migrating northern fur seal pups passing through the islands (Jochelson 1933). Subsistence of fur seals yielded sustenance, fuel, and raw materials used to create tools, arts, and crafts. Nearly every part of an animal was used, reflecting a non-wasteful ideology stemming from both resourceful ingenuity and spiritual respect for the animal. Hunting was more cooperative than competitive, with harvested animals shared throughout the community. Nearly all community members were involved in some part of the subsistence process, and task-groups related to processing of the harvest were closely tied to broader social structure and roles (Veltre and Veltre 1987).

Russia created settlements on the previously unoccupied Pribilof Islands, populated with Unangax̂ that the Russians had captured and enslaved for the purpose of commercial fur seal harvests (see the People of the Seal and Commercial Exploitation sections for details). This was the first time fur seals were harvested on land. While commercial harvest for pelts persisted under first Russia and later the United States, Pribilovians utilized and relied upon the meat of commercially harvested seals for sustenance. By the early 1930s, commercial harvest provided ample carcasses for fresh meat during the harvest season and salted meat for the remainder of the year on both St. Paul and St. George. Obtaining sustenance in that manner did not truly fulfill the need for “subsistence” according to Unangan cultural values.

Russian and American island agents also maintained a coordinated subsistence pup harvest (separate from the harvest of older juveniles for commercial fur trade) until 1890. The St. George Island Agent wrote in his log in 1887, “Today is for pup driving, the greatest day in the life of the Aleuts” (U.S. Treasury Dept. 1877). The pup harvest was terminated in 1891 as a conservation measure to help the recovery of the northern fur seal herd from pelagic sealing. That year, a village meeting about the termination of the pup harvest was held on St. Paul; the St. Paul Island Agent wrote in 1891 that Unangax̂ residents agreed to forego the pup harvest “if by so doing they would aid the government to protect seal life on the islands” (U.S. Treasury Dept. 1891). Although they agreed to the government’s conservation proposition, the Pribilovians still considered the termination of the pup harvest to be a harsh and extreme measure. In his deposition during the Fur Seal Arbitration, Chief Kerrick Artomanof of St. Paul said, “The pup seals are our chicken meat, and we used to be allowed to kill 3,000–4,000 male pups every year in November, but the Government agent forbade us to kill any more, and he gave us other meat in place of pup meat; but we do not like any other meat as well as pup-seal meat” (USA 1895). There are no records that indicate the harvest of pups was ever reconsidered and authorized as a source of preferred fresh meat during the autumn as the population recovered.

After the termination of commercial exploitation of fur seals (in 1972 on St. George and 1984 on St Paul), NMFS determined that subsistence use on the Pribilofs required authorization under the Fur Seal Act of 1966 (FSA). Fur seals were the primary subsistence food of Unangan residing on St. Paul and St. George at this time. NMFS first authorized subsistence use by regulation in 1985 under the provisions of the FSA, retaining many methods developed during the commercial harvest and maintaining many prohibitions, including an explicit prohibition of harvesting pups (50 FR 27914, July 8, 1985). The retention of the methods and prohibitions was due to general public perceptions regarding the killing of marine mammals, and a misunderstanding of subsistence use from a cultural perspective. At this same time the Pribilovians were faced with significant economic and social change to develop an independent economy not reliant on fur seals.

Cultural, social, and spiritual values associated with subsistence have persisted and continue to define fur seal subsistence use in the Pribilofs today (Veltre and Veltre 1987; Divine et al. 2022). Sharing of subsistence resources based on kinship, community, and need (with special consideration for Elders) is still practiced to ensure everyone is fed, regardless of their ability to directly participate in subsistence activities. Pribilovian subsistence also reflects deep respect for animals, and a high value placed on conservation of wildlife. According to the testimony by Pribilovian Larry Merculief,

> *No meat from a hunt is wasted and the hunters never take more than is needed. We do not sport hunt because the thought of killing an animal for fun and recreation is totally abhorrent to us. All life is viewed as precious and not to be taken in such a frivolous manner. Such respect for wildlife assures us that they will be available for our coming generations* (Merculieff 1979 as cited in Veltre and Veltre 1981).

Early Regulation of Subsistence Use (1966–1999)

The regulation of northern fur seal subsistence use differs notably from that of other marine mammals in the United States. Subsistence "take" of marine mammals is not prohibited and can be managed in some circumstances under the MMPA. The MMPA prohibits "take" (defined as hunting, harassment, capturing, or killing, or attempting to do so) of marine mammals, but section 101(b) provides an exemption allowing Alaska Native people who dwell on the coast to take marine mammals in a non-wasteful manner for subsistence purposes or the creation of handicrafts and clothing (16 U.S.C. 1371(b)). Apart from the non-wasteful provision, the government does not have the power to implement regulations on subsistence take of marine mammals except for stocks designated as depleted.

Although fur seals were designated as depleted under the MMPA in 1988, this is not the authority under which fur seal subsistence use is regulated. The FSA provided the federal government with unique management authority over the taking of fur seals predating the MMPA subsistence provisions (16 U.S.C. 1151–1187). Section 105(a) of the FSA allows the federal government to regulate the taking, including the subsistence use, of northern fur seals on the Pribilof Islands as deemed necessary and appropriate for the conservation, management, and protection of the population (16 U.S.C. 1155(a)). However, NMFS did not immediately authorize land-based subsistence harvest after the implementation of the FSA. Section 103(a) of the FSA allows Alaska Native people who dwell on the coast to take fur seals for subsistence, but only in canoes, without using firearms, among other conditions (16 U.S.C. 1153(a)). Such methods were impractical (as acknowledged in 51 FR 24828, July 9, 1986), as by 1966, commercial harvest had been land-based for 180 years and was efficient and familiar in the context of Pribilovians' daily life, but not aligned to the community's subsistence needs.

The FSA was later amended to include section 103(b) (16 U.S.C. 1153(b)), which references the little-used section 109(f)(2) of the MMPA (16 U.S.C.1379(f)(2)), which states that

> *the term 'subsistence uses' means the customary and traditional uses by rural Alaska residents of marine mammals for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of marine mammals taken for personal or family consumption; and for barter, or sharing for personal or family consumption.*

This provision requires that subsistence take must be for the initial purpose of consumption, with handicraft articles being secondary. To date, fur seals are the only marine mammal for which section 109(f)(2) has been exercised (50 FR 27914, July 8, 1985); other species, such as polar bears and sea otters (managed by the U.S. Fish and Wildlife Service, USFWS), are allowed to be used for handicraft articles without a requirement for consumption.

The impracticality of harvesting enough fur seals via FSA subsistence methods (i.e., in non-motorized canoes without firearms) during the period after 1966 meant that St. George and St. Paul remained reliant on the timing of seals killed in the commercial harvest for food security. In late 1972, the St. George Island Research Program terminated all harvesting of fur seals on St. George in order to study the fur seal population's response to this change in management (Gentry 1998). From 1973–1975, there was no commercial or subsistence harvest on St. George, leaving the residents without meat needed for basic survival. In response to this problem, arrangements were made to obtain and ship excess seal meat collected from the commercial harvest on St. Paul to St. George. However, inter-island transportation and cold storage were limited and much of the meat spoiled prior to arrival on St. George (Zimmerman and Letcher 1986; Zimmerman and Melovidov 1987).

In 1976, NMFS determined the subsistence needs of St. George could not be met due to the logistical constraints on inter-island transport. A land-based subsistence harvest was authorized, but it was very limited, ranging from 200–350 seals from 1976–1979. However, in 1985, the limit of 329 identified in the emergency interim rule (50 FR 27914, July 8, 1985) fell well short of community need, which was generally estimated by the community to be about 1,000 seals (Veltre and Veltre 1987). The government attempted to keep the harvest on St. George at the lowest level they deemed practical from 1976–1985 and continued to provide supplemental meat from St. Paul (Zimmerman and Letcher 1986) to maintain the experimental design between the harvested and unharvested islands (Gentry 1998; 50 FR 27914, July 8, 1985). Although the additional meat from St. Paul supplemented harvests on St. George, spoilage remained an issue. This method of receiving meat from St. Paul denied St. George residents the culturally important factor of subsistence through their own harvest efforts (Veltre and Veltre 1987).

In 1985, in the wake of the termination of the St. Paul commercial harvest in 1984, NMFS used its authority under Section 105(a) of the FSA to authorize land-based subsistence use of fur seals in the Pribilofs through emergency interim regulations (50 FR 27914, July 8, 1985). After considerable public comment, a delayed start to the 1985 subsistence season, and federal administrative transition, NMFS revised the interim rule and finalized a subsistence harvest rule in 1986 (51 FR 24828, July 9, 1986). There were strict regulatory limits on fur seal harvest by sex, age, and season, and taking of pups was not allowed, despite historical evidence of cultural and traditional preference (Jordan 1899; Veltre and Veltre 1987). This rule and subsequent NMFS rules in the 1980s and 1990s were developed with little reference to historical (pre-commercial harvest) Unangax̂ subsistence values and practices, and were created under the faulty assumption that Pribilovian subsistence practices would not be self-regulated and therefore posed a threat to the population. This assumption is reflected in the 1986 final rule (51 FR 24828, July 9, 1986) which states,

> *Without this final rule in place when the Pribilovians begin harvesting seals, the age and sex classes of fur seals that may be taken would not be limited. Females, pups, and harem bulls would be subject to harvesting as well as the subadult male fur seals that were the sole target of the commercial harvest since 1969. Absent this regulation, the harvest would not be limited in time and place, but could continue as long as seals were available at any location where they congregate.*

In hindsight, the federal perception that Pribilovians would pursue all age and sex classes of fur seals for subsistence use is not consistent with their stated preferences for younger male seals (Jordan 1899; Veltre and Veltre 1981). From a practical economics standpoint, Pribilovians did not have unlimited time and resources to pursue fur seals for subsistence whenever the seals were present on the islands. Further, it is clear from Pribilovian subsistence use under the current regulations (since 2014 and 2019 on St. George and

St. Paul islands, respectively) that subsistence activities are self-limiting and occur around familial and community preferences and needs.

Prior to the establishment of co-management agreements between Alaska Native Organizations and the Department of Commerce, the ACSPI provided input to NMFS through the public comment process, requesting the emergency subsistence regulations implemented in 1985 and 1986 be revised to allow a “family hunt” at a smaller scale of fewer than ten sealers (versus the large scale daily harvest drives using 10 or more sealers and crew; 51 FR 24831, July 9, 1986). Additionally, the Traditional Council of St George Island (TCSGI) provided comments on the proposed subsistence rule requesting a true subsistence harvest (versus the prescriptive commercialized harvest methods (51 FR 24831, July 9, 1986). The TCSGI request included an extended season (until November 1), hunting on an as-needed basis, the continuation of humane killing practices, and no commercial utilization of seal parts (51 FR 24830–24381, July 9, 1986). Some aspects of their original request were not advanced through regulatory changes until their 2007 Tribal Resolution (79 FR 65327, November 4, 2014).

TCSGI also recommended that NMFS implement a “family-style” individualized harvest where experienced sealers or islanders would help to ensure avoidance of killing females and unnecessary disturbance of rookeries, rather than requiring the use of the commercialized harvest structure and methods. A family-style harvest revolves around the family’s subsistence needs rather than those incorporated from the commercial harvest, which was created to maximize yield and profits from skins. They also expressed their belief that NMFS’ continuation of research examining the effects of cessation of the commercial harvest on St George were unnecessary, as the subsistence harvest levels were well below commercial levels; they stated that after already having had 13 years of additional subsistence restriction due to the research program, St. George residents should have similar subsistence rights to Unangan living on St. Paul Island, without the additional financial and time burden for travel and transport of meat from St. Paul (51 FR 24831, July 9, 1986).

NMFS’ approach to determining subsistence needs during this period largely focused only on Pribilovians’ most basic requirements for meat, not for subsistence aligning with Unangax̂ cultural values and food security. Likely in response to a great deal of public discourse over the degree to which every part of harvested fur seal taken for subsistence must be used to qualify as non-wasteful, the 1986 emergency final rule cited MMPA section 109(f)(2) and FSA section 103(b) requiring consumption and not handicraft articles to be the initial purpose of take. The comments from various environmental advocacy groups continued to promote the idea that the subsistence harvest was wasteful, all edible meat was not being utilized, the number of seals allowed to be harvested annually should be reduced through increased utilization, and alternative food sources were available on island (51 FR 24831–24832, July 9, 1986; 55 FR 30919, July 30, 1990; 58 FR 42027, August 6, 1993). In response to these comments, NMFS continued and expanded annual monitoring and weighing of cuts of meat and bone to estimate annual percent utilization of a sample of fur seal carcasses harvested on St. Paul Island and continued to encourage improvement of use of harvested seals through 1993. The Pribilovians regularly provided comments on the intrusive nature of the sampling and continued to insist that their subsistence use of fur seal was not being accomplished in a wasteful manner and the upper and lower limits should be increased or at least maintained (51 FR 24831–24832, July 9, 1986; 55 FR 30919, July 30, 1990; 59 FR Issue 132, FR Doc. 94–16849, July 12, 1994).

The subsistence regulatory process initiated in 1985 was the first in a series of regulations implemented and revised by NMFS on the subsistence taking of fur seals that caused socio-cultural hardship for Pribilovians. Changes to the rules that were enacted during the 1980s and 1990s continued these hardships through uncertainty in annual harvest levels and other restrictions. St. George was allowed to harvest twice per week from two sites, Northeast and Zapadni (even though there were four other sites that had been harvested during the commercial era); while on St. Paul they were allowed to harvest once per week from seven sites (51 FR 24828, July 9, 1986). From 1986 through 1991, the regulations provided the option for the Pribilovians to begin their harvest on June 30 and to extend the harvest season after August 8 if their subsistence needs had not been met. This provision was subsequently revised in 1992 to remove the option to extend the harvest after August 8 and start the season one week earlier on June 23 (57 FR 33900, July 31, 1992). This one week earlier start in the 1992 subsistence regulation was requested by ACSPI in June 1989 (56 FR 25066, June 3, 1991) as they knew that the option to extend the harvest after August 8 was going to be removed due to concerns by NMFS about accidental female mortality (55 FR 30919, July 30, 1990).

Subsequent analysis of female mortality (NMFS 2014, NMFS 2019) indicated that the consequences of annual mortality of less than 200 female fur seals would not be detectable at the population level, and that the concerns identified by NMFS (53 FR 28886, August 1, 1998; 54 FR 23233, May 31, 1989) had therefore been over-estimated (i.e., the highest accidental female mortality in any one year was 12, Zimmerman and Melovidov 1987). Both ACSPI and TCSGI continued to express in public comments the difficulty in meeting their subsistence needs under the existing regulatory restrictions. In addition, 1986 through 1993, the upper and lower range of the annual subsistence need was re-established by NMFS each year (see 52 FR 17307, May 7, 1987; 53 FR 28886, August 1, 1988; 54 FR 23233, May 31, 1989; 55 FR 21630, May 25, 1990; 56 FR 36735, August 1, 1991), by publishing a summary of the previous year's actual harvest and the proposed harvest range and subsequently by publishing a final rule with the upper and lower range of the limit, taking into account the average of the previous 3–5 years' actual harvest data and household survey information about their subsistence needs for the upcoming year.

Complicating the annual needs analysis, in order for Pribilovians to extend the harvest past the lower range limit, the harvest had to be temporarily suspended for 48 hours, the data were to be reviewed, and a written request had to be submitted from the Tribe. Thus, the lower range limit for each island in subsequent years was generally at risk of being reduced each year due to “averaging” (see, for example, the reduction in the lower range limit for St. George from 329 to 181 and for St. Paul from 2,400 to 1,145; 55 FR 30919, July 30, 1990). In addition, the communities were often approaching their lower limit in August and a 48-hour suspension during this time reduced their opportunities to harvest preferred-sized (i.e., smaller and younger) seals; there were also complications due to the time zone differences and communicating with NMFS representatives on the East Coast (55 FR 30919, July 30, 1990). On July 12, 1994, the annual estimates of the subsistence need were changed to three-year quotas (59 FR Issue 132, FR Doc. 94-16849, July 12, 1994), with the same provisions required for requesting to exceed the lower limit of the subsistence need range which had been inadvertently reducing the lower limit.

The complexity of the regulatory discourse during the 1980’s and 1990’s contrasts with the reality that Unangax̂ values and practices involve taking only the animals needed, and that the numbers taken for subsistence in the Pribilofs have always been small compared to commercial harvest and relative to the size of the fur seal population. During the 1985 harvest season, 3,384 seals were taken for subsistence on St. Paul and 329 seals on St. George, compared to 22,066 seals taken commercially in 1984 (USDOC 1985) and 40,000–126,000 seals taken annually during peak commercial harvest in 1943–1968 (Roppel 1984). Recognizing Tribal sovereignty and the utility of traditional knowledge in the management of subsistence use, and working through the co-management process, NMFS’ changes to regulations in 2014–2019 were more consistent with requests made by the Tribes in 1986 (51 FR 24828, July 9, 1986) to include greater subsistence flexibility, family style subsistence, and self-regulation. A detailed history of recent subsistence rulemaking is provided in the section below.

Co-Management and Recent Regulation (2000–Present)

The MMPA was amended in 1994 to include Section 119(a), allowing the Departments of Interior and Commerce to enter into cooperative agreements with Alaska Native Organizations (ANOs) to conserve marine mammals and provide co-management of subsistence use (16 U.S.C. 1388(a)). Co-management agreements were signed between NMFS and ACSPI in 2000 (revised in 2020; Appendix I) and TCSGI in 2001 (Appendix II). The co-management agreements encompass principles of shared management for fur seals as well as other marine mammals harvested in the Pribilof region including qawan (Steller sea lion; *Eumetopias jubatus*) and isugin (harbor seals; *Phoca vitulina*). The development of these agreements started a new period of fur seal management, in which NMFS has worked to foster substantial Tribal involvement.

The guiding principle in the co-management agreement with ACSPI was clarified in 2020 from earlier versions to reflect the evolution of the co-management relationship since 2000. It states:

> *The best way to conserve and provide for stewardship of laaqudan, qawan, and isugin critical to traditional practices and the Unangax̂ way of life is through a partnership between the ACSPI and NMFS that provides for full participation and contribution by Unangan of St. Paul, through the ACSPI, in decisions affecting the conservation and co-management of marine mammals used for subsistence purposes.*

This principle reflects the importance of mutual participation and consensus-based decision-making that characterizes co-management.

The ACSPI, TCSGI, and NMFS strive to support a successful partnership incorporating trust, close cooperation, and communication. All parties aim to facilitate inclusion of Pribilovian views and needs in management decisions relating to conservation and subsistence use of fur seals and other marine mammals. Since a co-management framework has been developed, Tribal Governments of both Pribilof Islands have implemented programs that promote full utilization of edible and inedible seal parts for traditional arts, crafts, and other legal uses. The result has been an expanded use of these materials by Unangax̂ and other Alaska Natives and increased fulfillment of the non-wasteful provisions of the MMPA.

The St. Paul and St. George co-management agreements are implemented by co-management councils consisting of equal membership by NMFS and Tribal representatives. These councils use an adaptive management framework to make non-regulatory, in-season, consensus-based adjustments to management decisions regarding issues such as the location, timing, and methods of subsistence use within the regulatory parameters. In addition to weekly co-management check-in meetings between NMFS and each Tribe, the St. Paul Co-Management Council meets bi-annually to formally discuss subsistence, land-use, research, and conservation issues; the Council also regularly reviews and updates a Co-Management Plan when appropriate. Based on the preference of the TCSGI, the St. George Co-Management Council communicates on a more informal basis but is still characterized by regular, two-way communication.

The co-management agreements facilitate shared responsibility of ACSPI and TCGSI for ongoing fur seal subsistence use monitoring and reporting, and include provisions for NMFS to support these efforts through grants, staff time, and technical support. Subsistence use reporting includes the timing, locations, number, and sex of marine mammals taken as well as compliance with the humane and non-wasteful provisions of the subsistence regulations; the Tribes also consult with NMFS throughout the season. The NOAA Office of Law Enforcement has investigated four noteworthy cases of illegal taking related to subsistence use since 2004. One of the cases was prosecuted criminally by the U.S. Attorney's Office in Anchorage. NMFS and ACSPI cooperated and coordinated as much as practical during the investigations through the established co-management relationship. St. Paul established a Tribal court in 1999. In one 2008 case, NOAA deferred to the Tribal court. These interactions and monitoring programs have led to development of a trusting and effective co-management relationship.

Although the co-management partnerships are non-regulatory, the partnerships developed have led to better communication and understanding between NMFS and the Tribes. NMFS has strived to incorporate Tribal input into recent regulatory changes, which has led to deregulation of many fur seal subsistence regulations promulgated under the FSA during the 1980s and 1990s. Notably on October 30, 2014 (79 FR 65327), NMFS allowed the subsistence use of pups on St. George Island for the first time since 1889, allowing a return to cultural preference for pup meat. In response to a petition from ACSPI received in 2012, NMFS changed the prior prescriptive and complicated regulatory process to a shared and flexible in-season management framework in 2019, and also authorized the subsistence use of pups (84 FR 52372, September 27, 2019; Jan 2020 Co-management Plan). At the same time, NMFS simplified and streamlined the regulations governing both Islands by eliminating several duplicative and unnecessary provisions.

The 2019 regulations, which are still in effect, authorize St. George to harvest up to 500 sub-adult and young of the year male fur seals, including pups, and accidental mortalities of up to 3 females across all available locations during two seasons (50 CFR 216.72(d)). For St. Paul, the regulations authorize subsistence use of up to 2,000 male fur seals younger than 7 years old, including pups, and accidental mortalities of up to 20 females (50 CFR 216.72(e)). The regulations allows the taking of fur seals over two subsistence use seasons annually. The first season is from January 1 through May 31 and allows the use of firearms to hunt, and the second season is from June 23 through December 31 without using firearms (84 FR 52372, September 27, 2019).

An additional co-management agreement with the Aleut Marine Mammal Commission (AMMC) was signed in 2006. This agreement specifies and focuses on Steller sea lions and harbor seals, but it broadly encompasses all marine mammals. The AMMC has expressed interest in co-management of subsistence use of fur seals. Recent discussions focused on the potential to revise the subsistence use regulations in the Aleutian Islands that were not previously considered.

The co-management relationships in the Pribilofs extend beyond marine mammal subsistence use to address management relating to the conservation of marine mammals generally, including land use and access, oil spill and emergency response planning, and outreach and education. An Ecosystem Conservation Office (ECO) on each island facilitates and supports marine mammal subsistence use and related traditional activities (Divine et al. 2022), and development and growth of a northern fur seal research program is underway at St. Paul ECO. Increasingly, a co-production of knowledge framework incorporating Indigenous Knowledge into research and understanding of fur seal ecology is being embraced (Divine et al. 2022).

The ECO offices' Island Sentinel programs on both Pribilof Islands monitor fur seal rookeries and shorelines year-round to document habitat degradation or alteration from impacts such as oil or fuel spills, marine debris accumulation, human disturbances, or fish waste accumulation (see related sections under Human Related Threats). They also observe and record natural changes and processes, such as presence/absence of all marine mammals, redistribution of fur seals on rookeries and hauling grounds, and the timing of various life history events for fur seals. The Tribes hold NMFS scientific research permits to conduct their own research and a NMFS stranding program agreement to respond to stranded or entangled marine mammals. All of these efforts have furthered progress towards achieving shared goals and outcomes regarding the conservation of marine mammals.

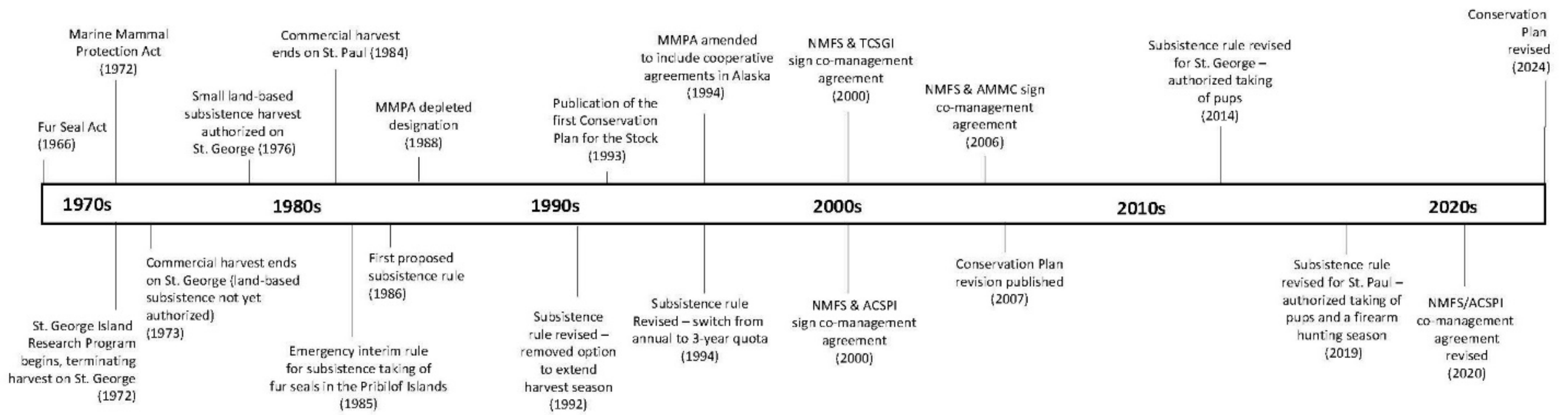

Figure 13. Timeline of events relating to subsistence and co-management of northern fur seals in the Pribilofs.

Threats

Northern fur seals are impacted by both natural and human-related threats. The historic commercial exploitation of northern fur seals on the Pribilof Islands significantly altered the sex and age composition of the population as well as its abundance and productivity. Although that historic threat has ended, other human-related threats and their associated stressors continue to play a role in the decline of the fur seal population on the Pribilof Islands. Natural threats also have the potential to impact northern fur seals at the population level. However, observations of mortality in northern fur seals are limited to the approximately 60 days per year that an individual seal spends on land; virtually all other mortality is unobserved at sea. This further complicates our ability to attribute specific mortality causes and understand the degree to which the associated impacts of identified threats contribute to fur seal mortality and population trends.

Threats are described here in no particular order relative to their respective degree or severity of threat to individual animals, the entire Eastern Pacific stock, or segments of the northern fur seal population. There has been no new analysis since the qualitative assessment in the previous plans that would allow a prioritization of threats, but such an assessment will be prioritized going forward. Methods for threats assessments include conceptual models that consider population demography, causal relationships among threats and stressors, and direct and indirect effects of those stressors and the demographic consequences (Margoluis 2009; Bolten 2011; Darst 2013; Harting 2021). Alternatively, structured expert elicitation can provide a means to rank threats to species (Martin et al. 2012); this approach has also been used for climate vulnerability assessment in marine mammals (Lettrich et al. 2019; Lettrich 2023). Using expert elicitation has the additional critical benefit of incorporating input from diverse experts, such as Tribal co-managers and local and Indigenous Knowledge holders, in addition to scientists and wildlife managers. NMFS plans to review methodologies for threats assessments along with the available data to develop a framework with Tribal co-managers, stakeholders, and experts to guide our approach to prioritizing threats and improving the effectiveness of this Plan.

Natural Threats

Natural threats to fur seals include trauma and starvation, disease and parasites, predation, and environmental change. NMFS cannot manage to a practical degree the natural threats to fur seals. However, it is important to understand these threats since they have the potential to have impacts at a population level.

Trauma and Starvation

Trauma and starvation are known causes of sub-lethal injury and death to northern fur seals in all age classes, but are particularly significant contributing factors to neonatal mortality (Fowler 1985; York 1985; Fowler 1987; Spraker and Lander 2010). Starvation, or nutritional stress, is generally associated with a deficit of food, and is typically characterized by emaciation, slow growth, and pre-mortem lethargy. Natural causes of starvation in pups may be due to a variety of factors, including failure of pups to nurse, failure of a mother and pup to bond, death of the mother, maternal malnutrition, or abandonment of the pup. Starvation may be characterized as either a natural or human-related threat.

Blunt force trauma is most often inflicted by reproductive (adult) males (on both males and females of all age classes) while they are acquiring or defending their territories on the rookeries. Additionally, sharp trauma or bite wounds inflicted on pups from sub-adult males and females cause trauma-related injury that can lead to death. Trauma can also be caused by intraspecific bite wounds or hyperthermia (extreme overheating) due to smothering by larger animals (Spraker and Lander 2010).

Necropsies of pre-weaned pups (*n*=2,735) from 1986–2006 found that 18 percent of deaths were trauma-related and 53 percent (*n*=1,454) were due to starvation (Spraker and Lander 2010). Of the trauma-related pup deaths, blunt force trauma accounted for 11.6 percent (*n*=316), and sharp trauma accounted for 6.6 percent (*n*=181). Of the 1,454 pups that died due to starvation, 28 percent (*n*=406) had also sustained secondary injuries from trauma.

The proportion of trauma-related mortality in pups decreased from 1986–2006, but is thought to have remained relatively constant when considering the entirety of the past 100 years (Spraker and Lander 2010). Starvation-related mortality in fur seal pups appeared cyclical from 1986–2006, with a slight increasing trend (Spraker and Lander 2010). From 1896 to 1897, starvation was the cause of 47.5 percent (*n*=220) of pup deaths on St. Paul (Lucas 1899a). In 1964, starvation was determined to be the primary cause of death in 36.7 percent of the 109 necropsied pups from an unspecified Pribilof Island rookery; however, 1964 was during the period of intentional culling of female fur seals, so these data cannot be compared to later years (Keyes 1965). In 1980, 6.3 percent of the total marked pups (*n*=410) on a rookery on St. Paul died within the first 60 days after birth (Calambokidis and Gentry 1985). Of the 25 pup deaths that were investigated, 16 percent (*n*=4) were due to trauma and 40 percent (*n*=10) were due to starvation (Calambokidis and Gentry 1985). While these historical starvation rates are informative, direct comparisons of starvation rates over time are not appropriate due to differing collection methods and the potential for commercial harvesting and herd reduction programs to have affected pup starvation rates.

The causes of death of sub-adult males from 1986–2006 included blunt force trauma, hyperthermia, entanglement, and bite wounds (Spraker and Lander 2010). Most causes of hyperthermia in sub-adult males and adult fur seals examined were associated with the subsistence harvest round-ups (Spraker and Lander 2010). Trauma-related injuries associated with intraspecific fighting was by far the most common natural cause of death in adult males accounting for 41 out of 47 of the deaths of males examined on St. Paul Island (Spraker and Lander 2010). This finding is not surprising since males have a higher mortality rate than females after 2 years of age, and particularly after 7 years, when males begin to defend territories (Johnson 1968; Lander and Kajimura 1982). In females, bite wounds (74 percent, *n*=81) and dystocia (difficult birth, 16 percent, *n*=16) were the most common causes of death (Spraker and Lander 2010).

Trauma and starvation are generally thought to cause natural fur seal mortality; however, these stressors can be exacerbated by anthropogenic influences including disturbance due to aircraft (see Aircraft Noise and Overflights), vessels (see Vessel Activity and Noise), commercial fishing (see Indirect Fishery Effects), entanglement in marine debris (see Entanglement in Marine Debris), or oil spills (see Oil and Gas).

Disease and Parasites

As with many other mammal species, fur seals are susceptible to disease and parasites. Necropsies of sub-adult seals taken in the St. Paul subsistence harvest during the 1980s suggest that the population was relatively disease-free compared to the period between the 1950s and early 1970s (NMFS 2007a). Fur seal mortality from ascarid (nematode worm) infection may have been prevalent during the 1950s and 1960s (Neiland 1961; Keyes 1965) and although not identified until the late 1970s, leptospirosis may have also contributed to mortality (Smith et al. 1977). Although infectious disease has previously been a contributing factor in northern fur seal mortality, no evidence has been found to indicate infectious disease as a sole or primary cause in the decline of northern fur seals from 1986–2006 (Spraker and Lander 2010).

An extensive case study on St. Paul Island found that of 2,735 pups necropsied from 1986–2006, only 3 percent died from infectious diseases (Spraker and Lander 2010). During that period, pneumonia was the most common infection and was detected in 42 pups. The second most common type of infection was omphalophlebitis (inflammation and/or infection of the umbilical vein), detected in 27 pups. Hookworm infections were found in 16 pups; however, all but one of these animals died from other causes (Spraker and Lander 2010).

Coxiella burnetii, a bacterial pathogen that naturally infects some species of mammals and birds, is present in northern fur seals on St. Paul. Archived blood serum provides evidence that *C. burnetii* has been detected in the northern fur seal population since the 1990s (Minor et al. 2013). The *C. burnetii* antibody prevalence in archived blood serum samples increased 20 percent from 1994–2011 (Minor et al. 2013). *C. burnetii* was also detected in tissue samples from subsistence harvested sub-adult male fur seals on St. Paul in 2010 and 2011 (Duncan et al. 2013a). This study identified two strains that have been increasingly associated with marine mammals, as well as a strain more commonly found in terrestrial environments and associated with disease in humans and terrestrial animals. During the 2010 pupping season, 75 percent of the 146 placentas tested for *C. burnetii* had positive detections but not all demonstrated pathology of infection (Duncan et al. 2012). However, in 2013 *C. burnetii* was not detected in tissues of harvested sub-adult male fur seals (Duncan et al. 2014a). None of the animals sampled showed clinical signs of active infection or symptoms found in other species (Duncan et al. 2013a; Duncan et al. 2014a).

Brucella spp. (*Brucella*) has been identified in fur seal placentas and blood serum (Duncan et al. 2014b). Six out of 119 placentas collected on St. Paul in 2011 were positive for *Brucella* and one of the positive placentas had accompanying severe placentitis (Duncan et al. 2014b). This finding suggests that *Brucella* could have the ability to cause placental disease. During a 2013 community harvest on St. Paul, tissues from 50 sub-adult males were sampled for *Brucella* and only one spleen sample tested positive at very low levels (Duncan et al. 2014a). Based on these limited data, there is little indication of a known impact on the population.

Research on parasites was previously summarized in a literature review that outlined the intestinal parasitic worm communities of fur seals on St. Paul Island (Kuzmina et al. 2021). Gastrointestinal tracts from 651 northern fur seals on St. Paul contained 19 total species, with tapeworms (cestodes) being the most abundant and found in over 98.5 percent of sampled fur seals (Kuzmina et al. 2021). On St. Paul, parasitic worms (acanthocephalans), nematodes (anisakids), and parasitic flatworms (trematodes) have also been documented in fur seals (Kuzmina et al. 2012; Kuzmina et al. 2014; Kuzmina et al. 2021). The concurrence of parasites and increased mortality rates in northern fur seals may be site-specific as well as correlated to population density. An intestinal parasite, hookworm, was responsible for 45 percent of the fur seal pup mortality in the 1970s (Gentry 1981). However, there was a dramatic decline in the incidence of hookworm in fur seal pups on St. Paul Island in later years (Lyons et al. 2001). On San Miguel Island, California (a sandy island), hookworm mortality exceeded 50 percent in 2006 and 2007 and was a significant cause of mortality of pups in the first 3 months of life (Melin et al. 2008). On Bering Island, Russia, hookworm infection and subsequent pup mortality was more common on a rookery with sandy topography versus a rocky topography (Fomin et al. 2019). Thus, monitoring for hookworm infections should consider fur seal breeding areas with high prevalence of sand when examining the causes of pup mortality across different terrestrial habitat.

Digenean trematodes were found in 32 percent of fur seals examined between 2012 through 2014 on St. Paul Island (Kuzmina et al. 2018). There were no significant differences in prevalence and intensity of infection in northern fur seals between separate rookeries. Seals with the highest intensities of digenean infections did not show visible changes in physical condition or any clinical signs indicating pathogenic effect.

Phocine morbillivirus, formerly known as phocine distemper virus (PDV), is a known pathogen in harbor seals (*Phoca vitulina*), which previously caused mass mortality on the Danish Island of Anholt (Härkönen et al. 2006) and was confirmed in sea otters in Alaska (Goldstein et al. 2009). Northern fur seal samples collected from 2009–2012 were also positive for both exposure and viral infection, although prevalence was reported in combination with other marine mammal species (VanWormer et al. 2019). Morbilliviruses are transmitted when pinnipeds are in close proximity, such as on rookeries and where cross-species transmission can and has occurred (VanWormer et al. 2019). The health impacts of phocine morbillivirus in northern fur seals are currently unknown.

Overall, studies do not suggest the prevalence of disease and parasites has been a significant threat to fur seals in recent years; however, high mortality from infectious disease should be considered a constant threat given the high densities of fur seals during the breeding season that would facilitate transmission. A majority of infectious disease studies do not address the health or survival implications of the presence of the disease, which makes it difficult to assess possible population level effects or tie the research to future monitoring programs (Cortés et al. 2022). In the future, disease and parasites may influence populations differently with changing conditions such as population density, stress, malnutrition, and climate change.

Predation

Killer whales (*Orcinus orca*), Steller sea lions, and sharks are known to prey on northern fur seals; however, overall predation impacts to the fur seal population have not been investigated.

Observations have shown that transient (mammal-eating) killer whales are probably the most significant predator of northern fur seals. Anecdotal reports by beachcombers, residents, and local fishermen to the St. Paul ECO indicate that killer whales are seen regularly around the islands. Since 1996, resident or ECO reports include 1–10 sightings of killer whales feeding on fur seals each year, including young fur seals in the fall months when pups are learning to swim (Indigenous Sentinels Network database, St. Paul). The arrival of fur seals to the Pribilof Islands in May and June coincides with the appearance of transient killer whales (Matkin and Durban 2011). Killer whales are observed around the Pribilofs from spring through the winter. Historical evidence shows that killer whale predation on fur seals in the Pribilof Islands (Hanna 1923) and elsewhere around their breeding grounds is not new (Lucas 1899a). Examinations of killer whale stomach contents in the Pribilof Islands are few and difficult to obtain (Hanna 1923; Scheffer et al. 1984).

Springer et al. (2003) hypothesized that declines in North Pacific populations of seals (including fur seals), Steller sea lions, and sea otters were attributed to increased predation by killer whales, and that killer whales shifted their prey base to smaller marine mammals following the removal of baleen whales by historical commercial whaling, killer whales' primary food source. Wade et al. (2007) also suggested that killer whales may have caused or contributed to the decline of these same species, but disagreed with the hypothesis of Springer et al. (2003), due to little evidence supporting the hypothesis that predation resulted from a lack of available cetacean prey. DeMaster et al. (2006) evaluated the Springer et al. (2003) hypothesis and reported a combination of increased predation pressure and prey changes provided a more consistent explanation of the observed pinniped declines rather than predation pressure alone.

In the eastern Aleutian Islands, 165 individual transient killer whales have been confirmed by acoustic and/or genetic analysis during boat-based field surveys from 2002–2004 (Matkin et al. 2007). Most of these transient individuals were present in the spring and early summer during the gray whale migration. In spring, the diet of transient killer whales was primarily gray whales but switched to northern fur seals in the summer (Matkin et al. 2007). During the summer season, there were 5 observed attacks on northern fur seals in the eastern Aleutian islands, which resulted in 4 kills (Matkin et al. 2007).

In Russia, observations of killer whale predation have been collected systematically by Chukotkan subsistence hunters. Killer whale predation of gray whales (*Eschrichtius robustus*) (66 percent) and walrus (*Odobenus rosmarus*) (26 percent) were most common during the 10-year period on the Chukotkan Peninsula (Melnikov and Zagrebin 2005). Melnikov and Zagrebin (2005) reported low killer whale predation rates of other pinnipeds, even though ringed seals (*Pusa hispida*) and spotted seals (*Phoca largha*) were quite numerous in the region. Genetic data indicate a close relationship and possible gene flow between transient killer whales in the Pribilof Islands and killer whales in the Russian Far East (Matkin et al. 2011).

In the Pribilof Islands, recent research has included community-based killer whale monitoring, acoustic surveys, and vessel-based surveys. Community-based killer whale monitoring was completed using shore-based surveys, local and traditional knowledge, and local fishery logbooks (Robson et al. 2010). A pilot acoustic study of killer whales around St. Paul reported killer whale vocalizations on 19 out of 22 days of recording using an autonomous unit deployed 6 km from the island (Newman and Springer 2008). It was assumed that all killer whales recorded were transients and were associated with predation events. On one occasion vocalizations were recorded at the same time that the fur seal predation was visually observed (Newman and Springer 2008). Vessel surveys of killer whale predation in 2008 documented 22 predation and harassment events in the Pribilofs, all of which targeted fur seals (Matkin et al. 2011). Surveys were conducted all around both St. George and St. Paul Islands, but most observed predation events occurred within a few miles of Reef Point on St. Paul, a high use area for northern fur seals as they leave from and return to rookeries on foraging trips. Of the 67 transient killer whales that have been identified in the Pribilof Islands since 2000, 15 have also been photographed in the eastern Aleutians (Matkin et al. 2007; Matkin et al. 2011).

Steller sea lions have been observed killing weaned fur seal pups close to shore on St. George Island (Gentry and Johnson 1981; NMFS 1993). There were two reports of Steller sea lions depredating on fur seal pups submitted to the Indigenous Sentinels Network on St. George in 2006 (Robson et al. 2010). Observed attacks on northern fur seals by Steller sea lions are not systematically recorded and therefore it is difficult to quantify their impacts.

There is little information on shark predation of northern fur seals. The white shark (*Carcharodon carcharis*) is a known predator (Keyes 1965). It is likely that sharks prey on northern fur seals in the Pribilof Islands because sharks are known to prey on fur seals along the coast of California (near San Miguel and the Farallon Islands), and the geographical ranges of northern fur seals and large sharks, such as Pacific sleeper sharks (*Somniosus pacificus*), overlap in the North Pacific.

Environmental Changes

Climate change[1] is driven by increased atmospheric carbon dioxide and warming temperatures and causes ocean acidification, sea ice loss, increased water temperatures, and altered ocean circulation. These physical ocean changes have consequences for marine mammals and include changes in storm frequency, sea level rise, loss or alteration of suitable habitat, and altered predator, prey, and toxin distribution and abundance (Gulland et al. 2022). Climate patterns such as El Niño also impact ocean temperatures, currents, and upwelling, which may ultimately affect both northern fur seals and their prey. All of these factors may have effects on fur seals with possible population-level consequences.

Sea surface temperature in the Bering Sea has warmed an average of 0.22°C per decade from 1966–2018 (Danielson et al. 2020). Although periods of cooling punctuate cyclical warm periods, the ecosystem responses to marine heat waves tend to persist (Suryan et al. 2021). At the same time that ocean warming is occurring, ocean acidification research has indicated an expansion of corrosive (lower pH) bottom waters (Siddon 2022). The Intergovernmental Panel on Climate Change, an intergovernmental panel of the United Nations, predicts continued ocean temperature increases, pH decreases, sea level rise, and weather changes in the future (IPCC 2019).

A climate vulnerability assessment for marine mammal stocks has been developed to assess a stock's exposure, sensitivity, and adaptive capacity to climate change (Lettrich et al. 2019; Lettrich et al. 2022). Exposure is based on projected climate change conditions in a stock's current distribution whereas sensitivity and adaptive capacity are based on an understanding of life history traits. Northern fur seals were scored "very high" in the exposure category and "moderate" in the sensitivity category, for a combined "high" score for vulnerability. In comparison, when applied to marine mammal stocks in the Pacific and Arctic oceans, 36 stocks scored very high, 60 high, 27 moderate, and 4 low for overall vulnerability. A non-exhaustive list of exposure factors for northern fur seals to climate change is presented below.

Habitat Loss and Alteration

Sea level rise is expected to result in terrestrial habitat loss due to reduced available hauling grounds for pinniped species such as fur seals that rely on coastal areas for rest, molting, birthing, and pup rearing (Fink 2017). Decreases in sea ice extent and thinner ice that is easily broken will be less protective of Alaskan coasts during storms and may lead to increased coastal erosion (USGCRP 2018). Due to increasing temperatures, subarctic

[1] Although climate change is included in the section on "Natural Threats", we note that the magnitude and rate of change that we are experiencing are human-caused and not natural (IPCC 2021).

and temperate pinniped species may exhibit northward expansion in their ranges (Fink 2017). Habitat alteration may also be seen in at-sea habitat use by fur seals to adapt to changing environments. Changes in ocean temperatures may result in changes in prey availability and distribution. For example, northward shifts in the distribution of groundfish have been documented in the eastern Bering Sea (Siddon 2022); such shifts in prey location could affect fur seal foraging locations and durations.

Harmful Algal Blooms

Declines in sea ice extent as well as warming ocean temperatures are expanding the range and duration of favorable conditions for harmful algal blooms (HABs) (Lefebvre et al. 2016). HABs are likely to increase in intensity and geographic distribution as Alaskan ocean waters continue to warm (Siddon 2022). HAB toxins (e.g. domoic acid and saxitoxin) are present throughout Alaskan waters at levels that are detectable in marine mammals, and that could potentially have consequences for their health (Lefebvre et al. 2016) as well as for humans who might consume them. Both domoic acid and saxitoxin are neurotoxins that affect the central nervous system. Domoic acid has previously been shown to cause reproductive failure (Brodie et al. 2006) and impair spatial memory in California sea lions (*Zalophus californianus*) (Cook et al. 2015) as well as increase fatal cardiac disease in sea otters (Moriarty et al. 2021). The clinical effects of domoic acid toxicosis have been observed in stranded fur seals in California (Lefebvre et al. 2010), but have not yet been detected in fur seals from the Eastern Pacific Stock.

In 2010, 5 percent of adult female northern fur seals tested from St. George were positive for domoic acid and 5 percent tested positive for saxitoxin (Lefebvre et al. 2016). More recently, saxitoxin was found in low but detectable levels in 18.4 percent of fecal samples of subsistence harvested juvenile male fur seals from St. Paul in 2022, and 30.2 percent in 2023 (C. Kovalcsik, unpublished data). All sampled livers in both years of this study were below detectable levels for both saxitoxin and domoic acid. These results indicate that levels of these toxins are low in seals from St. Paul, but ongoing monitoring will be important for both the health of northern fur seals and the humans who eat them.

Disease and Parasites

Climatic warming may alter host-pathogen relationships by changing transmission rates and mechanisms. For example, reduction in habitat may increase host density and increase density-dependent disease (Burek et al. 2008). Increased survival of pathogens, host and/or vector range distribution changes, or increased vulnerability of northern fur seals to exposure and infection due to compounding of other stressors on animals might also occur. Pinnipeds that are stressed or weakened are more susceptible to disease and parasites (Fink 2017). Recent research has shown that some viral pathogens (e.g., phocine morbillivirus) may increase due to Arctic sea ice reduction and expanded pathways between the North Atlantic and North Pacific that may allow more cross-species and cross-ocean transmission of diseases (VanWormer et al. 2019).

Weather and Storms

Climatic factors shape the life history of fur seals and also influence the post-weaning departure of fur seal pups from rookeries (Peterson 1965; Lea et al. 2009). In 1994, although sufficient food was available in June on the Pribilofs for lactating females to successfully begin nursing, births occurred during the first three weeks of July, coincident with lower rain, reduced wind conditions, and elevated temperatures (Trites and Antonelis 1994). Pups born earlier in June would likely succumb to hypothermia during periods of colder, wetter, and windier weather than July, which has less extreme weather. Moreover, a significant positive correlation has been reported between warmer sea surface temperatures off the coast of British Columbia and early survival of male fur seals between 4 months and 2 years of age (York 1991). A similar relationship also has been found between the survival of fur seals under two years of age and the temperature of the sea water near Hokkaido, Japan, where fur seals winter (Kuzin and Shatilina 1990). Modeling of weaned fur seal pup response (using telemetry data) to various habitat conditions also suggest that wind and ocean currents play an important role in their movement patterns (Johnson et al. 2021a).

Climatic conditions such as storms affect departure and movement of northern fur seal pups during weaning (Peterson 1965; Lea et al. 2009). In 2005, pup departures from St. Paul and St. George coincided with the onset of two strong storms. During these storm events, 41 percent of pups on St. Paul and 80 percent of pups on St. George departed (Lea et al. 2009). When departures within one day of the storm event were included, those numbers increased to 68 percent and 85 percent, respectively. Wind speed and wind chill were the most influential factors in predicting departure date in the Pribilofs, especially during years with higher November storm activity (Lea et al. 2009). Climate change is predicted to continue to increase the frequency of intense storms and therefore could affect post-weaning behavior of fur seal pups, which could in turn impact survival.

Increases in storm activity due to climate change is likely to increase pup mortality due to separation from their mothers, trauma, and being swept to sea before developing adequate swimming capability (Fink 2017). In 1950, severe storms and low temperatures may have contributed to the deaths of an estimated 700 yearling fur seals along the Oregon and Washington coasts (Scheffer 1950). Yearling seals, who were originally tagged in the Pribilofs, washed ashore dead during a period of severe and prolonged winter storms. Snow on rookeries, especially in large amounts, has also been known to affect haul out and nursing behaviors (Peterson 1962).

El Niño Southern Oscillation

Changes in environmental and oceanographic features caused by Pacific Ocean oscillations are correlated with population level impacts to fur seals (DeLong and Antonelis 1991; Melin and DeLong 2000; Carretta et al. 2012). Atmospheric circulations and wind patterns can create ocean basin variations in upwelling and drive large-scale ocean oscillations (Francis et al. 1998; Hare and Mantua 2000; Minobe 2000; Mantua and Hare 2002; Minobe 2002). These oscillations can cause abrupt transitions between different regimes (large and persistent changes) in marine ecosystems that affect their structure and function (Minobe 2000; Mantua and Hare 2002; Overland et al. 2012). Ecological regime shifts observed in the Bering Sea from 1970–2008 coincided with significant changes in sea ice, sea surface temperature, and surface air temperature, suggesting that different types of oscillations may best explain regime shifts in the Bering Sea (Zhang et al. 2010).

The El Niño Southern Oscillation is a pattern of pressure, temperature, and rainfall fluctuations that can have global climate impacts (Stabeno et al. 2007; Overland et al. 2012). El Niño events account for approximately one-third of the ice and sea surface temperature variability in the Bering Sea (Niebauer and Day 1989) and can have significant impacts on the distribution and survival through reproduction and recruitment of fish, and other processes, in ways that are not well understood (Hollowed et al. 2013). These events can particularly affect distribution and abundance of pollock (Joy et al. 2015), which is an important fur seal prey species. The reduced upwelling associated with El Niño can alter abundance, distribution, and fat content of pinniped prey species. This can negatively impact pinniped foraging behavior and success, body condition, and can ultimately lead to a decline in abundance (Gulland et al. 2022).

The peak years of fur seal strandings on the central California coast from 1975–1997 were reported during El Niño events (Fauquier et al. 1998). Most of these stranded fur seals were recently weaned pups that were emaciated and malnourished. The El Niño events of 1972, 1983, 1992, and 1997 had dramatic negative impacts on birth rates, and pup growth and survival on San Miguel Island, California (DeLong and Antonelis 1991; Carretta et al. 2012). However, survival of Pribilofs juvenile males was positively correlated with El Niño (York 1991) and higher air and sea surface temperature trends (York 1995). The patterns associated with El Niño may give insight into the impacts on pinniped populations driven by climate change. However, there is not yet a clear connection between the short-term responses to episodic climate variability (i.e., El Niño) that can be extrapolated to predict responses to long-term changes associated with climate change (Gulland et al. 2022).

Shifts in Prey Abundance and Distribution

Repeated cyclic and large-scale shifts in climatic and oceanic conditions have occurred in the Bering Sea (Stabeno and Overland 2001; Hunt Jr et al. 2002; Grebmeier et al. 2006; Siddon 2022). Climatic shifts can impact northern fur seal foraging success and survival through changes in the distribution, abundance, and accessibility of prey. The impacts of prey availability on fur seal foraging effort and pup mass have been demonstrated both observationally (Gentry 1998; Springer et al. 2008; Nordstrom et al. 2013a; Kuhn et al. 2014b) and theoretically (McHuron et al. 2022). For example, from 1974–1978, a period of high walleye pollock recruitment, foraging trips by female fur seals from the Pribilofs decreased in duration (Gentry 1998).

Shorter trip durations in from one year to the next suggest that prey may have been more abundant or located closer to the colony. Fur seals exhibit highly directional arrival and departure vectors with limited searching behavior near their breeding islands, suggesting that most foraging and diving occurs away from the Islands (Robson et al. 2004; Call et al. 2008). In addition, when telemetry instruments have included dive recorders, the majority of fur seal diving occurs at the end of the foraging trip, though limited foraging does occur near the islands (Kuhn et al. 2010; Jeanniard du Dot et al. 2018). Furthermore, theoretical models designed to examine the effects of prey availability on mother behavior and pup growth conclude that to achieve pup growth rates characteristic of a population experiencing rapid growth (e.g., Bogoslof Island), the primary foraging grounds need to be less than 150 km (~27 nautical miles) from the rookery (McHuron et al. 2022). In addition, ecosystem modeling that examined 50, 100, and 150 nautical mile (92.6, 185.2, and 277.8 km) radii around the Pribilof Islands during the 1990s indicated that ecosystem predatory demands were most in balance within the 100 nautical mile (185.2 km) zone given that the prey biomass and production are unsustainable within a 50 nautical mile (92.6 km) zone (Ciannelli et al. 2004).

Recent evidence suggests that the Bering Sea is experiencing an overall pattern of warming resulting in reduced sea ice cover and quality, altered timing of ice retreat, and increased sea surface and bottom temperatures (Stabeno and Bell 2019; Danielson et al. 2020; Frey 2023). Most climate models predict this trend will continue (Hermann et al. 2016). Environmental conditions strongly influence the recruitment, distribution, and abundance of pollock, as well as other important prey species (Wespestad et al. 2000; Mueter et al. 2011; Hollowed et al. 2013; Spencer et al. 2016; Eisner et al. 2020; Siddon 2022). Recent changes in sea ice and bottom temperatures in the Bering Sea have led to a northerly shift in the distribution of both young and adult pollock and other groundfish (Eisner et al. 2020; Siddon 2022). Warmer sea surface temperatures negatively impact pollock recruitment, which may be further exacerbated by increases of arrowtooth flounder (a key pollock predator) in areas of high juvenile pollock density, caused by their avoidance of shifting cold pools (Spencer et al. 2016). Using predicted changes to summer sea surface temperature, Mueter et al. (2011) predicted a 32–58 percent decline in pollock recruitment by 2040–2050, and Holsman et al. (2020) projected declines over 80 percent for pollock and cod after 2075. Shifts of important prey further from breeding islands will result in female fur seals traveling further to find food and longer trip durations, which have been directly linked to reduced pup mass and survival (Baker and Fowler 1992; Springer et al. 2008; McHuron et al. 2022).

Human Related Threats

Anthropogenic activities have the potential to disturb (harass) fur seals either directly or indirectly. The duration, timing, repetition, and intensity of disturbances are important to consider when quantifying harassment for assessing effects on an individual and/or population level. Interpreting the biological significance of harassment from these activities is more challenging than simply detecting short-term behavioral changes or changes to habitat. NMFS, other federal agencies, state agencies, Tribes, local entities, and stakeholders can, to varying degrees, manage the effects of the following human-related threats that have been identified; therefore, this forms the basis for 3 out of the 4 objectives included in this Conservation Plan.

Subsistence Harvest

The combined subsistence harvest of fur seals on St. Paul and St. George is low compared to commercial harvest levels, as well as current subsistence harvest limits. In 1985, the first year with no commercial harvest on either island, the harvest was 3,713 seals for St. Paul and St. George combined. The subsistence harvest has been fewer than 2,000 seals each year since 1986, with a declining trend (Figure 14). Accidental death of females has always been very low; no more than 6 females have been killed during any year from 1985 to the present, except for 1986, when 16 were killed (Figure 15). Since 2001, harvest data have been collected for St. Paul by the ACSPI ECO and can be accessed from semi-annual reports submitted by the ACSPI Tribal Government to NMFS as part of the Alaska Native Co-Management Funding Program. For St. George, the TCSGI ECO has collected harvest data for sub adult males and submitted annual reports since 2006, also as a part of the Alaska Native Co-Management Funding Program. Data on St. George's pup harvest was collected and reported by a NMFS contractor from 2015–2020 followed by a gap in collection from 2021–2022. Since 2023, this responsibility has been taken over by the TCSGI ECO. All harvest data are drawn from reports located on the NMFS website: Northern Fur Seal Subsistence Harvest Estimates and Reports[2].

[2]NMFS Alaska Region website, Northern fur seal subsistence harvest estimates and reports. Available at https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/northern-fur-seal-subsistence-harvest-estimates-and-reports, accessed January 2023.

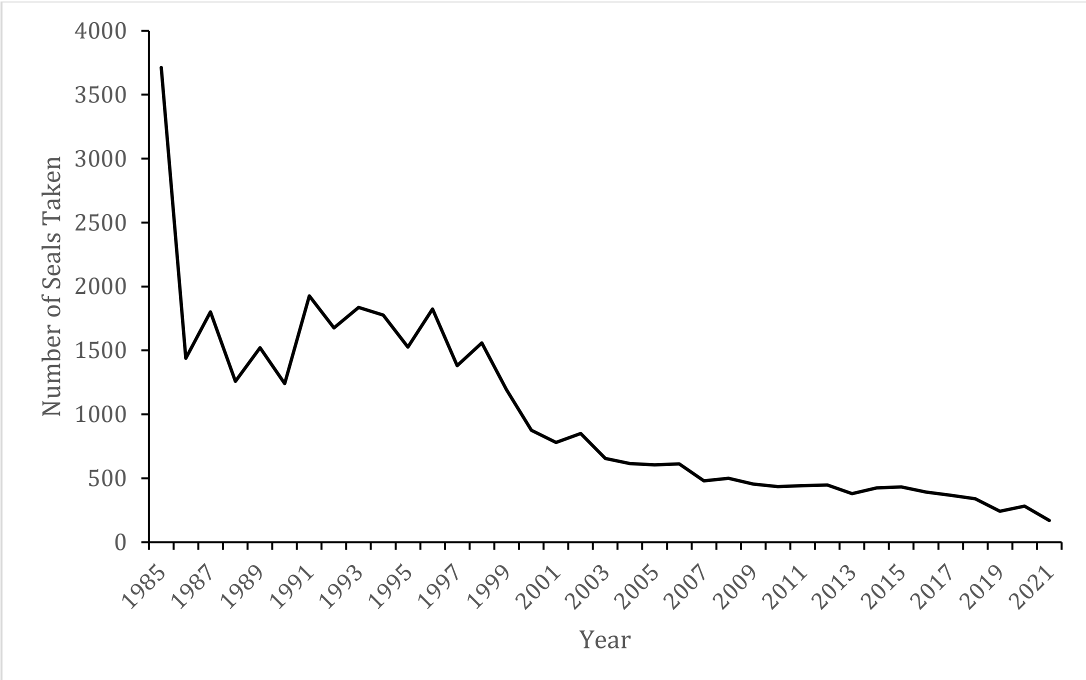

Figure 14. Subsistence harvest of northern fur seals from St. Paul and St. George Islands combined, 1985–2021.

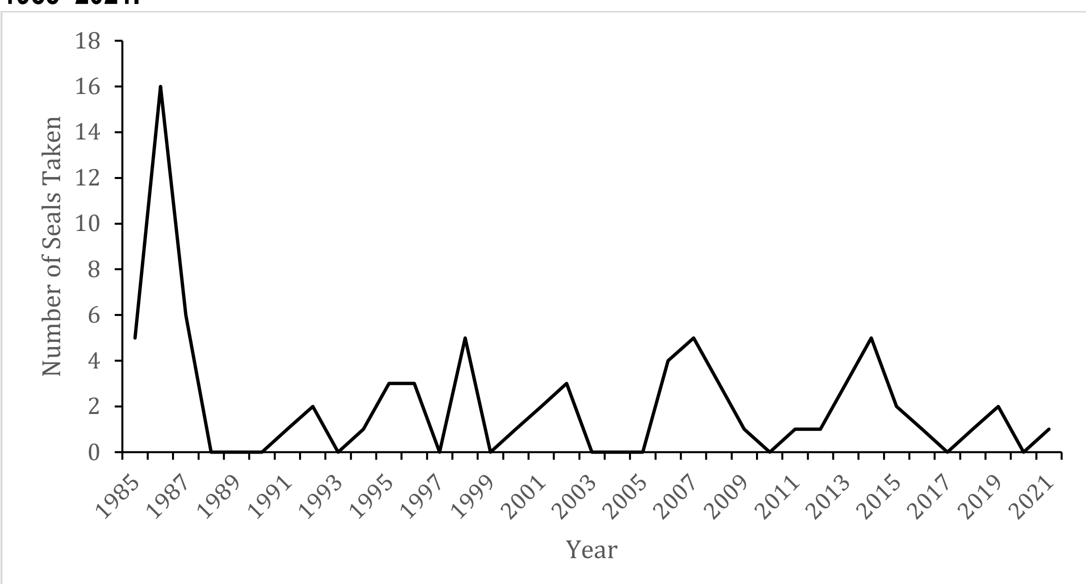

Figure 15. Accidental death of female northern fur seals during subsistence harvest from 1985–2021 for St. Paul and St. George Islands combined.

Since 1986, subsistence use of fur seals has remained far below the current harvest limits of 2,000 fur seals for St. Paul and 500 for St. George (50 CFR 216.72(d), (e)). Harvest reports from 2023 included 258 juvenile males (sub-adults and pups combined) and 1 female from St. Paul (Divine et al. 2024) and 16 juvenile males from St. George (Kashevarof 2023a; Kashevarof 2023b). Current subsistence use of fur seals is a known source of human-caused mortality that is co-managed by NMFS and Tribal partners, but is considered to have a negligible effect on the fur seal population (NMFS 2014; NMFS 2019).

Commercial Fishing

Commercial fisheries may have direct or indirect effects on northern fur seals. Direct effects of commercial fishing may include incidental take (bycatch) during fishing operations or entanglement in marine debris that is lost or discarded from fishing activities (described further under Entanglement in Marine Debris section). Indirect effects may include reduced fitness (e.g., foraging, growth) due to disturbances from vessel traffic, fishing activities, and the presence of fishing gear. Commercial fisheries may also indirectly affect northern fur seals by targeting the same species that fur seals use for prey, resulting in competition.

Federal groundfish fisheries are managed by NMFS under policies and management strategies developed, recommended, and regularly reviewed by the North Pacific Fishery Management Council (NPFMC) and NMFS. Salmon and nearshore fisheries in state waters are managed by the Alaska Department of Fish and Game (ADFG).

Direct Fishery Effects – Incidental Catch (Bycatch)

The MMPA prohibits "take" of any marine mammal in U.S. waters. The MMPA definition of "take" is to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (16 U.S.C. 1362(13)). An exception to this prohibition exists for mortality and injury incidental to commercial fishing operations if reported pursuant to the MMPA (MMPA section 118).[3]

Section 118 of the MMPA requires NMFS to classify each U.S. fishery into one of three categories on the List of Fisheries[4] based on the level of marine mammal mortality (deaths) and serious injury that they cause incidentally (i.e., accidentally or unintentionally) (16 U.S.C. 1387). In classifying fisheries, NMFS compares the numbers of marine mammals that are incidentally killed or seriously injured by commercial fishing operations to a stock's potential biological removal (PBR) level (50 CFR 229.2). To prepare the MMPA List of Fisheries, NMFS primarily uses marine mammal stock assessment reports, which generally summarize data from a rolling five-year period, and supplements these data with other sources, as needed. Commercial fisheries with frequent incidental deaths and serious injuries (that are by themselves responsible for the annual removal of 50 percent or more of any marine mammal stock's PBR) are classified as Category I. Fisheries with occasional deaths and serious injuries (that are by themselves responsible for greater than 1 percent and less than 50 percent annual removal of a stock's PBR) are classified as Category II. Fisheries with a remote likelihood

[3] NMFS Marine Mammal Authorization Program, available at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-authorization-program, accessed February 2023.
[4] NMFS List of Fisheries Summary Tables, available at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2023.

or no known deaths or serious injuries (that are by themselves responsible for less than or equal to one percent of a stock's PBR) are classified as Category III. Category I and II fisheries may be required by NMFS to implement actions to reduce incidental mortality and serious injury (16 U.S.C. 1387(b)).

Consistent with the MMPA, NMFS requires that all marine mammal mortalities and injuries in all commercial fisheries be reported. Self-reporting of all incidental mortality and injury to NMFS within 48 hours of the end of the fishing trip is a requirement in order for the incidental take to be authorized under section 118 of the MMPA (16 U.S.C. 1387(e); 50 C.F.R. 229.6). Additionally, some federal fisheries are required to have onboard observers to monitor and report any take of marine mammals as part of their duties. In some fisheries, electronic monitoring (EM) systems are used instead of observers. EM systems are able to document some marine mammal interactions within their field of view to monitor intentional and incidental catch[5]. Vessels fishing under the EM program are required to follow the same reporting procedures for all injuries and mortalities of marine mammals incidental to fishing activities.

The North Pacific Observer Program is responsible for monitoring a federally managed fishing fleet of nearly a thousand vessels that fish with a combination of hook-and-line, pot, and all trawl gear across the Alaska Exclusive Economic Zone (EEZ) (NMFS 2022). Fishing activities are classified as belonging to either partial or full coverage categories. Vessels in the full coverage category have one or two observers onboard for all trips. In the Bering Sea, nearly all trawl vessels are in the full coverage category. Vessels in the partial coverage category are placed in selection pools based on factors such as gear type and vessel length. The rate of observer coverage in the partial selection pool currently ranges from zero for vessels less than 40 feet in length or using certain gear types (e.g., jig, troll, dinglebar troll) to 23 percent for trawl vessels not covered by electronic monitoring (NMFS 2022). Electronic monitoring in some small fixed gear fisheries uses cameras instead of onboard observers to record and estimate catch information (50 CFR 679.51(f)). The NPFMC has recommended increased use of EM and NMFS has implemented an EM program for pelagic trawl pollock catcher vessels and tender vessels delivering to shoreside processors and stationary floating processors in the Bering Sea, Aleutian Islands, and Gulf of Alaska (89 FR 60796, July 29, 2024). NMFS develops an Annual Deployment Plan to explain how observers and EM will be deployed for the upcoming calendar year[6]. The Annual Deployment Plan defines partial coverage strata, participation requirements, and selection rates that can change each year. The partial coverage strata determine how trips will be monitored (for example which vessels belong to observer or EM selection pools and the requirements necessary to participate in

[5] NMFS Electronic Monitoring in Alaska web site: https://www.fisheries.noaa.gov/alaska/resources-fishing/electronic-monitoring-alaska.

[6] The 2023 Annual Deployment Plan can be found here: https://www.fisheries.noaa.gov/resource/document/2023-annual-deployment-plan-observers-and-electronic-monitoring-groundfish-and

each). They may be based on factors such as gear type, vessel length, funding, and monitoring goals.

The Alaska Marine Mammal Observation Program (AMMOP) authorizes collection of marine mammal bycatch data on incidental catch of marine mammals in fisheries managed by the State of Alaska that are not otherwise observed. AMMOP collected data on several State of Alaska fisheries from 1990–2013, but has not been funded or operated in recent years. State of Alaska salmon fisheries have not been observed since 2013.

Fur seals may become hooked, entrapped, or entangled in fishing gear during commercial fishing operations, resulting in incidental take or bycatch. These interactions sometimes, but not always, result in mortality or serious injury (Freed et al. 2022). Northern fur seal mortality and serious injury is known to occur in several fishing gear types, including trawl, gillnet, and longline fisheries. Data are limited because observers are not present on all vessels for all trips and fishers may not always self-report as required. As a result, rates of fisheries-caused mortality and serious injury may be greater than reflected in existing data and are considered minimum estimates (Muto et al. 2022).

An additional resource for fisheries-related mortality and serious injury data is the NMFS Alaska Region Marine Mammal Stranding Network database. Some fur seals that become entangled in fishing gear may escape with trailing gear that goes undetected or un-reported by observers or fishers. If these entangled animals haul out or are seen and reported to the Marine Mammal Stranding hotline[7], NMFS is sometimes able to identify the type of fishing gear and assign the mortality or serious injury to a specific fishery (Freed et al. 2022). Not all entangled animals are observed, reported, or have the cause of death determined; therefore, mortality and serious injury estimates from the stranding database are also considered minimum estimates (Freed et al. 2022).

The MMPA Lists of Fisheries[8] (89 FR 12257, February 16, 2024), northern fur seal stock assessment reports[9], and mortality and serious injury reports (e.g., Freed et al. 2022) from 1998–2020 were reviewed to determine which U.S. fisheries had self-reported and observed interactions with northern fur seals. Those fisheries and the northern fur seal bycatch observations are described below.

Bristol Bay Salmon Drift Gillnet and Set Gillnet Fisheries
The Bristol Bay salmon drift gillnet and set gillnet fisheries primarily target sockeye salmon (*Oncorhynchus nerka*), with annual commercial harvests averaging 28.1 million sockeye per year during 2000–2022 (Elison et al. 2022). To a lesser extent, these

[7] NOAA Fisheries Alaska Statewide 24-hour Stranding Hotline (877) 925-7773
[8] NMFS, MMPA List of Fisheries publications are available online at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed February 2024.
[9] NMFS, Marine Mammal Stock Assessment Reports by Region, available at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region, accessed February 2023.

fisheries also harvest Chinook (*O. tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), and pink (*O. gorbuscha*) salmon. These fisheries are listed as Category II in the 2024 MMPA List of Fisheries based on analogy with other Alaska drift gillnet and set gillnet fisheries. The inclusion of northern fur seals on the list of species and stocks incidentally taken in these fisheries is based on logbook data (self-reports) from 1990 and 1992. These fisheries occur in all coastal and inland waters east of a line from Cape Newenham to Cape Menshikof, encompassing nine major river systems (Figure 16), and generally operate from mid-June to the end of August with peak effort and harvest during a 3 to 4-week period in late June and early July.

These fisheries are managed by the ADFG as limited entry fisheries (with a set number of permits) with gear restrictions on the mesh size, net size, and area closures. These fisheries have not been observed by AMMOP; therefore, any reported bycatch is from fisher self-reports[4].

Self-reports (in logbooks) from the Bristol Bay drift gillnet fishery indicated 5 incidental takes of northern fur seal in 1990 and 49 in 1992 (Hill and DeMaster 1998). There are no confirmed reports of incidental take in the set net fishery. In 1990, self-reports from the Bristol Bay set and drift gillnet fisheries were combined. As a result, it is unknown whether some of the northern fur seal mortalities reported in 1990 may have occurred in the set net fishery (Hill and DeMaster 1998). Self-reported fisheries data are considered incomplete, and have mostly been unavailable or unreliable since these early reports.

Northern fur seals from both rookery complexes on St. George Island consume salmon to the extent that it is generally the second or third most frequent item in their diet (Zeppelin and Ream 2006). The estimates of the spatial and temporal distribution of lactating female northern fur seals from St. George indicate that they do not overlap with the Bristol Bay fisheries (Zeppelin and Ream 2006). Sterling and Ream (2004) identified that male fur seals from two of the St. Paul Island rookery complexes foraged in areas similar to adult lactating females from those same rookeries except that their trip durations were longer and ranged further from St. Paul Island. Assuming male fur seals from St. George forage similarly we would predict that their foraging trips may extend into Bristol Bay and interact with those salmon drift gillnet and set net fisheries.

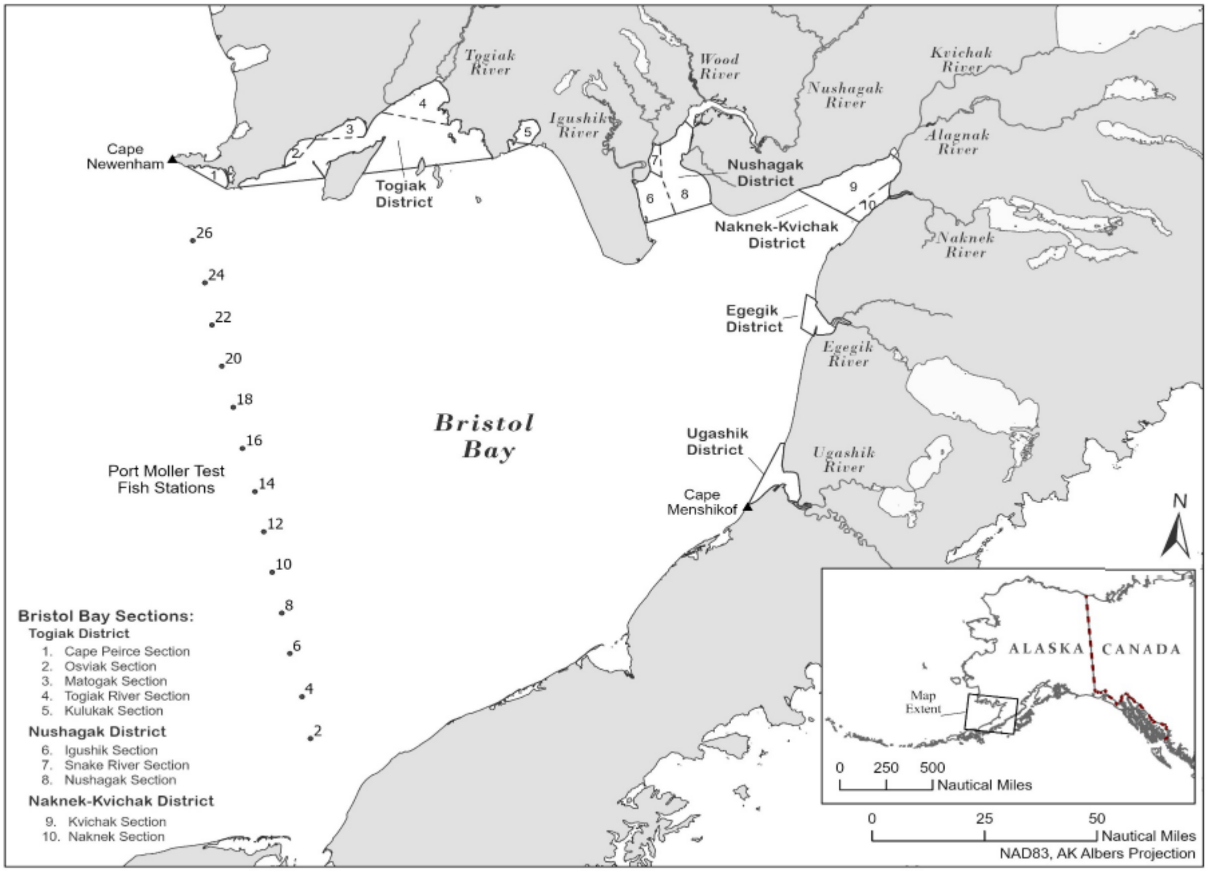

Figure 16. Bristol Bay commercial salmon fishing districts (excerpted from Elison et al. (2022) and used with permission).

Alaska Peninsula/Aleutian Islands Salmon Drift Gillnet Fishery

The Alaska Peninsula and Aleutian Islands salmon drift gillnet fishery targets all five species of salmon. This fishery is listed as Category II in the 2024 MMPA List of Fisheries based on analogy with other Category II Alaska drift gillnet fisheries and the similarity of gear and methods as other Alaska drift gillnet fisheries with higher rates of documented incidental take of fur seals (from self-reports/logbook data). There are no documented incidental takes of fur seals in this fishery. Nearly all of the fishing effort in this fishery occurs in the Alaska Peninsula Area of Area M (dotted area shown in Figure 17). The fishery in the North Alaska Peninsula subarea primarily targets sockeye and chum, with lesser amounts of pink and coho from late June through mid-August (Johnson et al. 2021b). The South Alaska Peninsula subarea fishery is much larger in volume and catches all five species of salmon, including large numbers of pink, sockeye, and chum throughout June, July, and August (Fox et al. 2022). Since 2014, there has been limited to no harvest of salmon by this fishery in the Aleutian Islands Area (including the Pribilof Islands) of Area M due to a lack of processing capacity (Wilburn and Keyse 2015; ADFG 2022).

This drift gillnet fishery is managed by ADFG as a limited entry fishery with gear restrictions on the mesh size, net size, and area closures. The fishery was observed by AMMOP at a 4 percent coverage rate in 1990, but has not been observed since[4]. Two northern fur seals were self-reported as taken in this fishery in 1990.[9]

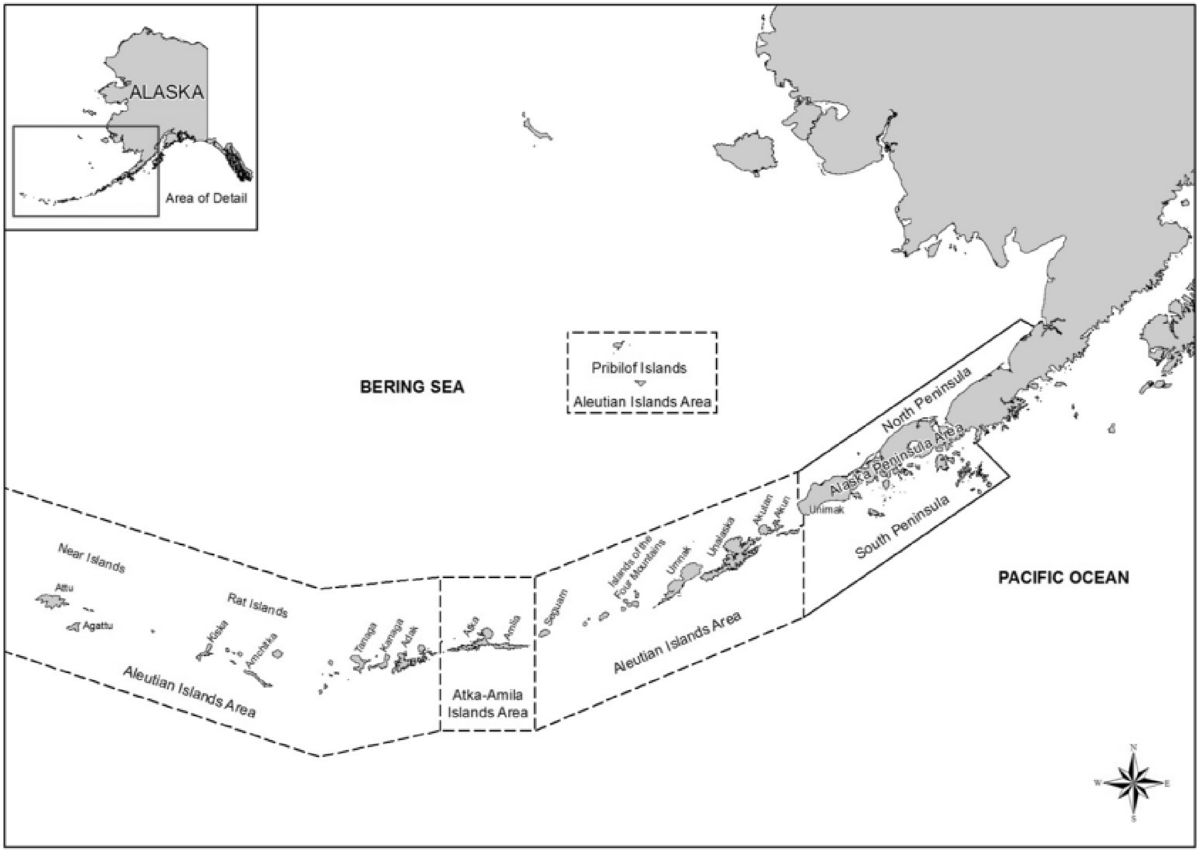

Figure 17. Map of ADFG Salmon Management Area M (all areas within dotted lines). Most of the effort occurs in the Alaska Peninsula Area to the east (excerpted from ADFG (2022) and used by permission).

During the summer, adult females from St. George and Bogoslof approach the Alaska Peninsula and Aleutian Islands (Figure 7B; Kuhn et al. 2014a) on their foraging trips indicating that they may overlap spatially and temporally with some salmon fisheries in this area. Sterling and Ream (2004) identified that male fur seals from two of the three St. Paul Island rookery complexes foraged in areas similar to adult lactating females from those same rookeries except that their trip durations were longer and ranged further from St. Paul Island. Assuming male fur seals from St. George and Bogoslof forage similarly we would predict that their foraging trips would also extend into these fisheries areas in Area M.

In general, there is some level of spatial or temporal overlap between fur seals and Alaska Peninsula/Aleutian Islands salmon drift gillnet fisheries. In addition, yearling and two-year-old seals' foraging trips extend into the Alaska Peninsula and Aleutian Islands (Zeppelin et al. 2019). However, by the fall/early winter, these fisheries are nearly complete and few vessels are still on the fishing grounds.

Alaska Prince William Sound Salmon Drift Gillnet Fishery

The Alaska Prince William Sound salmon drift gillnet fishery is an MMPA Category II fishery based on its level of incidental mortality and serious injury of GOA harbor porpoise (*Phocoena phocoena*) and Western U.S. Steller sea lions, not fur seals[4]. The inclusion of northern fur seals on the list of species and stocks incidentally taken in this fishery is based on logbook data (self-reports) from 1990 and 1991. This fishery targets all five species of salmon in all coastal waters entering the north central Gulf of Alaska between Cape Suckling and Cape Fairfield including the Bering River, Copper River, and all of Prince William Sound (Botz et al. 2021) (Figure 18). Pink salmon are caught in the highest numbers, followed by sockeye salmon. This fishery operates from mid-May to the end of September. Peak effort in this fishery depends on species and location, with Chinook harvests generally and primarily occurring from late May through mid-June, sockeye from late May through early July, chum from late June through July, and pink and coho from mid-July through August (Botz et al. 2021).

This fishery is managed by ADFG as a limited entry fishery with gear restrictions on the mesh size, net size, and area closures. The fishery was observed at 4 percent coverage in 1990 and 5 percent coverage in 1991 by the AMMOP, but has not been observed since[4]. One northern fur seal was self-reported as taken in this fishery in 1990 and one was self-reported in 1991.[9]

Northern fur seals migrate north through the northern Gulf of Alaska and southern Prince William Sound in May and June, but are not thought to be frequently or regularly present in Prince William Sound during the salmon driftnet fisheries. The two reports from 1990 and 1991 clearly indicated some fur seals were present in Prince William Sound. There is no temporal information regarding these two incidences of fur seal bycatch, but the lack of recent reporting or observations of fur seals in Prince William Sound suggest this interaction was an anomaly rather than a regular occurrence.

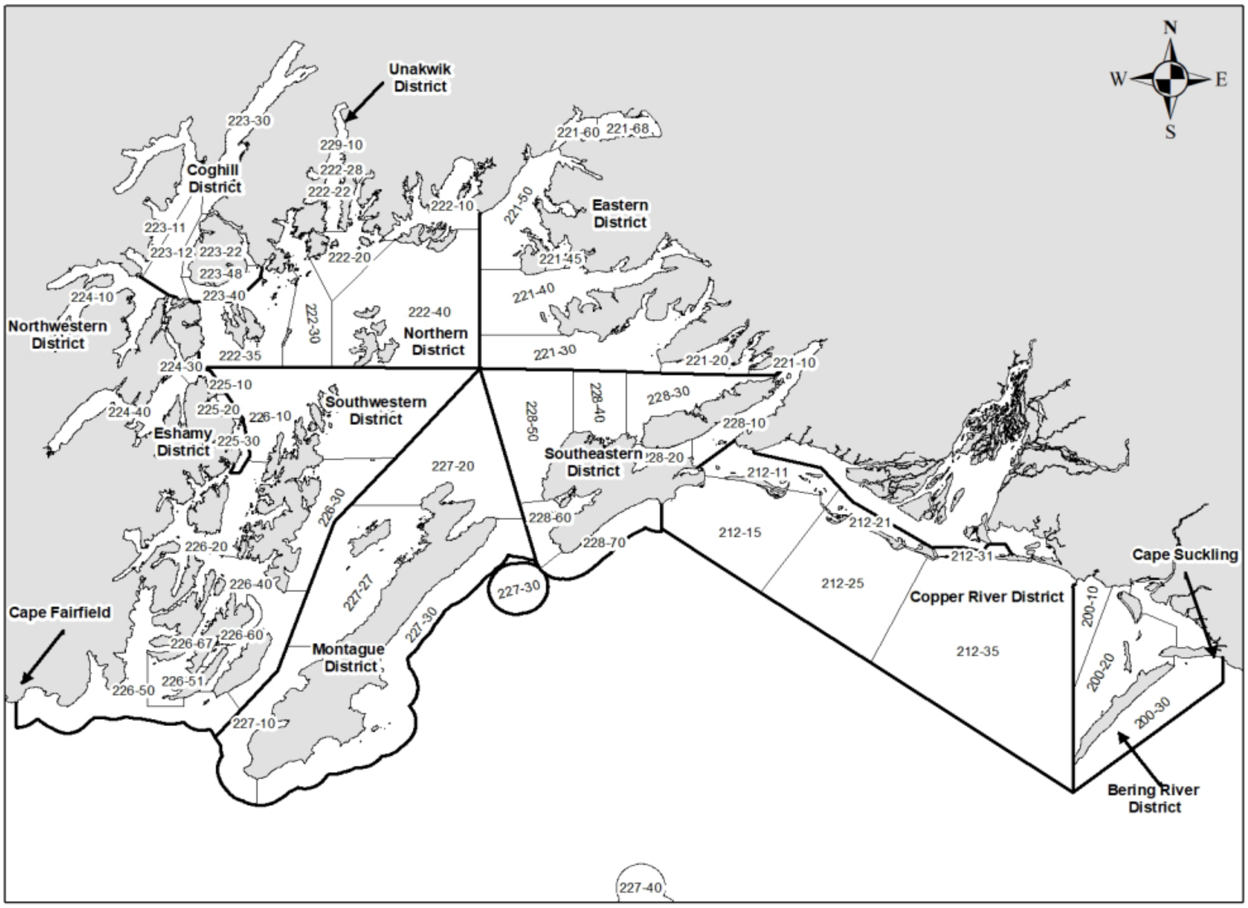

Figure 18. Prince William Sound management area and commercial fishing districts (excerpted from Botz et al. (2021) and used with permission).

Alaska Bering Sea/Aleutian Islands Flatfish Trawl

The Alaska Bering Sea/Aleutian Islands (BSAI) flatfish non-pelagic (i.e., bottom contact) trawl fishery is a Category II fishery based on its level of incidental morality and serious injury of Western U.S. Steller sea lions and two stocks of killer whales, not fur seals[4]. Fishing effort in this fishery occurs within the U.S. EEZ of the Eastern Bering Sea and the portion of the North Pacific Ocean adjacent to the Aleutian Islands, which is west of 170°W longitude up to the U.S.-Russian Convention Line of 1867 (Figure 19). The season generally extends from late January through November, with a reduction in effort occurring from mid-June through mid-August when flatfish are less abundant in the area (Figure 20). Yellowfin sole (*Limanda aspera*) is the primary species captured, with lesser amounts of other flatfish species (Figure 20).

This fishery is federally managed under the Fishery Management Plan for Groundfish of the BSAI Management Area (BSAI FMP). The authorized gear, fishing season, criteria for determining fishing closures, and area restrictions by gear type are defined in the regulations implementing the BSAI FMP (50 CFR part 679). Management measures for the BSAI groundfish fisheries constrain fishing both temporally and spatially.

This fishery is currently monitored under the North Pacific Observer Program in the full coverage category[10]. Observers reported bycatch of a total of 25 northern fur seals in 16 of 30 years between 1991 and 2021 (Freed et al. 2022), with an anomalous 10 seals in 2019 (Young et al. 2023).

It is unknown why the BSAI flatfish fishery has the highest rate of bycatch of northern fur seals. Flatfish are not common in the diet of northern fur seals (less than two percent frequency of occurrence; Zeppelin and Ream 2006), but it is possible that the location of the fishery in proximity to the Pribilof Islands and an extended season that overlaps with fur seal presence in the southeast Bering Sea causes higher levels of interactions than with other fisheries. That said, the rate of observed bycatch is still quite low, even with the higher relative rate of interaction in 2019 compared to the previous years. The mean estimated annual mortality and serious injury from this fishery is estimated at 2.7 seals for the period of 2015–2019 (Young et al. 2023).

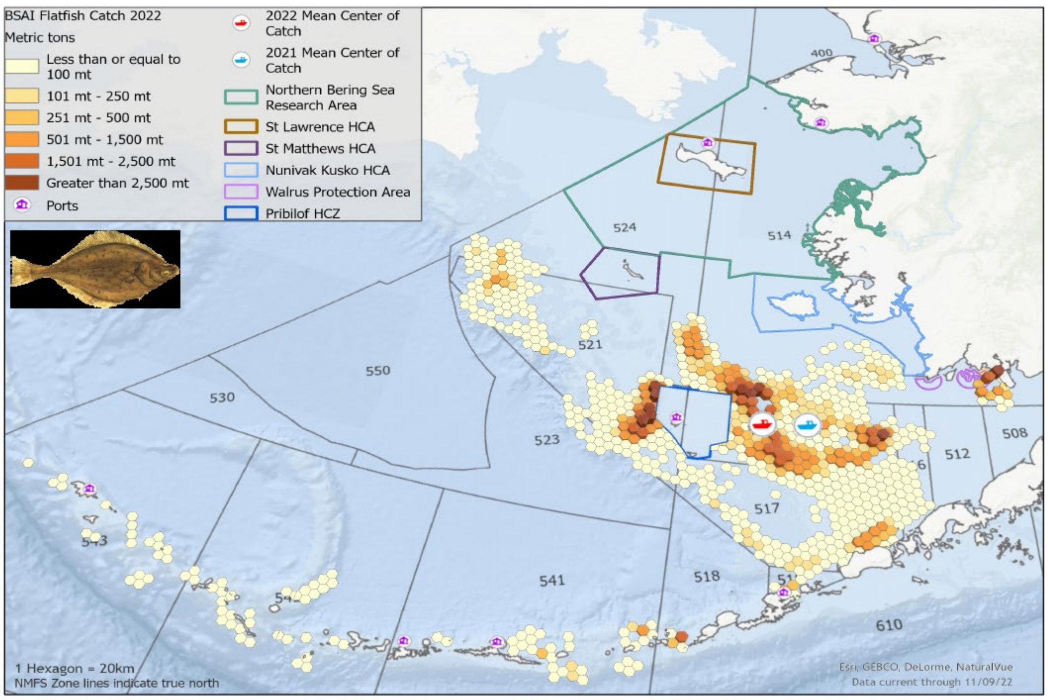

Figure 19. Distribution of 2022 fishing effort by the BSAI flatfish trawl fleet.[11] HCA= habitat conservation area and HCZ = habitat conservation zone.

[10] The Amendment 80 fleet in this fishery is required to have 200% observer coverage. With two observers onboard, nearly every haul is observed and therefore detection of incidental catch is high.
[11] Figure excerpted from the NMFS BSAI Inseason Management Report presented to the NPFMC in December 2022 and available at https://www.fisheries.noaa.gov/resource/document/alaska-inseason-management-annual-reports-north-pacific-fishery-management, Accessed March 2023.

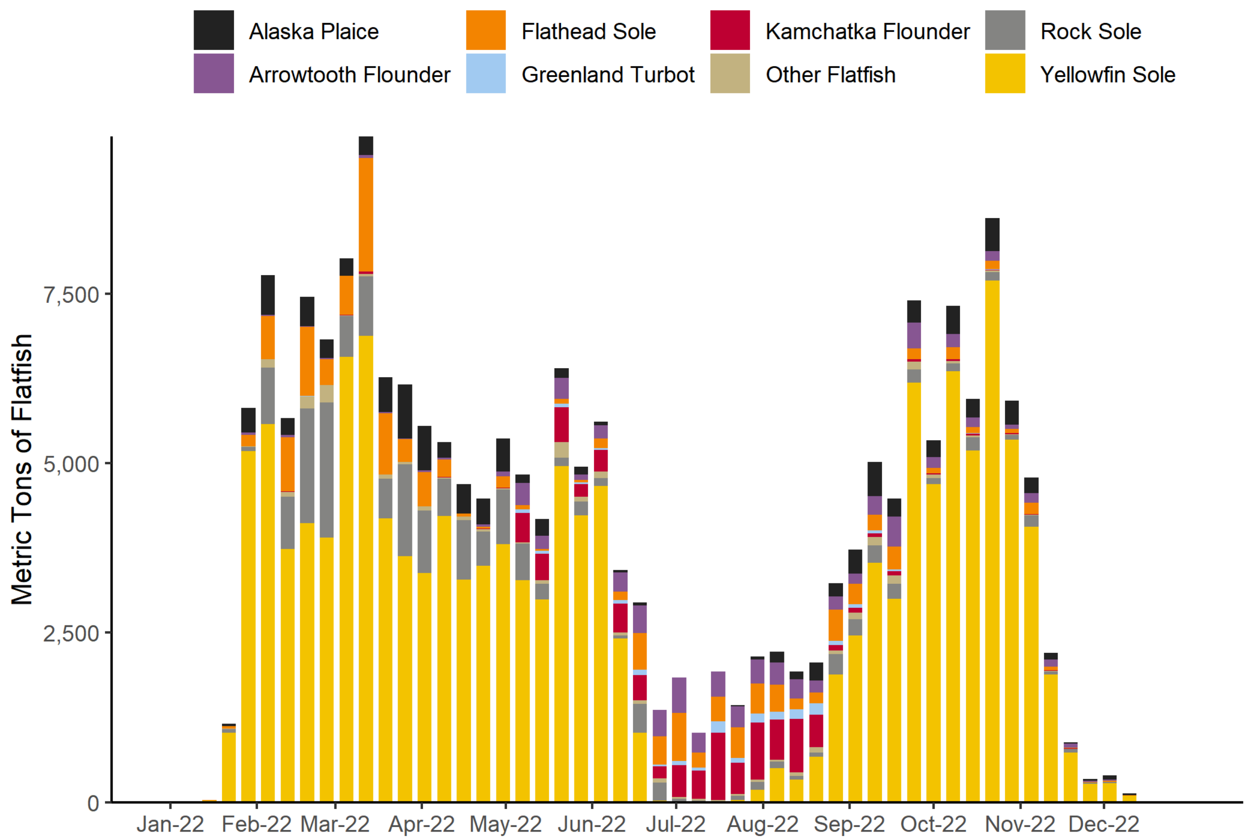

Figure 20. Catch composition and timing of the BSAI flatfish trawl fishery.

Alaska Bering Sea/Aleutian Islands Pollock Trawl

The BSAI pollock trawl fishery is a Category II fishery based on its level of incidental mortality and serious injury of Western U.S. Steller sea lions. The 2024 List of Fisheries does not include northern fur seals as a marine mammal species or stock incidentally killed or injured in this fishery; northern fur seals were previously included from 2013 to 2022 based on documented mortality and serious injury in 2005, 2007, 2008, and 2010. . Fishing effort in this fishery takes place in the U.S. EEZ of the Eastern Bering Sea and the portion of the North Pacific Ocean adjacent to the Aleutian Islands. This fishery uses trawl gear to target pollock. The use of non-pelagic (i.e., bottom contact) trawl gear in the directed fishery for pollock is prohibited; however, some pollock is caught as incidental catch (not targeted) in other fisheries (Figure 21).

The Bering Sea pollock trawl fishery occurs in two seasons: the A season from January 20 through June 10, and the B season from June 10 through November 1, although the seasons can close earlier (early April and September, respectively) if the fishery catches its seasonal allocation (Figure 21). The B season catcher/processor fleet operates nearer to the Pribilof Islands (Figure 22) and accounts for about one-third of the catch (Figure 21). The remainder of the B season pollock fleet operates further from the Pribilof Islands (Figure 23), but still within the foraging habitat of fur seals (Figure 7).

Management measures for the BSAI groundfish fisheries constrain fishing both temporally and spatially. This fishery is federally managed under the BSAI FMP. The authorized gear, fishing season, criteria for determining fishing closures, and area restrictions by gear type are defined in the regulations implementing the FMP (50 CFR part 679).

This fishery is monitored under the North Pacific Observer Program in the full coverage category. All trips are monitored with onboard observers or with EM. Observers reported mortality and serious injury of northern fur seals in 2005 (*n*=1), 2007 (*n*=3), 2008 (*n*=1), and 2010 (*n*=2), but not recently (since 2010).[9] Despite spatial and temporal overlap of the B season with foraging northern fur seals from the five rookery complexes from the Pribilof Islands, high consumption of pollock by fur seals, and complete observer coverage, bycatch of northern fur seals in this fishery is uncommon.

2022	TAC (mt)	Catch (mt)	%
Inshore	475,200	473,491	100%
Catcher/Processor	380,160	380,089	100%
Mothership	95,040	95,008	100%
CDQ	111,100	111,033	100%
Incidental Catch	49,500	44,781	90%
TOTAL	**1,111,000**	**1,104,402**	**99%**

* No reallocations in 2022

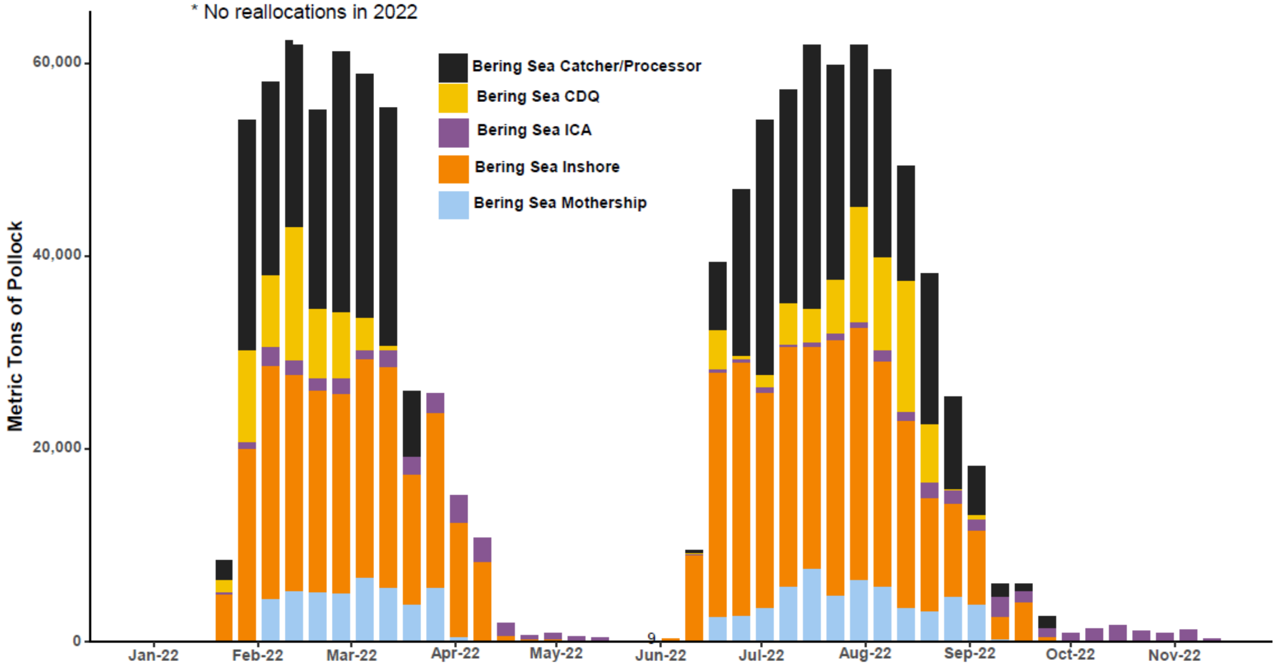

Figure 21. Bering Sea pollock catch by week and sector. The purple bars indicate incidental catch of pollock by the non-pelagic trawl fleet. All other colors represent targeted catch by the trawl fleet.[11] CDQ = Community Development Quota and ICA = Incidental Catch Allowance

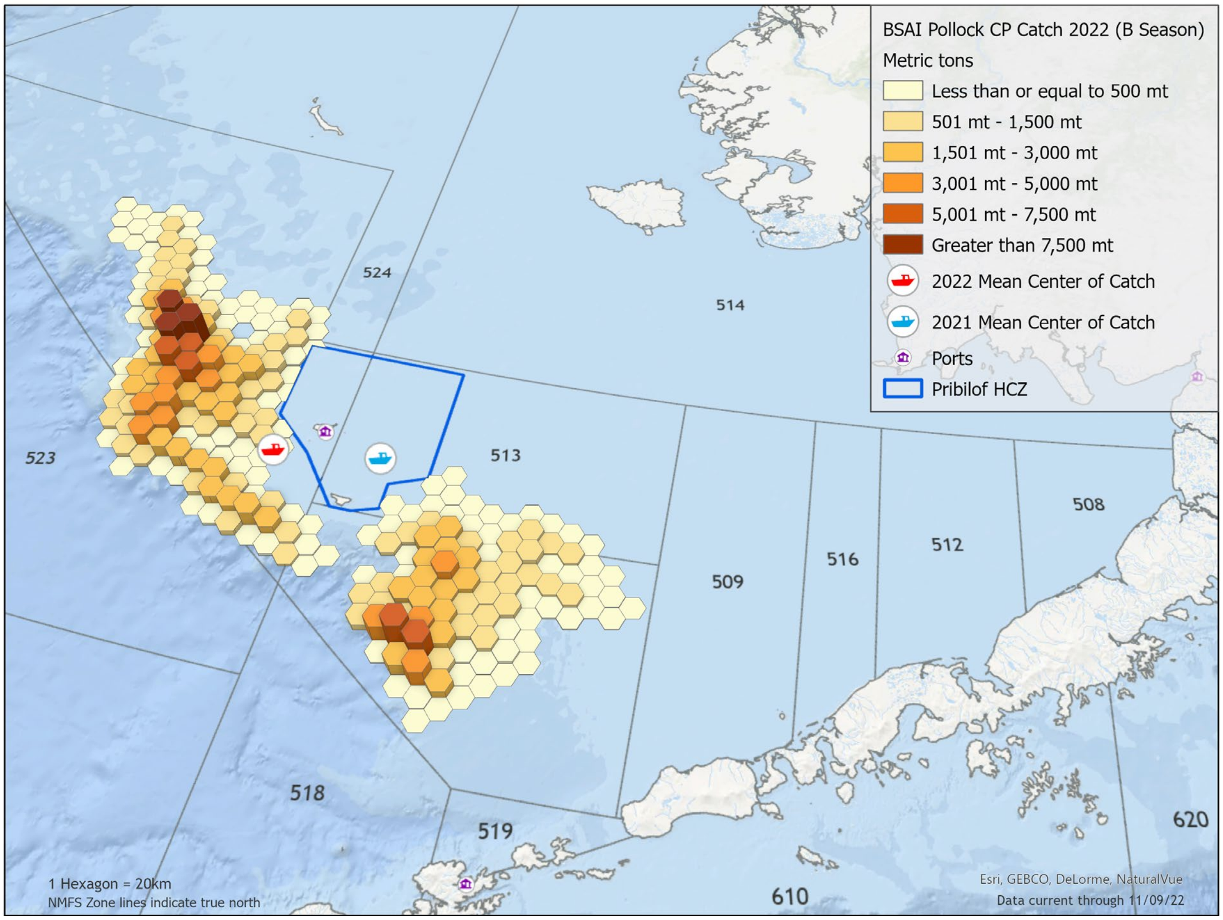

Figure 22. 2022 B Season Bering Sea pollock trawl directed fishery by catcher/ processors.[11] The 2021 (blue) and 2022 (red) mean centers of catch locations are shown to be relatively close to the Pribilof Islands port (purple) compared to catcher vessels shown in Figure 23.

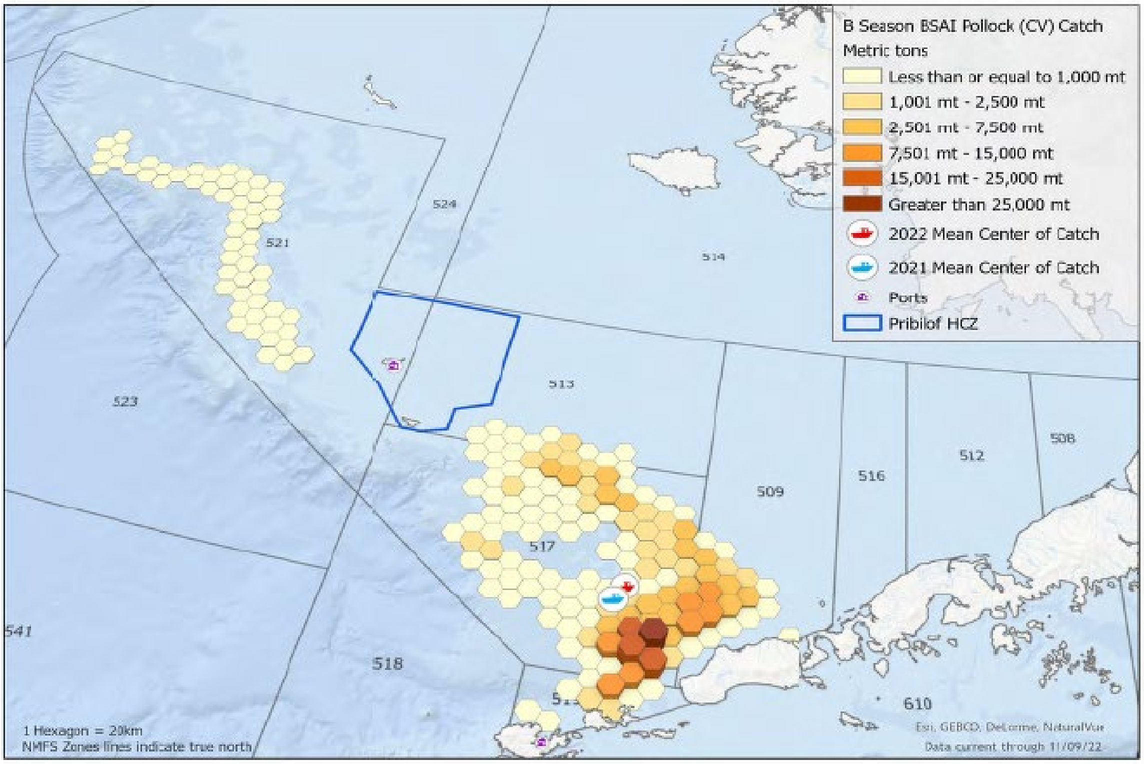

Figure 23. 2022 B Season Bering Sea pollock trawl directed fishery by catcher vessels.[11] The 2021 (blue) and 2022 (red) mean centers of catch locations for catcher vessels are shown to be further from the Pribilof Islands port (purple) than for catcher-processors shown in Figure 22.

Alaska Bering Sea/Aleutian Islands Pacific Cod Longline

The Alaska Bering Sea/Aleutian Islands Pacific cod longline fishery is a Category III fishery. Fishing effort in this fishery occurs within the U.S. EEZ of the Eastern Bering Sea and the portion of the North Pacific Ocean adjacent to the Aleutian Islands (Figure 24). This fishery uses longlines/set lines to target Pacific cod.

Management measures for the BSAI groundfish fisheries constrain fishing both temporally and spatially. This fishery is federally managed under the BSAI FMP. The authorized gear, fishing season, criteria for determining fishing closures, and area restrictions by gear type are defined in the regulations implementing the BSAI FMP (50 CFR part 679).

This fishery is monitored under the North Pacific Observer Program, with the majority of trips belonging to the full coverage category. Observers reported mortality and serious injury of northern fur seals in 2006 (*n*=1) and 2010 (*n*=1) in this fishery, but not in recent years.[9] Despite considerable temporal and spatial overlap of this fishery with foraging northern fur seals from the different rookery complexes from the Pribilof Islands, and minor consumption of Pacific cod by fur seals, bycatch in this fishery is rare.

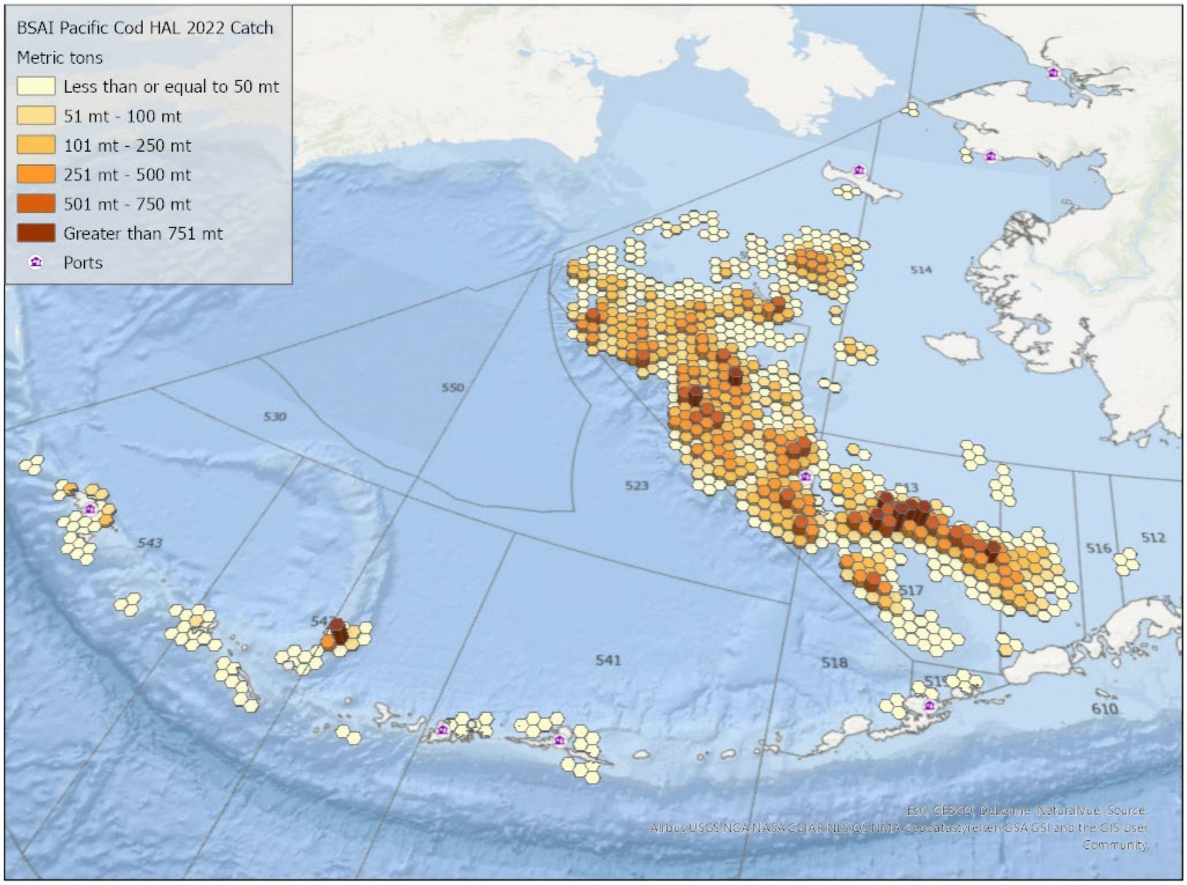

Figure 24. 2022 Pacific cod catch by fixed gear (non-trawl gear) in the Bering Sea/Aleutian Islands.[11] PIHCZ = Pribilof Island habitat conservation zone.

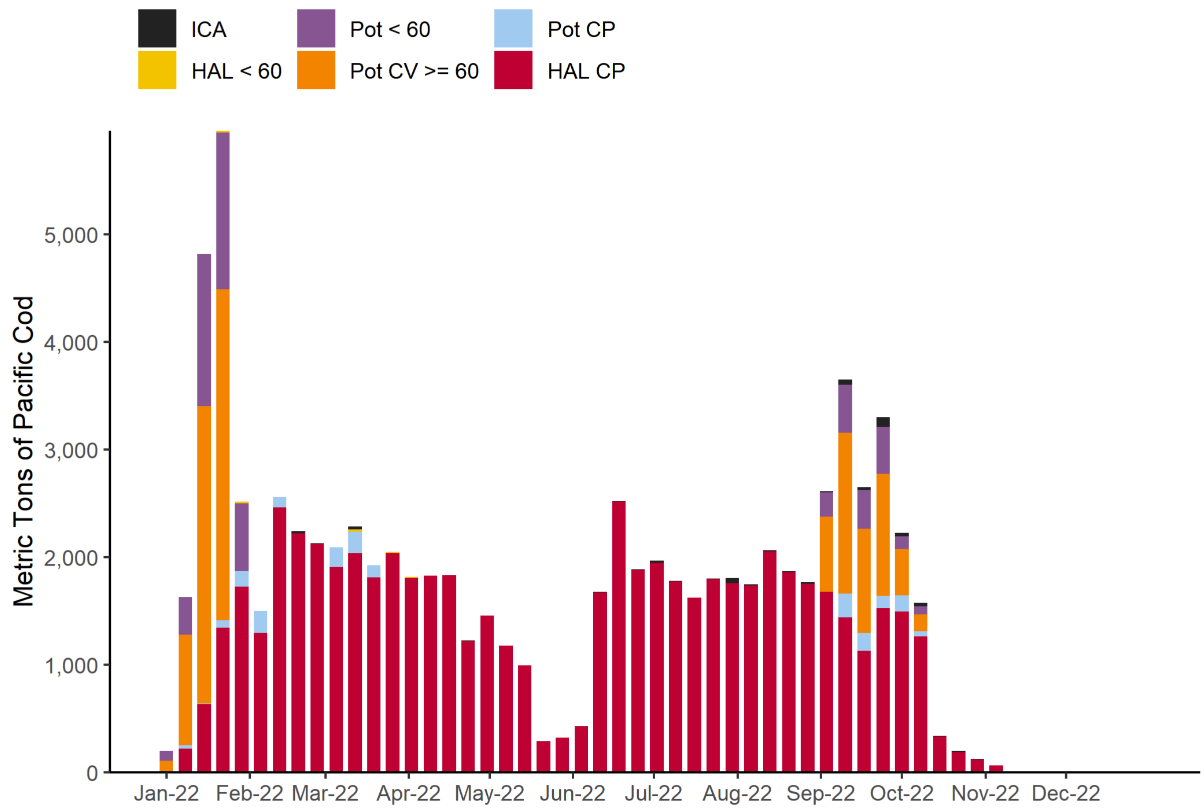

Figure 25. 2022 Bering Sea Aleutian Islands fixed gear (non-trawl) Pacific cod catch. Red and yellow bars represent the directed hook-and-line (longline) fisheries. ICA=incidental catch allowance (non-targeted catch), HAL=hook and line, CP=catcher/processor, CV=catcher vessel. <60 and >=60 refer to the vessel length categories in feet.

Other Fisheries

The 2024 MMPA List of Fisheries[4] also lists the Alaska Bering Sea/Aleutian Islands halibut longline fishery and the Washington/Oregon/California groundfish trawl fishery as Category III fisheries having interactions with northern fur seals.

Summary of Direct Fisheries Effects

Although there is likely underreporting of incidental takes of northern fur seals in fisheries that are unobserved, U.S. commercial fisheries do not appear to cause many direct fur seal mortalities or injuries. No fisheries are currently classified as Category I or II based on mortality and serious injury of northern fur seals. Human-caused mortality and serious injury resulting from U.S. commercial fisheries is estimated at 3.5 animals per year for the period 2015–2019 compared to a PBR of 11,403 (Young et al. 2023). Total human-caused mortality and serious injury during the 2015–2019 period is 373 northern fur seals: 3.5 in U.S. commercial fisheries (2.7 from observer data and 0.8 from stranding data), 2.4 in unknown (commercial, recreational, or subsistence) fisheries; 7 in marine debris; 0.4 due to other causes (car strike, dog attack); and 360 in the subsistence harvest (Young et al. 2023). These mortality and serious injury data do not reflect the total potential threat of entanglement, since additional northern fur seals initially considered seriously injured due to entanglement in fishing gear or marine debris were disentangled and released with non-serious injuries between 2015 and 2019 (Young et al. 2023). Total human-caused serious injury and mortality, including subsistence harvest, is only three percent of PBR. Section 118 of the MMPA requires fisheries to reduce marine mammal mortality and serious injury to insignificant levels approaching a zero mortality and serious injury rate (16 U.S.C. 1387), which NMFS has defined as levels less than 10 percent of the PBR level (50 CFR 229.2) (i.e., zero mortality rate goal (ZMRG); 69 FR 43338, July 20, 2004). For the Eastern Pacific stock of northern fur seals, PBR is 11,403 seals (Young et al. 2023), so the ZMRG threshold is 1,140 fur seals. Based on Young et al. (2023), total human-caused mortality and serious injury from U.S. commercial fisheries (3.5) is only 0.03 percent of PBR (11,403). Therefore, NMFS considers direct fishery mortality from all fisheries, even if underreported, to be insignificant.

Table 1. Summary of fisheries in the MMPA List of Fisheries with documented serious injuries or mortality of northern fur seals.

Fishery	List of Fisheries Category	Average annual serious injury and mortality from observer data, 2015-2019^	State/ Federal Management	Current Observer Coverage
Alaska Bristol Bay Salmon Drift Gillnet and Set Gillnet Fisheries	II*	0	State	None
Alaska Peninsula/Aleutian Islands Salmon Drift Gillnet Fishery	II Error! Bookmark not defined.	0	State	None
Alaska Prince William Sound Salmon Drift Gillnet Fishery	II Error! Bookmark not defined.	0	Federal	None
Alaska Bering Sea/Aleutian Islands Flatfish Trawl	II Error! Bookmark not defined.	2.7**	Federal	Full
Alaska Bering Sea/Aleutian Islands Pollock Trawl	II Error! Bookmark not defined.	0**	Federal	Full
Alaska Bering Sea/Aleutian Islands Pacific Cod Longline	III	0	Federal	Most in Full

^ From Young et al. (2023), Alaska marine mammal stock assessments, 2022.

* Based on analogy with other salmon gillnet fisheries for assumed interactions with northern fur seals.

**An additional 0.8 northern fur seals were reported in stranding data for Alaska Bering Sea/Aleutian Islands trawl fisheries combined.

Error! Bookmark not defined. Based on interactions with marine mammals other than northern fur seals.

Indirect Fishery Effects

Commercial fishing can indirectly affect northern fur seals by redistributing or removing northern fur seal prey. Specifically, fisheries may reduce or alter prey biomass and densities at spatial and temporal scales such that northern fur seals in an affected area have difficulty finding and capturing adequate prey, thereby potentially reducing their survival and reproduction. In the previous sections, we described the temporal and spatial overlap between various contemporary commercial fisheries and northern fur seals. In this section, we review the assessment of northern fur seal interactions with commercial fishing operations in the Bering Sea by the North Pacific Fur Seal Commission (NPFSC; 1957–1984), research after the NPFSC by NMFS and others, and describe our understanding of indirect interactions between commercial fisheries and northern fur seals since the depleted designation and changes to fisheries management (~1990 to the present). We also describe in-season walleye pollock fishery management actions in the Bering Sea to shift the distribution of catch to reduce salmon bycatch and protect Steller sea lions that may have altered prey availability differently among the northern fur seal rookery complex foraging areas on the Pribilof Islands (Figure 7, Zeppelin and Ream 2006).

Interactions between northern fur seals and fisheries has long been a topic of management concern, as recognized beginning in 1957 with signing of the Fur Seal Convention between the U.S., Canada, Japan, and Russia (Scheffer et al. 1984). The pelagic collections of northern fur seals in the southeast Bering Sea from 1958–1974 were implemented under the terms of the Convention, the initial period being a 6-year cooperative research program. The pelagic research was intended to supplement the land-based research, as well as inform the effectiveness of the herd reduction program. Further, it was intended to help achieve maximum sustained yield from commercial sealing of non-breeding males as an economic resource (i.e., seal pelts), and investigate the "*relationship between fur seals and other living marine resources*" (NPFSC 1957–1984). The initial premise of the studies of the relationship between northern fur seals and "other living marine resources" was to investigate whether northern fur seals could be reducing commercial fisheries catch (as Japan posited at the time), as this was the purpose of the herd reduction program from 1956–1968 (see Commercial Exploitation and Scheffer et al. 1984). As the northern fur seal population continued to decline after the herd reduction program was stopped ahead of schedule in the 1970s, the NPFSC began to speculate that commercial fisheries might be affecting the maximum sustained yield of the northern fur seal population in the Bering Sea (NPFSC 1984). Today marine mammal management is based on conservation principles under the MMPA. Northern fur seal management takes a precautionary approach, as the stock is below its OSP, designated as depleted under the MMPA, and continues to experience periods of significantly different rates of decline by portions of the populations on St. Paul and St. George (Figure 11; Towell et al. 2006).

Managers no longer use the term maximum sustained yield in reference to the northern fur seal population. Uncertainty regarding the relationships between fisheries and northern fur seals continue today, largely relating to the difficulty of estimating northern fur seal diet, different data collection methods used over time, and the fact that available evidence indicates they are an opportunistic predator (reaffirming the findings of Kajimura 1984).

Identifying and quantifying components of the northern fur seal diet was the first step to determine the importance of various prey species in their diet and whether northern fur seals compete with commercial fisheries for the same size prey. The first comprehensive description of the northern fur seal diet was conducted on behalf of the NPFSC by the member nations using seals harvested pelagically for research across their range from 1958-1974; the analysis of stomachs sampled from these animals (*n*=18,404) indicated that they were opportunistic predators consuming a variety of readily available fish and squid (Kajimura 1984). Kajimura (1984) estimated prey species importance in northern fur seal diet using a combination of percent volume and frequency of occurrence. In an attempt to correct for the bias in passage rates and accumulation of diagnostic parts (i.e., squid beaks and fish otoliths) in different parts of the gastro-intestinal (GI) tract, a modified volume method was developed (Bigg and Fawcett 1985; Bigg and Perez 1985). This metric excludes "trace" remains (e.g., squid beaks and fish bones) found in the stomach, resulting in underrepresentation of squid and larger fish whose hard parts do not pass the pyloric sphincter of the northern fur seal stomach. Because prey size was not measured until the 1970s, when the NPFSC resumed pelagic collections of northern fur seals in 1981, 1982, and 1985 in the Bering Sea, efforts were made to better describe the individual size of northern fur seal prey. This was done by directly measuring whole prey when present and estimating size from measurements of otoliths and beaks in GI tracts; however, sample size was limited in the 1980s (*n*=73) vs 1960s and 1970s (*n*=3,704) (Kajimura 1984; Sinclair et al. 1994).

In the late 1980s, research shifted to non-lethal methods for northern fur seal diet sampling, using enumeration and measurement of otoliths and beaks collected from scats to estimate diet instead of GI tract contents (Antonelis et al. 1986; Sinclair et al. 1996; Zeppelin and Ream 2006). Numerous captive and wild animal studies have shown this method has its own unique limitations and biases (Arim and Naya 2003; Bowen and Iverson 2012); like GI contents, scats represent a relatively limited temporal and spatial window of prey consumption (i.e., food consumed within last few days). Based on captive studies with limited sample sizes, we assume that wild foraging animals tend to complete most/basic digestion within 12–48 hours, so most prey consumed during the first few days of an up to 10 day foraging trip may not be present in a scat collected on land (Arim and Naya 2003; Bowen and Iverson 2012). In contrast to stomachs and GI contents, sampling scats underestimates the importance of squid, as beaks accumulate in the stomach with longer residence time (Bigg and Fawcett 1985), as well as larger bony prey in the diet (i.e., fish bones). Large hard parts that eventually pass through the digestive system may be too eroded to identify or reliably measure for diet studies (Sinclair et al. 2011). Northern fur seals are known to regurgitate larger bones and indigestible hard parts (i.e., squid beaks) on land and at sea, so the collection of regurgitations can help provide a more complete understanding of these prey in the diet. However, northern fur seal studies which include regurgitation data are limited to less than 10 percent of the overall diet sample sizes for the studies that include them (Kiyota et al. 1999; Yonezaki et al. 2005; Gudmundson et al. 2006). As with northern fur seal diet study methods, our understanding of northern fur seal prey selection, particularly with regard to pollock size and age class, also evolved.

Initially, northern fur seals were described as opportunistic foragers, given the importance of locally abundant prey species in their diets (Kajimura 1984). When prey in GI tracts were measured, an observed numerical dominance of age 0–1 pollock was initially interpreted as a preference for young pollock (Sinclair et al. 1996). This led to erroneous modeling results showing that northern fur seals did not compete with commercial pollock fisheries in the Bering Sea, which target age 3+ fish (Laevastu et al. 1980; Swartzman and Haar 1983; Livingston 1989). However, numerous subsequent analyses have shown that northern fur seals target and consume both juvenile and adult pollock, where their consumption follows the dominant year class of pollock (McAlister and Perez 1976; Sinclair et al. 1994; McHuron et al. 2020). For example, Sinclair et al. (1994) found mostly age 3+ pollock in GI tracts collected in 1981, age 0 in 1982, and age 1 in 1985, all of which positively correlated with appropriately lagged strong pollock year classes in 1978, 1982, and 1984, respectively. McHuron et al. (2020) also demonstrated that consumption of age 3+ pollock is higher in years of poor pollock recruitment. Thus, we have a more complete and accurate understanding of the importance of controlling for the variation in the timing and location of sampling when attempting to interpret both northern fur seal diet and prey availability. Given the full body of evidence, northern fur seals do not have a preference for age 0–1 pollock, rather they are opportunistic foragers, consuming and switching among prey based on their availability which varies significantly.

Table 2 provides an approximation of large and small pollock consumption by northern fur seals, because the size of pollock consumed were not recorded in the 1960s. It also includes data from northern fur seal stomach analyses including sample size, the average volume of pollock in the stomach, the average number of pollock found in the stomach, and the volume of each individual fish from July and August 1960, 1962, and 1963 prior to the foreign pollock fishery and 1964, 1968, 1973, and 1974 during the foreign pollock fishery. Northern fur seals were consuming large and small pollock both before and during the directed pollock fishery in the same year (Swartzman and Haar 1983), based on the significant shifts in volume per individual (see the last column of Table 2). Whether the shift in 1973 and 1974 to consumption of smaller individual pollock by northern fur seals was a result of strong pollock year class recruitment, fishing, or a combination of both is unclear, but in July 1964 and August 1968, large pollock were clearly being consumed both before and during the directed foreign pollock fishery.

Table 2. Sample size, average volume of pollock per northern fur seal stomach, average number of pollock per northern fur seal stomach, and average individual pollock volume in stomachs of northern fur seals collected in the Bering Sea in July and August 1960, 1962, 1963, 1964, 1968, 1973, and 1974. Adapted from Table 2 in Swartzman and Haar (1983).

Month/Year	No. stomachs containing prey	Avg. volume of pollock per stomach (cm^3)	Avg. number of pollock per stomach	Avg. individual pollock volume (cm^3)
July 1960	152	39,807	403	98.7
August 1960	61	37,124	148	251.0
July 1962	137	4,343	45	96.5
August 1962	277	17,266	323	53.5
July 1963	256	11,188	62	180.5
August 1963	536	9,758	163	59.9
July 1964	97	2,345	7	336.0
August 1964	213	29,296	792	37.0
July 1968	78	31,901	384	83.0
August 1968	53	11,206	30	373.5
July 1973	148	72,427	1418	51.1
August 1973	191	36,564	1305	43.3
July 1974	52	13,658	244	36.0
August 1974	110	15,198	390	38.9

The relationship between northern fur seals, their prey, and commercial fisheries during the 1980s and 1990s was further complicated by incomplete sampling of northern fur seal oceanic habitat. Prey studies and northern fur seal collections were conducted in areas not representative of all the foraging habitat used by northern fur seals from St. Paul and St. George foraging complexes, and subsequently extrapolated to represent the entire population. In addition, the northern fur seal diet data did not account for associated biases that we now understand regarding regurgitation and differential passage of prey remains. Because fish and squid are not distributed equally across shelf, slope, and basin habitats in the Bering Sea, it was recognized that northern fur seals collected predominantly over the continental shelf frequently foraged on different species than seals that foraged primarily over the slope and basin (Kajimura 1984; Sinclair et al. 1994).

In 1985, another assessment of the potential interactions between the pollock fishery, fish predators of pollock, and northern fur seals occurred (Livingston 1989). Livingston (1989) sampled an area thought to be representative of northern fur seals on St. Paul and St. George broadly, yet the prey and northern fur seal sampling sites corresponded primarily to the St. Paul English Bay and Reef Point rookery foraging complexes only (Figure 7). At this time the northern fur seal population segment on St. Paul was stable and the St. George population segment was still declining (Towell et al. 2006), while the commercial pollock fishery was shifting from joint ventures to its contemporary federal management structure under the Magnuson-Stevens Fishery Conservation and Management Act (Ianelli et al. 2023). Northern fur seals and fish biomass were collected simultaneously, but only in one month (August 1985), so northern fur seal sample sizes were significantly smaller (*n*=43) than in previous work (e.g., Swartzman and Haar 1983, Kajimura 1984). The analysis of fish biomass was also limited spatially to a significantly smaller northern fur seal foraging area (Loughlin et al. 1987) than we know exists today (Figure 7; Robson et al. 2004; Kuhn et al. 2014b). Furthermore, fish biomass was not sampled in the areas where northern fur seals were collected in 1981 (*n*=7) and 1982 (*n*=23), on the outer shelf between St. George and Unimak Pass (Sinclair 1988; Sinclair et al. 1994; Sinclair et al. 1996). Thus, it was assumed that northern fur seals were selecting smaller prey in 1981 and 1982 based on 1985 bottom and mid-water trawl data being representative of conditions in 1981 and 1982 (Sinclair et al. 1996). At the time, Sinclair et al. (1994; 1996) assumed their oceanic sampling of prey was representative of all fur seals on the Pribilof Islands, while we now understand that foraging habitat separation by rookery complexes (Robson et al. 2004) would not support such an assumption. Further assumptions about fur seal prey selection and diet from these same studies did not have our current corrections for biases which are inherent in using scats or GI tract (Gudmundson et al. 2006). Thus, this research and its assumptions were appropriate for the time, but today do not provide accurate evaluations of northern fur seal foraging habitats, the importance of prey availability due to strong pollock year class recruitment, and the possibility of competition with the pollock fishery.

Concurrent with northern fur seal diet and fisheries evaluations by the NPFSC, Fowler (1982) argued that the evidence supporting indirect effects of commercial fisheries on northern fur seals was generally lacking. Fowler (1982) concluded that during the growth and expansion of the foreign pollock fishery from 1964–1974, northern fur seal population responses were opposite of the predictions that fisheries were negatively affecting northern fur seals. Northern fur seals experienced higher growth rates, higher pregnancy rates, higher weight at birth, shorter foraging trip durations, heavier pups, and decreased on-land pup mortality from the 1950s to the 1970s on St. Paul Island, while catch of pollock was increasing significantly (Fowler 1982). However, the responses Fowler (1982) observed were also consistent with a density dependent response from the overall reduction of the northern fur seal population from 2.2 million to about 1.3 million by the late 1970s (Fowler 1990; Gerrodette and Demaster 1990; Fowler and Siniff 1992). The maximum net productivity level for the juvenile male harvest was predicted to be 1.3 million fur seals, yet the population continued to decline through the 1970s, and St. Paul Island northern fur seal harvests continued to fail to meet recruitment projections (NPFSC 1984). Thus, the perceived positive linkages between northern fur seals on St. Paul and foreign pollock fishing (Fowler 1982) could have instead been a result of the population reduction of northern fur seals (by approximately 1 million fewer seals) from 1950 to 1980, rather than food limitation due to fisheries catch. Fowler (1982) also did not consider the potential lagged responses by northern fur seal metrics to fisheries, where impacts may not be observed until some time after fishing occurred. That is, fishing activities in the early 1970s impacting non-breeding northern fur seals would not be observed until they reached maturity in the 1980s. In light of re-evaluation of the assumptions and conclusions posited by this historical work, developing quantitative estimates of spatial and temporal variation of fish and squid biomass, necessary to support northern fur seals at their OSP level, is critical to assessing whether changes to fisheries stock assessments or management actions are needed.

Moving forward to contemporary northern fur seal diet and fisheries evaluations, McHuron et al. (2020) developed a bioenergetic model using diet data from fecal samples and regurgitations, sex specific northern fur seal foraging behavior, and energetics to estimate the population level consumption of pollock by northern fur seals from the Pribilofs, as well as consumption of squid, hexagrammids/anoplopomatids, northern smoothtongue, pacific herring, pacific sand lance, and salmonids. Pollock comprised the greatest proportion of prey biomass consumed, and the size of pollock consumed tended to reflect pollock recruitment processes by aligning with the dominant year class, similar to some earlier studies (McAlister and Perez 1976; Sinclair et al. 1994). McHuron et al. (2020) then compared the estimated biomass of pollock consumed by northern fur seals to the pollock biomass consumed by arrowtooth flounder, Pacific cod, and pollock. They found that in five non-consecutive study years, the total biomass of pollock consumed by the Pribilof Islands northern fur seal population was comparable to other predators of pollock (McHuron et al. 2020). In some years, northern fur seals consumed more adult sized pollock, whereas the other fish predators primarily consumed juvenile pollock (Holsman et al. 2020). The diet of northern fur seals breeding in the Bering Sea varies by foraging rookery complex (Zeppelin and Ream 2006), and as discussed previously, the consumption of adult (age 3+) pollock by northern fur seals is not a new phenomenon (Lucas 1899b).

The importance of walleye pollock to the Pribilof Islands northern fur seal population is reflected in their diet, which highlights the need to determine the extent of interactions between commercial fisheries and northern fur seal productivity. The federal pollock fishery total allowable catch (TAC) is divided into roe-bearing (A season, January 20–June 10 annually) and non-roe-bearing (B season, June 10–November 1 annually) quotas. The A season occurs during the northern fur seal winter migration when 4-year-old and older male northern fur seals can occupy the Bering Sea, while the remaining population is generally in the broader North Pacific. The B season is the most likely fishery to interact with northern fur seal on St. Paul and St. George Islands for three reasons. First, current diets of northern fur seals from the Pribilofs collected primarily in August are made up of 40 to 76 percent pollock, estimated from analysis of scats and regurgitations (Gudmundson et al. 2006; Zeppelin and Ream 2006; McHuron et al. 2020).

Second, the B-season pollock fishery (Figure 22) begins at the same time as the arrival of pregnant female and non-breeding male northern fur seals on the Pribilofs (Figure 2). The temporal overlap continues through the first 5 to 12 foraging trips for adult females (females average 8–12 foraging trips within a season), due to the distribution in arrival times for different ages of pregnant females, with the oldest arriving first, typically by the last week of June (Bigg 1986; Gentry and Kooyman 1986). The spatial and temporal overlap is important because adult females are either pregnant or nursing during the entire B-season, thus their energetic demand is high and has implications for survival and productivity. By mid-October, the pollock fishery is typically concluded (Figure 21; Ianelli et al. 2023), while northern fur seals continue to forage in the Bering Sea until December, when a majority of pups are weaned and winter migrations out of the Bering Sea begin. In addition, the oldest adult males abandon their territories in mid-August after fasting for the preceding 2+ months (Gentry 1998) and return to forage in the Bering Sea. Two-year-old and yearling fur seals, (i.e., large numbers of young animals) are entering the Bering Sea and returning to the Pribilof and Bogoslof islands to begin their annual terrestrial period to facilitate molt and begin seasonal foraging trips in September to November. A majority of the northern fur seal population begins their migration by December and adult females as well as all fur seals less than four years old leave the Bering Sea (Kenyon and Wilke 1953; Zeppelin et al. 2019). Since the majority of Pribilof northern fur seal diet data from scats and regurgitations has only been collected in the month of August, the extent of their seasonal diet variation is unknown, but collections in September and October have occurred (NMFS unpublished data). However, seasonality has been observed in pup provisioning female northern fur seal trip durations. Trips tend to get longer as the season progresses, which may indicate seasonal movements in their prey, exploitation of other prey species, greater pup demand for milk, or some combination of all the above (Call et al. 2008; Merrill 2019). Alternatively, female trip duration may be extended due to reduction in prey distribution or availability due to fisheries removals. Additionally, the timing of juvenile male northern fur seals foraging around the Pribilofs coincides with that of adult females and with the pollock fishery (Sterling and Ream 2004; Call and Ream 2012). The data for juvenile male seals indicates that there is competition between juvenile males and adult females where their ranges overlap. Interactions between adult female northern fur seals and the pollock fishery vary significantly over the lactation period. During the end of the lactation period (October to November), catches of pollock are mostly incidental catch while intra-specific competition also increases and continues into the post-fishery season as younger cohorts of fur seals enter the Bering Sea.

Third, the spatial overlap between the B-season pollock fishery and complex-specific foraging habitat of adult female northern fur seals varies by rookery complex, as each rookery complex has, on average, different but overlapping foraging areas (Figure 7). Of the five rookery complexes on the Pribilofs, some have nearly complete spatial overlap with the fishery while others have much lower overlap (Figures 7, 22, and 23; Ianelli et al. 2018). Furthermore, pollock fisheries use space-time closures to reduce bycatch of Chinook salmon that also change the spatial and temporal dynamics of the fishery, resulting in more or less overlap with a specific northern fur seal rookery complex foraging area. An attempt to examine these broad relationships occurred by Short et al. (2021), who accounted for the spatial dynamics of northern fur seal foraging areas and the commercial walleye pollock fleet by creating an overall northern fur seal foraging area polygon derived from 1990s telemetry data and pelagic sealing catch from the turn of the century. Once they defined this northern fur seal foraging area, Short et al. (2021) then estimated pollock catch over time within that area, compared it to modeled St. Paul Island northern fur seal adult and pup survival, and showed the strongest cross-correlation with a 10–12-year lag between pollock catch and pup survival. The limitations to this approach are largely related to using a stock-specific foraging polygon that would have encompassed both St. Paul and St. George, but instead only modeled St. Paul Island adult and pup survival estimated in the 1970s, which varies significantly by both island and rookery complex. In addition, historic St. Paul Island pup and adult survival estimates are unlikely to be representative of St. Paul or St. George Islands in the past two decades.

There is conflicting evidence regarding the interaction of northern fur seals on St. George and St. Paul Islands and the pollock fishery. Some of the highest pollock catches in the past decade have come from areas northwest of St. Paul and southeast of St. George (Divine et al. 2022). Two identified persistent hotspots of pollock catch areas overlap with foraging areas for several rookery complexes, respectively. The pup production trend for the English Bay rookery complex on St. Paul is declining at the fastest rate of any complex over the last decade (Figure 11), and high pollock catch appears (qualitatively) to overlap with confirmed northern fur seal foraging habitat and the strong local community perception of competition between northern fur seals and the fishery (Figure 7, Divine et al. 2022). In contrast, similarly high pollock catch occurs within foraging habitat for both of the rookery complexes on St. George where pup production has been increasing 2.83 percent from 2007–2022, contrary to the 3.13 percent decline in pup production observed on St. Paul over the same period. Short et al. (2021) included both St. Paul and St. George foraging areas in their composite Pribilofs foraging areas, but only analyzed St. Paul pup production data, which may have resulted in false positive correlations. Furthermore, Steller sea lion protection measures implemented in 1992, 1999, 2000, and 2010 also altered the distribution of pollock fishing and changed the relative overlap with different northern fur seal rookery complex foraging areas.

However, to date there has been no analysis of whether fishing has been altered as a result of implementation of protection measures nor how these changes in fishing effort may be impacting northern fur seals from each of the rookery complexes. Recent studies still lack the appropriate temporal and spatial scales for understanding interactions between the northern fur seals and pollock fisheries. A quantitative spatial and temporal analysis of the pollock biomass remaining in the northern fur seal rookery complex foraging areas due to pollock catch management actions implemented since 1992 has not been completed, and should be prioritized as it will provide valuable information about the implications of future fishery management actions. Completing this analysis will be foundational in determining the extent of the interactions between the Bering Sea pollock fishery and northern fur seals.

Baraff and Loughlin (2000) theorized that fisheries may affect northern fur seals through interactive competition, which is consistent with a number of time-lagged correlations between St. Paul northern fur seal pup production trends and pollock fishery catches (Short et al. 2021). Interactive competition may include disruption of normal northern fur seal foraging patterns by the presence and movements of vessels and gear in the water, abandoning foraging areas by northern fur seals because of fishing activities, dispersion of dense prey schools, or an absolute reduction in prey numbers in a manner that reduces the effectiveness of northern fur seal foraging. The general persistence over time of foraging habitat use suggests that northern fur seal foraging during the past two decades has not been so heavily disrupted that consistently used habitats have been completely abandoned. We cannot determine whether any impacts to foraging patterns have occurred; only that there is general persistence of foraging patterns which reflect five foraging complexes. Alternatively, variation in lactating female foraging trip duration may provide evidence of competition over time or location after controlling for changes in prey.

As a similar example, indirect competition was suspected between Steller sea lions and the Atka mackerel fishery, which resulted in significant alteration of the fishery in an attempt to reduce competition and improve Steller sea lion vital rates (NMFS 2010). Trites et al. (2010) examined whether trends in Steller sea lions counts were negatively related to the number of tows (as a measure of the potential to disrupt foraging), the amount of Atka mackerel catch (as a measure of prey depletion), or the average catch per haul (as a measure of Atka mackerel abundance) within 10, 20, and 40 km of Steller sea lion trend sites. Contrary to predictions (NMFS 2010), Steller sea lion counts were not lower at sites that either had a higher number of tows or higher catch of Atka mackerel within 10, 20, and 40 km of the identified Steller sea lion rookeries and haulout sites (Trites et al. 2010). One of the problems with attempting to analyze the relationships between these measures of the Atka mackerel fishery is related to an inability to estimate available Atka mackerel biomass within Steller sea lion foraging areas, which are significantly smaller than the Atka mackerel stock distribution (Trites et al. 2010). A similar challenge is likely present with northern fur seals when examining whether pollock biomass is reduced in the foraging habitat of rookery complexes with different trends. Because the variation in pup production trends among northern fur seal rookery complexes is aligned with their specific foraging areas (Figure 7), the opportunity exists to quantify whether estimates of pollock abundance or catch within each rookery complex foraging area may be contributing to northern fur seal responses for those same complexes.

In response to habitat concerns identified by the Central Bering Sea Fishermen's Association in 1994, the NPFMC proposed Amendment 21a to the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area. Amendment 21a was approved by NMFS, and led to the subsequent creation of the Pribilof Islands Habitat Conservation Area (see Figure 22, PIHCA) as a no-trawl zone defined by, and designed to protect, Pribilof Islands blue king crab (*Paralithodes platypus*) habitat, as well as habitat for marine mammals, seabirds, and other crab species (60 FR 4110, January 20, 1995). The PIHCA extends approximately along the 100-meter depth contour to the west and south of St. Paul and St. George islands, and approximately 50 miles north and west. More recently, NMFS approved Amendment 118 that expanded prohibitions in the PIHCA to include a prohibition on directed fishing for groundfish and fishing for halibut using pot gear; this action was implemented to reduce bycatch and support the rebuilding of the Pribilof Islands blue king crab stock (85 FR 840, January 8, 2020). No specific evaluation or impact analysis of the effectiveness of the PIHCA on northern fur seals has ever been conducted. The PIHCA was implemented to promote blue king crab recovery beginning in 1995, and the fisheries most affected by the trawling closures were bottom trawling fish species that do not occur frequently in northern fur seal diets.

At a similar scale to the PIHCA, Ciannelli et al. (2004) applied an ecosystem model scaled to available predator and prey data for species breeding in the Pribilof Islands region. They applied bioenergetics and foraging theory to characterize the spatial extent of the theoretical Pribilof Islands ecosystem (i.e., the minimum area necessary to sustain the food web of the Pribilof Islands, inclusive of breeding seabirds and marine mammals). They compared energy balance from a food web model relevant to the foraging range of northern fur seals and found that the area of highest energy balance around the Pribilof

Islands extended 100 nautical miles surrounding the islands. The 100 nautical mile radius around the islands represents about 50 percent of the observed foraging range for lactating female northern fur seals, suggesting that northern fur seals depend on areas outside the 100 nautical mile zone modeled and that their model did not include the full suite of data necessary to describe the full range of northern fur seal foraging (Ciannelli et al. 2004) or potential indirect competition by fisheries for fur seal prey.

Debris Background

Marine debris is a persistent and widespread problem that impacts the global ocean in many ways. Marine debris is defined by NOAA as “any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes.” Sources of debris that enter marine ecosystems in Alaska include mostly derelict fishing gear and other fishing-related debris (buoys, bait jars, etc.), but also terrestrial litter, microplastics, and catastrophic loss of nearshore infrastructure (e.g., buildings, vessels, and docks) due to tsunamis and storm erosion (Pichel et al. 2012; NOAA 2013; NOAA 2015; Willis et al. 2017; Whitmire and Van Bloem 2018). This diversity of origin and variability of debris in each marine ecosystem makes prevention and removal difficult to regulate and fund. Marine debris smothers, breaks, and destroys marine and nearshore habitats. Entanglement of marine life in debris can result in a wide range of impacts to marine wildlife, including altered behavior, reduced growth rates, injury, and mortality (Fowler and Ragen 1990; Laist 1997). The Pribilof Islands, being uniquely situated in the middle of the Bering Sea, accumulate a diverse array of marine debris from far-reaching land and ocean sources that continue to threaten northern fur seals and other species that congregate on the islands.

The Pribilof Islands Stewardship Program began with youth beach cleanups in 1994 as a result of consistent observations of net fragments and packing bands entangling fur seals (Ragen et al. 1995). ECO offices on both St. Paul and St. George have since increased their role in response to marine debris by organizing, applying for funding, and leading shoreline debris cleanups. Since 2009, when funding for data collection began, hundreds of thousands of pounds of debris have been removed from Pribilof Island shorelines; the majority of the collected debris consists of fishing-related items, such as nets, line, and associated fishing gear that creates loops posing an entanglement threat to the fur seals when seals are out at sea.

Throughout the time series of fur seal disentanglement efforts and marine debris clean-up activities, the Pribilofs ECO offices and collaborating organizations have tracked and analyzed the types of debris removed from entangled fur seals and collected from coastal habitats (e.g., Zavadil et al. 2007). Continuing these efforts, St. Paul ECO has partnered with NOAA, Tanadgusix Corporation, Central Bering Sea Fishermen’s Association, Aleutian/Pribilof Islands Community Development Association, City of Saint Paul, Aleut International Association, Trident Seafoods, Ocean Conservancy, Net Your Problem, U.S. Coast Guard, and the TCSGI to continue clean-ups and initiate the use of Unmanned

Aircraft Systems (UAS) for aerial surveys to identify, quantify, target debris concentrations, and monitor re-accumulation in various habitat types.

Discussions with fishers suggest that net fragments left on deck after mending can easily be swept overboard when the net is redeployed (Zavadil et al. 2007). The lack of convenient and cost-effective net disposal and recycling facilities in fishing ports indirectly contributes to the problem of entanglement. These observations suggest that educational programs and debris disposal programs in fishing ports could reduce the amount of debris introduced into the sea, and possibly also reduce the rate of entanglement of wildlife in marine debris (e.g., Fowler and Ragen 1990; Arnould and Croxall 1995). In 2020, St. Paul ECO expanded outreach and education efforts to reduce the use and improve the disposal of plastic packing bands on the island, another common source of fur seal entanglements.

Entanglement in Marine Debris

Entanglement of fur seals in marine debris was first observed on the Pribilofs in the 1930s and has been documented ever since (Fowler 1987; Fowler and Ragen 1990; Laist 1997). The North Pacific Fur Seal Commission identified the need to conduct additional research on mortality due to entanglement (NPFSC 1984). Annual reports of the Standing Scientific Committee of the NPFSC reported observations from Russia and the U.S. of the incidence of entangled seals steadily increasing from 1967–1980. In 1985, after the termination of commercial exploitation, entanglement of fur seals was identified as a source of mortality potentially contributing to the observed population declines (USDOC 1985; Trites and Larkin 1989). NMFS scientists, managers, and Unangan continue to observe and respond to fur seals entangled in marine debris. During the 2022 season, St. Paul ECO successfully disentangled 46 of the 49 observed entangled northern fur seals, and in 2023, disentangled 52 (51 on St. Paul, 1 on St. George) out of 55 observed entangled fur seals.

Historically, nets and line were responsible for the majority of marine debris observed entangling northern fur seals that led to injury and mortality (Scordino and Fisher 1983; Fowler and Ragen 1990). Between 2014 and 2020, gear from various trawl fisheries remained the most common source of fur seal entanglement attributable to a specific fishery (Young et al. 2020; Freed et al. 2022). In addition to debris originating from specific fisheries, other types of debris such as ropes, packing bands, plastic bags, rubber bands, plastic tubing, and other items continue to be observed entangling fur seals and are not attributable to a specific fishery (Young et al. 2020, Appendix Table 1 in Freed et al. 2022).

The commercial exploitation of northern fur seals provided a rare opportunity to investigate the incidence of their entanglement in marine debris. During commercial harvest, non-breeding male seals were rounded up from their resting grounds and herded inland, and those estimated to be less than five years old were killed (Roppel 1984; Scheffer et al. 1984). Scientists were able to estimate the incidence of entanglement in marine debris among non-breeding male seals (between 2 and 4 years old) as the ratio of the number of harvested seals that were entangled to the total number harvested. The most common types of entangling debris included net fragments and plastic packing bands (Scordino and Fisher 1983). Scientists continued to mimic this sampling after commercial exploitation ended in 1984 by rounding up and herding non-breeding males inland and subsequently allowing them to escape to the water in a controlled manner (Fowler 1987; Fowler et al. 1992; Fowler et al. 1993). The scientific round-up method allowed scientists to count a sample of fur seals, detect entangled seals, and capture and tag those entangled as well as non-entangled (control sample) seals of similar size that met the previous commercial harvest criteria in order to compare the survival of entangled and non-entangled seals (Fowler and Ragen 1990).

The incidence of juvenile male entanglement increased steadily from 0.15 percent in 1967 to the peak in 1975 of about 0.7 percent (equivalent to 7 entangled seals per 1,000 harvested) (NPFSC 1982). Thereafter, incidence declined to about 0.4 percent and remained consistent through 1984 (Fowler 1987). These studies were modified from 1988–1992 to disentangle seals (Fowler et al. 1993) and evaluate their subsequent rate of survival. The incidence of observed entanglement declined to about 0.3 percent by 1992 (Figure 26; Fowler et al. 1993). Robson et al. (1999) reported no difference between entanglement rates on St. Paul and St. George islands from 1995–1997. Juvenile male entanglement rates remained generally consistent from 1995–2003; however, method changes make definitive comparisons problematic (Williams et al. 2004). Zavadil et al. (2007) estimated juvenile male entanglement rate to be between 0.15 percent and 0.35 percent using two different survey methods. However, they identified biases in the observational method indicating that the scientific round-up method may be a more accurate method to reliably track entanglement rates over time, consistent with the findings of Williams et al. (2004). However, the impact of disturbance to male haul-out areas must be considered, especially since fewer seals are observed on land due to the continued population decline. It is also difficult to reach an adequate sample size using research roundups.

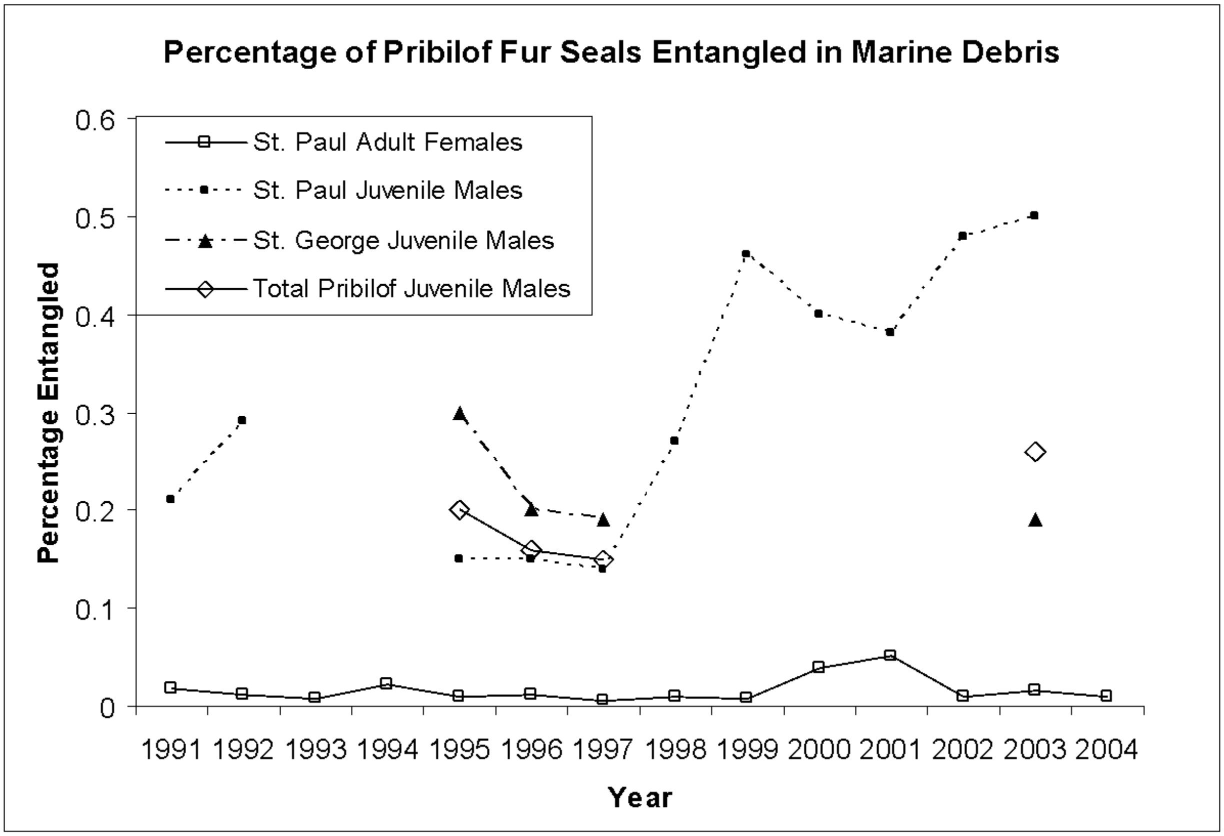

Figure 26. Summary of northern fur seal entanglement on the Pribilof Islands from 1991–2004, from Fowler et al. (1994); Williams et al. (2004); and MML, unpublished data.

Studies conducted during and after the commercial fur seal harvest also yielded information about the nature of entangling debris and its impact on fur seal survival. Historically, the average weight of entangling debris was less than 1kg (Scordino and Fisher 1983; Fowler 1987), which is relatively small compared to the size of the fishing nets used or debris found on Alaska beaches (Merrell Jr. 1980; Merrell 1985; Fowler 1987). About 50 percent of entangled seals that survived more than one year were able to free themselves of debris without intervention. However, if seals remained entangled for more than two years, the debris typically caused a 360 degree wound around their neck (Fowler and Baba 1992). Fowler (2002) found that the annual survival of observed entangled juvenile seals was about half of that of control seals and disentangled seals' annual survival was 7 percent lower than control seals who were never entangled.

Juvenile fur seals of both sexes are more likely than adults to become entangled because the size of their head and neck is similar to the standard stretched mesh sizes of nets used in fisheries (Fowler 1987; Feldcamp et al. 1988). Adult female fur seals may also have a higher probability of becoming entangled in debris than adult males because of their smaller size. Growth rates of both male and female seals are similar until about the fifth year of life, when males increase dramatically in size (York and Kozloff 1987). Females, however, remain smaller and thus continue to be more susceptible to the common mesh sizes of trawl net material for longer. In 1985, DeLong et al. (1988) estimated that between 0.06 percent and 0.23 percent of adult females on select St. Paul rookeries were entangled. A sample of adult females has been counted since 1991 during the counting of adult males on St. Paul to determine the percentage of adult females entangled (Figure 26). From 1991 to 1999, Kiyota and Baba (2001) counted 244,225 females and estimated that the average annual incidence of entangled females was 0.013 percent from 1991–1999 and the incidence of females with scars from previous entanglement was 0.029 percent (Kiyota and Baba 2001). In surveys of female entanglement conducted on St. Paul Island in mid-July from 1991–2006 (during counts of adult males), the rate of entanglement for adult female northern fur seals averaged 0.017 percent (Kiyota and Fowler 1994; Zavadil et al. 2007). Zavadil et al. (2007) estimated an entanglement rate of zero for adult females in July on St. George, which would have been the same period as the estimates of adult female entanglement from Kiyota and Baba (2001). However, monthly surveys that continued into November saw an increased entanglement rate that approached the rate of juvenile males (Zavadil et al. 2007) and was ten times higher than the rates estimated by Kiyota and Baba (2001). The female entanglement rate on St. George Island was 0.13 percent in October, which coincides with the arrival of progressively younger, non-breeding females on the rookery throughout the season (Zavadil et al. 2007). The difference between adult female and juvenile male entanglement may represent a combination of life history differences in the timing of arrival, such as how females arrive later than males of the same age (Bigg 1986), and sampling design not optimal for the detection of similar proportions of the available age classes of males and females.

Studies of pup entanglement have not been consistently implemented or reported. DeLong et al. (1988) conducted surveys of entangled pups and yearlings on St. Paul Island in 1985 from September 11–October 19, and observed a total of 39 entangled pups; however, they did not estimate the rate of entanglement. Zavadil et al. (2007) estimated a 0.07 percent entanglement rate of pups during their surveys at South rookery on St. George in 2005 (9 pups) and 2006 (4 pups). These studies indicate that pups can become entangled in nearshore debris prior to weaning and that systematic surveys until the peak of weaning can better characterize the prevalence of pup entanglement. These studies also suggest that beach clean-up may provide direct benefit for this vulnerable age class. Beach clean-ups were completed annually on St. Paul from 2003 to 2011, then periodically, in 2013, 2017, 2019, and 2022. Clean-ups have occurred intermittently on St. George since 2006.

Results from population trend models suggested that entanglement-related mortality was likely contributing significantly to the fur seal decline observed through 1987 (Trites and Larkin 1989). Modeling by Trites and Larkin (1989) found that a 2–5 percent reduction in adult female survival provided the best model fit to the available pup production trend data. Therefore, entanglement in marine debris was a plausible mechanism for the reduction in adult female survival in the late 1980s. Scientists estimated that entanglement mortality could have been as high as 15 percent for seals from birth to age

3 (Fowler 1985; Fowler 1987; Fowler 2002). However, there are no contemporary data to model the contribution of entanglement to current trends in abundance or survival. There are also no data to verify the assumptions of at-sea entanglement underlying the population level consequences described by Fowler (1985; 1987; 2002).

The relationship between observed entanglement rates on land and total entanglement mortality is difficult to establish. Laist (1997) suggested that while the entanglement rates seen on land are too low to account for the fur seal population decline, the unrecorded number of animals entangled and killed at sea may be a potentially significant factor. The on land entanglement rate observed is less than one percent annually (Figure 26) for juvenile (2–4-year-old) male seals that are observed on the Pribilof Islands. Observations of fur seal entanglement at sea are limited; the actual extent and significance of entanglement at sea is unknown (Fowler 1987; 2002), but incidental observations of multiple fur seals entangled in large nets do occur (Oregon stranding network correspondence, April 2009).

In 2011, NMFS standardized reporting of fur seal entanglement information from the regional and national Marine Mammal Stranding Networks for inclusion into the stock assessment process and annual stock assessment reports. The Eastern Pacific stock of northern fur seals occurs off the west coast of the continental U.S. in winter and spring and intermixes with the California stock, making them indistinguishable during this period. For this reason, any mortality or serious injury of northern fur seals reported from Washington, Oregon, or California during December through May is assigned to both the Eastern Pacific and California stocks of northern fur seals. Reports to the NMFS marine mammal stranding network from 2015–2019 indicated a minimum mean annual mortality and serious injury rate of seven northern fur seals from entanglement in marine debris and six from commercial and unknown fisheries combined (Muto et al. 2022). These rates do not include northern fur seals who have been disentangled from marine debris. The mortality and serious injury estimate is only from verified human-caused deaths and serious injuries. However, not all entangled animals strand nor are all stranded animals found, reported, or have the cause of death determined; thus, we expect that the actual number is much higher. From 2016–2020, 86 out of the 110 human-caused mortality and injury reports for northern fur seals were due to constricting neck entanglements from marine debris and fishing gear (Freed et al. 2022).

Entanglement in marine debris has behavioral and physiological effects on northern fur seals that lead to reduced survival. Research comparing the foraging trips and diving of entangled and control seals showed that entangled juvenile male fur seals had longer feeding cycles and reduced diving depths, making longer and shallower dives (Bengtson et al. 1989). Entanglement of female fur seals directly affects their dependent pups, causing significantly lower percent weight gain, weight at weaning, and survival compared to pups with debris-free mothers (DeLong et al. 1988). Additionally, entangled lactating females have been observed spending more time at sea feeding than non-entangled females, or do not return to the rookeries at all (DeLong et al. 1988).

Despite decades of research and response presented here, juvenile fur seals on land continue to be observed entangled in debris less than 1 kg, even though composition of beach cast debris continues to consist of pieces significantly larger than 1 kg. The lack of observations of fur seals entangled in large debris on land suggests that it rarely occurs, animals escape large entanglements before returning to land, or fur seals that cannot return to land suffer high mortality at sea. Studies of younger age classes of female fur seals suggest a similar prevalence of entanglement in small debris to that observed for juvenile males (Zavadil et al. 2007). We are unable to estimate at-sea entanglement of northern fur seals in large debris to fill this significant gap in our understanding of the actual consequences of entanglement. However, disentangling fur seals continues to improve survival of younger age classes, allows the opportunity to understand changes in the types and sources of debris, and helps identify effective prevention strategies. Disentanglement programs such as ACSPI ECO's will therefore continue to be an important component of fur seal conservation in the future.

Human Presence and Research

The two biggest islands in the Pribilof Archipelago, St. Paul and St. George, each support a small community and associated airports, harbors, and other infrastructure. Residents on the islands regularly engage in recreation and subsistence activities in the coastal areas, such as beachcombing, hunting, and fishing. Additionally, researchers and tourists visit the islands, and all of this human activity near the rookeries and hauling grounds has the potential to disturb or harass northern fur seals.

When fur seals are disturbed on land, they may react by fleeing to the water and can be cautious about returning to land and settling back into their natural resting and nursing behaviors (Ream and Sterling 2019). Studies have shown that fur seals are more reluctant to leave their rookeries and tolerate disturbances during the height of breeding season (Gentry 1998). Prior to the arrival of adult females, Gentry (1998) drove all territorial males from the breeding areas of two different rookeries. About 80 percent of males reoccupied their former sites within 7 hours and with fewer aggressive interactions than during the initial formation of their territory. Human disturbance near the rookeries can cause lactating fur seals to depart and separate from their pups, but they often return within a few hours after the disturbance has ceased. In order to approximate the effects of disturbance where adult females were displaced from the rookery, Gentry (1998) withheld pups from their mothers for up to eight hours. Adult females extended their onshore visits for durations of time equivalent to the withholding periods of their pups. If a pup was withheld for 3 hours, its mother would extend her on shore duration for 3 hours. The results of these experiments indicated that adult females have the capacity to compensate for disturbance events that lasted up to eight hours and still provide adequate suckling time for their pups (Gentry 1998). Juvenile males are less tolerant of human presence in the resting areas and are easily displaced from hauling grounds. Juvenile males were displaced repeatedly during the commercial exploitation for pelts on St. Paul, but no evidence of movement of juvenile male seals to St. George where the commercial harvest was prohibited in 1972 to avoid this disturbance was detected (Gentry 1998).

In a recent study on St. George Island, adult females did not show differences in trip duration, onshore duration, movement to an alternative site, or mean date of departure for winter migration due to human disturbance between disturbed (experimental) versus non-disturbed (control) study sites (Ream and Sterling 2019). For pups, movement to an alternative site and mean date of departure for winter migration were also unaffected by human disturbance (Ream and Sterling 2019). However, the mean duration spent during bouts in the water was shorter and the overall onshore duration was marginally shorter for pups at the experimental site. Merrill (2019) also found no differences in adult female foraging trip duration, onshore duration, or time of departure for winter migration between disturbed (harvest sites) and undisturbed (non-harvested sites) when trying to detect effects from the pup harvest on St. George Island from 2016 through 2018. NMFS has previously acknowledged concerns about the possible effects of repeated disturbance from subsistence use; however, studies and expert observations to date indicate that it is unlikely that disturbance events from subsistence use on the Pribilofs have an impact on population dynamics or recovery (NMFS 2019; 50 CFR part 216; Divine et al. 2022).

Studies suggest that some research activities have detectable effects on fur seals. Previous research on fur seal instrumentation and tag application and accompanying findings have resulted in significant alteration to procedures for attaching instruments and efforts to reduce the mass and drag from tag and instrumentation, thus reducing impact to the instrumented or tagged animal. Lactating female fur seals on a rookery were instrumented with various tag types (e.g., VHF, TDR, Critter Cams, etc.) and females equipped with tags that have a medium-sized frontal surface area experienced a 6 percent decrease in dive duration, a 9 percent increase in descent rates, and a 15 percent increase in ascent rates as compared to fur seals fitted with tags that had a smaller frontal surface area (Skinner et al. 2012). Other foraging behaviors like foraging trip duration, shore visits, and proportion of time spent diving were not affected by the instrument size (Skinner et al. 2012). In captive fur seals, tags have been shown to significantly affect behavior and energetics (Rosen et al. 2018). Rosen et al. (2018) found that depending on tag type, on average, metabolic rate increased 8.1–12.3 percent and swim speed decreased 3.0–6.0 percent. The combination of these two changes resulted in a 12.0–19.0 percent increase in total energy required to swim a set distance when instrumented with a relatively small tag as compared to untagged fur seals (Rosen et al. 2018). Instrumentation provides important information about behavior, life history, foraging, etc. that currently cannot be acquired by other means. However, researchers should work to balance the potential negative impacts with acquiring valuable data and consider these impacts when interpreting data from tagged animals (Rosen et al. 2018).

Some researchers have suggested that the abandonment of the Lagoon rookery on St. Paul in the late 1940s may have been caused by increased human activities (including the operation of a fur seal by-products processing plant) and by hunting pressure from residents of the village of St. Paul (Johnson et al. 1989). Little Eastern rookery, near the village of St. George, was abandoned by about 1914; however, the eastern portion of North rookery is closer to the village and remained active (Gentry 1998). Ream et al. (1994) suggested that rookeries with road access had higher rates of decline than those without road access. Similar analyses may provide insight into the effects of different levels of human presence at fur seal rookeries and hauling grounds.

Regulation prohibits unauthorized human access to fur seal rookeries and hauling grounds from June 1 until October 15 (50 CFR 216.81). After October 15, tourists and beachcombers can unknowingly displace juvenile male and female fur seals and lactating adult females and their dependent young by entering fur seal rookeries and hauling grounds. The human access closure dates for the rookeries and hauling grounds do not guarantee that fur seals will be absent, but reduce the risk of major disturbance by minimizing human presence during peak fur seal occupancy. Consistent with the ESA and MMPA, Steller sea lions can be taken for subsistence (50 CFR 216.23). Steller sea lion subsistence hunting near fur seal habitat introduces another source of potential human-caused disturbance that is co-managed by NMFS, ACSPI, and TCSGI. The Co-Management Plan for St. Paul Island identifies Sea Lion Neck as an important Steller sea lion subsistence area within the Morjovi rookery and hauling grounds (Figure 4) and prohibits access to this area for sea lion hunting before September 1. Subsistence use of both Steller sea lions and northern fur seals is now co-managed within the framework established under the co-management agreements signed between NMFS, ACSPI, and TCSGI, and the Co-Management Plan between ACSPI and NMFS for St. Paul.

Research projects that have the potential to disturb or harass fur seals are required under the MMPA to obtain a permit from NMFS. NMFS must receive and review an application prior to issuance of a permit authorizing fur seal research and any associated incidental or directed fur seal harassment. All current and previous research permits are available on the NMFS website[12]. Both ACSPI and TCSGI have maintained research permits authorizing 1) entanglement response, 2) sample collection from dead animals and sample export, 3) UAS, and 4) hauling ground and rookery observations, monitoring, and remote camera maintenance.

St. Paul ECO initiated a research project in 2022 to monitor responses of lactating female fur seals to disturbance by human presence. They are coordinating with subsistence users, authorized tour operators, and permitted researchers to use the Indigenous Sentinels Network application developed by ECO to record times present on or near fur seal rookeries at Northeast Point on St. Paul. They have also placed 119 VHF flipper tags on adult females in 2022–2023, allowing them to monitor their movements. This five-year study aims to pair these data on human presence with the VHF data to better understand female fur seal responses to disturbance and will conclude in 2027.

[12]Available on the NMFS website, Authorizations and Permits for Protected Species at https://apps.nmfs.noaa.gov/, Accessed January 13, 2023.

Research improves understanding of species that can be used for conservation, recovery, and better management of populations. Based on the 2007 Programmatic Environmental Impact Statement regarding fur seal research, long-term effects are not anticipated due to the low frequency of resulting mortality and disturbance (NMFS 2007b). NMFS (2007b) evaluated the effects of scientific research and under the preferred alternative estimated mortality to be negligible (i.e., less than 10 percent of PBR). Regarding human disturbance from other activities, regulatory closures help to minimize harassment, therefore, effects from human presence and research are considered negligible to minor at a population level. As data from sources such as St. Paul ECO's VHF study are further analyzed and we continue to better understand fur seal responses to disturbances, ACSPI, TCSGI, and NMFS will continue work together as co-managers to determine whether current management measures relating to disturbance are adequate, and if not, how they can be improved in a way that reflects our collective scientific understanding.

Construction Activities and Noise

Construction projects are important for economic and community stability for the Pribilof Islands. Projects include small boat harbor construction, airport upgrades, enhancing dock facilities, and repairs to the breakwater and seafood processing plants. NMFS issues MMPA authorizations for incidental take (typically harassment) of fur seals resulting from construction and development projects.[13] Activities associated with development projects can include pile driving, fill placement, vessel activity, and building construction. These activities have the potential to create stress (physical, chemical, or biological) that can have adverse effects on fur seals including acoustic disturbance (in-air or in-water noise), physical or visual disturbance, and habitat alteration.

Acoustic, visual, and physical disturbance can be caused by construction activity and noise. Fur seals depend on acoustic cues for vital biological functions (e.g., mother-young interactions, breeding, finding prey, avoiding predators). The sound emitted from construction activities can be loud enough to interfere with these functions. Possible impacts include disturbance ranging from vigilant behavior, masking of species-relevant sounds, avoidance or abandonment of vital habitat, and physical injury to auditory apparatus. If construction activities, such as dredging, occur in or near pinniped rookeries, masking of biologically important noises could decrease reproduction potential (Todd et al. 2015). Visual disturbance from construction activities could potentially lead to displacement or increased stress levels from the presence of humans. Physical disturbance includes direct contact with construction equipment or being entangled in gear that may result in injury. Disturbance from construction projects can also cause stampedes of distressed fur seals, leading to injury or crushing of smaller individuals.

[13]NOAA Fisheries, Incidental Take Authorizations Under the Marine Mammal Protection Act, Available at https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act, accessed March 17, 2023.

Construction projects include building new infrastructure or maintaining or replacing existing infrastructure, resulting in different degrees of habitat alteration. Habitat alteration can have temporary effects such as increased sedimentation and turbidity, or long-term impacts, including habitat loss. Changes to habitat may also have indirect effects on the survival and availability of prey species and may even exclude prey from foraging areas due to construction activities (e.g., dredging, Todd et al. 2015).

Little research has been done on the effects of construction activities on northern fur seals. However, previous construction projects on St. George and St. Paul islands have shown it is possible to minimize effects to northern fur seals by implementing mitigation measures to reduce exposure of the animals to loud sounds and visual disturbance. Conducting projects when fur seals are not present, or are at a distance, will minimize impacts. Gentry et al. (1990) concluded that non-breeding fur seals on St. George Island did not avoid prolonged, airborne construction sounds (85 dB re 20 μPa peak source level). Additionally, fur seals did not avoid ground vibrations from heavy equipment working within 100 m, and showed no response to subterranean blasts 0.6 to 2 km away (75 dB re 20 μPa at 50 m from the source) or to heavy construction 500 m away (Gentry et al. 1990). No external response was detected in fur seals (either by changing behavior or orienting towards the source or water) to upland blasting approximately 1 km from a resting area at Zapadni Rookery. Due to wind conditions, however, the blast was not distinctly audible to the observer at the hauling grounds near the seals (M.T. Williams pers. obs. Aug. 1996).

More recent construction on the Pribilofs includes the St. Paul Small Boat Harbor in 2010, Reef rookery observation tower and walkway construction in 2010, Zapadni Reef blind construction in 2012, the 2015 Tribal Government Dock project, and the Federal Emergency Management Administration emergency repairs to breakwaters for the St. George Harbor in 2016. Standard mitigation for harbor construction projects includes avoiding seasons when northern fur seals or other marine mammals may be present in the harbor, the installation of temporary fencing, and the use of visual deterrents or air streamers to prevent fur seals from hauling out in or near construction zones. In addition, protected species observers from the local Tribal Governments are hired to monitor nearshore areas to prevent fur seal exposures to construction activities.

From January through May 2010, heavy equipment, generators, and hand-held power tools were operated at Reef rookery on St. Paul Island to replace and repair fur seal observation towers and walkways. No fur seals were present at Reef rookery during the majority of construction activities from January through April. During the final construction and inspections, 52 male fur seals were harassed on land and departed to the water due to the presence of construction and monitoring staff. Construction may have delayed the onshore arrival by 4–19 days in sections of the rookery where construction was taking place when compared to areas of the rookery where no construction was occurring (Williams et al. 2011). Since work was finished by May 19, no females or pups were harassed during this construction. Williams et al. (2011) concluded that there were no population-level or long-term consequences for the fur seal population from the construction work completed at Reef rookery in 2010. Zapadni Reef, another rookery on St. Paul Island, underwent similar construction from April to May 2012. The construction footprint at Zapadni Reef was relatively small, duration of the project was short, and construction was finished before fur seal arrival, resulting in low likelihood that there were direct impacts on the fur seal population. A dock was constructed in Village Cove Boat Harbor on St. Paul Island in April of 2015. In-water pile driving with vibratory and impact hammers were required for the construction project. The Indigenous Sentinels Network monitored the project area during pile driving activities. No marine mammals were observed within the monitoring zone in the harbor during the construction period, potentially because the work was completed before fur seals arrived.

The effects of construction activities on northern fur seals will vary greatly depending on the scope and timing of the construction project. While construction activities may disturb seals or modify habitat, measures can be adopted that greatly reduce the likelihood of significant or long-lasting effects. Conducting construction activities when fur seals are not present is the best way to avoid harassment. To prevent habitat loss, a top priority should be to avoid permanent modifications to rookery and hauling ground locations.

Oil and Gas

Northern fur seals rely on the water-repellent quality of their fur rather than a thick layer of blubber to provide insulation from the cold temperatures of the Bering Sea and North Pacific Ocean. For this reason, fur seals are particularly vulnerable to oil exposure. Oiling of their fur diminishes the insulating capacity and can result in death from hypothermia (Kooyman et al. 1976; Ziccardi et al. 2015). Other impacts of direct exposure to hydrocarbons in pinnipeds include injury to the skin, eyes, and mucous membranes (Wright et al. 2022). In addition to effects of external oiling, inhalation of petroleum product vapors may result in increased levels of toxic hydrocarbon volatiles in blood and tissues of northern fur seals (Spraker et al. 1994; Schwacke et al. 2014). The toxic effect of inhalation may be lethal, particularly during the first few hours of a spill when volatile fractions are released, or for significant spills of refined products (i.e., gasoline or diesel fuel), which contain higher percentages of these compounds. Possible effects include lethargy, sickness, and destruction of the central nervous system and respiratory system (Ziccardi et al. 2015). Ingestion of oil via grooming of oiled pelage, or indirectly through consumption of oiled prey, may also have deleterious effects via absorption into the blood that would be expected to affect internal organs (Helm et al. 2015; Ziccardi et al. 2015). Ingestion of oil can cause nausea, gastrointestinal tract irritation, and vomiting. Vomiting can result in aspirating oil into the lungs, leading to respiratory impacts (Takeshita et al. 2017).

Population level oil impacts would likely be seen if an oil spill was to occur near a rookery during breeding season (Helm et al. 2015). Northern fur seals concentrate on the breeding grounds from June to December on the Pribilofs (Gentry 1998) and Bogoslof Island (Kuhn et al. 2014a). Adult females and subadult males frequently return to the sea to forage during this period (Gentry 1998; Sterling and Ream 2004; Call et al. 2008; Jeanniard-du-Dot et al. 2017), which would increase exposure to floating oil released by a spill. By early September, breeding males abandon their breeding sites and enter the water to forage (Bartholomew and Hoel 1953). During the breeding and pupping season, pups often congregate in tidal pools and shallow nearshore waters where oil can become trapped or concentrated. By November, pups regularly enter the water after weaning to forage and begin their winter migration (Gentry 1998; Lea et al. 2009). During the southward winter migration (e.g., British Columbia, Washington, Oregon, and California), fur seals may also be at risk of exposure to oil spills (Jarvela Rosenberger et al. 2017).

Mathematical models have been developed to predict fur seal mortality from hypothetical spills (Reed and French 1989). Two simulation scenarios, both of a 10,000 barrel spill, were modeled to predict the effects of a potential oil spill in the Bering Sea. One spill scenario was modeled in Unimak Pass in spring during peak migration of fur seals to the Pribilof rookeries, and the second scenario was modeled near St. Paul Island in July during the height of pupping season. In both scenarios, a 10,000 barrel Prudhoe Bay crude oil spill is simulated for 10 days and the northern fur seal population is set at 1.16 million fur seals. The Unimak Pass scenario resulted in fouling of 0.05 percent of the males and 2.9 percent of the females in the population (Reed and French 1989). The St. Paul Island spill scenario fouled 3.2–4.6 percent of the males and 2.1–3.7 percent of the females depending on the assumption that all fur seals on Gorbatch and Ardiguen rookeries would be oiled in the model if oil reached the shoreline (Reed and French 1989). The St. Paul scenario predicted fur seal mortality ranging from 3,562–30,724 fur seals depending on the mortality rate once a fur seal was oiled and whether rookeries on the island were oiled (Reed and French 1989). The two modeled scenarios resulted in population reductions of up to 4 percent of the population during the year of the spill (Reed and French 1989).

An oil spill in February 1997 provided empirical data on the impacts of such an event on fur seals. Approximately 5,000 South American fur seal (*Arctocephalus australis*) pups are known to have died as a result of a 1.5 million gallon crude oil spill (approximately 35,700 barrels) off the coast of Uruguay (Mearns et al. 1999). The spill occurred during the peak of the pupping season, and pups became oiled as the oil reached the beaches of the breeding colony.

From 1979–1996, 14 oil spills, primarily diesel fuel, were reported near the Pribilof Islands (Whitney and Yender 1997). The largest spills were approximately 40,000 gallons in November 1979, 15,000 gallons in March 1987, and 25,000 gallons in March 1990. Most of the spills occurred from February through March and no spills occurred from June through September.

From 1995–2021,120 oil spills were reported near the Pribilof Islands (41 of which were vessel-based spills), according to the Alaska Department of Environmental Conservation

(ADEC).[14] The 120 spills include petroleum and non-petroleum (synthetic) oil spills. The largest spill in the Pribilofs during this time period occurred in 2017 when a fishing vessel sank near St. George Island. The capsized vessel released 35,456 gallons of diesel into the marine environment, none of which was recovered.[14] During the same time period (1995–2021), 1,079 spills were reported in the eastern Aleutian Islands, 499 of which were vessel-based.[14] Due to the subjective nature of the reporting of the location of spills and the nearby rookeries on Bogoslof Island, spills in the eastern Aleutians are important to consider for possible impacts to northern fur seals. The 3 largest of the eastern Aleutian Island spills from 1995–2021 were 39,000 gallons in November 1997, 321,052 gallons in December 2004, and 145,000 gallons in March 2008. If these spills had occurred during spring or fall during fur seal migration, they could have significantly impacted fur seals migrating through Aleutian Islands passes. The number of seals affected by an oil spill in an Aleutian Island pass would depend on the amount and type of spill, the location, and the time of year (French et al. 1989).

Northern fur seals range into the North Aleutian Basin (NAB) planning area, which has been of interest to the oil and gas industry for exploration and development. In 1988, BOEM issued 23 leases that were followed by litigation and resolution resulting in the relinquishment of the leases in 1995. The original BOEM 2007–2012 oil and gas leasing program proposed one lease sale for the NAB; however, BOEM removed the NAB from its revised 2007–2012 leasing program. In 2014, by Presidential memorandum, the NAB was withdrawn from leasing for a time period without expiration, a withdrawal that prevents consideration of the NAB for any oil and gas leasing for purposes of exploration, development, or production. BOEM has identified that the NAB leases are unavailable in the 2023–2028 leasing program. In addition, the Northern Bering Sea Climate Resilience Area (NBSCRA) was also identified as unavailable for leasing in the 2023–2028 leasing program due to its withdrawal from leasing by Executive Order 13990 (which reinstated the original withdrawal in 2016) (86 FR 7037, January 20, 2021). This withdrawal prevents consideration of these areas for future oil or gas leasing for purposes of exploration, development, or production in the area defined as the NBSCRA in E.O. 13754 (81 FR 90669, December 9, 2016).

Contingency plans to deal with unexpected oil spills from tankers enroute to West Coast refineries or from spills in the Aleutian Islands passes will be difficult to implement because of the large area involved and remoteness of this region. In the event of a spill in which oil approaches or contacts a fur seal rookery, clean-up efforts may be conducted in nearshore and offshore regions. Disturbance to northern fur seals may result from the presence of oil-spill response workers and associated aircraft, vessel, and ground support vehicles, leading to immediate departure of fur seals from the area. Prolonged or intense disturbance could result in abandonment of the site. Harassment of breeding fur seals from oil response activities on the rookeries could result in increased mortality of fur seal

[14] ADEC. Online database of PPR Spills Database Search. Available at https://dec.alaska.gov/applications/spar/publicmvc/perp/spillsearch. Accessed March 2022.

pups due to disrupted nursing, early weaning, or crushing due to stampedes of frightened animals. Consideration of the impacts of harassment must be balanced with the need to remove oil from the shoreline.

NMFS coordinates with the U.S. Coast Guard, USFWS, ADFG, ECO, and other agency and stakeholder partners to revise and update the Pribilof Islands Wildlife Protection Guidelines.[15] Those guidelines provide recommendations to responders (including primary strategies of keeping spilled oil away from wildlife and their habitats, secondary strategies of keeping wildlife away from spills, and tertiary strategies of responding to impacted wildlife), lists of response resources and expertise, documentation and planning forms and templates, and flow charts for response actions and decisions. The probability of a spill occurring and impacting fur seals can be decreased by managing exploration, production, and transportation activities to avoid vulnerable northern fur seal habitat both spatially and temporally. Prevention of oil spills is the best way to avoid impacts from this human related threat. The remoteness of the Pribilof Islands and other fur seal rookery sites demands on-site preparedness. NMFS has purchased and stockpiled natural fiber-based oil absorbent material on St. Paul Island in preparation for a response. NMFS will continue to pursue effective strategies for mitigating impacts of an oil spill on the Pribilof Islands as a means to conserve the northern fur seal.

Aircraft Noise and Overflights

Helicopters and fixed-wing aircraft generate significant noise from their engines, airframe, and propellers and can disturb fur seals with the noise or physical presence of low-flying aircraft. Observations made from low-altitude aerial surveys report highly variable behavioral responses from pinnipeds ranging from no observable reaction to diving or rapid changes in swimming speed/direction (Efroymson and Suter 2001). In general, it is difficult to determine if behavioral reactions are due to aircraft noise, the physical presence and visual cues associated with aircraft, or a combination of those factors (Richardson et al. 1995). It is also possible that aircraft activity can adversely affect fur seals because the sound masks fur seal vocalizations on land (Insley 1993). Masking prevents animals from hearing sounds necessary for survival and reproduction. In addition, wildlife species do not always exhibit clear externally visible behavioral responses to anthropogenic disturbance, but do demonstrate significantly increased heart rate or other internal physiological responses (MacArthur et al. 1979; Ditmer et al. 2015; Wascher et al. 2022).

The biggest concern of low overflights of fur seal hauling grounds and rookeries is disturbances resulting in stampedes. In 1981, a large twin-engine aircraft passed approximately 300–500 feet over the Gorbatch hauling ground on St. Paul Island and caused a large stampede of bachelor bulls into the water, whereas a large twin-engine

[15] Available on NOAA Fisheries Alaska Oil Spill Response Guidelines webpage at https://www.fisheries.noaa.gov/alaska/marine-life-distress/alaska-oil-spill-response-guidance, Accessed December 15, 2022.

cargo plane passing at low altitude over a group of sleeping sub-adult male fur seals at a hauling ground adjacent to East Rookery on St. George Island caused little disturbance other than some seals lifting their heads (Johnson et al. 1989).

Activity levels of juvenile males near the old and new airports on St. George Island were higher for approximately five minutes following aircraft overflights (Williams 1997). However, no evidence was found for population-level effects (e.g., reduction in pup production, pup health indices, or shifts in the distribution of the breeding population) on fur seals during the peak of aircraft overflights on the southern breeding areas on St. George in 1993 and 1994 (Williams 1997). The potential for fur seals to habituate to aircraft disturbance has not been studied in detail, and researchers found that subtle habituation may have occurred on St. George in 1994 (Williams 1997).

Drones or UAS also have the potential to negatively impact northern fur seals (Thirtyacre et al. 2021). Because the distance at which UAS could disturb fur seals physiologically or behaviorally may vary by sex, age class, time of year, location, group size, or other factors, NMFS recommends that researchers or emergency responders coordinate with NMFS for authorization and consideration of mitigation measures for UAS flights within 1,000 feet of fur seals.

The noise and physical presence of aircraft can harass fur seals, and attempts to manage and mitigate aircraft harassment to fur seals have included the establishment of Aircraft Advisory Zones and Requested Aircraft Flight Paths. These have reduced overflights of fur seal rookeries on St. George and St. Paul islands, including the Polovina Complex. Aircraft noise may disturb seals; however, previous studies have not found evidence of significant population-level effects due to noise, perhaps due to the implementation of these mitigating factors.

Vessel Activity and Noise

Vessel activity around the Pribilof Islands is primarily associated with commercial fishing for halibut and subsistence activities. Crab fishing vessels deliver crab for processing on St. Paul Island (there has been no crab processing on St. George since crab rationalization in early 2000s), and vessels pick up crab pots that are stored at upland lease sites on St. Paul and St. George. The majority of crab fisheries do not occur during the fur seal breeding season on the islands, with the exception of the golden king crab season, which generally occurs in October and November depending on the quotas established by the NPFMC. Vessel-based tourism around the Pribilof Islands generally includes fewer than four vessel visits per year, largely as a result of restrictions on harbor and docking provisions due to the Jones Act. Construction activities may be supported with a few contracted barges during the project period, but otherwise a barge goes to St. Paul about once every 4–6 weeks to deliver groceries and supplies as well as once or twice per year to deliver fuel. There are no ferries operating in the Pribilofs. Research vessel activity in the Pribilofs is generally limited to few annual visits from NOAA hydrographic or fisheries research vessels and USFWS Alaska Maritime National Wildlife

Refuge research vessel, RV *Tiĝlax̂*. Due to the active volcanic activity at Bogoslof Island and its designation as a Steller sea lion rookery no transit zone (50 CFR 224.103(d)), there is generally no regular nearshore vessel traffic near Bogoslof Island. Research vessels are the only source of nearshore vessel traffic on Bogoslof.

If fur seals are exposed to vessel noise and presence, they may deflect away from the noise source, engage in avoidance behavior, exhibit alert or vigilance behavior, or experience and respond to acoustic masking (the inhibition of the biological use of sound). At low levels (i.e., few vessels and short duration activities) these disturbances are not likely to result in significant disruption of normal behavioral patterns. Any nearshore vessel activity in the Pribilof or Bogoslof islands would be moving at slow speeds to maneuver safely or enter or exit the harbor and would avoid rapid changes in direction, limit propeller cavitation (as it reduces maneuverability), and airborne engine noise would likely be tolerated as it is strongly attenuated by wind.

There are no reports of northern fur seals being struck by vessels or reports of stranded fur seals with injuries consistent with a vessel strike; however, vessel strikes of fur seals have been documented elsewhere. For example, Byard et al. (2012) reported an Australian fur seal mortality due to injuries consistent with a vessel strike to the abdomen. The juvenile male fur seal was observed regularly in a small boat harbor near the docks prior to the observed injury and subsequent mortality (Byard et al. 2012). Many other pinnipeds (primarily phocids, see Olson et al. 2021) are reported to be struck by vessels, however limited population level consequences are reported. NMFS inspected thousands of northern fur seals skins annually for scarring during the commercial harvest of fur seals (see Commercial Exploitation). These skin inspections resulted in the identifications of lesions and scars indicative of previous entanglements (Scordino and Fisher 1983). Scarring reduces the value of skins and therefore it is suspected that if there were scars indicative of vessel strikes that those would have been detected and reported similarly through 1984. In addition, Spraker and Lander (2010) examined causes of mortality among adult females and pups from 1986–2006 and found no lesions or injuries consistent with vessel strikes; therefore, we conclude vessel strikes are unlikely to be a significant threat for northern fur seals.

Vessel activity near hauling grounds and rookeries is likely a greater concern for disturbance of northern fur seals than at-sea encounters where fur seals can dive to avoid the disturbance. However, it appears that the terrain and water depth adjacent to northern fur seal rookeries and hauling grounds prevents the close approach of most vessels other than small (less than 10 meter) inflatables. The site tenacity and territoriality exhibited by northern fur seals is greater than other species of pinnipeds and other fur seals (Gentry 1998), and these behavioral traits reduce the likelihood of overt escape responses from land during the breeding season as noted in other fur seal species (Cowling et al. 2015; Back et al. 2018). During the breeding season, adult males tenaciously hold and defend territories for breeding females from intrusion by other male fur seals and humans (Gentry 1998). Adult females and pups may orient towards human disturbance but their response is mediated by adult male's territorial defense behavior. More than 100 years of disruptions of non-breeding northern fur seals on their haul outs due to commercial exploitation has not resulted in abandonment of these traditional sites (Gentry 1998), so while there are individual energetic costs to short-term displacement and disruption of non-breeding fur seals sites, it does not appear that northern fur seals are susceptible to long-term consequences from short-term disturbance. Disturbance at land-based sites can result in significant disruptions, particularly when and where large territorial males can crush pups in their efforts to escape to the water.

Although there is likely considerable variability in pinniped response to vessels at hauling grounds (within and between species), an assessment showed that Australian fur seals' alert behavior increased due to vessel traffic but varied depending on the vessel type, number of vessels, and distance (Speakman et al. 2020). Examination of harbor seals at 3 hauling grounds in Puget Sound, Washington, found that seals exhibited external behavioral responses to recreational vessels at distances as great as 800 m (Cates and Acevedo-Gutiérrez 2017). The variables that most affected the likelihood of a flushing response in harbor seals were 1) frequency (number of boats per hour), 2) vessel type, 3) vessel speed, and an interaction of those three variables (Cates and Acevedo-Gutiérrez 2017). Similarly, in a glacial fjord in Alaska, displacement of harbor seals off of their calved ice platforms was dependent on the ship route (Jansen et al. 2015).

Tour vessel activity near northern fur seal rookeries on St. Paul Island in 2016 resulted in large scale unauthorized incidental take by harassment. Several small boats from a cruise ship company carried tourists within 10 meters of a northern fur seal breeding area, harassing the seals and changing their normal behavioral patterns. The NOAA Office of Law Enforcement took action and fined the company for harassment of the fur seals (prohibited under the MMPA). In addition, the regulations at 50 CFR 216.81 prohibit the unauthorized approach of any rookery or hauling ground on the Pribilof Islands from June 1 to October 15, and NMFS is considering the utility of marine geo-fencing (monitoring of vessel activity using Automatic Identification System) to assist the public to comply with these management measures to conserve northern fur seals. Responsible wildlife viewing is important for all marine mammals (see Alaska Marine Mammal Viewing Guidelines and Regulations[16] for more information) but is especially important near northern fur seal rookeries to ensure breeding and pup rearing are not disturbed. Tour operators must ensure they understand and avoid the negative impacts their potentially illegal activities can cause, and NMFS and other stakeholders should conduct more outreach to increase public understanding of this threat.

Vessel activity near the Pribilof Islands also results in accidental vessel groundings and shipwrecks on the islands. Vessel groundings and sinkings may lead to oil spills (see Oil and Gas section for more information), and also have the potential to introduce invasive

[16]Available on NMFS "Alaska Marine Mammal Viewing Guidelines and Regulations" webpage at https://www.fisheries.noaa.gov/alaska/marine-life-viewing-guidelines/alaska-marine-mammal-viewing-guidelines-and-regulations, accessed January 3, 2023.

species (such as rats) and marine debris. The synthetic materials aboard fishing and other vessels that can become marine debris are an entanglement risk to northern fur seals (see Entanglement in Marine Debris). Rat-infested ships also pose a threat from the potential for disease transmission and alteration of the terrestrial ecosystem of the Pribilof Islands. The potential effects of the introduction of invasive species such as rats have not been evaluated and their potential risk to northern fur seals is unknown. See more detailed information about the risk of rat introduction to the Pribilof Islands and measures that can be taken to reduce the risk in the Pribilof Islands Wildlife Protection Guidelines (2023) at the NOAA Fisheries Alaska Oil Spill Response Guidance webpage[15].

Motorized Vehicle Traffic

Impacts of motorized vehicle traffic may result from visual stimulus, noise, or pollution. Vehicle exhaust fumes and leaking fluids add pollutants to the habitat used by fur seals on St. Paul and St. George islands. Similar to aircraft and vessel traffic, fur seals may respond to passing vehicles or audible noise by becoming alert or vigilant, vocalizing, or temporarily abandoning an area. Ream et al. (1994) suggested that fur seal abundance at St. George rookeries with road access declined faster from 1914–1992 and contributed a smaller proportion to pup production than rookeries with no road access. Whether the results were related to vehicle traffic, human presence, or both is unknown. Vehicle access near northern fur seal rookeries on the Pribilofs is closed annually by regulation from June 1–October 15 at all rookeries to minimize disturbance (50 CFR 216.81). Vehicle traffic likely increases when closures end. Automobile and all-terrain vehicle traffic on roads and trails adjacent to fur seal breeding and resting areas may affect the continued use of these areas on the Pribilofs. Structured monitoring would need to be conducted to determine the significance of this potential threat. Motorized vehicle traffic is currently not a threat on Bogoslof Island.

Environmental Contaminants

Persistent organic pollutants (POPs), heavy metals, radionuclides, and microplastics are all environmental contaminants that pose a risk to northern fur seals. Environmental contaminants have been linked with health problems (Randhawa et al. 2015; Deming et al. 2018), and are factors attributed to the decline in populations of other pinniped species (Beckmen et al. 2016; NMFS 2020a); it is therefore important to assess and monitor trends in their environmental levels and work to better understand their potential effects on fur seals. There are no known sources of these contaminants on the Pribilof Islands that would be routes of exposure to fur seals (Lindsay 2008b; Lindsay 2008a), and the likely routes of exposure are atmospheric or oceanic given the highly migratory nature of fur seals.

POPs are toxic environmental contaminants produced by human activity (e.g., industrial by-products, agrochemicals, etc.). Fur seal blubber samples collected in 1990 from St. Paul found concentrations of organochlorines (OCPs), a group of POPs, to be approximately an order of magnitude higher than concentrations found in Alaskan harbor, bearded, and ringed seals (Krahn et al. 1997). A historical perspective of POP concentrations in fur seals is provided by Reiner et al. (2016), who analyzed liver and blubber samples from juvenile male fur seals collected between 1987 and 2007 on St. Paul. They found that legacy POPs, including polychlorinated biphenyls (PCB) and dichlorodiphenyltricholoethane (DDT), declined or stayed the same over time, while recent and current-use POPs, including flame retardants and polybrominated dipheyl ether (PBDE), exponentially increased with sampling year. PCB contamination in fur seals on St. Paul has been found in high enough concentrations to suggest the potential for population-level effects (Wang et al. 2010).

Factors such as age and location play a role in levels of POP exposure and accumulation. Mothers can transfer OCPs to pups via milk, and pups have been found to have higher concentrations of PCBs in their blood compared to females of breeding age; this suggests significant exposure to young fur seals at a critical development stage, which could impact neurological and immune system development (Beckmen et al. 1999). St. George fur seals have previously had higher OCP concentrations in their blubber than St. Paul fur seals, sometimes reaching concentrations exceeding recommendations for safe human consumption (Loughlin et al. 2002). Fur seal milk from St. Paul had higher PCB levels than from St. George, which may impact the immune systems of pups (Loughlin et al. 2002). More recently, concentrations of POPs (including PCBs, OCPs, PBDEs, and methoxylated PBDE) in fur seal blubber from St. Paul has been linked to changes in gene expression relating to blubber metabolism (Soulen et al. 2022). Sequestering toxins in blubber may prevent vital organs from being affected. However, toxic effects could be more pronounced when seals are metabolizing blubber during fasting, which could also pose a risk to humans who consume affected blubber (Soulen et al. 2022).

The heavy metal mercury is a common environmental pollutant that bioaccumulates and biomagnifies in food webs. Mercury enters ecosystems through natural sources (e.g., volcanism) and a variety of anthropogenic activities (e.g., power generation, mining, and other industry) and is converted by bacteria into the more toxic methylmercury. Methylmercury can impair or suppress the nervous, cardiovascular, and endocrine systems, decrease reproductive success, and disrupt development (Scheuhammer et al. 2007; Kenney et al. 2012). Some high levels of mercury have been detected in fur seal livers (Kim et al. 1974; Noda et al. 1995), blood, hair (Anas 1974), muscle, and kidneys (Noda et al. 1995). However, Noda et al. (1995) showed that the highest concentrations are more likely to occur in older animals where the accumulation of inactive mercury selenide molecules is likely driving concentrations. Higher total mercury concentrations have been detected in the hair of fur seals when compared to young Steller sea lions in both Prince William Sound and Southeast Alaska (Beckmen et al. 2002). More recent mercury concentrations in female fur seals and pups sampled from St. Paul, St. George, and Bogoslof have not been above thresholds for concern (Rea et al. 2020). However, there were regional differences in total mercury concentrations likely dependent on foraging habitat (Rea et al. 2020). Some studies indicate that heavy metals like mercury are likely to present a significant detriment to the recovery of Steller sea lions in some parts of their range (Kennedy et al. 2019; Levin et al. 2020; Rea et al. 2020; Kennedy et al. 2021) but there is not enough data to draw conclusions about the impacts of heavy metals on fur seals.

The effects of other heavy metals on fur seals have not been extensively studied, although Ferdinando (2019) found high levels of chromium and zinc, and especially high levels of vanadium, in fur seal vibrissae samples from subsistence taken animals from the Pribilofs between 1990 and 2005. Vanadium may be toxic for marine mammals with a similar mechanism to mercury (Saeki et al. 1998).

The 2011 Tohoku earthquake and subsequent Fukushima nuclear power plant coolant failure resulted in the release of radionuclides into the atmosphere and marine environment. Impacts to marine mammals and their exposure levels to these substances were of concern, especially for those who rely on marine mammals for subsistence. Sub-adult male fur seals taken for subsistence on St. Paul were found to have been exposed to small quantities of Fukushima-derived radiocesium (Ruedig et al. 2016). However, the quantities detected were small, and therefore, no impact was expected on fur seals or human consumers of fur seals. Radiation exposure from this source is predicted to decrease over time due to the half-life decay of radiocesium and dilution in the Pacific Ocean.

Microplastics are plastic debris measuring less than five millimeters and are a common contaminant across marine environments. Ingestion of microplastics by organisms can either cause direct physiological damage by interfering with digestion or exposure to harmful toxins through chemical additives (Miller et al. 2020). Bioaccumulation over an animal’s lifespan may occur, and transfer of microplastic particles from prey species to captive gray seals (*Halichoerus grypus*) has been demonstrated (Nelms et al. 2018). Microplastics have been found in the scat of northern fur seals across their range in the U.S., with the most likely cause of occurrence being ingestion of fish containing microplastic particles and fibers (Donohue et al. 2019). The health implications for northern fur seals are not yet clear, but ACSPI ECO is currently implementing dedicated scientific research and monitoring on microplastics in northern fur seals.

There are significant data gaps regarding the effects of environmental contaminants at the individual health and population level (Cortés et al. 2022). Future monitoring and research should focus on determining the impacts of contaminants on fur seal vital rates, population trends, and impacts to human consumers.

Seafood Processing Discharges

Crab and halibut processing waste is authorized to be discharged into the nearshore environment (within 3 nautical miles) on both St. Paul and St. George islands by seafood processing facilities and mobile vessels under the Pribilof General National Pollutant Discharge and Elimination System (NPDES) permit number AK-G52-7000 issued by the Environmental Protection Agency (64 FR 1010, January 7, 1999, expired). The permit did not authorize pollutant discharges within one-half nautical mile of areas of concern (e.g., rookeries, hauling grounds) for fur seals from May 1 through December 1. The authority for discharge permits has shifted to the Alaska Department of Environmental Conservation; there is no current permit to discharge seafood wastes for St. Paul or St. George. Trident Seafoods has a processing facility located on St. Paul Island. Under the Pribilof general NPDES permit, the Trident facility is required to submit monthly Discharge Monitoring Reports (DMRs), which indicate whether the facility operated that month. The most recently submitted DMRs are available on the Alaska Department of Environmental Conservation EDMS Map Explorer (under permit AKG527702).[17] Notices of Intent are also submitted here when there is a change in the processing or facility information that would affect permit coverage. The latest Notice of Intent includes information about Trident's anticipated processing for each species and months for the year under normal operations with open fisheries and typical quotas. Crab (snow, king, tanner) fishing and processing waste usually occurs between October and May, when fewer fur seals are on island. The facility is currently not operating for the 2022–2023 winter season due to the closure of commercial Bristol Bay red king crab and snow crab fisheries. Previous violations of the terms of the permits are known to have occurred at this facility (USDC-11-1616 2011; Dec. 2022). Operating outside of permit conditions could increase the risk of negative impact to fur seals.

Waste materials discharged from processing fish species that are not currently authorized (e.g., black cod) may contain greater amounts of oils and grease that may compromise fur seals' pelage if discharged during their presence on the Pribilofs. High-volume processing of bottom fish results in processing waste that may be particularly detrimental to fur seal pelage. A complete description of processing options and volume as well as timing of discharges will need to be considered prior to determining the effects on fur seals.

Northern Fur Seal Conservation Plan Objectives and Actions

Background

NMFS intends to implement the following conservation objectives and actions outlined in this Conservation Plan with the primary goal being to facilitate conserving and restoring the Eastern Pacific stock of northern fur seals until the population abundance levels are above OSP and the stock is no longer depleted. Many of these actions relate to either interim management of anthropogenic threats or to increasing our understanding of northern fur seal physiology, ecology, and life history to support future management.

[17]Alaska Department of Environmental Conservation EDMS Map Explorer, Available at https://dec.alaska.gov/Applications/Water/EDMS/nsite/map/help, accessed March 17, 2023.

The implementation of this Conservation Plan will be dynamic and therefore, as new information is obtained, additional actions may be identified and incorporated via public notice and comment during subsequent revisions. We will align future updates to mirror NMFS guidance for Recovery Planning (NMFS 2020b), consistent with the MMPA that Conservation Plans should be modeled on recovery plans for ESA-listed species (16 U.S.C. 1383b(b)(2)).. Each revision will assess the success of actions taken to recover the stock and will prioritize or recommend new actions as needed. As new data are collected, analyzed, interpreted, and integrated, conservation actions may change accordingly. NMFS will adapt its conservation actions and management for consistency with a current understanding of northern fur seal sensitivity to the various threats, such as those described in the current Plan.

To prepare this Conservation Plan, the NMFS Alaska Regional Office collaborated with AFSC MML and the ECO offices on both St. Paul and St. George to reorganize and align the various initiatives and actions with current management and conservation priorities. The overall consensus was to remove the lengthy conservation action narratives presented in previous plans, as those were duplicative of the text in the main body of the Plan. Each conservation action includes the subsection “Work done since 2007” to indicate progress that has been made on that specific conservation action since the last publication of the Conservation Plan. These sections include work that has been completed either by NMFS, ACSPI, TCSGI, or other partners individually, or as collaborative efforts among these entities. Also included for each action is an “Initiatives” subsection to provide future direction to NMFS, ACSPI, TCSGI, or other partners for addressing the action. Conservation objectives and actions in this outline are not listed in order of priority. Priorities are identified in the Implementation Schedule that follows.

Objective 1. Identify and reduce human caused mortality of the Eastern Pacific stock of northern fur seals.

1.A. Improve understanding of the sources, fates, and effects of marine debris

1.A.1 Assess entanglement rates and continue disentanglement programs to reduce mortality and harm to fur seals entangled in marine debris

Work done since 2007

- St. Paul and St. George Ecosystem Conservation Offices (ECOs) evaluate their individual response capabilities to disentangle entangled seals.
- St. Paul ECO captures and disentangles fur seals encountered during their research and monitoring activities, as practical.
- Marine Mammal Lab (MML) researchers capture and disentangle fur seals encountered during their research activities, as practical.
- MML researchers and island residents photograph and report their observations of entangled seals to St. Paul and St. George ECOs for evaluation of response.

- National Marine Fisheries Service (NMFS) and ECOs report entanglement observations and successful disentanglements to NMFS Alaska Regional Office for inclusion in the National Stranding Database.

Initiatives

- Continue to expand St. Paul disentanglement program; expand to St. George as feasible; align and coordinate with NMFS/MML entanglement response.
- Continue and expand entanglement studies (e.g., directed roundups and/or use UAS to estimate terrestrial entanglement rates, summarize data that has been collected on types of debris over time, etc.).
- Assess alternative sampling designs to quantify biases and determine appropriate long-term methods to estimate trends in entanglement by age and sex.
- Develop methods to evaluate and confirm the origin/age of debris removed from entangled seals.
- Develop methods to estimate survival of entangled and disentangled seals.

1.A.2 Survey and remove marine debris in northern fur seal habitats

Work done since 2007

- St. Paul and St. George ECOs have collected marine debris deposited on terrestrial fur seal habitat biennially (as funding and capacity allows).
- St. Paul and St. George ECOs have surveyed specific terrestrial areas to characterize the composition and accumulation rates of marine debris.
- St. Paul ECO has arranged to backhaul collected marine debris off both islands for disposal or recycling.
- St. Paul ECO has completed a marine debris prevention grant focused on changing behaviors related to packing band use and discards.
- St. George ECO has accumulated the collected marine debris on the island and it is stored near the harbor for future shipment off island. In 2023, ACSPI ECO began the effort of beginning this shipment process, and expects to continue in 2024.
- St. Paul ECO has data characterizing debris removed from beaches on St. Paul since 2003.
- St. Paul ECO has data characterizing debris from fur seals disentangled on St. Paul.

Initiatives

- Analyze marine debris data collected since 2003 to determine trends or changes in accumulation rates or debris composition.
- Examine the distribution and abundance of marine debris on shore relative to entangling debris removed from seals (see Objective 1, Action 1.A.1) to determine whether correlations exist between debris washed ashore on the Pribilof Islands and that observed entangling northern fur seals.
- Assess remote sensing or other methods to detect debris at sea relative to fur seal at-sea habitat use (Objective 3, Action 3.C.2).
- Develop methods and incentives for partners to collect, report, and dispose of at-sea accumulations of marine debris.

- Continue the marine debris removal efforts and surveys to characterize debris recovered from coastlines on St. Paul and St. George islands.
- Analyze the cost-effectiveness of disposal and recycling options for collected marine debris.
- Complete a literature review of marine debris research that has been conducted since 2007 and use it to inform Action 1.A.3 below.
- Design and conduct field and laboratory experiments to determine the probable fate (longevity, rates of accumulation, exchange between terrestrial and marine debris, deterioration, and fouling, and movements) of abandoned, lost, and discarded fishing gear and other potentially hazardous debris in and near areas inhabited by fur seals, particularly areas used by juvenile age classes.
- Continue to coordinate closely between NMFS and ECOs on above listed Initiatives.
- Create and maintain a photo archive to document items of debris where origin can be identified (e.g., ADFG pot tags, buoys, etc.).

1.A.3 Develop and implement efforts to support education to reduce and prevent marine debris

Work done since 2007

- NOAA National Ocean Service Marine Debris Program was created to centralize/coordinate activities and funding.
- The NOAA National Ocean Service Marine Debris Program began development of an Alaska Marine Debris Action Plan, which is ongoing.

Initiatives

- Determine the sources of marine debris and identify methods of reducing or mitigating the source(s). For example: continue and expand programs that encourage reduced use of materials that are commonly found entangling northern fur seals (e.g., packing bands).
- Continue, develop, and expand education programs in Alaska to reduce the amount of marine debris in marine and terrestrial fur seal habitats.
- Work with new and existing partners to develop incentives to prevent, remove, and reduce marine debris.
- Create incentives to reduce gear abandoned, lost, and derelict/ghost gear as well as report and recover lost fishing gear.
- Continue development of the Alaska Marine Debris Action Plan.
- Promote Pribilof School District participation in education and outreach programs that address marine debris (e.g., Ocean Guardian School Program, etc.).
- Continue to coordinate closely between NMFS and ECOs on above listed Initiatives.

1.B. Improve assessments of incidental take of fur seals in commercial fishing operations

1.B.1 Implement and evaluate fishery and marine mammal observation programs in the North Pacific Ocean and Bering Sea

Work done since 2007

- As part of the stock assessment review process Alaska Fisheries Science Center (AFSC) evaluates the data collected by the marine mammal observer programs to estimate incidental take by commercial fisheries of marine mammals including northern fur seals.
- AFSC prepares estimates of marine mammal serious injury and mortality annually.
- AFSC and NMFS Alaska Regional Office review the northern fur seal mortality and serious injury and data annually.
- The Alaska Marine Mammal Observation Program (AMMOP) collects important data on incidental catch of marine mammals in State-managed fisheries that aren't otherwise observed, and collected data on several fisheries around the State from 1990–2013. The AMMOP program was officially transferred from the Alaska Regional Office to the Fisheries Monitoring and Analysis Division of AFSC.
- Observers from AFSC Fisheries Monitoring and Analysis Division collect snouts (for whiskers and canine teeth) and deep tissue samples from fur seals killed during fishing activities in Alaska. Tissue samples are analyzed to check species and sex at Southwest Fisheries Science Center.

Initiatives

- Continue observation programs in northern fur seal habitat to estimate the extent and frequency of incidental take and to identify changes in fisheries-related mortalities related to fishing practices or gear changes.
- Continue to review existing and future data collected from fisheries observer programs to assess and account for the effects of incidental take in the northern fur seal stock assessments.
- Continue to gather biological data from fur seal bycatch in fisheries, to inform efforts to understand and mitigate effects of bycatch of fur seals.

1.C. Evaluate subsistence use

1.C.1 Monitor and manage subsistence uses

Work done since 2007

- Subsistence use monitoring was improved by sampling and reporting through co-management with Tribal Governments (ECO island sentinels).
- Occurrence of heat stress mortality was reduced to zero by 2010 through co-management between NMFS and Tribal Governments.
- Through the co-management process, ACSPI and NMFS were able to reduce the occurrence of accidental female mortality during subsistence use from an average of 2.5 females per year from 1986–2000 (before co-management), to

an average of 2.0 females per year (2001–2007), to an average of 1.4 females per year (2008–2021).
- ACSPI implemented their own Tribal policy to end summer harvests of sub-adults by July 31 rather than August 8 on St. Paul to reduce accidental mortality of females.
- NMFS revised subsistence use regulations for St. George in 2014 and St. Paul in 2019 to improve food security for both communities, following petitions from St. George and St. Paul requesting NMFS revise regulations.
- Implemented family style harvests as practical to reduce disturbance and meet subsistence needs.
- Co-produced a Co-Management Plan for Subsistence Use on St. Paul Island that is regularly updated by the St. Paul Co-Management Council.

Initiatives
- Utilize and expand co-management planning to share responsibilities for balancing effects on fur seals while ensuring food security for the communities of St. Paul and St. George.
- Continue subsistence use monitoring and sampling to understand emerging safety and health concerns.

1.C.2 Develop, implement, and analyze data from subsistence use sampling programs

Work done since 2007
- Co-managers have developed a process for joint review of subsistence data more frequently to iteratively improve data collection efforts and modify methods accordingly.
- Analyzed age data from the subsistence use of fur seals and identified a significant selection bias towards smaller 3–4-year-old animals compared to the proportions that naturally occur in the population, suggesting that condition analyses and other metrics are not practical without developing a correction formula to account for the size selection bias (i.e., subsistence preference for smaller seals) detected among subsistence users.
- Evaluated community subsistence patterns to better understand the need for regulatory changes to ensure food security and cultural preservation.
- Determined that subsistence use patterns differ between St. George and St. Paul; it is important to note that selection is not random when analyzing fur seal subsistence data.
- NMFS revised the subsistence use regulations in 2014 and 2019 to reflect the reality of community need and subsistence use patterns, and NMFS and ACSPI implemented a Co-Management Plan in 2020 (revised 2024).
- St. Paul ECO discontinued sampling efforts that have been deemed ineffective or did not contribute valuable data. St. Paul ECO initiated new sampling efforts that are being or need to be evaluated for their efficacy (bile, blubber thickness) moving forward.
- St. Paul ECO collected liver and blubber annually during traditional harvests and provided them to the Alaska Marine Mammal Tissue Archival Program, which has standard protocols for length, canine teeth (age), vibrissae, blood/blood serum, bile, blubber, liver, muscle, and fur.

- St. Paul ECO has increased their sampling and analysis of subsistence harvested fur seals for food safety concerns.
- St. Paul ECO increased staff capacity and communication with subsistence users.

Initiatives

- Evaluate petitions received from St. George, St. Paul, and AMMC in 2022–2023 to change the subsistence regulations again to align more closely with cultural and subsistence need in communities.
- Work with subsistence users in communities prior to sampling subsistence resources to consider alternative methods, ensure continued community support, and minimize the intrusive nature of sampling Tribal members' food resources.
- Evaluate existing long-term data sets and archival sampling of historic fur seal harvests when considering new or revised sampling programs.
- Develop and implement a program with sampling plans that include standardized sampling, reporting, and meta-data storage protocols, in order to address emerging zoonotic diseases, food security, and ecological questions of interest to the subsistence communities and NMFS.
- Continue to analyze teeth from subsistence use to identify possible changes and trends in fur seal age structure and to link age to the ongoing sampling program.
- Develop guidelines to evaluate minimum sample sizes for each data type needed to detect expected trends and variability in those trends.
- Work with subsistence users to evaluate community preferences and patterns relative to the regulatory framework, and whether additional regulatory revisions may be required.
- Continue to work closely as co-management partners (NMFS, ACSPI, and TCSGI) on all above listed Initiatives, and any expanded activities from Initiatives.

1.C.3 Identify, evaluate, authorize, and co-manage subsistence use of northern fur seals in other coastal regions of Alaska

Work done since 2007

- Began conversations with the AMMC to identify subsistence use needs and patterns to determine how best to authorize and monitor the use of fur seals in the Aleutian Islands.
- St. Paul ECO works closely with AMMC to provide training and support, and to ensure ongoing communication regarding subsistence use and sampling of northern fur seals.
- St. Paul ECO works with the Indigenous People's Council for Marine Mammals to improve communications among Tribal co-managers regarding subsistence use of northern fur seals.

Initiatives

- Assess and quantify the nature, location, and extent of subsistence use and determine whether unaccounted mortality may be influencing the population and whether/what actions may be necessary to address it.

Objective 2. Assess and avoid or mitigate adverse effects of human related activities on or near the Pribilof Islands and other habitat essential to the survival and recovery of the Eastern Pacific stock of northern fur seals.

2.A. Increase implementation of co-management agreements with Tribal Governments and Alaska Native Organizations

Work done since 2007

- In 2020, NMFS and the ACSPI renegotiated their Co-Management Agreement to reflect the 2019 revision of the subsistence use regulations.
- NMFS and ACSPI have also developed and implemented a Co-Management Plan to improve the management of subsistence use of northern fur seals (and other marine mammals used for subsistence purposes). This was jointly updated in 2024.
- NMFS and TCSGI have continued to implement their co-management agreement to reflect the revision of the subsistence use regulations in 2014.

Initiatives

- Continue coordination between NMFS and Tribal co-managers to address changes in subsistence use for future regulatory revisions or other co-management actions.
- Continue to implement co-management agreements (see Appendices I and II) to utilize and integrate traditional knowledge, local wisdom and values, and science.
- Identify and resolve conflicts between landowners over land use or land access that may arise in association with fur seals.
- Provide information to the affected community as a means of increasing the understanding of the sustainable use, management, and conservation of fur seals.
- Support St. Paul and St. George ECOs to continue standardized data collection and documentation of Indigenous Knowledge within the framework of the Indigenous Sentinels Network.
- ACSPI and TCSGI ECOs should prepare annual summaries of Indigenous Sentinels Network and other data collected by Island Sentinels for Co-Management Council review (St. Paul) and progress reports (St. George).
- Evaluate 5-year patterns/trends in Indigenous Sentinels Network data and report independently or utilize in relevant conservation actions.
- Expand the Indigenous Sentinels Network to other locations as possible.

2.B. Advise and consult with the relevant action agencies and industries to ensure taking is authorized and effects are minimized

Work since 2007

- NMFS has and continues to review permits and analyze effects related to harbor dredge maintenance, artificial reef creation, and other development activities on St. Paul and St. George islands.
- NMFS reviewed permits and suggested monitoring and mitigation activities to authorize emergency harbor repairs on St. George.
- NMFS reviewed permits and suggested monitoring and mitigation activities to authorize repair and replacement of municipal and fisheries outfall lines on St. Paul.
- 2017–2022: NMFS reviewed and participated in the development of the St. Paul Island Comprehensive Economic Development Strategy.
- NMFS reviewed permits to authorize bathymetric and hydrographic surveys in the Bering Sea and worked with the applicant to implement monitoring and mitigation activities.
- NMFS reviewed applications for scientific research and issued authorizations for permits to conduct scientific studies.

Initiatives

- Advise the relevant federal action agencies and industries to confer with NMFS to determine whether proposed, planned, or contemplated actions could take fur seals or damage habitats essential to their survival and, if so, steps that could be taken to avoid or minimize possible adverse effects.
- Review proposed coastal development, fishery management, harbor development and management, fuel transport and transfer, seafood processing, and related economic development plans to determine and recommend measures necessary to avoid or minimize possible adverse effects on fur seals or their habitat.

2.C. Conduct studies to quantify effects of human activities near terrestrial fur seal habitats

Work done since 2007

- NMFS and TCSGI completed a pilot study to investigate the responses of northern fur seals to subsistence harvest of pups on St. George in the autumn.
- Investigated the relationship on both islands between estimates of pup production at both the rookery and rookery complex level, as well as a variety of covariates related to proximity to development or exposure to various sources of disturbance.
- 2022–2023: St. Paul ECO began a study pairing analysis of VHF tagged adult female northern fur seal movements with human presence data from subsistence users, authorized researchers (federal, Tribal, etc.), authorized tour operators, and other causes of disturbance.

Initiatives

- Study short-term behavioral responses and the long-term consequences of threats to properly account for incidental (e.g., airborne and underwater noise, vehicles, and vessel traffic), and intentional harassment (e.g., round-ups, bull counts, pup counts), and intentional invasive harassment (e.g., capturing, handling, tagging).
- NMFS should continue to collaborate with St. Paul ECO to implement their VHF tagging study described above.
- Co-managers and scientists should jointly evaluate and assess adequacy of current management measures intended to mitigate effects of disturbance using results from above initiatives.

2.D. Undertake conservation or management measures as necessary to eliminate or minimize adverse effects on fur seals or their habitat

2.D.1 Develop oil spill response plans and mitigation strategies specific to terrestrial habitat used on the Pribilof Islands and Bogoslof Island and at-sea habitats used for foraging and migration

Work done since 2007

- 2014: Revised Pribilof Islands Wildlife Protection Guidelines to update local oil spill response priorities and capabilities.
- 2023: Revised Pribilof Islands Wildlife Protection Guidelines to update local oil spill and marine debris response priorities and capabilities. This version is reformatted to align with national standards including the National Contingency Plan and Alaska Wildlife Protection Guidelines (2020).[15]

Initiatives

- Review oil spill response plans, mitigation strategies, and wildlife protection guidelines specific to the Pribilof Islands and Bogoslof Island.
- NMFS will provide, through the Federal On Scene Coordinator, notices to mariners for areas affected by an oil spill.
- Develop spatially explicit models to estimate the probability of exposure of fur seals during their seasonal migrations to an oil spill in the Bering Sea, North Pacific, and associated passes.

2.D.2 Develop habitat conservation measures and manage access to fur seal breeding and resting areas on the Pribilof Islands

Work done since 2007

- 2018: Replaced the fur seal viewing blinds at Little Zapadni and Gorbatch rookeries on St. Paul.
- St. Paul landowners identified NMFS signage on private land and co-managers are working toward a solution.

Initiatives

- Work with landowners to develop agreements and plans for restricted and public access to NMFS lands retained by the government for the conservation of fur seals on the Pribilof Islands.
- Work with commercial users and public access stakeholders/rightsholders to operate, maintain, and repair fur seal viewing platforms on the Pribilofs.
- Work with the Federal Aviation Administration to ensure that pilots consult existing notices and information in Federal Aviation Administration Chart Supplements and that the information in those supplements is applicable to the Pribilofs.

2.E. Assess and monitor pollutants

2.E.1 Compile and evaluate existing data on pollutants

Work done since 2007

- Analyzed the exposure of northern fur seals to radionuclides introduced into the environment as a result of the Fukushima earthquake (Collaboration between St. Paul ECO, Colorado State University, and NMFS).
- Analyzed the levels of mercury and selenium in northern fur seal tissues (University of Alaska Fairbanks, ACSPI, and NMFS).
- Initiated a pilot study to evaluate the health of fur seals through an integration of physiological and immune function (Colorado State University and NMFS).

Initiatives

- Compile, synthesize, and evaluate the adequacy of existing data concerning the presence, levels, and possible effects of heavy metals, petroleum compounds, polychlorinated biphenyls, chlorinated hydrocarbons, and other environmental pollutants on northern fur seals.
- A brief summary of pollution studies has already been undertaken as part of this Conservation Plan and this work should be built upon with further assessment of past data and an analysis of existing tissues in storage.

2.E.2 Monitor and study environmental pollutant exposure

Work done since 2007

- Samples from fur seals collected for subsistence use have been collected consistent with protocols for the Alaska Marine Mammal Tissue Archival Program by co-managers on St. Paul.

Initiatives

- Design and conduct laboratory or field studies necessary to fill critical data gaps concerning the possible acute and chronic effects of environmental pollutant exposure levels found in fur seal tissues.
- Periodic comparisons between samples from subsistence use (Objective 1, Action 1.C.2) and from seals found dead on the rookeries (Objective 3, Actions

3.A and 3.B) may provide insight into effects of environmental pollutant exposure.
- After a thorough review of the contaminant literature, a study design should be developed to determine how frequently, and which tissues to collect for periodic monitoring.
- Work with subsistence users and Tribal co-managers to continue to improve sampling and analysis of tissues (Objective 1, Action 1.C.2) to ensure food safety.
- Evaluate the usefulness of carcass salvage and necropsy programs to determine and monitor the levels of environmental contaminants in selected tissues.

2.E.3 Evaluate and document unusual mortality of northern fur seals

Work done since 2007
- The Marine Mammal Health and Stranding Response Program (MMHSRP) has continued to expand its network across coastal Alaska and the Pacific Northwest. St. Paul and St. George ECOs are both involved with the MMHSRP; they have identified, reported, and sampled dead northern fur seals as practical.

Initiatives
- As practical, sample fur seal carcasses that are out of season/out of habitat or that may be related to an Unusual Mortality Event to monitor for disease and human interaction.

2.F. Quantify relationships between northern fur seals and fisheries

2.F.1 Assess potential interactions between fur seal prey resource use and fisheries

Work done since 2007
- Addressed the relationship between pollock catch and first year survival of fur seals (Short et al. 2021).
- Used co-production of knowledge to explore fur seal ecology and commercial fishery interactions in the Pribilof Islands (Divine et al. 2022).
- Developed a bioenergetics model using recent data on age- and sex- specific fur seal foraging behavior, diet, and energetics to estimate population level consumption of pollock (McHuron et al. 2020).
- Assessed fur seal foraging behavior in the context of environmental conditions including commercial groundfish catch (Joy et al. 2015).
- NMFS completed a Final Supplemental Environmental Impact Statement supporting regulatory changes to subsistence use in 2019, which included an evaluation of the impacts of commercial fisheries as part of the overall analysis.
- Developed a model to explore the influences of changes in prey availability on behavior and reproductive success of lactating female fur seals as well as the viability of primary foraging grounds around rookeries (McHuron et al. 2023).

Initiatives

- Identity species and age classes of commercial and non-commercial prey consumed by northern fur seals and any temporal and spatial overlap of fur seals and fisheries.
- Analyze and review any relevant information regarding the distribution and abundance of northern fur seals prey resources, commercial catch of fur seal prey, and the energetic requirements of fur seals.
- Measure any effects of fishing on prey (both commercial and non-commercial), including composition, distribution, abundance, and schooling behavior.
- Model effects of fishing on commercial and non-commercial prey composition, distribution, abundance, and schooling behavior, evaluating model sensitivity, validity, and conformity to known data sets.
- Consider methods to incorporate the energetic requirements of fur seals into ecosystem models and how their inclusion may contribute to relevant multispecies stock assessments or fisheries management under existing Fishery Management Plans.
- Develop methods to evaluate the effects of existing fisheries closures and other management actions on northern fur seals into fishery management strategies to better balance economic, social, and biological objectives.

2.F.2 Report fishery interactions

Work done since 2007

- NMFS observer programs have continued to report observations and bycatch of northern fur seals in domestic fisheries.
- NMFS stock assessment reports have included analysis of observer program data to extrapolate to unobserved fisheries.

Initiatives

- Continue and expand reporting systems to provide information relevant to the status of commercial fish stocks, fisheries management and fishing operations, and the recovery of the fur seal population.
- Evaluate stomach contents of seals taken incidentally in fishing operations, stranded, or dead on the rookeries.

Objective 3. Continue and, as necessary, expand research and management programs to monitor trends and detect natural or human-related causes of change in the Eastern Pacific stock of northern fur seals and habitats essential to its survival and recovery.

3.A. Monitor and study changes in northern fur seal populations

3.A.1 Estimate stock vital rates

Work done since 2007

- Analyzed the data from the 1987–1989 tagging to inform the vital rates program initiated in 2008 (Melin et al. 2006).
- Tagged 933 adult females and 6,604 female pups on St. Paul from 2007–2022, except 2020–2021 (due to Covid).
- Tagged 559 adult females and 12,106 pups (approximately 50 percent male, 50 percent female) on St. George from 2009–2022, except 2020–2021 (due to Covid).
- Identified the need to estimate emigration rates among breeding areas to improve current survival estimates.
- Applied 360 VHF radio transmitter tags to adult female seals in 2010–2019 to investigate foraging trip and onshore duration for various research interests on St. Paul and St. George islands.
- Applied 84 VHF radio transmitter tags to adult female seals in 2022 on St. Paul and St. George islands for emigration investigations, and continue to collect data on foraging trip and onshore duration.
- Completed field surveys to address killer whale predatory behavior on migrating fur seals in the eastern Aleutian Islands (Matkin et al. 2007).
- Completed a pilot acoustic study of killer whales around St. Paul Island to estimate predation events (Newman and Springer 2008).
- Analyzed the ages of females and their associated reproductive rates in 2005, 2007, and 2008 (Adams et al. 2007; Testa et al. 2010; Shero et al. 2018).
- Analyzed the age distribution of dead adults collected on the rookeries during population assessments from 1973–2006 (McKenzie 2009).

Initiatives

- Continue studies to estimate the age- and sex- specific survival and reproduction of fur seals from rookeries and rookery complexes as appropriate to extrapolate for the entire Eastern Pacific stock.
- Continue to collect condition indices (weight) of live pups from representative rookeries or rookery complexes of the Eastern Pacific stock (NMFS).
- Assess the nature and magnitude of predation by Steller sea lions, killer whales, and sharks on fur seals, including pre-weaned pups.
- Analyze teeth collected from dead animals to determine age structure and use biochemical markers to link to vital rates and life history (e.g., reproductive rates,

growth rates, feeding behavior, or other variables indicative of the general health and condition).
- Model demographic scenarios (e.g., pup survival, adult survival, etc.) to observed pup production and pup condition trends among the representative rookeries or rookery complexes of the Eastern Pacific stock.

3.A.2 Continue regular counts of adult males and estimates of pup production on St. Paul, St. George, and Bogoslof islands

Work done since 2007

- Continued to make biennial counts of dead pups concurrent with pup production to estimate early season mortality of pups.
- Estimated late season pup mortality at vital rates sites prior to tagging and weighing live pups at those sites.
- Continued annual counts of adult males and biennial estimates of pup production on St. Paul and St. George islands.
- Completed four estimates of pup production on Bogoslof Island.
- Completed a first series of unmanned aircraft surveys of pups concurrent with the shear sampling method in 2021 and 2022.

Initiatives

- Continue annual counts of adult males and biennial estimates of pup production and condition on both St. Paul and St. George islands to detect and monitor trends in pup production and population size.
- Continue regular post breeding season surveys to estimate on-land pup mortality of representative population units of the Eastern Pacific stock in order to estimate pup production prior to their first molt, after their first molt, and prior to tagging for inclusion into vital rates studies.
- When practical, continue to estimate pup production and condition in addition to adult male counts on Bogoslof Island.
- Regularly evaluate the sensitivity of alternative/unmanned systems methods (e.g. UAS) to detect population changes and the potential use of alternative methods to estimate population abundance.

3.A.3 Monitor and study changes in diet, foraging behavior, and physiology

Work done since 2007

- Completed additional research on northern fur seal diet and related topics (Zeppelin and Orr 2010; Kuhn et al. 2014a; Jeanniard-du-Dot et al. 2017).
- Completed research on foraging behavior (Call et al. 2008; Lea et al. 2010; Kuhn 2011; Benoit-Bird et al. 2013a; Benoit-Bird et al. 2013b; Nordstrom et al. 2013b; Kuhn et al. 2014b; Battaile et al. 2015a; Joy et al. 2015; Kuhn et al. 2015; Zeppelin et al. 2015; Jeanniard du Dot et al. 2018; Kuhn et al. 2020; Merrill et al. 2021; Kuhn et al. 2022).
- Completed research on fur seal physiology (Beauplet et al. 2005; Rosen and Trites 2014; Diaz Gomez et al. 2016; Rosen et al. 2018; McHuron et al. 2019; VanWormer et al. 2019; Diaz Gomez et al. 2020; McHuron et al. 2020; McHuron et al. 2022).

- Completed research on fur seal migration and movement (Johnson et al. 2008; Kuhn et al. 2009; Lea et al. 2009; Hanks et al. 2011; McClintock et al. 2014; Pelland et al. 2014; Sterling et al. 2014; Zeppelin et al. 2019; Johnson et al. 2021a).

Initiatives

- Continue to expand studies to identify species and age classes of prey consumed by fur seals, especially during the summer breeding and during times of year when little data exist, such as winter non-breeding seasons, using scat and other biogeochemical analyses (e.g., environmental DNA, stable isotopes, and fatty acid analysis).
- Expand diet studies to include understudied age and sex classes of fur seals (adult males and juveniles), while continuing to estimate diet variability for adult females.
- Continue to improve estimates of energy requirements for all age classes and sexes of northern fur seals (see McHuron et al. 2020 for initial analysis) that are applicable and accessible for ecosystem models.
- Continue to examine the movement patterns and habitat use of all age and sex classes during the breeding and non-breeding seasons, including foraging effort, dive patterns, and factors related to rookery departure and return dates.
- Examine maternal attendance patterns during the breeding season including foraging trip durations, pup provisioning cycles, energy transfer, and how they influence pup growth, condition, and survival.
- Continue studies to examine relationships between diet, foraging behavior, and condition, health, reproduction, and survival.
- Examine relationships among food habits, foraging behavior, physiology of all age and sex classes, and changes in oceanographic and atmospheric conditions within foraging habitat (Objective 3, Action 3.C.3) and in relation to fisheries interactions and other anthropogenic disturbances (Objective 2, Action 2.F.1).

3.A.4 Promote joint research and collaborative programs

Work done since 2007

- North Pacific Universities Marine Mammal Consortium completed work at Reef rookery and Bogoslof Island (Nordstrom et al. 2013a; Nordstrom et al. 2013b; Jeanniard-du-Dot et al. 2017; Jeanniard du Dot et al. 2018).
- North Pacific Universities Marine Mammal Consortium completed captive work at Vancouver Aquarium (Rosen and Trites 2014; Rosen et al. 2017).
- Co-management programs between NMFS and ACSPI, and NMFS and TCSGI included marine debris clean ups, entanglement observations and response, subsistence use monitoring, sampling of fur seals taken for subsistence use (biosampling), and VHF tagging research.
- The development of the Indigenous Sentinels Network by ACSPI has provided an opportunity for greater collaboration between ACSPI and other scientists to use community-based data in northern fur seal research.
- Continued work annually on San Miguel Island to estimate survival, reproduction, pup production, foraging ecology, and migration (DeLong et al.

2009; Zeppelin and Orr 2010; Melin et al. 2012; Lee et al. 2018; Zeppelin et al. 2019).
- Developed an integrated approach to community-based monitoring of killer whales around the Pribilof Islands (Robson et al. 2010).
- AFSC, Point Blue Conservation, and the U.S. Fish and Wildlife Service (USFWS) completed work at Southeast Farallon Island including northern fur seal pup production, tagging, and resighting tagged fur seals (started in 2017).
- Continued work in the western Bering Sea and broader North Pacific to estimate fur seal abundance and study migratory and foraging behavior (Waite et al. 2012a; Waite et al. 2012b; Lee et al. 2014; Belonovich et al. 2016; Hooker et al. 2021).
- Foraging ecology of fur seals on Bogoslof Island was studied in 2001–2004, 2006–2007, 2009, 2015, and 2019 (Zeppelin and Orr 2010; Benoit-Bird et al. 2013b; Nordstrom et al. 2013a; Battaile et al. 2015a; Battaile et al. 2015b).
- Completed consequences of female foraging strategies comparative studies between Bogoslof and St. Paul islands in 2005 and 2006 (Springer et al. 2010).
- Colorado State University completed disease and parasites research (Spraker and Lander 2010; Duncan et al. 2012; Duncan et al. 2013a; Duncan et al. 2014a; Duncan et al. 2014b; Conway et al. 2022; Cortés et al. 2022).
- Participated in joint research with the New England Aquarium, Seattle Aquarium, Mystic Aquarium, and Vancouver Aquarium on captive fur seal studies (McHuron et al. 2022).
- NMFS and ACSPI ECO have presented to the Ecosystem Committee of the North Pacific Fishery Management Council on the status of the northern fur seal research and management annually since 2017; additional presentations to the Science and Statistical Committee and Ecosystem Committees as requested since 2017.

Initiatives
- Continue and expand comparative studies of northern fur seals on the Commander Islands, Tyuleny Island, Farallon Island, and San Miguel Island to evaluate population differences between the Eastern Pacific stock and other populations.
- Foster comparative research between northern fur seals and other Bering Sea and North Pacific marine species.
- Convene a Working Group with NMFS scientists/co-managers, Tribal co-managers, marine mammal experts, scientists, and primary stakeholders including State of Alaska representation, to evaluate the body of evidence regarding the differential abundance trends among segments of the Eastern Pacific stock and their importance for understanding the overlap between northern fur seals and the commercial fishing industry.

3.B. Improve assessment of the effects of disease

3.B.1 Compile and evaluate existing data

Work done since 2007

- Published research on disease in northern fur seals (Spraker and Lander 2010; Duncan et al. 2012; Myers and Atkinson 2012; Duncan et al. 2013a; Duncan et al. 2013b; Minor et al. 2013; Duncan et al. 2014a; Duncan et al. 2014b; Lefebvre et al. 2016; VanWormer et al. 2019; Johnson et al. 2021c; Conway et al. 2022; Cortés et al. 2022).

Initiatives

- Compile and evaluate existing data to determine whether and how diseases may cause or contribute to changes in vital rates and population trends.
- Continue to evaluate the parasite loads and relevant life histories to determine how parasites may cause or contribute to changes in vital rates and population trends.
- St. Paul ECO began sampling and analyzing subsistence harvested northern fur seals for Harmful Algal Bloom toxins in 2022, and this work is ongoing.
- St. Paul ECO began a three-year partnership in 2022 with Colorado State University to test fur seals on St. Paul local for *Toxoplasma gondii*, as well as testing local cats to evaluate transmission pathways – this work will continue through 2024.
- In 2023, St. Paul ECO began sampling freshly dead stranded and subsistence harvested fur seals for Highly Pathogenic Avian Influenza (HPAI); this work is ongoing.

3.B.2 Determine and mitigate disease effects

Work done since 2007

- Analyzed phocine morbillivirus transmission in the North Pacific (VanWormer et al. 2019).
- Implemented treatment to mitigate hookworm disease on San Miguel island (DeLong et al. 2009).
- Reviewed and synthesized literature on fur seal disease to inform future health monitoring and research efforts (Cortés et al. 2022).

Initiatives

- Develop long-term disease monitoring studies and reporting plans.
- Develop criteria to determine if disease is a threat to fur seals or subsistence users (Objective 1, Action 1.C.2).
- Determine source of disease and, as practical, recommend additional conservation measures to mitigate disease effects.

3.B.3 Continue management programs to prevent disease transmission to northern fur seals from other species

Work done since 2007

- Continued the regulatory prohibition of dogs on the Pribilof Islands.

- Veterinary support was subsidized for cats on the island from 2007–2011, 2017, and from 2022–2023 (NMFS, St. Paul ECO).
- Continued collaboration with USFWS and ECOs to support rat prevention.

Initiatives

- Develop education and outreach related to disease transmission risks from domesticated, introduced species, and invasive species.
- Continue the regulatory prohibition of dogs on the Pribilof Islands to prevent disease transmission to fur seals from dogs.
- Continue to support management programs that prevent disease transmission from invasive species to fur seals.
- Develop management programs to evaluate and prevent disease transmission to fur seals from domestic and feral cats.

3.C. Describe and monitor northern fur seal habitats and occupancy of those habitats

3.C.1 Compile and evaluate available terrestrial habitat-use data

Work done since 2007

- ECO completed surveys within the framework of the Indigenous Sentinels Network, including timing of arrival and departure, and winter presence/absence surveys.
- NMFS began VHF tagging in 2007 to estimate attendance, onshore duration, perinatal visit duration, etc. This has continued in subsequent years. (Merrill et al 2021).
- NMFS aggregated telemetry data on northern fur seal trip durations going back to the 1950s into a single data frame.
- NMFS standardized a northern fur seal telemetry database dating back to 1992.

Initiatives

- Develop terrestrial habitat descriptions and geospatial habitat use maps and make them available to the public.
- Develop and implement programs to effectively detect and monitor temporal or spatial changes in terrestrial habitat use important to the survival and recovery of the Eastern Pacific stock.
- Co-produce terrestrial habitat access plans for human activities based on changes in fur seal habitat use with NMFS and Tribal co-managers (Objective 2, Actions 2.A and 2.C).
- Collaborate to summarize and analyze St. Paul’s Indigenous Sentinels Network data.
- Analyze tag-resight data to provide estimates of the timing of arrival onshore from the winter migration, onshore durations, and the timing of departure for the winter migration.

3.C.2 Compile and evaluate available at-sea habitat-use, food habits, and available fish resource data

Work done since 2007

- Compiled MML telemetry database for at-sea information and standardized all available fur seal telemetry for analyses.
- Developed models to estimate diet consistency among islands and breeding complexes.
- Developed isotopic models to predict foraging habitat (Zeppelin et al. 2015).
- Characterized patterns in late season juvenile foraging (Zeppelin et al. 2019).
- Compared fur seal foraging behavior to relative prey abundance of walleye pollock (Kuhn et al. 2015).
- Collected oceanographic conditions, prey abundance, and depth distribution using Saildrones (Kuhn et al. 2020).
- Investigated the relationship between fishery catches of pollock and first year survival of fur seals (Short et al. 2021).
- Alaska Climate Integrating Modeling Project (ACLIM) and Lenfest Ocean Program examine climate change impacts.
- Developed a foundation for estimating the spatial and temporal co-occurrence of fur seals and fisheries.
- Developed bioenergetic models of northern fur seal year-specific consumption of walleye pollock to inform future multispecies stock assessment models (McHuron et al. 2020).
- Estimated prey and energy consumption of fur seals to inform management (McHuron et al. 2022).

Initiatives

- Investigate surveys and platforms of opportunity sighting data to reliably estimate the at-sea density of northern fur seals.
- Investigate the consistency of at-sea habitat use over time; incorporate climate predictions (ACLIM 1 & 2) of environment and fish to contribute to the understanding of changes in representative population units of the Eastern Pacific stock.
- Examine fish stock assessment information and resource availability in relation to fur seal at-sea habitat use, diet, and foraging behavior.
- Characterize the spatial and temporal relationships among prey resource availability, oceanographic conditions, and fur seal foraging.
- Evaluate the practicality of sampling fur seals at-sea by various methods in selected parts of their range to improve estimates of the quantity or quality of available prey resources in understudied areas.

3.C.3 Conduct oceanographic and fish surveys related to pelagic fur seal habitat use

Work done since 2007

- Collected oceanographic conditions, prey abundance, and depth distribution in fur seal foraging range around St. Paul Island using an unmanned Saildrone to follow northern fur seals (Kuhn et al. 2020).

- NMFS AFSC integrated all Bering Sea shelf survey information (1982–2018) into AFSC standardized telemetry database.
- Created open access survey and oceanographic data, model data (seasonal), and climate projections including Alaska Climate Integrated Modeling Project (ACLIM), Forage and Euphausiid Abundance in Space and Time (FEAST), and Climate Enhanced Age-based model with Temperature specific Trophic Linkages and Energetics (CEATTLE).

Initiatives

- Study the natural influences on fish distribution and fur seal feeding ecology to determine if additional studies are needed to delineate and characterize areas of special biological importance to the Eastern Pacific stock.
- Study the distribution and abundance of commercial and non-commercially utilized fur seal prey from summer and winter at-sea habitats.

3.D. Identify and evaluate ecosystem changes

3.D.1 Evaluate Optimum Sustainable Population, carrying capacity, and maximum net productivity

Work done since 2007

- MML updated the density dependence analyses from Fowler (1990); Fowler and Ragen (1990); Gerrodette and Demaster (1990); and Fowler and Siniff (1992) for St. Paul, St. George, and Bogoslof islands.

Initiatives

- Convene a workshop to bring together experts to evaluate current methods, available data, and the level of certainty required to determine how OSP, carrying capacity and maximum net productivity estimates used in the depleted designation can be evaluated for application to the current population.
- Assess whether the upper and lower bounds of the range of OSP have changed, and how any changes in carrying capacity can be explained (causes), and how changes could affect recovery projections and expectations.

3.D.2 Continue and regularly evaluate environmental data collected by the, Indigenous Sentinels Network

Work done since 2007

- St. Paul and St. George ECOs conduct environmental and wildlife surveys as part of the Indigenous Sentinels Network (e.g., timing of arrival and departure, winter presence/absence survey).

Initiatives

- Continue to promote, expand, and standardize data collection, including expansion of St. George ECO data collection as feasible
- Prepare annual summaries of Indigenous Sentinels Network data for Co-Management Council Review (ECOs, supported by NMFS).

- Evaluate 5-year patterns/trends in Indigenous Sentinels Network data and report independently or utilize in relevant conservation actions or initiatives (ECOs, supported by NMFS).
- Continue to expand the Indigenous Sentinels Network to other locations as practical; AMMC began using this platform for the Aleutian region in 2023, and St. George plans to begin using it in 2024.

3.D.3 Compile and evaluate existing physical environmental data as it relates to northern fur seal prey distribution and abundance

Work done since 2007

- Participated in development of the Marine Mammal Climate Vulnerability Assessment (Lettrich et al. 2019).
- Evaluations of Bering Sea cold pool and “marine heatwaves” using Lenfest and ACLIM2 models.
- Completed research on relationships between oceanographic features, prey aggregations, and foraging behavior of fur seals (Kuhn 2011; Pelland et al. 2014; Sterling et al. 2014; Joy et al. 2015).
- Followed a fur seal while recording oceanographic conditions and mapping prey abundance and depth distribution using Saildrones (Kuhn et al. 2020).
- Assessed maternal foraging trip duration as an indication of foraging and reproductive success for rookeries as it relates to ocean bottom temperatures and prey distribution (Merrill et al. 2021).
- Studied prey patch patterns and how they predict habitat use of fur seals (Benoit-Bird et al. 2013a).

Initiatives

- Compile and evaluate the utility of existing oceanographic, climate, and environmental data for the Bering Sea and North Pacific Ocean.

3.D.4 Select and evaluate appropriate environmental indices

Work done since 2007

- Ongoing evaluations of Bering Sea cold pool and “heatwaves” using Lenfest and ACLIM2.
- AFSC has published annual Ecosystem Status Reports for the Eastern Bering Sea and Aleutian Islands (Eastern Bering Sea 2023 and Aleutian Islands 2023)
- Provided evidentiary support for winds and ocean currents as environmental indices relative to movement for fur seal pups (Johnson et al. 2021a).
- Weather effects of fur seal pup entry into migration (Pelland et al. 2024).
- Determined maternal foraging trip duration as it relates to ocean bottom temperature and prey distribution shifts (Merrill et al. 2021).

Initiatives

- Select the most appropriate environmental indices (based on Action 3.D.3) and initiate periodic, long-term sampling programs to detect changes and monitor trends in key components and characteristics of essential fur seal habitats.

3.D.5 Quantify environmental effect on fish stocks and fur seal behavior, foraging, and productivity

Work done since 2007

- Assessed how physical oceanographic features aggregate fur seal prey and affect fur seal diving behavior (Kuhn 2011).
- Investigated the relationship between fishery catches of pollock and first year survival of fur seals (Short et al. 2021).
- Evaluated fur seal population size and behavior effects in relation to prey abundance (Kuhn et al. 2014a; Kuhn et al. 2014b; Kuhn et al. 2015).
- Explored how female and pup metabolic rates, body size, and lactation duration may be affected by trip duration in response to reductions in prey availability (McHuron et al. 2022).

Initiatives

- Utilize data from Action 3.D.3 to examine pup survival, condition, weaning, and migratory behaviors.
- Utilize data from Action 3.D.3 to examine lactating female survival, condition, foraging behavior, weaning, reproduction, and migratory behaviors.
- Determine ecosystem linkages between fur seals, other top predators, and the dynamics of commercial and non-commercial prey species (e.g., osmerids, cephalopods).

3.D.6 Conduct northern fur seal ecosystem modeling

Work done since 2007

- Developed bioenergetic models of fur seal year-specific consumption of walleye pollock to inform future multi-species stock assessment models (McHuron et al. 2020).
- Ongoing evaluations of Bering Sea cold pool and “heatwaves” using Lenfest and ACLIM2 models.
- Assessed the influences of prey availability and energy gained from foraging on the behavior and reproductive success of fur seals (McHuron et al. 2022).

Initiatives

- Determine and undertake studies and ecosystem modeling as necessary to understand the outcomes of implementation of Objective 3, Actions 3.A.2, 3.C.2, 3.C.3, 3.D.3, 3.D.4, 3.D.5, and Objective 2, Actions 2.F.1 and 2.F.2 to identify critical data gaps, or to address the extent and magnitude of natural changes or long-term trends in the marine ecosystem throughout the northern fur seal range.

Objective 4. Coordinate and assess the implementation of the Conservation Plan.

4.A. Coordinate implementation of the Conservation Plan

Work done since 2007

- NMFS continued to support the position of the Pribilof Program Manager as the Conservation Plan coordinator.
- NMFS hired an additional biologist to assist in implementation of the Pribilof Program.

Initiatives

- NMFS should align coordination and implementation of the conservation actions outlined in this Plan as follows:
    - Pribilof Islands Program staff (based in the Alaska Regional Office) will continue to coordinate implementation of the Conservation Plan and will annually assess and report on the implementation of the Conservation Plan, in order to parallel the policy to report on the implementation of ESA Recovery Plans.
    - The Pribilof Program Manager, in collaboration with Tribal co-managers, will coordinate the preparation of an Eastern Pacific stock status review every 5 years to establish the need for a revision to the Conservation Plan.
    - The Pribilof Program Manager acts as the principal agency representative on St. Paul and St. George islands.
    - The Pribilof Program Manager will maintain responsibility for determining whether federal actions that trigger Endangered Species Act Section 7 consultations might have relevance to northern fur seals, and take action as appropriate.
    - The Assistant to the Pribilof Program (also based in the Alaska Regional Office) assists and supports in the responsibilities described above. The Assistant acts in the capacities described here, secondary to or in the absence of the Pribilof Program Manager.
    - Conduct an assessment of natural and human-caused threats to the Eastern Pacific stock using expert elicitation and/or quantitative methodology to rank and prioritize threats according to magnitude of their potential contributions to population decline. This will guide conservation planning and prioritization of conservation objectives for the next revision of the Plan, as well as guide management decisions in the interim.

4.B. Develop and implement education and outreach programs

Work done since 2007

- NMFS provided Alaska Native Science and Engineering Program internships in 2010–2012 and 2019.
- St. Paul ECO has hosted youth interns annually.

- St. Paul ECO has coordinated Bering Sea Days from 2007–2019 (education and outreach activities in the local pre-K-12 school); NMFS has participated most years.
- St. Paul ECO has hosted youth interns annually, has brought youth to traditional harvests for hands-on learning experiences, and hosted traditional foods and science camps (2007–present).
- St. Paul ECO posts Public Service Announcements and other announcements as needed and reports to community members annually.
- Coordinated with the Pribilof School District to participate in NOAA Summer Camp at Seattle Aquarium in some years.
- Conducted regular outreach to NPFMC.

Initiatives

- The Pribilof Program Manager must coordinate the education of and outreach to the affected public to successfully implement management actions.
- The Pribilof Program Manager will provide information to regional Fishery Management Councils, enforcement agencies, state agencies, researchers, and other stakeholders of emerging issues.
- Continue formal outreach engagement with the aquaria housing fur seals post pandemic.
- Provide targeted outreach to the tourism industry on islands regarding regulations.

4.C. Develop and promote international conservation efforts

4.C.1 Develop bilateral or multilateral research and conservation agreements

Work done since 2007

- NMFS collaborated with the Mega-move initiative.
- NMFS participated in various international groups to conserve marine mammals including: North Pacific Marine Science Organization, International Union for Conservation of Nature, Bering Sea Working Group, etc.
- NMFS worked with scientists and managers from other countries where northern fur seals are found to obtain population abundance estimates and other information about international populations to support conservation actions and initiatives.
- St. Paul ECO has participated in various international Indigenous groups to learn from and support conservation actions and initiatives regarding northern fur seals and other marine mammals internationally.

Initiatives

- NMFS should explore developing agreements (through Commerce and State Departments) to coordinate conservation and research efforts for northern fur seals with Canada, Russia, Japan, and other countries as appropriate.
- Continue work with scientists and managers from other countries where fur seals are found to obtain population abundance estimates and other information about those populations to support conservation.

- Send the approved Conservation Plan and implementation schedule to appropriate agencies and organizations in Canada, Russia, and Japan.
- Promote collaborative research programs to examine interchange of animals between areas and to compare biological characteristics and population parameters among regions.
- Consider management issues including adequacy of protective regulations, and mechanisms for allocating allowable take of fur seals between jurisdictions.

4.C.2 Identify and evaluate illegal, unreported, and unregulated fisheries

Work done since 2007

- NMFS shares information and data with international collaborators (e.g., providing genetic data and tissue samples for the purpose of identifying the stock of origin for northern fur seal bycatch).
- NMFS international affairs continues to work to stop Illegal, Unreported, and Unregulated fisheries.

Initiatives

- Coordinate among NMFS offices (i.e., Office of International Affairs, Trade, and Commerce) to share information regarding the characterization of illegal take of fur seals.
- Identify and participate with international collaborators/meetings/workshops tasked with assessing threats to marine species with emphasis on fur seal habitat outside our Exclusive Economic Zone.

4.D. Enforce existing regulations

Work done since 2007

- Reported violations of existing laws and regulations (e.g., tour vessels, dog on island) to NOAA Office of Law Enforcement (OLE).
- ECO monitors rookery trespass (rookery patrols), surveillance, and annual reporting to Alaska Regional Office (which reports specific incidents to OLE as needed).

Initiatives

- NOAA and the Tribes should investigate violations in a timely fashion.
- NOAA should improve outreach and communication to the communities regarding enforcement.
- NOAA and ACSPI should continue to cooperate on regulation and enforcement in accordance with Section VIII of the Co-management Agreement between ACSPI and NMFS.

Implementation Schedule

This implementation schedule provides a priority rating, anticipated duration/frequency, and annual cost for each conservation action identified in this revised Conservation Plan. NMFS has estimated the costs to implement these actions over the five fiscal years subsequent to finalization of the current Plan. An annual inflation adjustment of 7 percent has been included to reflect the reality of the marketplace. As these are only estimates, actual costs for specific projects may vary from those indicated here.

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
1.A	**Improve understanding of the sources, fates, and effects of marine debris**								
1.A.1	Assess entanglement rates and continue disentanglement programs to reduce mortality and harm to fur seals entangled in marine debris	2	Annual	75	75	75	75	75	
1.A.2	Survey and remove marine debris in northern fur seal habitats	2	Annual	40	40	40	40	40	
1.A.3	Develop and implement efforts to support education to reduce and prevent marine debris	1	Triennial	20			20		

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
1.B	**Improve assessments of incidental take of fur seals in commercial fishing operations**								
1.B.1	Implement and evaluate fishery and marine mammal observation programs in the North Pacific Ocean and Bering Sea	2	Annual	2.F.2	2.F.2	2.F.2	2.F.2	2.F.2	Alaska Marine Mammal Observer Program costs amortized among all marine mammal programs to be implemented by AFSC
1.C	**Evaluate subsistence use**								
1.C.1	Monitor and manage subsistence uses	1	Annual	100	100	100	75	50	Regulatory change anticipated in 2025
1.C.2	Develop, implement, and analyze data from subsistence use sampling programs	2	Biennial	50		50		50	
1.C.3	Identify, evaluate, authorize, and co-manage subsistence use of northern fur seals in other coastal regions of Alaska	2	Biennial	15		15		15	

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
2.A	**Increase implementation of co-management agreements with Tribal Governments and Alaska Native Organizations**	1	Annual	350	350	350	350	350	Alaska Native Organization Co-management funding program + Existing staff
2.B	**Advise and consult with the relevant action agencies and industries to ensure taking is authorized and effects are minimized**	1	Annual	4.A	4.A	4.A	4.A	4.A	Existing staff work
2.C	**Conduct studies to quantify effects of human activities near terrestrial fur seal habitats**	2	Periodically	50	50		50	50	Costs depend on development
2.D	**Undertake conservation or management measures as necessary to eliminate or minimize adverse effects on fur seals or their habitat**								

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
2.D.1	Develop oil spill response plans and mitigation strategies specific to terrestrial habitat used on the Pribilof Islands and Bogoslof Island and at-sea habitats used for foraging and migration	2	Periodically		50	50			Existing staff work + Contract work for modeling
2.D.2	Develop habitat conservation measures and manage access to fur seal breeding and resting areas on the Pribilof Islands	2	Periodically		50				Existing staff work depends on project
2.E	**Assess and monitor pollutants**								
2.E.1	Compile and evaluate existing data	1	Every 5 years					20	Existing staff work
2.E.2	Monitor and study environmental pollutant exposure	2	Periodically		50		50		
2.E.3	Evaluate and document unusual mortality of northern fur seals	3	Every 5 years			25			Existing staff work + Marine Mammal Health & Stranding Program

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
2.F	**Quantify relationships between northern fur seals and fisheries**								
2.F.1	Assess interactions between fur seal prey resource use and fisheries	1	Annual	150	150	150	150	150	Existing staff work
2.F.2	Report fishery interactions	1	Annual	20	20	20	20	20	Fisheries observers costs are shared over multiple marine mammal species and fisheries + Existing staff
3.A	**Monitor and study changes in northern fur seal populations**								
3.A.1	Estimate Eastern Pacific stock vital rates	1	Annual	150	150	150	150	150	MML + Resighting contract + Existing staff
3.A.2	Continue regular counts of adult males and estimates of pup production on St. Paul, St. George, and Bogoslof* islands	1	Biennial	100	20	100	100	100	MML + Alaska Regional Office existing staff + Image analysis contract
3.A.3	Monitor and study changes in diet, foraging behavior, and physiology	2	Annual	150	150	150	150	150	Fish Identification Contract + Tags

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
3.A.4	Promote joint research and collaborative programs	1	Annual						MML + Alaska Regional Office existing staff time + External partners
3.B	**Improve assessment of the effects of disease**								Marine Mammal Health & Stranding Program
3.B.1	Compile and evaluate existing data	2	Periodically		25		25		Marine Mammal Health & Stranding Response Program + One Health + Existing staff
3.B.2	Analyze samples and mitigate disease effects	2	Periodically	20		20		20	Analyze annually as needed
3.B.3	Continue management programs to prevent disease transmission to northern fur seals from other species	2	Periodically						As needed
3.C	**Describe and monitor fur seal habitats and occupancy of those habitats**								
3.C.1	Compile and evaluate available terrestrial habitat-use data	3	Annual						Existing staff time

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
3.C.2	Compile and evaluate available at-sea habitat-use, food habits, and available fish resource data	1	Annual	25	25	25	25	25	Modeling contract
3.C.3	Conduct oceanographic and fish surveys related to pelagic fur seal habitat use	1	Annual						AFSC fishery stock assessment
3.D	**Identify and evaluate ecosystem changes**								
3.D.1	Evaluate Optimum Sustainable Population, carrying capacity, and maximum net productivity	1		50				50	
3.D.2	Continue and regularly evaluate environmental data collected by Indigenous Sentinels Network Program for the Pribilof Islands	2	Annual	2.A	2.A	2.A	2.A	2.A	Existing staff time + Data collection costs captured in 2.A
3.D.3	Compile and evaluate existing physical environmental data as it relates to northern fur seal prey distribution and abundance	1	Every 5 years preceding 3.D.1		50				

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
3.D.4	Select and evaluate appropriate environmental indices	1		3.D.1				3.D.1	
3.D.5	Quantify environmental effect on fish stocks and fur seal behavior, foraging and productivity	1	Every 5 years preceding 3.D.1			150			
3.D.6	Conduct northern fur seal ecosystem modeling	1	Every 5 years preceding 3.D.1				100		
4.A	**Coordinate implementation of the Conservation Plan**	3	Annual	150	150	150	150	150	Existing Pribilof Program staffing
4.B	**Develop and implement education and outreach programs**	2	Annual	25	25	25	25	25	Existing staff time
4.C	**Develop and promote international conservation efforts**								
4.C.1	Develop bilateral or multilateral research and conservation agreements	2	Every 5 years					50	Existing staff time

Action				Estimated Fiscal Year Costs (thousands of $)					Comments
#	Title	Priority	Duration/ Frequency	FY 1	FY 2	FY 3	FY 4	FY 5	
4.C.2	Identify and evaluate illegal, unreported, unregulated fisheries	1	Annual	15	15	15	15	15	Existing staff time
4.D	**Enforce existing regulations**	1	Annual	50	50	50	50	50	Existing staff time + Office of Law Enforcement
Total costs				1605	1595	1710	1620	1605	
Inflation Adjustment (7% of total)					112	120	113	112	

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Appendix I: Co-management Agreement with ACSPI

[PDF saved to Google Drive. Electronic copy available at https://media.fisheries.noaa.gov/dam-migration/nfs-st-paul-comanagement-agreement-2020.pdf]

Appendix II: Co-management Agreement with TCSGI

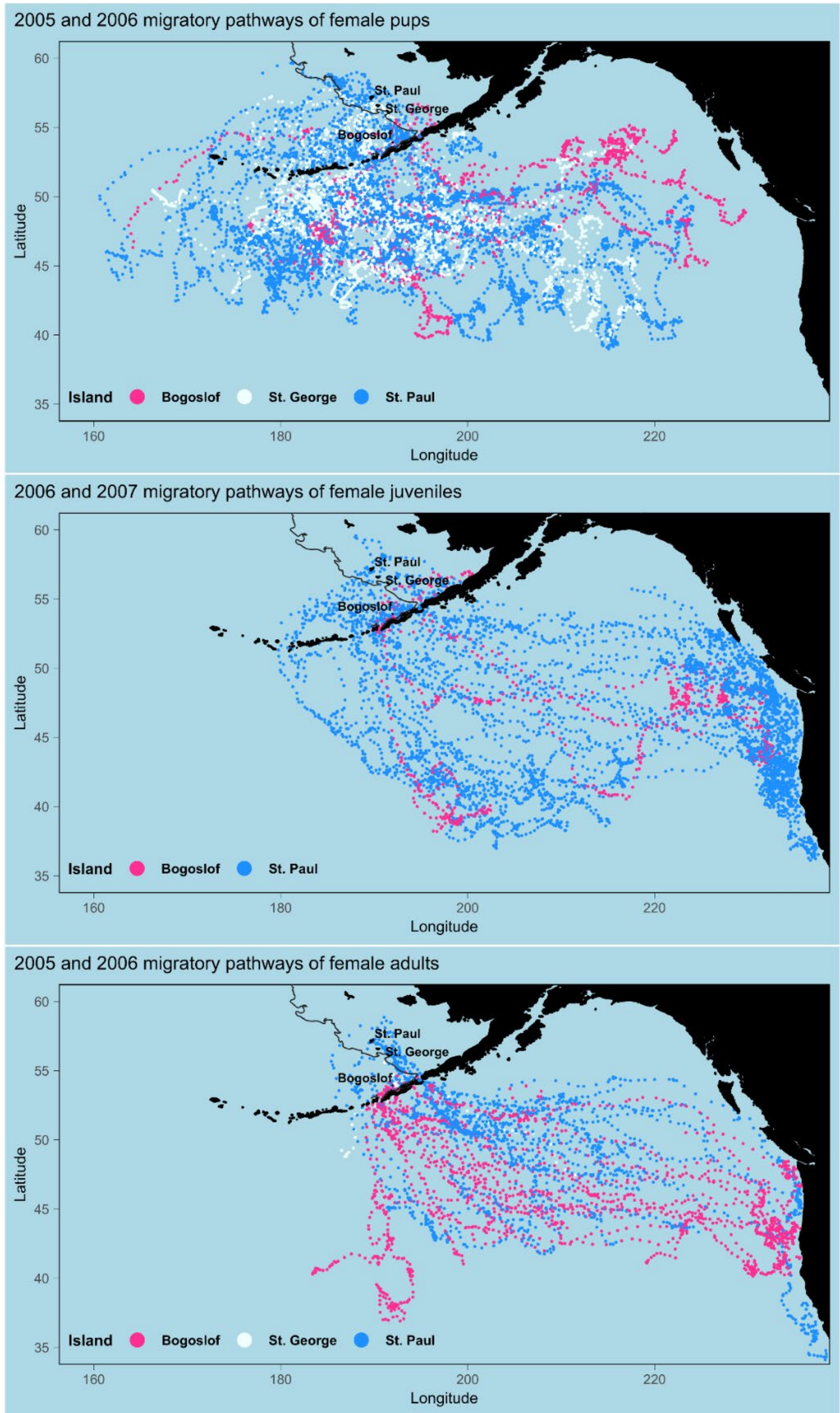
[PDF saved to Google Drive. Electronic copy available at https://media.fisheries.noaa.gov/dam-migration/01stgeorgeagreement-akr.pdf]

Appendix III: Co-management Agreement with AMMC

[PDF saved to Google Drive. Electronic copy available at https://media.fisheries.noaa.gov/dam-migration/ammc06-akr.pdf]

Appendix IV: Migration and Performance Measures Analyses for the Eastern Pacific Stock of Northern Fur Seals

In Appendix IV Table 1, we summarize 34 years of data collection (1988–2022) since the northern fur seal population was designated as depleted under the MMPA (53 FR 17888, May 18, 1988). We have further divided the entire depleted period into a recent period (2007–2022) aligned with the revision of the Conservation Plan in 2007 to explore whether recent trends are different from those of the entire period. The initial stock designation identified fur seals breeding on the Pribilof Islands as the depleted stock independent of those breeding on the western side of the Bering Sea and North Pacific Ocean and San Miguel Island. The first observations of breeding fur seals on Bogoslof Island occurred in the early 1980s and with the growth of the population augmented by emigration through the 1990 and early 2000s, it was determined that the Bogoslof population would be included with those fur seals breeding on the Pribilof Islands stock into the Eastern Pacific stock.



Appendix IV Figure 1. (A) 2005–2006 winter migration of northern fur seal female pups, (B) 2006–2007 female juveniles, and (C) 2005–2006 female adults. Colors represent islands of departure for Eastern Pacific stock: pink=Bogoslof, white=St. George, and blue=St. Paul Islands. Note that sampling was not consistent among the three Eastern Stock islands within each year.

Appendix IV Table 1. Summarizes Pribilof Island rookery complex-specific pup production trends, August female pup weights and on-land mortality estimates, and July and August adult female trip durations during two different periods, 1988–2022 and 2007–2022. Additionally, the table includes percent frequency of occurrence and percent minimum number of individual pollock reported in the diet of adult female fur seals (from Table 2 in Zeppelin and Ream 2006) for each Pribilof Island rookery complex. Percent frequency of occurrence of walleye pollock (*Gadus chalcogrammus*) at Bogoslof Island was provided by the NMFS Marine Mammal Lab for the years 1997, 2001, 2002, 2005, 2007, 2011. Performance Plot column uses the pup production annual percent change shown in the first two rows as the x-axis with the estimated mean values as the y-axis.

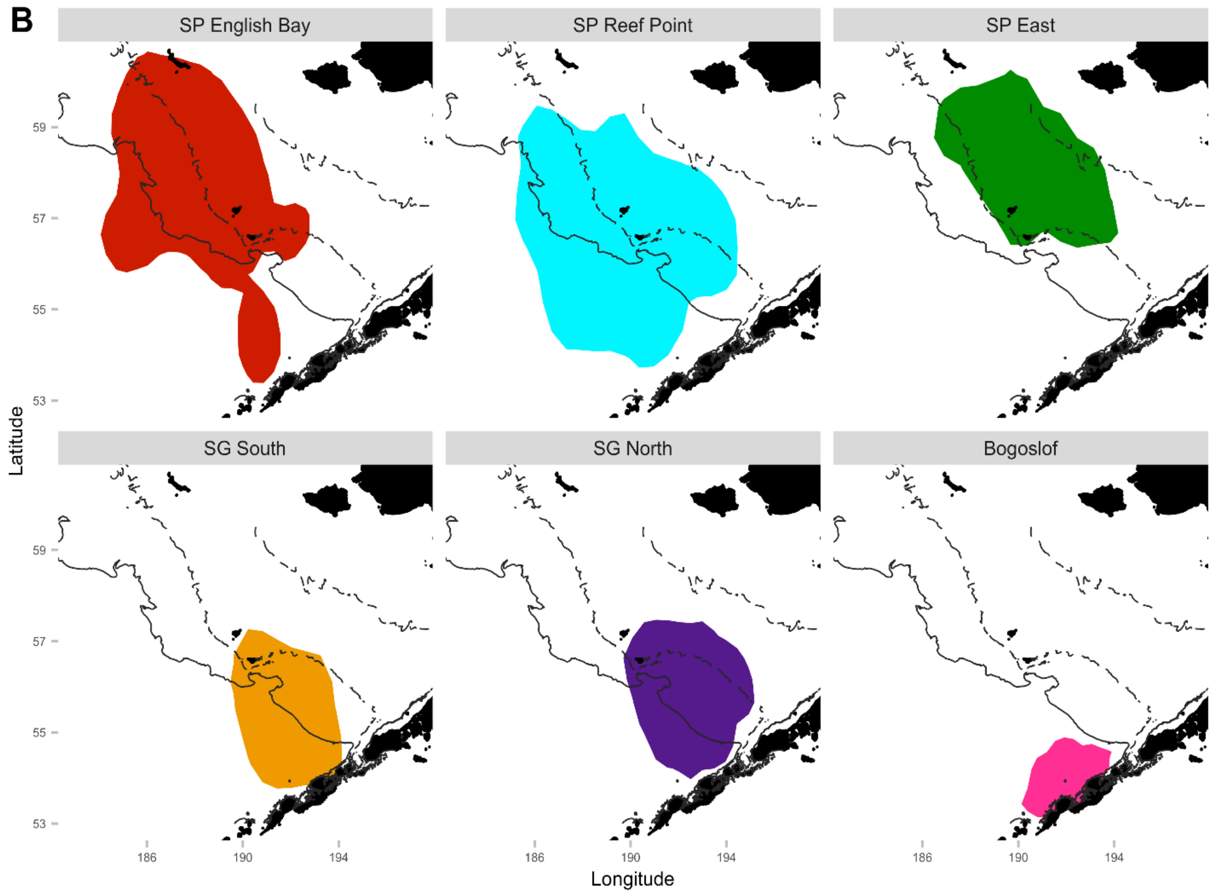
A

Eastern Pacific Stock northern fur seal population performance measures

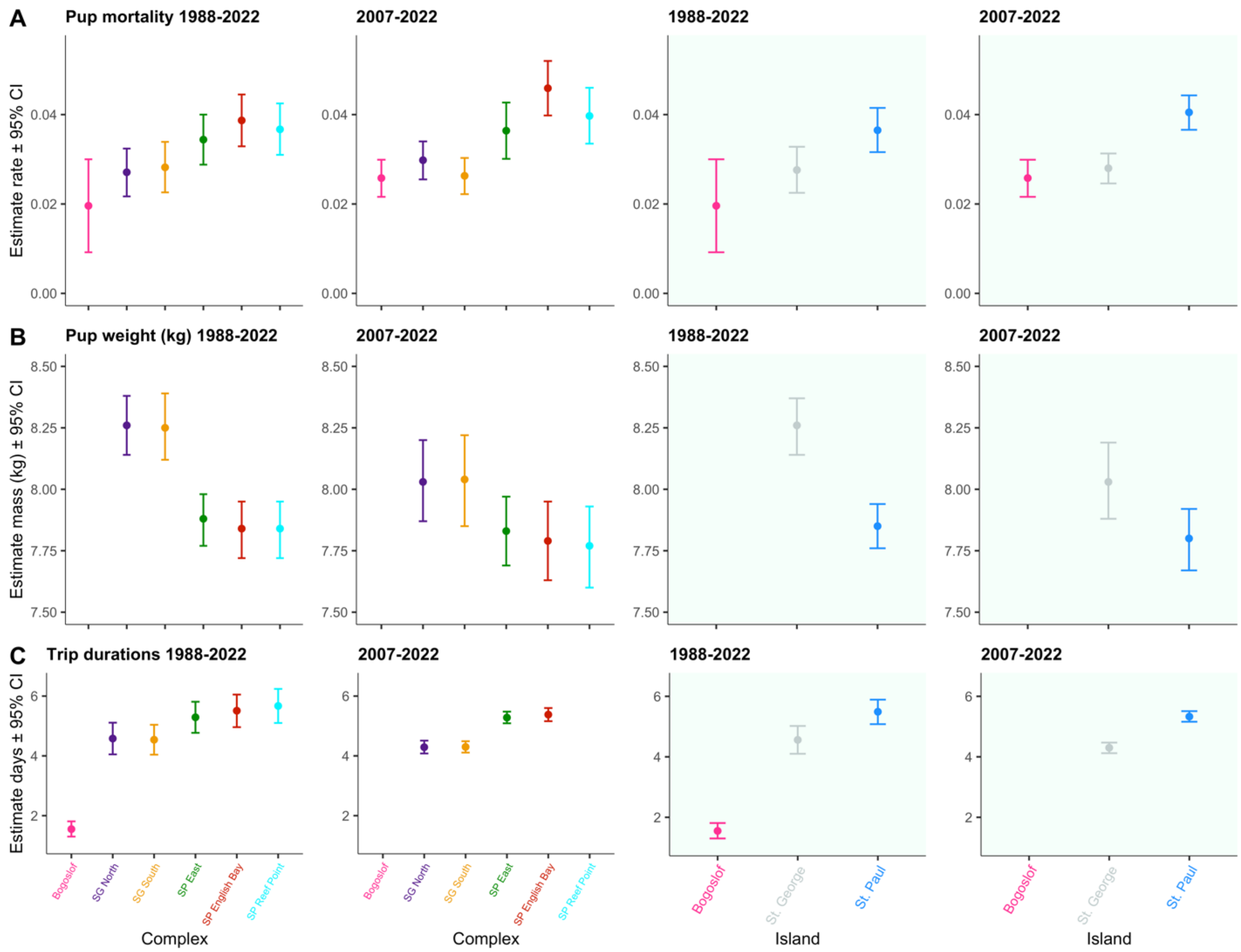
By Pribilof Island rookery complexes and islands for the years 1988-2022 and 2007-2022

	Eastern Pacific Stock islands			Pribilof Island rookery complex					
	St. Paul (±SE)	St. George (±SE)	Bogoslof (±SE)	SP English Bay (±SE)	SP Reef Point (±SE)	SP East (±SE)	SG South (±SE)	SG North (±SE)	Performance Plot
Pup production (annual % change)									
1988-2022	-3.43	-0.45	9.58	-4.47	-3.21	-2.68	-0.96	-0.21	
2007-2022	-3.17	2.67	5.77	-4.92	-3.22	-1.85	1.12	3.49	
Aug female pup weight (kg)									
1988-2022	7.85 (0.05)	8.26 (0.06)		7.84 (0.06)	7.84 (0.06)	7.88 (0.05)	8.25 (0.07)	8.26 (0.06)	
2007-2022	7.80 (0.06)	8.03 (0.08)		7.79 (0.08)	7.77 (0.08)	7.83 (0.07)	8.04 (0.09)	8.03 (0.08)	
Aug on-land pup mortality (%)									
1988-2022	3.65 (0.30)	2.76 (0.30)	1.96 (0.50)	3.87 (0.30)	3.67 (0.30)	3.44 (0.30)	2.82 (0.30)	2.71 (0.30)	
2007-2022	4.05 (0.20)	2.80 (0.20)	2.58 (0.20)	4.59 (0.30)	3.97 (0.30)	3.64 (0.30)	2.63 (0.20)	2.98 (0.20)	
Jul/Aug foraging trip durations (d)									
1988-2022	5.49 (0.21)	4.56 (0.23)	1.55 (0.13)	5.51 (0.28)	5.67 (0.29)	5.29 (0.26)	4.54 (0.26)	4.58 (0.27)	
2007-2022	5.33 (0.09)	4.30 (0.09)		5.38 (0.11)		5.28 (0.10)	4.30 (0.10)	4.29 (0.11)	
Walleye pollock in the diet (Zeppelin & Ream 2006)									
%MNI	79.00	22.60		76.40	67.00	74.80	10.40	32.20	
%FO	70.52	59.19	8.70[†]	74.80	67.00	68.60	45.60	65.70	

[†] Luxa, K. pers. comm. (Summary of Bogoslof collections from 1997, 2001, 2002, 2005, 2007, 2011)



Appendix IV Figure 2. Summarizes Pribilof Island rookery complex-specific home range maps showing adult female foraging habitat for each of the five Pribilof Island complexes as well as Bogoslof Island (added from Figure 7B). Methods for producing the table are described below.



Appendix IV Figure 3. Results from the performance measure in Appendix IV Table 1. Each row represents each performance measure (A = pup mortality, B = female pup weight, C = adult female trip durations) analyzed by rookery complex and island (shaded background) and over the two periods (1988–2022 and 2007–2022).

Methods

Field methods for estimating pup production, counts of dead pups, and collecting pup weights can be found in Fur Seal Investigations[18]. The time periods were chosen based on the entire period of the depleted designation (1988–2022), and a reduced period from 2007–2022 associated with the timing of the second revision of Conservation Plan (NMFS 2007).

[18] https://www.fisheries.noaa.gov/alaska/marine-mammal-protection/alaska-fur-seal-investigations-decade

On-Land Pup Mortality Rates

In 19 of the 35 years from 1988–2022, on-land pup mortality surveys were conducted in approximately the third week of August on the Pribilof Islands (between 11 August and 4 September with a median sampling date of 20 August). Four opportunistic surveys were completed on Bogoslof Island (see sampling in Appendix IV Table 2). We estimated on-land pup mortality rates for each island and foraging complex using generalized linear mixed models for the two different sampling periods of 1988–2022 and 2007–2022. However, the nested random effects in the models differed between the two sampling periods as a result of limited observations within a complex and some rookeries only having a single observation in the latter sampling period. For both sampling periods, island was included as a fixed effect while nested random effects in the 1988–2022 sampling period included rookery complex, rookery, and year. The 2007–2022 sampling period only included rookery complex. Standard errors and confidence intervals were produced by bootstrap sampling model parameters. All analyses were conducted in R statistical software version 4.2.2. Sample sizes in each year and from each complex are show below in Appendix IV Table 2.

Appendix IV Table 2. Sampling of dead pups grouped by year and by Eastern Pacific stock complex used for Appendix IV Table 1 pup mortality analyses.

Eastern Pacific Stock northern fur seal pup mortality sampling 1988-2022

Number of rookeries surveyed for dead pups within each foraging complex

	Eastern Stock foraging complex					
	Bogoslof	SG North	SG South	SP East	SP English Bay	SP Reef Point
1988	-	4	2	2	2	-
1989	-	-	-	2	-	2
1990	-	4	2	6	4	3
1992	-	4	2	6	4	3
1994	-	4	2	6	4	3
1996	-	4	2	3	3	-
1997	1	-	-	-	-	-
1998	-	4	2	3	1	3
2000	-	4	2	3	2	1
2002	-	4	2	6	4	3
2004	-	4	2	7	4	3
2006	-	2	1	2	1	1
2008	-	2	1	2	1	1
2010	-	2	1	2	1	1
2011	1	-	-	-	-	-
2012	-	2	1	2	1	1
2014	-	2	1	2	1	1
2015	1	-	-	-	-	-
2016	-	2	1	2	1	1
2018	-	2	1	2	1	1
2019	1	-	-	-	-	-
2021	-	-	-	2	2	1
2022	-	2	1	2	1	1

Pup Weights

NMFS has standardized sampling of pup weights during the third week of August coincident with the seasonal period when pup production is estimated. Pup weights are not sampled on Bogoslof Island, and weights collected in 1993 on St. George Island were not selected due to sampling dates occurring too early in the season. Both male and female pups were weighed, and female pups have been selected based on the critical role of female versus male fur seals in reproduction (Gentry 1998).

In 22 of the years between 1988 and 2022, 17,991 female pups were weighed from the five Pribilof Island rookery complexes shown in Figure 7 (see Appendix IV Table 1). The median date of weighing was 24 August with sampling dates ranging from 16–31 August. To account for pup growth across the sampling dates, observed weights were adjusted to 24 August by adding the multiple of the difference in sampling days from 24 August and a constant daily female pup growth rate of 67.63 grams day^{-1}. The value of 67.63 grams day^{-1} was the average growth rate of 56 female pups monitored on the Pribilof Islands in 1985, 1995, 1996, 2005, 2006, 2016, and 2017 and is similar to the value reported by Gentry (1998, p. 242) of 66 grams per day.

We estimated female pup weights (adjusted to 24 August) for each island and rookery complex using linear mixed models, with island included as a fixed effect and nested random effects specified to appropriately account for uncertainty between rookery complex, rookery, and year (i.e., variability in measurements between groups). Pup weights were log-transformed prior to model fitting and data for two overlapping time periods, 1988–2022 and 2007–2022, analyzed separately. Standard errors and confidence intervals were produced by bootstrap sampling model parameters. All analyses were conducted in R statistical software version 4.2.2. Number of female pups weighed in each year and from each rookery complex are show below in Appendix IV Table 3.

Appendix IV Table 3. Number of sampling sites and total number of female pups weighed, grouped by year and Pribilof Island rookery complex.

Eastern Pacific Stock northern fur seal pup weight sampling 1988-2022

Number of sampling sites and total number of female pups weighed in each complex

	Pribilof Island rookery complex				
	SG North	SG South	SP East	SP English Bay	SP Reef Point
1988	-	-	6 (375)	4 (514)	3 (184)
1989	-	-	6 (367)	4 (669)	3 (125)
1990	-	-	6 (513)	4 (274)	2 (124)
1992	4 (177)	2 (113)	2 (263)	1 (115)	1 (116)
1994	4 (299)	2 (131)	2 (503)	1 (205)	1 (217)
1995	4 (182)	2 (111)	2 (467)	1 (211)	1 (169)
1996	4 (203)	2 (128)	2 (224)	1 (185)	1 (111)
1997	4 (210)	2 (101)	2 (243)	1 (131)	1 (121)
1998	4 (233)	2 (111)	2 (225)	1 (169)	1 (112)
1999	-	-	2 (213)	1 (115)	1 (134)
2000	4 (190)	2 (102)	2 (273)	1 (135)	1 (134)
2001	-	-	2 (251)	1 (127)	1 (132)
2002	4 (204)	2 (96)	2 (211)	1 (107)	1 (106)
2004	4 (191)	2 (88)	2 (250)	1 (103)	1 (136)
2006	4 (216)	2 (88)	2 (241)	1 (90)	1 (115)
2008	4 (208)	2 (90)	2 (285)	1 (91)	1 (124)
2010	4 (188)	2 (115)	2 (246)	1 (115)	1 (111)
2014	2 (148)	1 (64)	2 (224)	1 (109)	1 (129)
2016	2 (138)	1 (88)	2 (263)	1 (112)	1 (151)
2018	2 (150)	1 (77)	2 (259)	1 (113)	1 (127)
2021	-	-	2 (271)	1 (104)	1 (110)
2022	2 (192)	1 (65)	2 (285)	1 (121)	1 (139)

Foraging Trip Duration

We summarize 3,541 foraging trip durations measured from 403 lactating northern fur seals over 13 years. These data were standardized and merged from published studies (Goebel 2002; Springer et al. 2010; Merrill 2019; Merrill et al. 2021) and unpublished research. Only years with trips in both July and August were selected, in part to capture the known seasonal changes in foraging trip durations from July to August, and also to match the seasonal sampling of dead pups, pup weights, and pup production surveys (see sampling in Appendix IV Table 3). We estimated female July and August foraging trip durations for each island and rookery complex using linear mixed models, with island included as a fixed effect and nested random effects specified to appropriately account for uncertainty between rookery complex, year, and seal (i.e., variability in measurements between groups). Foraging trip durations were log-transformed prior to model fitting and data for two overlapping time periods, 1988–2022 and 2007–2022, analyzed separately. Standard errors and confidence intervals were produced by bootstrap sampling model parameters. All analyses were conducted in R statistical software version 4.2.2. Number of adult females and average number of trips recorded per female in each year and from each Eastern Pacific stock complex are show below in Appendix IV Table 4.

Appendix IV Table 4. Number of adult females and the average number of trips per seal monitored in each year and in each Eastern Pacific stock rookery complex.

Eastern Pacific Stock northern fur seal foraging trip duration sampling 1988-2022

Number of seals/average number of trips per seal within each foraging complex

	Eastern Stock foraging complex					
	Bogoslof	SG North	SG South	SP East	SP English Bay	SP Reef Point
1995	-	-	-	8/3.2	12/4.1	12/4.1
1996	-	29/5.0	12/4.8	-	-	-
2005	20/10.6	-	-	10/5.2	-	10/4.8
2006	20/13.9	-	-	9/5.6	-	10/4.8
2014	-	-	-	19/5.3	-	-
2015	-	-	-	13/6.5	-	-
2016	-	-	-	38/5.1	-	-
2017	-	22/6.7	33/7.3	32/5.1	10/5.1	-
2018	-	7/7.3	24/7.3	30/5.4	23/5.9	-
2019	-	4/7.8	20/7.2	25/3.9	11/5.8	-
2020	-	-	-	23/5.5	23/4.7	-
2021	-	-	5/5.2	23/6.1	20/5.4	-
2022	-	-	4/6.0	16/6.6	10/6.1	-

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