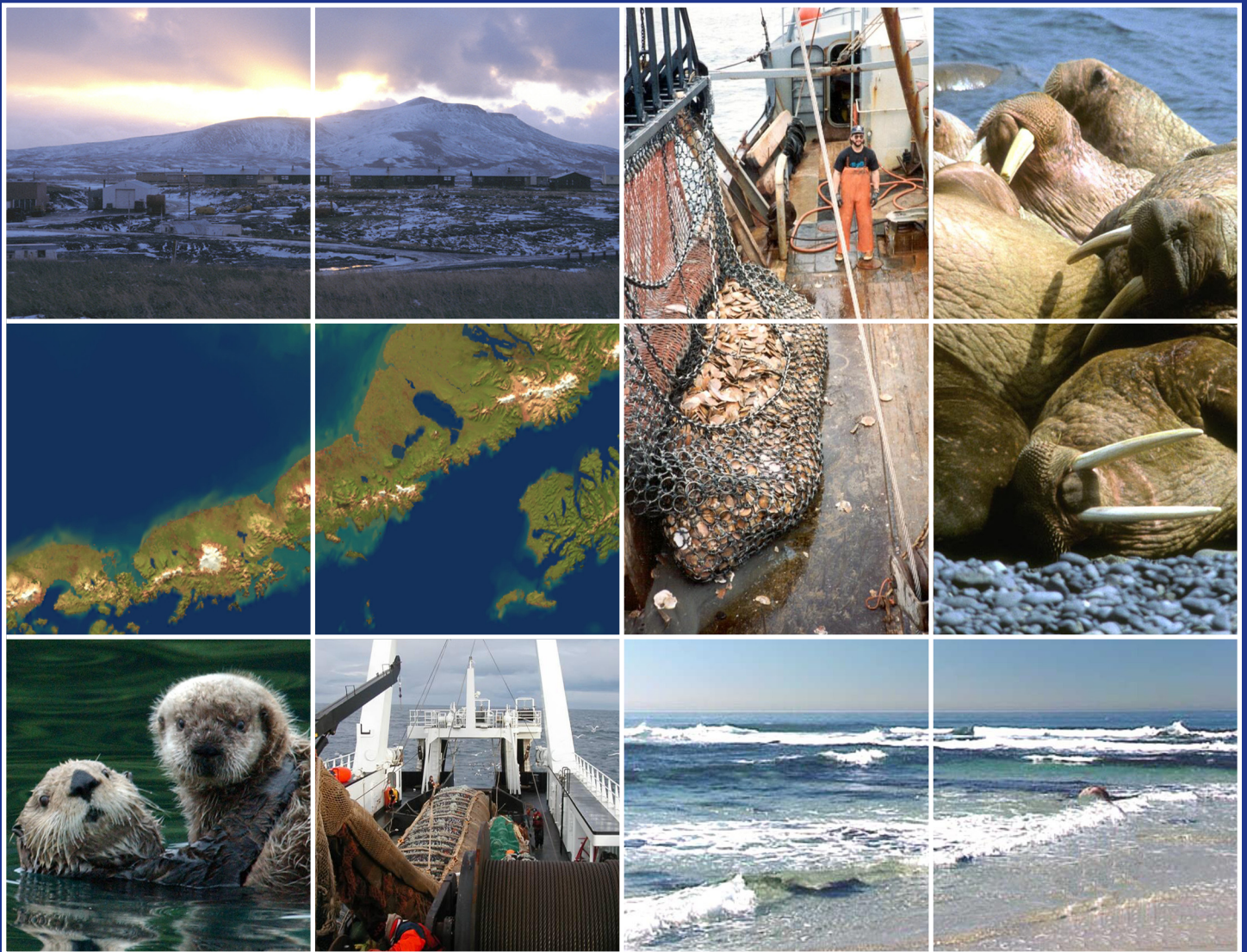


# Literature and Information Related to the Natural Resources of the North Aleutian Basin of Alaska



Minerals Management Service – Alaska Region  
U.S. Department of the Interior



Argonne National Laboratory



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**LITERATURE AND INFORMATION RELATED TO  
THE NATURAL RESOURCES OF THE NORTH ALEUTIAN BASIN OF ALASKA**

**prepared by**

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**for**

**U.S. Department of Interior  
Minerals Management Service  
Alaska Outer Continental Shelf Region  
Anchorage, Alaska**

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## NOTATION

The following is a list of the acronyms, initialisms, and abbreviations used in this document.

ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AMAP	Arctic Monitoring and Assessment Programme
Argonne	Argonne National Laboratory
ARRT	Alaska Regional Response Team
AYK-SSI	Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
BESIS	Bering Sea Impact Study
BEST	Bering Ecosystem Study
BLM	Bureau of Land Management
CIFAR	Cooperative Institute for Arctic Research
CFEC	Commercial Fisheries Entry Commission
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOI	U.S. Department of Interior
EIS	environmental impact statement
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
GIS	geographic information system
IAI	Impact Assessment, Inc.
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPRB	North Pacific Research Board
OCS	Outer Continental Shelf
UBC	University of British Columbia
USGS	U.S. Geological Survey

**LITERATURE AND INFORMATION RELATED TO  
THE NATURAL RESOURCES OF THE NORTH ALEUTIAN BASIN OF ALASKA**

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**1 INTRODUCTION**

The North Aleutian Basin Planning Area of the Minerals Management Service (MMS) is a large geographic area with significant natural resources. The Basin includes most of the southeastern part of the Bering Sea Outer Continental Shelf, including all of Bristol Bay. The area supports important habitat for a wide variety of species and globally significant habitat for birds and marine mammals, including a number of federally listed species. Villages and communities of the Alaska Peninsula and other areas bordering or near the Basin rely on its natural resources (especially commercial and subsistence fishing) for much of their sustenance and livelihood. The offshore area of the North Aleutian Basin is considered to have important hydrocarbon reserves, especially natural gas.

In 2006, the MMS released a draft proposed program, *Outer Continental Shelf Oil and Gas Leasing Program, 2007–2012* and an accompanying draft programmatic environmental impact statement (EIS). The draft proposed program identified two lease sales proposed in the North Aleutian Basin in 2010 and 2012, subject to restrictions. The area proposed for leasing in the Basin was restricted to the Sale 92 Area in the southwestern portion. The proposed final program published in April 2007 scheduled only one sale in the North Aleutian Basin in 2011. Additional EISs will be needed to evaluate the potential effects of specific lease actions, exploration activities, and development and production plans in the Basin. A full range of updated multidisciplinary scientific information will be needed to address oceanography, fate and effects of oil spills, marine ecosystems, fish, fisheries, birds, marine mammals, socioeconomics, and subsistence in the Basin.

Scientific staff at Argonne National Laboratory were contracted to assist MMS with identifying and prioritizing information needs related to potential future oil and gas leasing and development activities in the North Aleutian Basin. Argonne focused on three related tasks: (1) identify and gather relevant literature published since 1996, (2) synthesize and summarize the literature, and (3) identify and prioritize remaining information needs. To assist in the latter task, MMS convened the North Aleutian Basin Information Status and Research Planning Meeting (the Planning Meeting) in Anchorage, Alaska, from November 28 through December 1, 2006.

That meeting and its results are described in *Proceedings of the North Aleutian Basin Information Status and Research Planning Meeting* (the Planning Meeting report)<sup>1</sup>.

Citations for recent literature (1996–2006) that could provide information to support an assessment of the impacts of oil and gas development on natural, cultural, and socioeconomic resources in the North Aleutian Basin were entered in a database. The database, a series of Microsoft Excel spreadsheets with links to many of the reference materials, was provided to MMS prior to the Planning Meeting and was made available for participants to use during the meeting. Many types of references were identified and collected from the literature, such as workshop and symposium proceedings, personal web pages, web pages of government and nongovernmental organizations, EISs, books and articles reporting research results, regulatory documents, technical reports, newspaper and newsletter articles, and theses and dissertations. The current report provides (1) a brief overview of the literature; (2) descriptions (in tabular form) of the databased references, including geographic area covered, topic, and species (where relevant); (3) synopses of the contents of the referenced documents and web pages; and (4) a full citation for each reference.

At the Planning Meeting, subject matter experts with research experience in the North Aleutian Basin presented overviews of the area's resources, including oceanography, fish and shellfish populations, federal fisheries, commercial fishery economics, community socioeconomic, subsistence, seabirds and shorebirds, waterfowl, seals and sea lions, cetaceans, sea otters, and walrus. These presentations characterized the status of the resource, the current state of knowledge on the topic, and information needs related to an assessment of the effects of oil and gas development. An overview of each presentation and the presentation materials used at the meeting are provided in the Planning Meeting report. The reader should refer to that report as well as to the information presented in the current report for a more complete understanding of each resource.

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<sup>1</sup> LaGory, K.E., J.R. Krummel, J.W. Hayse, I. Hlohowskyj, E.A. Stull, and L. Gorenflo. 2007. *Proceedings of the North Aleutian Basin Information Status and Research Planning Meeting*. OCS Study MMS 2007-031, U.S. Department of Interior, Minerals Management Service, Alaska Outer Continental Shelf Region, Anchorage, Alaska.



## **2 OCEANOGRAPHY AND ECOSYSTEMS**

This overview of information on oceanography and ecosystems of the North Aleutian Basin and southeastern Bering Sea is based on a collection of about 120 reports, research papers, and web-published materials dated from 1996 to 2006. Some literature on oceanography and ecosystems for areas outside the southeastern Bering Sea is included because the information is relevant to conditions in the North Aleutian Basin. Examples are the effects of the ice edge on oceanographic parameters, oceanographic effects of climate variability, regime shift (rapid reorganization of an ecosystem from one relatively stable state to another), pollutants, and general circulation. A summary of model results related to circulation patterns, water mass distribution, and transport in the North Aleutian Basin was presented at the Planning Meeting by Wieslaw Maslowski of the Naval Postgraduate School. Application of this model to assessments of oil and gas development and information needed to improve the model were also provided.

Information on oceanography collected for the current report covers the following topics: physical oceanography (bathymetry, circulation, temperature, density, salinity, tides, and currents), chemical oceanography (nutrients and pollutants), benthos, biological oceanography (productivity, plankton, ecosystems and trophic structure), and coastal areas (shallow water, lagoons, estuaries, and islands). Table 1 summarizes the content of recent publications; full citations for these references are presented in Section 7.1.

In 1997, the bathymetry of the Bering Sea and Chukchi Sea was published by the U.S. Geological Survey (USGS), and in 2005 the USGS published a database on the coastal bathymetry that included the Bering Sea. Recent publications of circulation have included regional circulation of the Gulf of Alaska and Bering Sea, coastal currents near the Alaska Peninsula and Aleutian Islands, and more detailed studies of currents, turbulence, and fronts associated with Aleutian passes. Physical features studied include water transport, water origins, circulation (at the surface, intermediate depths, in deep waters, and over the Bering shelf), currents, gyres, fronts, tides, flow at the shelf edge, sea ice, and cold pools.

Climate and weather studies of the Bering Sea include the effects of solar radiation and temperature on sea ice and ocean circulation, and the formation of the cold pool. A sea ice atlas has been developed for Alaska and is periodically updated. Weather and climate have been evaluated in terms of biological oceanography and the organization of ecosystems. Historical data on sea surface temperatures have been studied for interannual changes in weather and climate. Modeling studies of water-column mixing have been interpreted in relation to nutrients and productivity.

Studies of physical oceanography of the Bering Sea have emphasized regional ocean circulation, primarily from data obtained in the summer. Evaluations of the potential effects of impacts from oil and gas exploration, development, and operations, as well as potential pollutant discharges, require circulation data on a relatively local scale and at all seasons of the year. More in-depth knowledge of the mechanisms of tidal effects in nearshore areas also is needed for an assessment of potential oil and gas development impacts in these nearshore areas.

Distribution and transport of nutrients (e.g., nitrogen, phosphorus, and silica), carbon, and pollutants have been studied in relation to global climate, circulation, open water currents, currents in island passes, water column mixing, the ice edge, cold pools, circulation over the shelf, and planktonic productivity. Studies of organic and inorganic pollutants in the Bering Sea have included measurements of concentrations in seawater and biota, special distribution and transport, and pathways of distribution.

A large proportion of the shorebirds of the Western Hemisphere that breed in the Arctic use the coastal lagoons on the Aleutian Peninsula as staging areas during migration. Little information is available on the tides or currents into and out of these lagoons. These lagoons are close to areas of potential future development and should be studied.

The marine biology of the Bering Sea has been studied extensively in the last five years. Bacterial and viral production, turnover rate, and mortality rate have been measured. An experimental study investigated the ability of diatoms to alter the physical property of sea ice. The distribution of dinoflagellate cysts was interpreted with respect to sea surface temperature and sea ice. Phytoplankton studies have included measurements of primary productivity of the Bering Sea shelf edge, the time series of the spring bloom along the ice edge, and development of coccolithophore populations responsible for altering water color.

Studies relating productivity to climate have identified isotopic evidence for declining primary productivity in the Bering Sea. Secondary productivity research has looked at the biomass of gelatinous zooplankton, data on composition and abundance of zooplankton and ichthyoplankton, the importance of episodic weather events, and the importance of water masses and circulation. Zooplankton in the Aleutian passes has been discussed in relation to the influence of the Alaska Stream and Alaska Coastal Current.

Ecological organization of the Bering Sea has received a great deal of attention, including the role of sea ice in organizing the ecosystem. Trophic pathways have been investigated using fatty acid signatures. However, the Bering Sea ecosystem has recently experienced changes in climate and changes resulting from unusual meteorological conditions. Biomass and diversity calculations from fishery trawl data have been used to evaluate regime shifts in the Bering Sea. An oscillating-control hypothesis has been proposed to explain changes from bottom-up control of ecosystem function in cold regimes to top-down control in warm regimes. This hypothesis has been explored with respect to planktonic and benthic production, marine mammals, and fish.

Various studies of the biological implication of regime shifts have been published. Regional atmospheric and hydrographic forcing is related to major changes in various components of the northern Bering Sea ecosystem. The effects of ecosystem change and regime status on fish population dynamics have been evaluated, emphasizing the walleye pollock (*Theragra chalcogramma*). Coordinated research efforts (e.g., the Bering Sea Ecosystem Study and the Bering-Aleutian Salmon International Survey) and workshops have been funded to study Bering Sea ecosystems, basin-shelf interactions, and regional changes associated with climate.

Studies of Bering Sea benthic environments have examined carbon cycling, the importance of echinoderms in carbon remineralization, benthic community organization,

productivity and community interactions, the effects of onshore disturbances on offshore benthic communities, and sediment oxygen demand in the St. Lawrence Island polynya. The role of the Bering Strait in benthic productivity and carbon cycling also has been evaluated.

There appear to be no recent studies of contaminants in the sediments or the benthos in the potential lease areas of the North Aleutian Basin. This information would be important in assessing and monitoring the impacts from oil and gas exploration, development, and operations. Benthic organisms of this area include important fishery species, as well as species consumed by marine birds and mammals.

Studies of the coastal areas of the Bering Sea have investigated the effects of tidal currents, fronts, and transport through Aleutian passes on zooplankton and seabirds. The impacts of sediment load from land disturbance on nearshore ice and benthic communities also have been assessed. No recent information was found on the biota of nearshore and intertidal areas of the north shore of the Alaska Peninsula. This information is needed because development of oil and gas production and transportation facilities could affect these areas, and because these areas would be the areas potentially affected by any spills that may occur.

**TABLE 1. Publications from 1996 to 2006 Related to Oceanography and Ecosystems of the North Aleutian Basin.**

Authors	Date	Location	Topic	Document Content
Abromaitis	2000	Bering Shelf	Primary productivity	This thesis discusses the primary productivity of the Bering and Chukchi Sea shelves using stable isotope ratios in seabirds.
Alexander	1999	Bering Sea	Research programs	This paper presents an overview of interdisciplinary studies of the Bering Sea ecosystems up to about 1997.
AMAP	1998a	Worldwide	Climate	This chapter presents an overview of climate change, UV-B radiation, and its effect on the biosphere in high latitudes.
AMAP	1998b	Worldwide	Pollutants	This chapter discusses the pathways of pollutant distribution in high-latitude environments.
AMAP	1998c	Worldwide	Physical	This chapter gives a general description of the physical and geographical characteristic of high latitudes.
Ambrose et al.	2001	Chukchi Sea	Benthos, chemistry	Observations of high densities and respiration rates of echinoderms support the conclusion that echinoderms dominate the benthic fauna of Arctic shelves and are important in carbon remineralization.
Arzhanova et al.	1996	Bering Sea	Chemistry, primary productivity	This paper assesses relationships between seasonal variability of nutrients and primary production in the Bering Sea.
Bailey	2000	Bering Sea	Regime shift, secondary productivity	Control of recruitment of walleye pollock appears to have shifted in recent years from environmental effects on larvae to biological control of juveniles. Ecosystem change and regime status need to be considered when evaluating mechanisms underlying fish population dynamics.
BESIS Project Office	1997	Bering Sea	Climate, productivity	This report considers the impacts of climate change on the Bering Sea, including physical and biological parameters.
BEST Planning Group	2004	Bering Sea	Research program	This report discusses the development of a research plan for the eastern Bering Sea Ecosystem.
Bond and Overland	2005	Bering Sea	Weather, circulation, primary productivity, secondary productivity	This paper explores the importance of air-sea interactions associated with episodic weather events to the transport of nutrients into the Bering Sea region and associated primary and secondary productivity.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Brodeur et al.	1999	Bering Sea	Secondary productivity	This paper reports a nearly 10-fold increase in gelatinous zooplankton in the Bering Sea from the 1970s to the 1990s and evaluates hypotheses about the cause of the increases.
Broerse et al.	2003	Bering Sea	Physical oceanography	This paper reports the source of wintertime “bright waters” is suspended particulate matter that reduces transparency.
Budge et al.	2002	Bering Sea	Primary productivity, sea ice	This presentation used fatty acid signatures to evaluate trophic pathways of sea ice algae.
Chen et al.	2003	Bering Sea	Carbon flux	This paper used isotopic ratios to evaluate particulate organic export fluxes.
Cherniawsky et al.	2005	Bering Strait	Physical	This paper reports the results of measuring Bering Strait transports using satellite altimetry.
Chernyak et al.	1996	Bering Sea, Chukchi Sea	Pollutants	This paper reports observations of pesticides used in the 1990s in air, ice, fog, seawater, and surface microlayer in the Bering and Chukchi Seas.
CIFAR	2003	General	Research program	This report identifies studies funded in the second year (July–June 2002/2003) of a cooperative agreement between the Cooperative Institute for Arctic Research and the National Oceanographic and Atmospheric Administration (NOAA). Results are summarized and publications listed.
CIFAR	2004	General	Research program	This report identifies studies funded in the third year (July–June 2003/2004) of a cooperative agreement between the Cooperative Institute for Arctic Research and NOAA. Results are summarized and publications listed.
CIFAR	2005	General	Research program	This report identifies studies funded in the fourth year (July–June 2004/2005) of a cooperative agreement between the Cooperative Institute for Arctic Research and NOAA. Results are summarized and publications listed.
Cokelet and Stabeno	1997	Bering Sea	Physical	This paper reports mooring observation of thermal structure, density stratification, and currents in the southeastern Bering Sea basin.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Cokelet et al.	1996	Bering Sea	Physical	Acoustic doppler current profiler measurements were used to measure geotropic circulation in the Bering Sea basin.
Connors et al.	2002	Bering Sea	Benthos, regime shift, ecosystem	Data on Bering Sea bottom trawl surveys were interpreted in terms of regime shift and ecosystem reorganization.
Cooper et al.	2002	Bering Sea	Primary productivity, sediment carbon flux	Data on chlorophyll a and sediment oxygen demand was used to evaluate whether UV radiation affects productivity in the St. Lawrence Island polynya, a region of high biological productivity.
Coyle	2005	Aleutian Islands	Circulation, zooplankton	Physical and biological (zooplankton) indicators were used to identify the water masses prevalent in ocean passes in the eastern and central Aleutian Islands. The central passes were characterized as an oceanic environment influenced by Alaskan Stream water, while the eastern passes were influenced by the Alaska Coastal Current.
Doyle et al.	2002	Bering Sea, Gulf of Alaska	Ichthyoplankton	This paper examines data on ichthyoplankton assemblages in the southern Bering Sea, the Gulf of Alaska, and off the U.S. west coast.
Duffy-Anderson et al.	2006	Bering Sea	Ichthyoplankton	This paper analyzed spatial and temporal patterns of summer ichthyoplankton assemblages on the eastern Bering Shelf and interpreted them in relation to water masses and circulation.
Gradinger and Bluhm	2005	Beaufort Sea	Disturbance	This paper discusses the impact of sediment load on nearshore ice and benthic communities. Implications for the impacts of on-land disturbances on nearshore communities are discussed.
Grebmeier	1999	Bering Sea, Chukchi Sea	Ecosystems, benthic productivity	This paper discusses the role of the Bering Strait in benthic productivity and carbon cycling.
Grebmeier	2006	Beaufort Sea, Chukchi Sea	Research programs, ecosystems	This website describes the Western Arctic Shelf–Basin Interactions Project. This project investigates global climate change and the physical, chemical, and biological interactions.
Grebmeier and Dunton	2000	Bering Sea, Chukchi Sea	Ecosystems, benthic productivity	This paper discusses the high productivity of the Beaufort and Chukchi Seas and discusses benthic productivity and community interactions.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Grebmeier et al.	2006	Bering Sea	Productivity, regime shift	This paper shows that northern Bering Sea ecosystems are shifting away from the characteristics of extensive seasonal sea-ice cover, high water column and sediment carbon production, and tight pelagic-benthic coupling of organic production. These changes are contemporaneous with changes in regional atmospheric and hydrographic forcing. Geographic displacement of marine mammal population distributions has coincided with a reduction in benthic prey populations, an increase in pelagic fish, a reduction in sea ice, and an increase in air and ocean temperatures.
Hare and Mantua	2002	North Pacific, Bering Sea	Regime shift, physical, biological, ecosystem	This report evaluated 100 physical and biological time series to identify regime shifts in North Pacific and Bering Sea ecosystems using atmospheric, terrestrial, oceanic, and ecosystem factors.
Herman et al.	2002	Bering Sea	Physical	This paper describes an eddy-resolving circulation model that includes both tidal and subtidal dynamics for the southeast Bering Sea. Modeling results suggest that the pattern of vertical mixing in this area is strongly affected by both tidal and subtidal currents.
Hoff	2006	Bering Sea	Biological, regime shift	Fishery trawl data were used to evaluate regime shift in the eastern Bering Sea, using biomass data for diversity calculations.
Hunt et al.	2002	Bering Sea	Physical, biological, regime shift	This paper proposes the Oscillating Control Hypothesis, which predicts that pelagic ecosystem function in the southeastern Bering Sea will alternate between primarily bottom-up control in cold regimes and primarily top-down control in warm regimes, and discusses this hypothesis with regard to climate and physical oceanography, planktonic and benthic production, and marine mammal and fish populations.
Hunt and Stabeno	2002	Bering Sea	Physical, biological, ecosystem	This paper explores the relationships between climate change and ecosystems of the southeast Bering Sea.
Hunt and Stabeno	2005	Aleutian Islands	Physical, biological	This paper discusses the differences in oceanography east and west of Samalga Pass. The authors conclude that there are at least two ecological regions, and that there is high variability on both long and short time scales.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Huntington	2000	Bering Sea, Chukchi Sea	Climate, physical, biological	This report is a compendium of papers discussing the impacts of changes in climate and sea ice in the Bering Sea and Chukchi Sea on the marine environment presented at the February 2000 Marine Mammal Commission workshop on changes in sea ice.
Interagency Arctic Research Policy Committee	2005	General	Research programs	This website maintained by the National Science Foundation, Office of Polar Programs, provides links to past issues of the publication <i>Arctic Research of the United States</i> .
Jin et al.	2006	Bering Sea	Modeling, primary production	A vertically one-dimensional ecosystem model was developed and applied to the southeastern Bering Sea middle shelf. The simulation studies showed the effects of tidal mixing, wind stirring, and thermal stratification on the timing and magnitude of the phytoplankton bloom and gross and net primary production.
Johnson et al.	2004	Bering Sea, Aleutian Basin	Physical	Mean circulation and water properties within the Aleutian Basin of the Bering Sea were investigated using hydrographic and subsurface pressure displacement data from a regional array of 14 profiling conductivity-temperature-depth floats. The data revealed the deep signature of the Bering Slope Current, Aleutian North Slope Current, and the Bering Slope Current. Transport estimates were derived from the data.
Kachel et al.	2002	Bering Sea	Modeling, physical, primary production	This paper describes the use of a model based on surface heat flux and water-column mixing to explain the existence of cold belts associated with fronts. Tidal and wind mixing in the presence of a nutrient reservoir pump nutrients into the photic zone and prolong primary production.
Kaltin and Anderson	2005	Bering Sea, Chukchi Sea	Physical, chemical	This paper presents an evaluation of the relative importance of processes that influence the transport of carbon dioxide in water transported over the Bering-Chukchi Sea shelf.
Khen	2005	Bering Sea	Physical	This paper analyzes the temperature, salinity, and pycnoclines of the Bering Sea during 2002–2003.



**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
King	2005	Bering Sea	Regime shift, physical, biological, ecological	This report provides an overview of fisheries and ecosystem responses to recent regime shifts in the North Pacific. It includes a detailed chapter on recent changes in temperature and physical, biological, and ecosystem components of the southeastern Bering Sea.
Kowalik	1999	Bering Sea	Physical	This paper describes tides and tidal currents in the Bering Sea.
Krembs et al.	2002	General	Chemical, biological	This poster session describes outdoor experiments on the ability of a diatom to alter the physical properties of sea ice.
Ladd et al.	2005a	Aleutian Islands	Physical, chemical	Water properties (salinity, temperature, and nitrate) were measured through Aleutian Island passes. These data were interpreted with respect to water movement, origin, and nutrient transport. Samalga Pass was identified as the transition between the eastern and central Aleutian Islands
Ladd et al.	2005b	Aleutian Islands	Physical, biological	This paper discusses the relationship between hydrographic features of Aleutian passes and observations of seabird foraging.
Livingston et al.	1997	Bering Sea	Research programs	This report contains papers on the Bering Sea ecosystem, including past and ongoing research, inventory of data and information bases, and data gaps and future research needs.
Loughlin and Ohtani	1999	Bering Sea	Physical, chemical, biological	This compendium of papers on the Bering Sea ecosystem includes reports by many of the important Bering Sea researchers on the physical, chemical, and biological components of the ecosystem.
Lovvorn et al.	2005	Bering Sea	Chemical	This paper discusses transport of organic matter under sea ice in the north-central Bering Sea.
Luchin et al.	1999	Bering Sea	Physical	Vertical structure, temporal variability, and features of temporal and spatial structure were analyzed from data on temperature and salinity.
Luchin et al.	2002	Bering Sea	Physical, regime shifts	This paper discusses long-term and large-scale patterns of atmosphere-ice-sea relationships.
MacDonald et al.	2003	General	Climate, pollutants	This paper discusses potential relationships between global climate change and long-range transport of persistent organic pollutants.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Macklin	1999	Bering Sea	Physical, chemical, biological	This report presents a multi-author review of the conditions occurring in the Bering Sea during the anomalous conditions of the summers of 1997 and 1998. The report includes physical, chemical, and biological parameters.
Merico et al.	2003	Bering Sea	Phytoplankton	Satellite imagery was used to survey for blooms of the coccolithophorid <i>Emeliana huxleyi</i> in the Bering Sea. No evidence was found for blooms of this alga from 1978 to 1995. Imagery of the blooms of 1996 and 1997 were analyzed.
Minobe	2002	Bering Sea	Physical	This paper discusses interannual and interdecadal changes in the Bering Sea.
Mizobata and Saitoh	2003	Bering Sea	Physical	This research used remote sensing to describe cyclonic and anticyclonic eddies in the southeastern Bering Sea during 1998–1999.
Mizobata and Saitoh	2004	Bering Sea	Physical, primary production	This research used remote sensing to assess variability of eddies and primary productivity along the Bering Sea shelf edge during 1998–2000.
Mordy et al.	2005	Aleutian Islands	Physical, chemical, primary production	This paper presents detailed data on salinity, water flow, nutrients (nitrate, phosphate, silicic acid) and primary production along the eastern Aleutian Islands and island passes.
Napp et al.	2000	Bering Sea	Physical, biological	This paper examines the differences in the physical processes of oceanic and shelf waters in the eastern Bering Sea. The report concludes that in the oceanic region, interannual variation in food for first-feeding pollock larvae is determined by advection; in the shelf region, it is the coupled dynamics of the atmosphere-ice-ocean system.
Napp and Hunt	2001	Bering Sea	Climate, physical, biological	This paper discusses the linkages among climate, weather, ocean and biology in the southeastern Bering Sea.
Niebauer	1998	Bering Sea	Physical, regime shift	This paper examines the variability in Bering Sea ice cover as affected by a regime shift in the North Pacific in the period of 1947–1999.
Niebauer et al.	1996	Bering Sea	Biological	This paper presents time series of the spring bloom for the Bering Sea ice edge.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Niebauer et al.	1999	Bering Sea	Physical	This paper examines the interactions between ocean, ice, and atmosphere that characterize the Bering Sea.
NOAA	2006	Bering Sea	Climate, ecosystems	This web page provides links to Arctic information, including the Bering Sea Climate and Ecosystems website.
NPRB	2005	North Pacific, Bering Sea, Arctic Ocean	Biological, ecosystems	The science plan identifies eight general categories for research: lower trophic level productivity, fish habitat, fish and invertebrates, marine mammals, seabirds, humans, other prominent issues, and integrated ecosystem research programs. For each category, more specific research needs are identified for the NPRB's two statutory priorities –fishery management issues and marine ecosystem information needs
Okkonen	2001	Bering Sea	Physical	This paper discusses the results of current measurements across the Aleutian Basin to the Bering Slope.
Okkonen et al.	2004	Bering Sea	Productivity	This paper reports on the use of satellite and hydrographic observations of chlorophyll a concentrations, salinity, and fluorescence to describe the surface structure of the “Green Belt” and its relationship to the Bering Slope Current. The results suggest that eddies are important in causing the variability in chlorophyll distribution during the spring bloom in the central Bering Sea.
Overland and Stabeno	2004	Bering Sea	Physical, ecosystems	This paper discusses the shift in temperatures of the Bering Sea and the effects on the ecosystem.
Overland et al.	2002	Arctic	Physical	This report discusses what is known and not known about large-scale atmosphere-cryosphere interactions. It discusses the most pressing scientific questions to be resolved.
Radi et al.	2001	Bering Sea, Chukchi Sea	Biological	Surface sediment samples from the Bering and Chukchi Seas were examined for dinoflagellate cysts. Distributions of taxa were interpreted with respect to latitude and hydrographic conditions, including sea ice and sea surface temperature.
Reed	1998	Bering Sea	Physical	This paper describes flow over the southeastern Bering Sea shelf.
Reed and Stabeno	1996	Bering Sea	Physical	This paper describes the climatological mean summer circulation over the eastern Bering Sea shelf.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Reed and Stabeno	1997	Aleutian Islands	Physical	This paper describes flow along the Aleutian chain.
Reed and Stabeno	1999	Bering Sea, Aleutian Islands	Physical	This paper describes flow through the Aleutian passes into the Bering Sea and eastward currents along the Aleutian Island chain.
Robertson	1997	Bering Sea, Chukchi Sea	Bathymetry	This paper describes bathymetry coverages for the Bering and Chukchi Seas developed by the USGS.
Rodionov et al.	2005a	Bering Sea	Climate	This paper discusses the Aleutian low and winter climatic conditions in the Bering Sea.
Rodionov et al.	2005b	Aleutian Islands	Climate	This paper discusses the spatial and temporal variability of climate along the Aleutian chain.
Rodionov et al.	2005c	Bering Sea	Physical	This paper presents historical and recent data on sea surface temperatures of a location near the Pribilof Islands in the Bering Sea.
Sasaki and Minobe	2005	Bering Sea	Physical	This paper examines interannual variability of sea ice in the Bering Sea and its relationship to atmospheric variability. The relationship between sea ice and atmospheric circulation anomalies indicates a relationship to large-scale atmospheric circulation associated with the Aleutian low and to relatively local atmospheric fluctuations associated with pressure anomalies over Alaska. These results suggest that in order to understand the interannual sea ice variability in the Bering Sea, a better understanding of the wind anomalies over the Bering Sea are important.
Schell	1998	Bering Sea	Biological	This paper presents isotopic evidence for declining primary productivity in the Bering Sea.
Schell	2000	Bering Sea	Biological	This paper reports the use of isotope ratios in whale baleen to assess productivity in the Bering Sea.
Schumacher and Stabeno	1998	Bering Sea	Physical, biological	This paper discusses characteristics of the continental shelf of the Bering Sea.
Schumacher et al.	2003	Bering Sea	Climate, biological	Discusses climate change in the southeastern Bering Sea and its biological consequences.
Smith and Lee	2005	Alaska	Physical	Abstract describing the development of a GIS-based <i>Alaska Sea Ice Atlas</i> by the University of Alaska.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Springer et al.	1996	Bering Sea	Biological	This paper discusses primary productivity (the “green belt”) at the Bering Sea shelf edge.
Stabeno and Overland	2001	Bering Sea	Physical	This paper discusses observations of earlier transitions from winter to spring in the Bering Sea.
Stabeno et al.	1998	Bering Sea	Physical	This paper contains under-ice observations of water column temperature, salinity, and spring phytoplankton dynamics on the eastern Bering Sea shelf
Stabeno et al.	1999	Bering Sea	Physical	This chapter discusses the physical oceanography of the Bering Sea, including general circulation, circulation in passes, circulation in the upper ocean, interior flow, eddies, deep circulation, shelf-slope exchange, shelf flow, and tidal currents.
Stabeno et al.	2001	Bering Sea	Physical	This paper discusses the various implications of the temporal variability of the physical environment on the southeastern Bering Sea.
Stabeno et al.	2002a	Bering Sea	Physical, chemical	This paper investigates variability of physical and chemical characteristics along the 70-meter isobath of the southeastern Bering Sea. Defines the southeastern cold pool, an intermediate zone, and the northern cold pool.
Stabeno et al.	2002b	Bering Sea	Physical	This paper reports investigations of inflow through Unimak Pass. Discusses the seasonal effects of freshwater discharge, tidal mixing, and alongshore winds. Discusses implications of inflow with nutrient transport.
Stabeno et al.	2005a	Bering Sea	Physical	This paper is an introduction to processes that control variability in productivity and ecosystem structure of the Aleutian Archipelago.
Stabeno et al.	2005b	Bering Sea	Physical	This paper examines temperature, salinity, and transport in Aleutian passes.
Stabeno et al.	2006	Bering Sea	Physical	This report discusses long-term changes in temperature and ice cover of the Bering Sea shelf.
Steward et al.	1996	Bering Sea, Chukchi Sea	Biological	This paper reports measurements of viral and bacterial production, turnover rate, and mortality rate in seawater of the Bering and Chukchi Seas.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Strachan et al.	2001	Bering Sea, Chukchi Sea	Pollutants	This paper presents measurements of organochlorine compounds in the Chukchi and Bering Seas, with an emphasis on PCBs and DDT.
Tynan	1999	Bering Sea	Physical, biological	This paper discusses the effects of the 1997 El Niño on the pelagic ecosystem of the Bering Sea. This paper links shifts in whale distributions to shifts in plankton associated with either the El Niño or longer term changes.
University of Alaska	2001	Alaska	Physical	This web page provides a link to the <i>Alaska Sea Ice Atlas</i> and related publications.
USGS	2007	Bering Sea, Chukchi Sea, Beaufort Sea	Bathymetry	This web page provides links to the USGS database on the coastal bathymetry of the Bering, Chukchi, and Beaufort Seas.
van Meurs and Stabeno	1999	Bering Sea	Physical, chemical	Satellite-tracked drifters showed an episodic event of onshore flow in the southeastern Bering Sea. Such flow can be a mechanism for replenishment of nutrients on the shelf.
Vance et al.	1998	Bering Sea	Biological	This paper reports aquamarine waters in the eastern Bering Sea. This color anomaly was ascribed to coccolithophorids, such as <i>Emiliana huxley</i> .
Vlietstra et al.	2005	Aleutian Islands, Bering Sea	Physical, biological	This paper discusses the relationships between tidal fronts, zooplankton size, and the size of prey used by the short-tailed shearwater.
Wang	1999	Kuskokwim River	Pollutants	This report contains investigations of the spatial distribution of mercury and other chemicals in the Kuskokwim River. Transport of chemicals in water and sediments is also addressed.
Weller et al.	1998	Alaska, Bering Sea	Climate	Regional workshop report on climate change impacts.
Wells et al.	1997	Bering Sea, Arctic Ocean	Chemical	This paper discusses transport of organic matter between the Bering Sea and Arctic Ocean and the effect on CO <sub>2</sub> distributions.
Williams	1999	Alaska	Physical, biological	This thesis discusses the interrelationships between Pacific herring and physical variables.

**Table 1 (Cont.)**

Authors	Date	Location	Topic	Document Content
Wirts and Johnson	2005	Aleutian Basin, Bering Sea	Physical	This paper discusses the implications of temperature-density-depth measurements on circulation of the southeastern Aleutian Basin during 2002–2003.
Woodgate and Aagaard	2004	Bering Strait	Physical	This paper reports measurements of freshwater flow through the Bering Strait.
Woodgate et al.	2005	Bering Strait	Physical	This paper reports measurements of freshwater flow through the Bering Strait.
Wyllie-Escheverria and Ohtani	1999	Bering Sea	Biological	This chapter discusses the role of sea ice in organizing the Bering Sea ecosystem. Two methods of indexing seasonal ice cover in the Bering Sea are evaluated and the consequences of sea ice variability to the ecosystem are discussed. The residence time index reflects the duration of ice each year while the seasonal sea ice index is the southernmost position of sea ice along longitude 169°W. Both indices were derived from, and confirm the use of, satellite data for understanding biotic as well as abiotic variables.
Wyllie-Escheverria and Wooster	1998	Bering Sea	Biological	This paper examines year-to-year variations in Bering Sea sea ice and some consequences for fish distributions. The southernmost extension of winter ice cover varies and reflects large-scale changes in driving forces, especially in the position and intensity of the winter Aleutian Low Pressure System. Variations in the distributions of some fish stocks reflect those of ice and thermal conditions. The relationship among climate variations, sea ice cover, subsurface thermal conditions, and fish distribution provides information on how climate affects marine ecosystems and may also have practical application in predicting fish distributions.
Yao et al.	2002	Bering Sea, Chukchi Sea	Pollutants	This paper reports measurements of organochlorine pesticides in seawater of the Bering and Chukchi Seas.





### 3 FISH AND FISHERIES

This overview of information on fish and fisheries of the North Aleutian Basin and southeastern Bering Sea is based on a collection of about 150 reports, research papers, and web-published materials dated from 1996 to 2006. Some literature on life history, impacts of human activity, and ecology for locales outside of the southeastern Bering Sea (such as the Gulf of Alaska) is included when the literature adds to the knowledge base for species occurring near the North Aleutian Basin.

Presentations at the Planning Meeting included overviews of (1) federal fisheries by Diana Evans of the North Pacific Fishery Management Council, (2) commercial fisheries by Gunnar Knapp of the University of Alaska Anchorage, and (3) marine fish abundance and distribution by Michael Sigler of the National Marine Fisheries Service (NMFS). The presentations, which can be found in the Planning Meeting report, summarize available information and information needs on these topics relevant to an impact assessment of oil and gas development in the Basin.

Information on fish and fisheries collected for this report includes general descriptions of distribution and habitat; population size, population parameters, and population dynamics; biotic relationships, including disease and parasitism and trophic and ecosystem relationships; impacts of human activities (such as offshore placer mining) and impacts of commercial fisheries on other groups of marine animals such as noncommercial fishes; fishing activity and catch; and regulatory status, management, and conservation. Table 2 presents brief summaries of the content of recent publications; full citations are provided in Section 7.2.

Since 1996, publications have included descriptions of meetings and research programs, literature databases or bibliographies on fish species or groups, and general species descriptions. Research on walleye pollock and shellfish have perhaps received the most attention. Specific studies of life history or general biology have been published for a variety of fishes, including arctic cod (*Arctogadus glacialis*), walleye pollock, and threaded sculpins (*Gymnocanthus pistilliger*), as well as for a variety of shellfish (such as crabs and molluscs).

Recent publications evaluating the distributions of some species in the Bering Sea and Bristol Bay have been prepared annually for fishery forecasting, fishery trends, and habitat management. The relationship between fish distribution and physical oceanographic factors, including sea ice and regime shifts, has also been studied. The Alaska Department of Fish and Game (ADFG) and the Alaska Department of Natural Resources (ADNR) have produced detailed maps of spawning habitats for anadromous fish and Pacific herring (*Clupea pallasii*). Distributions of shellfish, such as king crab (*Paralithodes camtschaticus*), snow crab (*Chionoecetes opilio*), and weathervane scallop (*Patinopectea caurinus*) have been studied to support fishery management. In order to understand population fluctuations in many fish species, spatial and temporal patterns of larval and early juvenile fish have been studied. The distribution of fishes and the identification of sensitive habitat are also important information for oil spill response planning for Bristol Bay (ARRT 2001).

Fish population size, population variability, recruitment, and escapement are regularly monitored in the southeastern Bering Sea and the streams of the Alaska Peninsula and Bristol Bay. Recent publications for salmon have addressed short- and long-term trends in populations, escapement goals, escapement surveys, population variation and structure, and genetic relationship between populations. Studies of various crab populations have used data from population surveys and tagging studies to examine the relationship of population characteristics to physical factors and predation by groundfish; growth rates; differential catch rates of males and females; and bycatch of females and juveniles. Recent publications for Pacific herring include estimates of stocks and studies of the relationship of herring populations to environmental and oceanographic variables. Recent studies of walleye pollock have examined genetics, egg hatching and egg cannibalism, population distribution and characteristics, and the abundance of larval and juvenile fish. Studies of groundfish include trawl surveys and population structure of Pacific populations of halibut (*Hippoglossus stenolepis*) using parasites as population markers.

Fish survey data can provide a detailed view of the distribution and abundance of important fishery species in the North Aleutian Basin. However, no recent information was found for many nearshore species, including those inhabiting the lagoons of the Alaska Peninsula. In addition, many fishery studies did not provide a year-round view of the distribution of commercially important species, but rather focused primarily on distribution and abundance during the harvest season. Because impacts of oil and gas development must be assessed for four seasons, more data on abundance and distribution for all four seasons are needed.

Recent studies on the ecology of fishes in the Bering Sea have discussed the general ecology of a few selected species, the potential effects of climate variability or regime shifts on species, the dynamics of ecosystems at the ice edge, predation and parasitism, and factors affecting recruitment and population dynamics. Larval fish and juvenile fish are an important part of the food base of birds, fish, and mammals, and information on ichthyoplankton distribution and abundance is needed for the North Aleutian Basin. Assessments of the impacts of oil and gas development on ecological relationships in the North Aleutian Basin have not been conducted.

Relatively few studies have investigated the impacts of environmental factors on fisheries and/or the impact of fisheries activities on other species. Consequently, there is a relatively poor understanding of the role that fisheries have on human activities and natural ecosystem of the Bering Sea. Incidental catch by fisheries has been studied with respect to population dynamics, conservation, and regulation of other fish species, seabirds, and marine mammals. The effects of offshore placer mining on crabs, effects of seismic air guns on the behavior of snow crabs, interactions between the gillnet fishery and oil and gas activities, and the effects of oil spills on various species have been studied. Heavy metal and organic contamination have been measured in crabs in the Norton Sound and in freshwater fish. Although there has been considerable work done on the effects of the *Exxon Valdez* oil spill, relatively little recent information was found on the interaction between fisheries and oil and gas development. Further study of the impacts of exploration, development, and production on fishery resources of the North Aleutian Basin is needed.

In general, there are many recent fishery publications for the North Aleutian Basin. Commercial and subsistence fisheries for salmon, groundfish, crab species, and other shellfish are monitored each season. Population estimates are used to evaluate harvest strategies and predict catch. Historical records of catch are evaluated to identify trends in population and catch parameters (such as abundance and harvest levels). Some studies have examined the potential role of climate and oceanographic conditions on trends in population and catch parameters. Catch statistics are gathered to estimate subsistence use and economics of the fishery and to set management policies and regulations. The economies of fishing communities also have been profiled.

Many of the recent studies of fish and fisheries are related to regulations and management plans. Regulations have been promulgated to identify fishery seasons, licensing, catch limits, and other restrictions and requirements, and in an effort to minimize or control bycatch of other fish, seabirds, and marine mammals. Alternative harvest strategies, ecosystems, and sustainability have been studied to facilitate the evaluation and establishment of management practices. Although fisheries have been well-studied in the southeastern Bering Sea, one subject that has not been addressed in depth is the effect of oil and gas activities on the regulation of fishing activities.

**TABLE 2. Publications from 1996 to 2006 Related to Fish and Fisheries of the North Aleutian Basin.**

Authors	Date	Location	Topic	Species	Document Content
ADFG	1997a	Bristol Bay	Management	General	Bristol Bay commercial fisheries annual report for 1996.
ADFG	1997b	Western Alaska	Management	Shellfish	Western Region shellfish fisheries annual management report.
ADFG	2004	Aleutian Islands	Management, impacts	General	ADFG news release about fishery closures after the <i>Selendang Ayu</i> oil spill.
ADFG	2005	Aleutian Islands	Management	General	An announcement of reopening of the Makushin/Skan Bay area to commercial fishing. This area was previously closed to all commercial fishing activity due to the <i>Selendang Ayu</i> oil spill.
ADFG	2006a	Bristol Bay	Management	Salmon	Map showing the location of the Bristol Bay salmon districts.
ADFG	2006b	Alaska	Management	Salmon	Web page providing links to detailed information for 1997–2006 on management and forecasts, as well as a news release updated by ADFG on salmon, including run size and harvest by method.
ADFG	2006c	Alaska	Fishery	Shellfish	Website giving links to Alaska shellfish fishery information.
ADFG	2006d	Togiak Bay	Harvest, management, forecast	Pacific herring	A website providing links to historical information on the Togiak herring fishery, including annual management report, season summary, announcements and updates, in-season harvest summary, and preseason forecast. Covers 1997–2005.
ADFG	2006e	Alaska	Distribution	Anadromous fishes	ADFG catalog and map atlas of statewide anadromous waters and maps, including the North Aleutian Basin.
ADFG	2006f	Alaska	Fishery subsistence	General	ADFG website with annual subsistence fisheries reports, 1999–2003 (most recent report).
Adkinson and Finney	2003	Bristol Bay	Fishery	Salmon	Examines harvests and value of Bristol Bay salmon fisheries for the years 1955–2003. Discusses causes of fluctuations and forecasts of future returns.
ADNR	2005a	Alaska Peninsula	General	General	Generally describes freshwater and marine fishes and other fauna of lease areas of the Alaska Peninsula.
ADNR	2005b	Alaska	Distribution	Anadromous fish	A table listing anadromous fish streams in Alaska indicating species.
ARRT	2001	Bristol Bay	Distribution, impacts	Fishery	Describes distribution, habitats, and fishery of Bristol Bay. Identifies sensitivity areas for oil spill contingency planning.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Aydin	2002	Bering Sea	Management	General	Ecosim policy maximization routines were used to examine fishing policies for a mid-1980s model of the eastern Bering Sea shelf/slope ecosystem containing 38 functional groups and including catch and bycatch. In addition to yield maximization, the simulations explored “ecological” maximization (using the 1/PB index discussed in the workshop as a criterion) and examined mechanisms for increasing pinniped biomass through selective prey manipulation, especially with respect to the endangered Steller sea lion.
AYK-SSI	2006	General	Population	Salmon	This report addresses the trends and causes of variation in salmon abundance and fisheries by assembling existing information, gaining new information, and improving management and restoration techniques through a collaborative and inclusive process. Includes life history, populations, fisheries, and subsistence, among others.
Bailey	2000	General	Ecology, population	Walleye pollock	Discusses factors influencing recruitment of walleye pollock. Identifies a change from the importance of environmental factors on larval fish to the importance of predation on juvenile fish by cod and flatfish.
Bailey et al.	1997	General	Population	Walleye pollock	Identifies factors in the population biology of walleye pollock.
Bailey et al.	2000	General	Ecology, population	Walleye pollock	Discusses factors affecting the population dynamics of walleye pollock.
Baker et al.	2006	Bristol Bay	Population	Salmon	Escapement goals for sockeye, chinook, chum, coho, and pink salmon for the Bristol Bay area.
Barnard and Burt	2006	Bering Sea	Fishery	Golden king crab, scarlet king crab, snow crab, grooved tanner crab	Summaries of data collected by observers for the 2005 pre-rationalized BSAI crab fisheries in the Bering Sea, including golden king crab, scarlet king crab, snow crab, and grooved tanner crab.
Barnard and Pengilley	2006	General	Population, fishery	Red king crab	This study evaluated the effectiveness of the first season of the federal Crab Rationalization Program to reduce bycatch of females and juveniles. There was no indication that the first season of the program reduced bycatch. Data supported a conclusion of increased discarding of legal males.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Barnhart	2006	Bering Sea	Management, fishery	Weathervane scallop	Annual management report for weathervane scallops, including management, historic background, 2004/2005 fishery, and stock status.
Barnhart and Rosenkranz	2006	Bering Sea	Fishery	Weathervane scallop	Contains observer data for the 2002/2003 statewide weathervane scallop fishery, including catch-and-effort and bycatch.
Blaylock et al.	2003	Eastern Pacific, Bering Sea	Population	Halibut	Statistical analysis of parasite data on fish collected from California to the Bering Sea supports the conclusion that two major groups of halibut exist and suggests the possibility of a third group in the central and northern Bering Sea.
Blood	2002	General	Population	Walleye pollock	Laboratory study of development and time-to-hatching of walleye pollock eggs.
Bond and Overland	2005	Bering Sea	Ecology, climate	Walleye pollock, tanner crab	Discusses the presumed effect of decadal climate variability on recruitment of walleye pollock, tanner crabs, and coccolithophorids.
Bowers et al.	2005	Bering Sea, Bristol Bay	Fishery, management, population	Shellfish	Annual management report for commercial and subsistence shellfish fishery for 2004/2005 contains information on the Aleutian Islands and Bering Sea/Bristol Bay. Includes all species of crabs, octopus, sea urchins, sea cucumbers, and snails.
Brodeur et al.	2003	Bering Sea	Distribution, ecology	Salmon	This article is an extensive literature review of research on the movement, distribution, food resources, and other aspects of the life history of juvenile salmon, including populations in the eastern Bering Sea.
Buklis	1999	Alaska	Fishery, socioeconomics	Salmon	Discusses the economics of a mixed subsistence and commercial salmon fishery subject to supply trends. Discusses impacts on income.
Byerly et al.	1999	Alaska	Fishery	Salmon	Data on Alaska commercial salmon catches by species and area from 1878 to 1997.
Callaway	1997	Alaska	Fishing communities, subsistence	General	Discusses the potential impact on subsistence communities of climate change, on the basis of pre-1997 data.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Cascorbi	2004	General	Management	Crabs	Proposed guidelines for seafood choice based on conservation concerns and support of sustainability goals.
CFEC	2004	Alaska	Management	General	Describes the decisions and activities of the Alaska Commercial Fisheries Entry Commission for 2004, including adjudications, licensing, research, and revenue.
CFEC	2005	Alaska	Management	General	Describes the decisions and activities of the Alaska Commercial Fisheries Entry Commission for 2005, including adjudications, licensing, research, and revenue.
Christian et al.	2003	Bering Sea	Impacts	Snow crab	Field and laboratory studies of the effects of seismic air guns on the behavior and physiology of snow crabs were conducted with Atlantic populations.
Clark	2005a	Bristol Bay, Alagnak River	Distribution	Sockeye salmon	Distribution of sockeye salmon in the Alagnak River system, of Bristol Bay.
Clark	2005b	Bristol Bay	Management	Salmon	A review of the Bristol Bay salmon management program, including stock assessment activities.
Connors et al.	2002	Bering Sea	Ecology, climate	General	This paper compiles data from bottom trawl surveys conducted from 1963–2000. Time series are presented for three sites in the southeastern Bering Sea. All three sites show strong evidence of a shift in benthic biomass and community structure in the early to mid-1980s. The data suggest that a complete reorganization of benthic and demersal food webs may have taken place. The timing of the shift is consistent with effects of the strong regime shift observed in climate indices in 1976–1977.
DeCicco	2003	Alaska	Management	General	Fishery management in the northwest Alaska management area, 2001–2003. Includes management programs and data on sport, subsistence, and commercial fisheries.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Dieter et al.	2003	Worldwide	Fishery impacts	General	Worldwide annotated bibliography of scientific and popular literature on demersal, mobile fishing gear and its effects in marine ecosystems. The primary focus is bottom trawling, dredging, and raking, and the resulting direct disturbance of marine habitats and associated biological communities. Papers addressing other topics, such as bycatch and discards, and seafloor impacts of marine aggregates dredging and gravel extraction, are also referenced. Papers discussing impacts from other activities, such as longline fishing, trapping, use of chemicals, and dynamite blasting, are not referenced.
DOC	1997	Alaska	Management, fishery impacts	Groundfish	Rule establishing exclusive zones for hook-and-line groundfish fisheries to control seabird bycatch is discussed.
DOC	1998	Alaska	Management	Halibut	Regulations to reduce seabird bycatch by halibut fisheries are described.
Downton and Miller	1998	Alaska	Fishery	Salmon	Using multivariate time series models, Alaska's statewide commercial catch of three salmon species during 1925–1994 is shown to be related to surface temperatures in particular large regions of the eastern North Pacific
DuBois	2002	Arctic-Yukon-Kuskokwim Delta	Population	Pacific herring	Report on Pacific herring stocks of the Arctic-Yukon-Kuskokwim Delta region of the Bering Sea.
DuBois	2003	Arctic-Yukon-Kuskokwim Delta	Population	Pacific herring	Report on the age, sex, and size composition of Pacific herring from coastal spawning sites in the Arctic-Yukon-Kuskokwim region.
Duffield et al.	2007	Bristol Bay	Socioeconomics, subsistence	Salmon	This report provides estimates of the economic values associated with sustainable use of wild salmon ecosystem resources, primarily fisheries and wildlife, of the major watersheds of the Bristol Bay region. Both regional economic significance and social benefit-cost accounting frameworks were considered. This study reviews and summarizes existing economic research on the key sectors in this area and reports findings based on the original survey data on expenditures, net benefits, attitudes, and motivations of the angler population.



**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Duffy-Anderson et al.	2006	Eastern Bering Sea	Distribution	Larval fish	Spatial and temporal patterns of larval and early juvenile fishes from the eastern Bering Sea were examined and float trajectories modeled for samples collected during summers 1996–2000.
Dunaway and Sonnichsen	2001	Alaska	Fishery management	General	Sport fishery management report for 1999. Discusses management plans affecting fish, major issues, ongoing research and management, access programs and outreach programs. Discusses sport fishing effort. For each species, this report describes fishery history, historical performance, management, the 1999 fishery, and outlook for 2000.
Dye et al.	2006	Bristol Bay	Fishery, management	Salmon	This report summarizes Bristol Bay sport fisheries during 2006. Fisheries include Alagnak and Nushagak/Mulchatna Chinook salmon, Kvichak sockeye salmon, lower Talarik Creek and upper Nushagak River rainbow trout, and northern pike. The sport fisheries are described, and estimates of sport effort, catch, and harvest, and escapement are provided. Overviews of management for each fishery are provided, such as pertinent sport fishing regulations and management plans.
Failor-Rounds	2005	Alaska	Fishery	Sablefish, black rockfish, Greenland turbot, arrowtooth flounder, rock sole, yellowfin sole	Contains a description of the historic background, the 2004 fishery, and stock status for the Aleutian Islands sablefish and black rockfish fishery. Also gives harvest data for Greenland turbot, arrowtooth flounder, rock sole, yellowfin sole, and other flatfish.
Fall and Krieg	2006	Bristol Bay	Fishery, subsistence	General	Discusses the subsistence fishery of Bristol Bay, including permits, species, and catch.
Farley et al.	2003	Bering Sea, Bristol Bay	Distribution, population	Salmon	The numbers, distribution, and age composition of juvenile salmon were estimated from fall surveys of the eastern Bering shelf, including Bristol Bay.
Finney et al.	2000	General	Population	Salmon	Lake sediment records and biological indicators were used to construct a 300-year record of sockeye abundance.
Flint and Miles	2002	Alaska	Fishery impacts	General	Describes the relationship between boat harbors, fish processing, organic contamination, and Steller’s eiders.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Flynn and Hilborn	2004	Port Moller, Bristol Bay	Fishery management	Sockeye salmon	Examined variability in indices for forecasting sockeye salmon run size. Correcting models for age composition, migration route, and timing may decrease error by as much as 10%.
Flynn et al.	2003	Bristol Bay	Distribution	Sockeye salmon	Presents a model using age composition data to identify spatial distribution of component stocks migrating to Bristol Bay.
FWS	1998	Bering Sea, Aleutian Islands	Management, fishery impacts	Halibut	Biological opinion on the effects of the Bering Sea/Aleutian Islands halibut fishery on the short-tailed albatross.
FWS	1999	Bering Sea, Gulf of Alaska, Aleutian Islands	Management, fishery impacts	Groundfish	Endangered Species Act Section 7 consultation for the 1999-2000 hook-and-line groundfish fisheries of the Gulf of Alaska, Bering Sea, and Aleutian Islands area.
FWS	2001	Alaska	Fishery, subsistence	General	2000 Fisheries Resource Monitoring Plan status report to the Regional Advisory Councils and Federal Subsistence Board.
Gharrett et al.	2001	Alaska	Population	Salmon	Genetic variability in coho salmon was measured for Bering Sea and Gulf of Alaska stocks.
Gillispie	1997	Arctic	Ecology	Arctic cod	Thesis on the biology and ecology of the arctic cod.
Gravel et al.	2006	General	Population	Snow crab	Over 8,000 large male snow crabs were tagged. Gender, size, frequency, and catch per unit were recorded.
Gunderson	1996a	General	Ecology	Walleye pollock	Discusses the ecology of juvenile walleye pollock.
Gunderson	1996b	General	General	Walleye pollock	Identifies research priorities related to juvenile walleye pollock.
Hammond et al.	2001	Bering Sea	Fishery	Walleye pollack	Applies a Bayesian spatial composition estimation tool to Bering Sea acoustic fish survey data to determine applicability for estimating abundance ratios of juvenile and adult fish. The results suggest the tool may be usefully applied to actual surveys.
Hart and van Tamelen	2002	Alaska	General	Shellfish	User's guide to the ADFG's literature database on shellfish.
Hoff	2000	Bristol Bay	Ecology	Threaded sculpin	Describes the biology and ecology of the threaded sculpin, a shallow-water fish found in Bristol Bay and other waters of the North Pacific.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Jackson	2006	Alaska Peninsula, Aleutian Islands	Fishery	Pacific herring	History, harvest strategy, and catch of Pacific herring in the Alaska Peninsula and Aleutian Islands Management Area for 2005.
Jackson and Poetter	2006	Alaska Peninsula, Aleutian Islands	Fishery	Pacific herring	Describes the herring fishery for 2004, 2005, and 2006 for the Alaska Peninsula and Aleutian Islands Management Area.
Jewett	1999	General	Impacts	Crabs	Evaluates effects of offshore placer mining.
Jewett and Naidu	2000	Norton Sound	Impacts	Red crab	Measured heavy metals in tissue and organs of red crab in Norton Sound to study effects of offshore placer mining.
Jewett et al.	2003	Alaska	Impacts	Arctic grayling, northern pike, and whitefish	Mercury concentrations in the flesh of Arctic grayling, northern pike, and whitefish were measured and human health implications evaluated.
Johnson and Wiess	2006	Alaska Peninsula, Bristol Bay	Distribution	Anadromous fish	Lists anadromous fish for the lakes and streams of the southwest region of Alaska, which includes the Alaska Peninsula and Bristol Bay.
King	2005	Bering Sea	Ecology, climate	General	This report includes a section on climate shifts in the Bering Sea and subsequent effects on fish communities.
Logerwell et al.	2005	Aleutian Islands	Distribution, ecology	Demersal fish	Discusses the composition and distribution of demersal fish populations and communities in the Aleutian Islands region. Food habits and growth of these species are also discussed.
Loher and Armstrong	2005	Bering Sea	Population	King crab	Distribution and abundance of ovigerous females were investigated using trawl surveys from 1975 to 2001. Near-bottom temperatures are presented for 1974–2001. It is suggested that temperature may be an important factor in the distribution of this species.
Loher et al.	2001	Aleutian Islands, Gulf of Alaska	Population	Red king crab	Presents in situ growth rate of juvenile red king crabs, comparisons to Unalaska and Kodiak Islands, and a primarily pre-1996 reference list.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Lovvorn et al.	2005	Bering Sea	Ecology, oceanography	General, planktonic fish, benthic fish	Production from spring blooms at the retreating ice edge may sink to the bottom with little grazing by zooplankton, thereby supporting abundant benthic communities. This report discusses organic matter pathways to macrobenthos and macrozooplankton under ice cover in late winter (March–April) and open water in late summer (September) in the north-central Bering Sea.
Lowe and Fritz	1997	Alaska Peninsula	Fishery	Groundfish	Projects groundfish stocks and fishery potential for the Aleutian Island region for 1998.
McDermott et al.	2005	Aleutian Islands	Population, ecology	Atka mackerel	Tag-recapture methods were used to estimate populations and movement of Atka mackerel in the Aleutian Islands. Life history of this fish is also discussed.
McNair and Holder	2000	Arctic-Yukon-Kuskokwim Delta	Population	Salmon	Lists by release site all the salmon releases in the Alaska-Yukon-Kuskokwim area.
Mecklenburg et al.	2002	Alaska	General	General	A comprehensive guide to the fishes of Alaska. Includes identification keys, family and species accounts, morphological features, geographic range, and an extensive bibliography.
Megrey	1996	General	Ecology, population	Walleye pollock	Discusses the relationship of juvenile walleye pollock abundance to adult recruitment and linkages with the environment.
Merrick and Calkins	1996	General	Ecology	Walleye pollock	Discusses the importance of walleye pollock in the diet of Steller sea lions.
Meyers et al.	1996	Alaska	Disease	Tanner crab	Provides results of bitter crab syndrome surveys from 1988 to 1991.
MMS	2004	General	Impacts	General	A study of the drift gillnet fishery and oil/gas interactions and mitigation possibilities.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Moles and Norcross	1998	General	Impacts	Flatfishes	This paper discusses the effects of oil-laden sediments on flatfishes. Juvenile yellowfin sole ( <i>Pleuronectes asper</i> ), rock sole ( <i>P. bilineatus</i> ), and Pacific halibut had reduced growth following 30-90 days of exposure to sediments laden with Alaska North Slope crude oil. Changes in fish health bioindicators after 90 days occurred at hydrocarbon concentrations (1600 µg/g) that reduced growth. Chronic hydrocarbon pollution of nearshore nursery sediments could alter growth and health of juveniles. Recruitment may decline because of increased susceptibility to predation and slower growth.
Morstad and Baker	2006	Kvichak River	Management	Salmon	Discusses management and regulatory history, stock status, and review and development of an action plan for sockeye salmon in the Kvichak River.
Mueter et al.	2006	Eastern Bering Sea	Management, population	Walleye pollack	Presents statistical analyses of leading hypotheses linking recruitment variability to biotic and abiotic factors. The results support the cold-pool hypothesis that recruitment is significantly stronger when winter preceding the age-0 and age-1 stages is mild.
Mundy	1998	Alaska	Management, sustainability	Salmon	A detailed discussion of the principles and criteria for sustainable salmon management.
Murphy	2005	Alaska Peninsula	Management	Groundfish	Defines the 2005 fishery management plan for areas including the north Alaska Peninsula.
Murphy and Tschersich	2005	Alaska Peninsula	Management	Salmon	Defines the 2006 salmon management plan for the north Alaska Peninsula area.
Murphy and Tschersich	2006	Alaska Peninsula	Population, fishery	Salmon	Salmon escapement and harvest data for the north Alaska Peninsula area.
Murphy et al.	1999	Prince William Sound	Impacts	Salmon	Discusses recovery of pink salmon spawning habitat after the <i>Exxon Valdez</i> oil spill.
Myers et al.	2000	General	Population	Salmon	Presents factors affecting the ocean production of salmon.
Napp and Hunt	2001	Bering Sea	Ecology, climate	General	Discusses linkages among climate, weather, ocean, and biology.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Napp et al.	2000	General	Ecology	Walleye pollock	Discusses the biological and physical processes affecting the feeding environment of larval walleye pollock.
Nelson et al.	2006	Alaska Peninsula	Management	Salmon	Discusses escapement goals for the Aleutian Peninsula and Aleutian Islands Management Areas.
NMFS	2001	Bering Sea, Gulf of Alaska, Aleutian Islands	Management, fishery impacts	Groundfish	Biological opinion regarding incidental take from groundfish fisheries.
NMFS	2003	Bering Sea, Gulf of Alaska, Aleutian Islands	Management, fishery impacts	Groundfish	Supplement to the 2001 biological opinion and incidental take from groundfish fisheries.
NMFS	2006	General	Fishery impacts	General	Draft summary table from stock assessment report, including estimates of mortality of marine mammals due to fisheries.
NPFMC	2006	Alaska	Management	Multiple	Website for the North Pacific Fisheries Management Council.
O'Connell et al.	1998	Bering Sea, Prince William Sound	Population	Pacific herring	Genetic variability of Pacific herring was measured for populations from the Bering Sea to Prince William Sound.
Olsen	2002	General	Population	Walleye pollock	An examination of spatial and temporal genetic variation in walleye pollock.
Oswood et al.	2000	Alaska	Distribution	Freshwater fish	Biogeography of the freshwater fishes of Alaska.
Paul	2000	Bering Sea	General	Snow crab	A bibliography on the snow crab.
Paul et al.	2002	General	Ecology, management	Crabs	Collection of papers on crabs in coldwater regions, and their biology, management, and economics.
Peterson	2000	Prince William Sound	Impacts	General	A critique of previous studies on the effects of the <i>Exxon Valdez</i> oil spill.
Rugolo et al.	2006	Bering Sea	Distribution, population	Red king crab	Detailed results of trawl surveys of distribution and abundance of red king crab (Bristol Bay and Pribilof districts), blue king crab (Pribilof and Northern districts), tanner crab (Southern district), snow crab (all districts), and hair crab (all districts).
Salomone	2006	Bristol Bay	Fishery	Salmon	A summary of effort and harvest of sockeye salmon for Bristol Bay in 2001–2006.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Sands	2006	Bristol Bay	Fishery	Salmon	A summary of the Bristol Bay commercial salmon fishery in 2004–2006.
Schabetsberger et al.	1999	General	Population	Walleye pollock	Discusses egg cannibalism in walleye pollock.
Schumacher and Kruse	2005	General	Management, sustainability	General	Examination of issues related to sustainable ecosystem services.
Seeb and Crane	1999	Southwest Alaska	Population	Salmon	Genetic relationships between 64 populations of chum salmon in southwestern Alaska.
Sepez et al.	2005	Alaska	Fishery, socioeconomics	General	Social and economic profiles of 136 fishing communities in Alaska based on 2000 data. Included are people and places (location, demographics, education, local housing, and local history), community infrastructure (current economic activity, governance, and facilities), and involvement in North Pacific fisheries (commercial, subsistence, and recreational fishing).
Spalinger	2006	Alaska Peninsula, Aleutian Islands, Gulf of Alaska	Population	Shellfish, groundfish, walleye pollock	Includes data from trawl surveys of the Kodiak, South Peninsula, and Eastern Aleutian Management Districts for June–September 2005. Species surveyed included tanner crab and red king crab. Average haul weight and composition of fish and invertebrates were measured. Groundfish included flathead sole, arrowtooth flounder, and walleye pollock.
Stehn et al.	2001	Alaskan waters	Fishery impacts	General	Discusses incidental catch of seabirds by longline fisheries.
Trudel	2002	Bering Sea	Ecology	Salmon	Discusses sea lice on pink salmon.
Tschersich	2006	Alaska Peninsula, Aleutian Islands, Atka-Amelia Islands	Management	General	Summarizes the 2005 season and historical information concerning management of subsistence and commercial fisheries of the Alaska Peninsula, Aleutian Islands, and Atka-Amelia Islands.
Tschersich and Foster	2006	Alaska Peninsula, Aleutian Islands	Population	Salmon	Presents Alaska Peninsula and Aleutian Islands Management Areas escapement and catch sampling results.
van Tamelen and Woodby	2003	General	General	Crabs	Presents the agenda of the December 11–13, 2002, meeting on crab research. Gives a brief bulleted summary of presentations.

**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Vining and Zheng	2006	Bristol Bay	Population	Red king crab	Provides population estimates for red king crab in Bristol Bay (1972–2005).
Webb and Woodby	2006	General	General	Crabs	Summary of the interagency crab research meeting, December 2005.
West	2006	Bristol Bay	Population	Salmon	Drift gillnets were used in the Kvichak, Egegik, and Ugashik Rivers to estimate in river abundance. Travel times were estimated.
West and Fair	2006	Bristol Bay	Population	Salmon	Abundance, age, size, and gender statistics for Bristol Bay in 2003.
Westing et al.	2005	Bristol Bay	Fishery	General	A detailed description for 2004 of the Bristol Bay commercial and subsistence salmon fisheries and the herring fisheries.
Westing et al.	2006a	Bristol Bay	Fishery	Pacific herring	A review of the Togiak herring fisheries of Bristol Bay.
Westing et al.	2006b	Bristol Bay	Fishery	Salmon, Pacific herring	A detailed description for 2005 of the Bristol Bay commercial and subsistence salmon fisheries and the herring fisheries.
Williams	1998	General	Distribution	Salmon	Discusses a recent review of a 40-year database that examines how fluctuating water temperatures affect the distribution of salmon.
Williams	1999	General	Population, ecology	Pacific herring	Discusses interrelationships of Pacific herring populations and large-scale environmental and oceanographic variables.
Williams and Quinn	1998	General	Population	General	Presents a parametric bootstrap method for estimating catch-age compositions.
Witherell	1999	Bering Sea	Management, ecology	Groundfish	Discusses incorporating ecosystem considerations into the management of Bering Sea groundfish fisheries.
Wolfe and Utermohl	2000	Alaska	Fishery, subsistence	General	Estimates wild food consumption for rural Alaska populations.
Wyllie-Escheverria	1997	Bering Sea	Distribution, oceanography, climate	General, walleye pollock, climate	This dissertation discusses sea ice and fish distribution in the Bering Sea.



**Table 2 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Wyllie-Escheverria and Ohtani	1999	Bering Sea	Ecology, oceanography, climate	General, walleye pollock, Arctic cod, climate	This chapter discusses sea ice variability and the Bering Sea ecosystem. The distribution of walleye pollock changes on a multi-annual scale, while distribution of Arctic cod and predation pressure on age-1 pollock varies interannually with warm or cool conditions.
Wyllie-Escheverria and Wooster	1998	Bering Sea	Ecology, oceanography, distribution, climate	General, walleye pollock, Arctic cod, climate	This paper examines year-to-year variations in Bering Sea sea ice and some consequences for fish distributions. The southernmost extension of winter ice cover varies and reflects large-scale changes in driving forces, especially in the position and intensity of the winter Aleutian Low Pressure System. Variations in the distributions of some fish stocks reflect those of ice and thermal conditions. The relationship among climate variations, sea ice cover, subsurface thermal conditions, and fish distribution provides information on how climate affects marine ecosystems and may also have practical application in predicting fish distributions.
Zheng	2003	General	Management	Red king crab	Evaluates alternative harvest strategies based on simulation modeling of 2002 population status.
Zheng and Kruse	2005	Bering Sea	Population, ecology	Crabs	Presentation on ecosystem effects on Bering Sea crab populations.
Zheng and Kruse	2006	General	Population, ecology, climate	Red king crab	Examines the correlations between geographic and seasonal variability of crab stock, physical forcing, and groundfish predation. Results suggest a mix of climate forcing and predation in influencing crab recruitment.



#### 4 SEABIRDS, SHOREBIRDS, AND WATERFOWL

This overview of information on seabirds, shorebirds, and waterfowl of the North Aleutian Basin and southeastern Bering Sea is based on a collection of about 150 reports, research papers, and web-published materials dated from 1996 to 2006. Some literature on the life history of species, the impacts of human activity on species, and migration for locales outside of the southeastern Bering Sea is included when the literature adds to the knowledge base for species occurring in the North Aleutian Basin.

Presentations at the Planning Meeting included overviews of (1) seabird and shorebird populations and distributions by Kathy Kuletz of the U.S. Fish and Wildlife Service (FWS) and (2) waterfowl populations and distributions by William Larned and Christian Dau of the FWS. The presentations, which can be found in the Planning Meeting report, summarize available information and information needs on these topics relevant to an impact assessment of oil and gas development.

Information on birds collected for this report includes general species descriptions; distribution, migration, and habitat; population size, population parameters, and dynamics; biotic relationships, including trophic and ecosystem relationships; impacts of human activities; and regulatory status, management, and conservation. Table 3 summarizes the content of recent publications, and full citations are provided in Section 7.3.

The life histories of birds have been described in detail in *The Birds of North America Online*, published by the Cornell Laboratory of Ornithology and the American Ornithological Union (<http://bna.birds.cornell.edu/BNA/>). The web articles are written by authorities in the life history and ecology of each species. The articles provide details on distribution, systematics, migration, habitat, food habits, behavior, breeding, demography and populations, conservation and management, and priorities for future research. Descriptions are not yet available for some Bering Sea species, such as the short-tailed albatross (*Phoebastria albatrus*). General life history information for the short-tailed shearwater (*Puffinus tenuirostris*), the short-tailed albatross, and certain other wide-ranging seabirds is not available at the same level of detail as for other species. While these species may not breed in the Bering Sea, the region is an important foraging and winter habitat. More study of the distribution and habits of these species may be needed.

Distribution, migration, and habitats of seabirds are monitored by the ADFG. In 1997, detailed maps were published that included seabird colonies on the Aleutian Islands, Alaska Peninsula, and Bristol Bay coastline. USGS and FWS have developed the North Pacific Pelagic Seabird Database, which includes observations on species and abundance from ship transects and other surveys. The database is an important source of information in assessing population trends, distribution, and impact assessment and is being used to produce a seabird atlas.

The North Aleutian Basin provides habitat for many seabirds. Surveys of seabirds have been accomplished with a variety of techniques, which makes statistical analysis of trends in population size and distribution difficult. While the winter range of eiders has been studied, the winter range of other species is incomplete or lacking. Several wide-ranging seabirds use the Bering Sea as wintering habitat, and resident and migrating Alaskan species are found in coastal

lagoons and unfrozen areas of the sea. Determining the relationship between seabird distribution and potential oil and gas development in the North Aleutian Basin could be difficult.

The North Pacific Pelagic Seabird Database (which includes the North Aleutian Basin) contains estimates of the population sizes of nesting seabirds and of seabirds observed at sea. Surveys have been conducted on a seasonal and annual basis on waterfowl, including nesting, migrating, and wintering populations. These surveys focus on eiders and geese, but observations of other waterbirds are included. Survey information has been used to determine breeding status, productivity, and trends in populations. Long-term trends of seabird populations in the Aleutian Islands have been studied by examining paleoarcheological evidence. Oceanographic conditions and changes in prey base have been used to interpret these long-term trends. The genetic structure of selected species that could be affected by oil spills has been studied to determine the potential for recovery by recolonization.

Conservation of waterfowl, shorebirds, and seabirds has received regulatory attention due to the threatened or endangered status of their populations. The Steller's eider, spectacled eider (*Somateria fischeri*), and short-tailed albatross have received the most attention. Critical habitats have been designated, regulations governing longline fishing have been promulgated, and recovery plans pursuant to implementation of the Endangered Species Act (ESA) have been enacted. Environmental assessment of oil and gas development has resulted in the development of Biological Opinions for listed species. These opinions contain useful information on the ecology of the listed species.

Two species have been particularly well studied. The ecology of the Kittlitz's murrelet (*Brachyramphus brevirostris*) and the Steller's eider (*Polysticta stelleri*) have received special attention due at least in part to the threatened or endangered status of their populations. Studies of the Kittlitz's murrelet have focused on habitat requirements. Studies of the Steller's eider have looked at factors affecting migration, ecological relationships during the winter, and diet.

Studies of seabirds have described abundance, feeding behavior, and diet in relation to oceanographic features. Fronts and current patterns in Aleutian passes provide important feeding habitats for a variety of seabirds. Seabirds have been shown to be affected by recent ecosystem changes in the Bering Sea, and have been proposed as sensitive indicators of environmental change. Potential impacts to eiders from recent changes in clam populations in wintering locations have been studied. Population trends require continued study in order to provide a basis for assessment of future potential environmental impact.

The coastal lagoons of the Alaska Peninsula form a unique habitat for migrating shorebirds and waterfowl. A large proportion of western hemisphere shorebirds use these lagoons as staging areas during migration. Few recent studies of these lagoons and their birds were found. Since these habitats may be affected by North Aleutian Basin oil and gas development, further study of the ecology of these lagoons and their shorebirds may be warranted.

Three important impacting factors on seabirds and shorebirds have been studied: (1) effects of oil spills on populations, (2) presence of inorganic and organic contaminants in seabirds, and (3) the effects of construction and development activities. Studies of oil effects have largely been conducted in Prince William Sound (as related to the *Exxon Valdez* oil spill), and studies of construction and development effects have focused on the effects of North Slope oil and gas development. Contaminant studies have been conducted on populations important in subsistence harvest, on Bering Sea islands, and in the Yukon-Kuskokwim Delta.

One aspect of oil and gas development that has not been well studied is the effects of oil platforms on seabirds. Literature about these effects was found only for the North Atlantic and the Gulf of Mexico. The potential for bird collision at a proposed windfarm on St. Lawrence Island also has been assessed and the results of that assessment may be relevant. Collisions and attraction to lights are of particular concern. Because of the length of winter darkness and the importance of the region as habitat for wintering seabirds, studies of both collisions and attraction are needed.

**TABLE 3. Publications from 1996 to 2006 Related to Seabirds, Shorebirds, and Waterfowl of the North Aleutian Basin.**

Authors	Date	Location	Topic	Species	Document Content
ADFG	1997a	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing seabird colonies and waterfowl habitat distribution of Togiak Bay and the Walrus Islands area.
ADFG	1997b	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing seabird colonies and waterfowl habitat distribution of Nushagak Bay area.
ADFG	1997c	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing seabird colonies and waterfowl distribution of the Kvichak Bay area.
ADFG	1997d	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing seabird colonies and waterfowl habitat distribution of the Egigik Bay area.
ADFG	1997e	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing waterfowl habitat distribution of the Ugashik Bay area.
ADFG	1997f	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing waterfowl habitat distribution of the Cinder River area.
ADFG	1997g	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing waterfowl habitat distribution of the Port Heiden area.
ADFG	1997h	Bristol Bay	Distribution	Seabirds, waterfowl	Map showing seabird colonies and waterfowl habitat distribution of the Kujulik Bay area.
ADNR	2000	Bristol Bay, Alaska Peninsula	Distribution	Seabirds	Map showing the location and size of seabird colonies for Bristol Bay and the north and south Alaska Peninsula to Port Moller and Ikofski.
Agler and Kendall	1997	Prince William Sound	Impacts	Seabirds, waterfowl	This report includes trends in marine bird populations following the <i>Exxon Valdez</i> oil spill.
Ainley et al.	2002	General	Ecology	Common murre	This chapter discusses the life history and ecology of the common murre.
Alaska Maritime National Wildlife Refuge	2006	Alaska	Population	Seabirds	Website with links to yearly reports, "Breeding Status and Population Trends of Seabirds in Alaska," from 1996 to 2004 (most recent).
Alaska Natural Heritage Program	2005	Alaska	General	Kittlitz's murrelet	A description of the taxonomy, ecology, distribution and abundance, existing protection, challenge, research and inventory needs, conservation and management needs, and a bibliography.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Alaska Shorebird Working Group	2000	Alaska	Conservation	Shorebirds	Describes conservation regions in Alaska, shorebird species priorities, conservation issues, goals and objectives, implementation, and coordination. Discusses immediate priority projects for shorebirds in Alaska. Identifies Western Hemisphere Shorebird Reserve Network Sites in Alaska.
ARRT	2001	Alaska	Distribution	Seabirds	Presents excerpts from the Alaska Seabird Colony Catalog in the form of detailed maps.
BLM	2005	North Slope	Impacts	Spectacled eider, Steller's eider	This appendix of the National Petroleum Reserve Alaska EIS discusses the potential sources of impacts of petroleum development on spectacled eider and Steller's eider.
Bustnes et al.	2000	Norway	Ecology	Steller's eider	Paper reporting the diet of wintering Steller's eiders in Norway.
Byrd and Drago	1997	Alaska	Population	Seabirds	Report presenting data on breeding success and population trends of seabirds in Alaska in 1996.
Byrd et al.	2005	Aleutian Islands	Population	Seabirds	This paper discusses seabird population trends and the ecological factors, including predation, that affect seabirds near island passes in the Aleutian Island chain.
Causey et al.	2005	Aleutian Islands	Population	Seabirds	Paleoarcheological data were examined to evaluate trends in marine bird populations in the Aleutian Islands. Although effects of human predation could be detected on a local scale, evidence suggests that local oceanography and changes in prey base in the past had a significant effect on abundance of seabirds.
Center for Biological Diversity et al.	2001	General	Regulation	Kittlitz's murrelet	This petition to add Kittlitz's murrelet to the endangered species list discusses potential threats to the species.
Christopher et al.	2002	Bering Sea, Gulf of Alaska	Impacts	Common murre	Reports on measured mercury concentrations in common murre from the Bering Sea and Gulf of Alaska.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Circumpolar Seabird Working Group	1997	Worldwide	Distribution, conservation	Eiders	Discusses the worldwide range and abundance of eiders, utilization of eiders, and management, conservation, and population trends. Identifies management issues and actions, and develops management guidelines.
Dau and Mallek	2006	Southwestern Alaska	Population	Emperor goose, Brant, Steller's eider, other waterbirds	Overflights were used to survey populations of emperor geese and other waterbirds from Kokechek Bay to Unimak Island, including both sides of the peninsula, during April and May 2004. Brant and Steller's eider were among the species counted.
Dau et al.	2000	Alaska Peninsula	Distribution	Steller's eider	Reports the results of banding and recovering molting Steller's eiders along the lower Alaska peninsula.
Day and Nigro	2000	Prince William Sound	Ecology	Marbled murrelet	Discusses feeding ecology of marbled murrelets in Prince William Sound.
Day and Nigro	2003	Prince William Sound	Ecology	Kittlitz's murrelet	Evaluates Kittlitz's murrelet on Prince William Sound reproductive problems.
Day et al.	1997a	Kenai Peninsula	Impacts	General	Reports on the effect of the <i>Exxon Valdez</i> oil spill on bird habitat use along the Kenai Peninsula.
Day et al.	1997b	Prince William Sound	Impacts	General	Reports on the effect of the <i>Exxon Valdez</i> oil spill on bird habitat use in Prince William Sound.
Day et al.	1999	General	Ecology	Kittlitz's murrelet	This chapter discusses the life history and ecology of Kittlitz's murrelet.
Day et al.	2000	Prince William Sound	Ecology	Kittlitz's murrelet	Describes at-sea habitats of Kittlitz's murrelets in Prince William Sound.
Day et al.	2003a	Prince William Sound	Ecology	Kittlitz's murrelet, marbled murrelet	Examines the habitat use and niche overlap between Kittlitz's murrelet and marbled murrelet in nearshore waters of Prince William Sound. Discusses the significance of habitat differences as related to morphological differences.
Day et al.	2003b	St. Lawrence Island, Bering Sea	Impacts	Eiders, general birds	Assesses the potential collision potential of eiders and other birds near a proposed wind farm at St. Lawrence Island in the Bering Sea.



**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Day et al.	2005a	Beaufort Sea	Impacts	Eiders, general	Reports the results of studies of migration and collision avoidance of eiders and other birds at Northstar Island in 2001–2004.
Day et al.	2005b	North Slope	Ecology	Eiders	This paper presents observations of factors affecting migration of eiders, including weather. The height of migrating eiders was determined.
DOC	1997	Alaska	Regulation, impacts	Seabirds	Establishes management measures for the fisheries of the Exclusive Economic Zone to reduce seabird bycatch in hook-and-line groundfish fisheries.
DOC	1998	Alaska	Regulation, impacts	Seabirds	Establishes management measures to reduce seabird bycatch in halibut fisheries.
DOD	1999	Beaufort Sea	Impacts	General	Environmental impact statement addressing impacts of the Northstar project.
DOI	1997	General	Regulation	Steller’s eider	Final rule for establishing the threatened status for the Alaska breeding population of the Steller’s eider.
DOI	2000	General	Regulation, habitat	Spectacled eider	Identifies and supports proposed critical habitat for the spectacled eider.
DOI	2001a	General	Regulation, habitat	Spectacled eider	Final determination of designated critical habitat for the spectacled eider.
DOI	2001b	General	Regulation, habitat	Steller’s eider	Final determination of designated critical habitat for the Alaska-breeding population of the Steller’s eider.
DOI	2001c	General	Regulation	Aleutian Canada goose	Final rule to remove the Aleutian Canada goose from the federal list of endangered and threatened wildlife.
DOI	2003	General	Regulation	Steller’s eider	Announces the availability of the recovery plan for the Alaska breeding population of the Steller’s eider.
DOI	2005a	General	Impacts	Seabirds	This website describes the Seabird Tissue Archival and Monitoring Project.
DOI	2005b	General	Ecology	General	This website provides access to the FWS’s Wetlands Digital Data.
Dragoo et al.	2000	General	Population, ecology	Seabirds	This report provides information on breeding status and population trends of seabirds in Alaska in 1999.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Dragoo et al.	2003	General	Population, ecology	Seabirds	This report provides information on the breeding status, population trends, and diets of seabirds in 2001.
Dragoo et al.	2004	General	Population, ecology	Seabirds	This report provides information on the breeding status, population trends, and diets of seabirds in 2002.
Drew and Piatt	2005a	North Pacific	Population, distribution	Seabirds	Report describing the North Pacific Pelagic Seabird Database.
Drew and Piatt	2005b	North Pacific	Distribution	Seabirds	This presentation describes the creation of the North Pacific Pelagic Seabird Database and the studies that have used the database.
Esler et al.	2000	Prince William Sound	Impacts	Harlequin duck	This paper compares winter survival of adult harlequin ducks in oiled and unoled areas in order to interpret impacts of the <i>Exxon Valdez</i> oil spill.
Esler et al.	2002	Prince William Sound	Impacts	Harlequin duck	This paper discusses recovery of harlequin duck populations after the <i>Exxon Valdez</i> oil spill. Constraints to recovery are discussed.
Estes et al.	1997	Aleutian Islands	Impacts	Bald eagles	This paper reports data on organochlorines in bald eagles from the Aleutian Archipelago.
Flint and Fowler	1998	St. Paul Island	Impacts	Seabirds	This paper discusses experiments to assess the influence of wind on recovery of oiled seabirds.
Flint and Miles	2002	Aleutian Islands, Alaska Peninsula	Impacts	Steller's eider	This report discusses the effects of boat harbors, fish processing, and organic contamination on wintering Steller's eiders.
Flint et al.	1997	Alaska	Impacts	Spectacled eider, diving ducks	Discusses lead exposure of diving ducks in western Alaska.
Flint et al.	1998	General	Population	Northern pintail	Reports modeling of the productivity and population growth rate of the northern pintail.
Flint et al.	1999	St. Paul Island, Bering Sea	Impacts	Seabirds	Presents modeling of bird mortality associated with the M/V <i>Citrus</i> oil spill off St. Paul Island.
Flint et al.	2000	Alaska Peninsula	Population	Steller's eider	Reports annual survival and site fidelity of Steller's eiders.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Flint et al.	2004	General	Ecology	Long-tailed duck	This paper discusses movements of flightless long-tailed ducks during wing molt.
Fowler and Flint	1997	St. Paul Island, Bering Sea	Impacts	King eider	The persistence of oiled king eider carcasses following an oil spill was modeled to help determine mortality rates.
Fredrickson	2001	General	Ecology	Steller's eider	This chapter discusses life history and ecology of Steller's eider.
FWS	1996a	Alaska	Population	Seabirds	A catalog of Alaska seabird colonies.
FWS	1996b	General	Regulation	Spectacled eider	Recovery plan for the spectacled eider.
FWS	1999a	Bering Sea, Aleutian Islands	Regulation, impacts	Short-tailed albatross	Biological Opinion on the effects of the Bering Sea/Aleutian Islands fishery on the short-tailed albatross.
FWS	1999b	Alaska	Population	Sea ducks	This report discusses population status and population trends in sea ducks in Alaska.
FWS	2000	Alaska Peninsula	Impacts	Steller's eider	Biological Opinion on the effects of harbor construction on the Steller's eider.
FWS	2001	Alaska	General	Short-tailed albatross	This fact sheet describes the short-tailed albatross.
FWS	2002	Alaska	Regulation	Steller's eider	Recovery plan for the Steller's eider.
FWS	2004a	Southwest Alaska	Population	Steller's eider	This report presents the Steller's eider spring migration survey in southwest Alaska.
FWS	2004b	Alaska Peninsula, Bristol Bay, Bering Sea	Regulation, habitat	Steller's eider	Critical habitat map for the Steller's eider.
Gaston and Hipfner	2000	General	Ecology	Thick-billed murre	This chapter discusses the life history and ecology of the thick-billed murre.
Gilchrist	2001	General	Ecology	Glaucous gull	This chapter discusses the life history and ecology of the glaucous gull.
Gill	2004	Alaska	General	Shorebirds	This report contains summaries of studies on Alaska shorebirds ongoing in 2003.
Gill and McCaffery	1999	Alaska	Population	Bar-tailed godwits	This paper provides population estimates of bar-tailed godwits based on observations from the staging grounds.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Gill and Senner	1996	Alaska	Conservation, ecology	Shorebirds	This paper discusses the importance of Alaska to western hemisphere shorebirds.
Golet et al.	2002	Prince William Sound	Impacts	Pigeon guillemot	This paper discusses the long-term and indirect effects of the <i>Exxon Valdez</i> oil spill on pigeon guillemots.
Goudie et al.	2000	General	Ecology	Common eider	This book chapter describes the life history and ecology of the common eider.
Grand et al.	1998	Alaska	Impacts	Spectacled eider	This paper discusses the effects of lead poisoning on spectacled eider survival rates.
Grand et al.	2002	Yukon–Kuskokwim Delta	Impacts	Spectacled eider, common eider	This paper presents concentrations of trace elements in the eggs and blood of spectacled and common eiders.
Guillemette	1998	Gulf of St. Lawrence	Ecology	Common eider	This paper discusses aspects of feeding, diving, and digestion of common eiders feeding on blue mussel beds in the winter.
Guillemette	2001	Gulf of St. Lawrence	Ecology	Common eider	This paper discusses spring feeding rates of common eiders in the Gulf of St. Lawrence.
Handel and Gill	2000	Alaska	Ecology	Black turnstone	This paper discusses monogamy in the black turnstone.
Handel and Gill	2001	General	Ecology	Black turnstone	This chapter describes the life history and ecology of the black turnstone.
Harding et al.	2005	Alaska, Russia	Population	Horned puffin	This paper discusses census methods for crevice-nesting puffins.
Hatch et al.	1996	Bering Sea, Chukchi Sea, Gulf of Alaska	Population	Common murres, thick-billed murres, tufted puffins	This report provides estimates of seasonal movements and habitat use by common murres and tufted puffins.
Hatch et al.	2000	Bering Sea, Chukchi Sea, Gulf of Alaska	Population	Common murres, thick-billed murres, tufted puffins	This report provides estimates of seasonal movements and habitat use by common murres, thick-billed murres, and tufted puffins.
Hobson	1997	General	Ecology	Pelagic cormorant	This chapter discusses life history and ecology of the pelagic cormorant.
Hodges et al.	1996	Alaska	Population	Seabirds	Reports the results of aerial surveys of seabirds in 1957–1994.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Hunt et al.	2001	North Pacific	Ecology	Seabirds	This report discusses consumption of prey by marine birds in the subarctic North Pacific Ocean. It contains aggregate estimates by region of prey class, consumption rates, biomass, and energy transfer. The report also contains estimates of the populations of major groups of seabirds.
Hunt et al.	2005	Gulf of Alaska	Ecology	Seabirds	This paper presents data on prey consumption and energy transfer by seabirds (shearwaters, murrelets, puffins, murrelets, auklets, and sea ducks) in the Gulf of Alaska.
Irons et al.	2000	Prince William Sound	Impacts	Seabirds	This paper compares populations of a variety of seabirds before and after the <i>Exxon Valdez</i> oil spill. Data are interpreted with respect to life history parameters.
Jahncke et al.	2005	Aleutian Islands	Distribution, ecology	Seabirds	This paper presents the differences in seabird abundance, distribution, and diet between the eastern and central Aleutian Islands. Oceanographic factors and diet are evaluated.
Jones et al.	2001	General	Ecology	Parakeet auklet	This book chapter discusses the life history and ecology of the parakeet auklet.
Kitaysky et al.	2006	North Pacific	Ecology	Red-legged kittiwake	This paper discusses the effects of lipid-poor diets on condition of juvenile red-legged kittiwakes. The authors conclude lipid-poor diets may result in population declines.
Kucklick et al.	2002	Bering Sea, Gulf of Alaska	Impacts	Common murre, thick-billed murre	This presentation discusses the presence of persistent organic pollutants in murre eggs.
Kuletz	2004	Alaska	Population	Kittlitz's murrelet	This paper discusses the relationship between glaciation and Kittlitz's murrelet.
Kuletz et al.	2003	Prince William Sound	Population	Kittlitz's murrelet	This paper discusses the relationship between glaciation in Prince William Sound and Kittlitz's murrelet.
Lacroix et al.	2003	Beaufort Sea	Impacts	Long-tailed duck	This paper reports the results of studies of the effects of underwater seismic surveys on molting male long-tailed ducks.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Ladd et al.	2005	Aleutian Islands	Distribution	Seabirds	This paper discusses the foraging behavior of different seabirds at the convergence zones and fronts between water masses in Aleutian passes.
Lance et al.	2001	Prince William Sound	Population, impacts	General	This paper investigates evidence of population recovery of a wide variety of affected species oiled by the <i>Exxon Valdez</i> oil spill.
Lanctot et al.	1999	Prince William Sound	Population	Harlequin duck	This study looks at genetic differences in harlequin duck populations to evaluate the potential for migration to repopulate depleted populations.
Larned	1998	Western Alaska	Population	King eider	This report presents the results of aerial surveys of king eider molting areas in western Alaska.
Larned	2000a	Southwest Alaska	Population	Steller's eider, seabirds	This report presents the results of aerial surveys of Steller's eiders and other seabirds.
Larned	2000b	Southwest Alaska	Population	Steller's eider	This report presents the results of 2000 spring migration surveys for the Steller's eider.
Larned	2002	Southwest Alaska	Population	Steller's eider	This report presents the result of 2002 spring migration surveys for the Steller's eider.
Larned	2003	Bering Sea	Population	Spectacled eider	This report presents the results of late wintering surveys of spectacled eiders in the Bering Sea in 1996-1997.
Larned	2004	Southwest Alaska	Population	Steller's eider	This report presents the result of 2004 spring migration surveys for the Steller's eider.
Larned	2005	Southwest Alaska	Population	Steller's eider	This report presents the result of 2005 spring migration surveys for the Steller's eider.
Larned and Tiplady	1997	Bering Sea	Population	Spectacled eider	This report presents the results of late wintering surveys of spectacled eiders in the Bering Sea in 1996-1997.
Larned and Tiplady	1999	Bering Sea	Population	Spectacled eider	This report presents the results of late wintering surveys of spectacled eiders in the Bering Sea in 1998.
Laubhan and Metzner	1999	Alaska Peninsula	Population	Steller's eider	This paper reports the results of surveys of wintering Steller's eiders in Izembeck Lagoon and Cold Bay
Litzow et al.	2002	Gulf of Alaska	Ecology	Pigeon guillemot	This paper presents data on survival of pigeon guillemot chicks in areas of low-lipid food and high-lipid food.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Lovvorn et al.	2000	Bering Sea	Ecology	Spectacled eider	This study describes the development of an empirically based computer model of the foraging energetics of the spectacled eider that winters southwest of the St. Lawrence Island polynya in the Bering Sea.
Lovvorn et al.	2003	Bering Sea	Ecology	Spectacled eider	This paper presents the results of studies of diet and body condition of wintering spectacled eiders. Diet was investigated by examination of stomach contents.
Mallek and Dau	2004	Southwestern Alaska	Population	Emperor goose, seabirds	This report presents the results of aerial surveys of Emperor geese and other seabirds in southwestern Alaska during fall 2002.
Mallek and Dau	2005	Southwestern Alaska	Population	Emperor goose, seabirds	This report presents the results of aerial surveys of Emperor geese and other seabirds in southwestern Alaska during fall 2005.
McCaffery and Gill	2001	General	Ecology	Bar-tailed godwit	This book chapter presents the life history and ecology of the bar-tailed godwit.
Meehan et al.	1999	Alaska	Ecology, population, climate	Seabirds	This paper discusses the importance of seabird populations as indicators of the ecosystem effects of climate change and environmental effects of development.
Melvin et al.	2006	Alaska	Distribution	Seabirds	This report discusses observations of seabirds obtained during stock assessments of Pacific halibut and sablefish. Species composition by region is presented. Implications for longline fishery impacts on seabirds are discussed.
Murphy et al.	1997	Prince William Sound	Impacts	Seabirds, shorebirds, waterfowl	This paper discusses the effects of the <i>Exxon Valdez</i> oil spill on birds based on pre- and post-spill surveys.
Pearce et al.	2005	Worldwide	Population, conservation	Steller's eider	This paper presents studies of genetic differentiation among Steller's eider populations in order to facilitate conservation.
Petersen and Douglas	2004	Bering Sea	Ecology	Spectacled eider	This study describes the environmental characteristics of wintering areas for spectacled eiders and discusses the relationship of these characteristics to population biology.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Petersen and Flint	2002	Bering Sea, Beaufort Sea	Population	Common eider	This paper describes the degree of isolation of Bering Sea and Beaufort Sea populations of the common eider.
Petersen et al.	1998	Bering Sea	Ecology	Spectacled eider	This paper presents data on the diet of spectacled eiders.
Petersen et al.	1999	Bering Sea, Arctic Alaska, and Russia	Population	Spectacled eider	This paper reviews data and observations on spectacled eiders to identify seasonal habitats, including wintering grounds.
Piatt and Drew	2004	Aleutian Islands	Population	Seabirds	This paper uses the North Pacific Pelagic Seabird Database to estimate the abundance of seabirds within 100 km of the <i>Selendang Ayu</i> grounding on Unalaska Island.
Piatt and Ford	2000a	Alaska	Distribution	Seabirds	This report describes a computerized pelagic seabird atlas for Alaska.
Piatt and Ford	2000b	Alaska	Population	Seabirds	This report describes the use of a pelagic seabird atlas for monitoring seabird populations in areas of potential development.
Piatt and Kitaysky	2002	General	Ecology	Horned puffin	This chapter describes the life history and ecology of the horned puffin.
Piatt and Springer	2004	Bering Sea	Ecology	Seabirds	This paper discusses the factors affecting the biogeography of seabirds in the Bering Sea.
Piatt et al.	2006	Alaska	Distribution, population	Seabirds	This atlas was developed from the North Pacific Pelagic Seabird Database. It illustrates data on abundance and distribution of 31 species/groups of seabirds.
Richman and Lovvorn	2003	Bering Sea	Ecology	Spectacled eider	This paper discusses the characteristics of clam species that affect the energetics of spectacled eiders.
Robertson and Savard	2002	General	Ecology	Long-tailed duck	This chapter discusses the life history and ecology of the long-tailed duck.
Russell	2005	Gulf of Mexico	Impacts	Migrating birds	This report gives detailed observations of migrating birds on offshore gas and oil platforms in the northern Gulf of Mexico.



**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Schauer and Murphy	1996	Alaska	Ecology	Common murre	This paper presents the results of studies of predation on eggs and nestlings of common murres at Bluff, Alaska.
Sea Duck Joint Venture	2003	General	General	Steller's eider	This fact sheet describes the Steller's eider.
Solovieva	1999	General	Ecology	Steller's eider	This dissertation discusses research on the biology and bioenergetics of the Steller's eider.
Springer et al.	1996	Aleutian Islands	Ecology	Seabirds	This paper discusses seabirds as indicators of marine ecosystem conditions.
Stehn et al.	2001	Alaska	Population	Seabirds	This paper discusses the incidental catch of seabirds by longline fisheries.
Stephenson and Irons	2003	Bering Sea, Gulf of Alaska	Population	Colonial seabirds	This paper discusses differences in colonial nesting seabird populations in the eastern Bering Sea and Gulf of Alaska using data from the Beringian Seabird Colony Database.
Stout	2002	Alaska, Russia	Impacts	Eiders	Livers and kidney tissues were collected from eiders in Alaska and Russia for organic and elemental analyses. Results showed that organochlorine and many elemental levels were below toxic thresholds; however, in many cases, cadmium, copper, lead and selenium appeared high relative to other waterfowl. With the exception of lead, local anthropogenic sources for these elements are not known. Although adverse physiological responses have not been documented in eiders, these four elements cannot be ruled out as contaminants of potential concern for some eider species.
Suydam	2000	General	Ecology	King eider	This chapter describes the life history and ecology of the king eider.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Systad and Bustnes	2001	Arctic	Ecology	Common eider, king eider, long-tailed duck	This paper describes the effects of darkness and low temperatures on winter foraging of common eiders, king eiders, and long-tailed ducks. The numbers of common eiders and king eiders species remained fairly constant throughout winter, whereas long-tailed ducks moved out of the area in midwinter. As day length decreased, eiders extended their feeding period into lower light intensities. The ability to survive when days are short might be explained by use of stored nutrient reserves, night feeding, or high prey availability.
Trust et al.	2000	St. Lawrence Island, Bering Sea	Impacts	Spectacled eider	Inorganic and organic contaminants were measured in spectacled eiders from St. Lawrence Island.
Vander Pol et al.	2003	Alaska	Impacts	Murres	This poster discusses trends in concentrations of organic pollutants in eggs from murre colonies.
Vlietstra et al.	2005	Aleutian Islands	Ecology	Short-tailed shearwater	This paper associates sizes of prey with fronts in Aleutian passes with respect to the diet of the short-tailed shearwater.
Ward et al.	1999	Southwestern Alaska	Impacts	Brant, Canada goose	Observations of the response of fall-staging brant and Canada geese to aircraft overflights.
Wiese and Robertson	2004	General	Impacts	Seabirds	Presents a computer model for assessing the effects of chronic exposure of seabirds to low levels of oil discharge.
Wiese et al.	2001	North Atlantic	Impacts	Seabirds	This paper discusses the sources of mortality to seabirds congregating at offshore oil platforms. Seabirds aggregate around oil drilling platforms and rigs in above average numbers due to night lighting, flaring, food and other visual cues. Bird mortality has been documented due to impact on the structure, oiling and incineration by the flare. Hydrocarbon development in the northwest Atlantic could affect both regional and global breeding populations.

**Table 3 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Wilbor	1999	Bering Sea	Population	Long-tailed duck	This report discusses the status of the long-tailed duck.
Wilson et al.	2004	Alaska	Impacts	Spectacled eider, king eider	Reports the levels of metals and trace elements found in the blood of spectacled and king eiders.
Winker and Rocque	2004	General	Impacts	Seabirds	This report discusses the use of archived seabird samples as resources for marine environmental assessment.
York et al.	2001	General	Impacts	Seabirds	This report discusses the use of archived seabird samples and protocols for collecting and banking seabird eggs.



## 5 MARINE MAMMALS

This evaluation of information on marine mammals of the Bering Sea, Bristol Bay, and the North Aleutian Basin<sup>2</sup> is based on a collection of about 200 reports, research papers, and web-published materials dated from 1996 to 2006. Information is included on 25 species of cetaceans (whales, porpoises, and dolphins); pinnipeds (seals, sea lions, and walrus); and sea otters. These species are included because (1) they occur in Bristol Bay and adjoining shores, (2) they are wide-ranging in the Bering Sea and cannot be ruled out for regions potentially affected by oil and gas development activities, (3) impacts on them may be similar to those on species occurring in the North Aleutian Basin, or (4) they are part of the subsistence culture of Alaska Natives in Bristol Bay and the southeastern Bering Sea. A few poorly known species, such as the beaked whales, are included because they are mentioned in literature pertaining to other species. Literature concerning mammals in the Chukchi Sea and Beaufort Sea is included when the results of the studies could potentially be extrapolated to mammals of the southeastern Bering Sea.

Presentations at the Planning Meeting included overviews of (1) important pinniped populations by John Bengtson of the National Marine Mammal Laboratory, (2) North Pacific right whale (*Eubalaena japonica*) and other cetaceans by Philip Clapham of the National Marine Mammal Laboratory, and (3) northern sea otters (*Enhydra lutris kenyoni*) and Pacific walrus (*Odobenus rosmarus divergens*) by Angela Doroff of the FWS. The presentations, which can be found in the Planning Meeting report, summarize available information and information needs on these topics relevant to an impact assessment of oil and gas development in the Basin.

Recent literature on marine mammals identified and collected for this report includes general species descriptions; information on distribution and habitat; estimates of population size, population parameters, and dynamics; biotic relationships, including trophic and ecosystem relationships; impacts of human activities; and regulatory status and management. Table 4 presents summaries of the content of selected recent publications. Full citations are presented in Section 7.4.

Since 1996, the regulatory status under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) of certain stocks of marine mammals that inhabit the North Aleutian Basin area (e.g., sea otter, North Pacific right whale) has changed. New fishery regulations have been implemented to protect critical habitat for the Steller sea lion (*Eumetopias jubatus*), and critical habitat has been designated for the North Pacific right whale.

Large areas of critical habitat exist for the Steller sea lion in the Bering Sea. In 2005, the FWS listed the Southwest Alaska distinct population segment of the northern sea otter as threatened under the ESA. In 2006, the NMFS established critical habitat for the North Pacific right whale in the Bering Sea and Gulf of Alaska, and is proposing to expand the area of these habitats and released the draft recovery plan for the fin whale (*Balaenoptera physalus*).

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<sup>2</sup> Dr. Lisa Rotterman, Minerals Management Service, Anchorage, provided valuable input for the preparation of this section.

The Marine Mammal Commission prepares annual reports to Congress on the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA. The American Cetacean Society publishes fact sheets on the general biology, distribution, life history, and status of marine mammals. These fact sheets, which include bibliographies, are available for many of the species found in Bristol Bay and the Bering Sea, such as the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), Dall's porpoise (*Phocoenoides dalli*), and the harbor porpoise (*Phocoena phocoena*), among others.

Detailed species information on marine mammals is updated periodically and published in Alaska Marine Mammal Stock Assessments. These annual reports contain information on many or all of the marine mammals found in the southeastern Bering Sea. These stock assessments give good, up-to-date summaries of what is known for each species, including (1) stock definition and geographic range; (2) population size, including historic and recent data; (3) current and maximum productivity estimates and potential biological removal; (4) annual human caused mortality and serious injury, including subsistence and commercial harvest; (5) stock status, including regulation and management; and (6) references. The stock assessments also identify data gaps and assessments that cannot be made due to missing or incomplete data.

The MMPA allows Alaska Natives to harvest marine mammals for subsistence uses. Per the MMPA requirements, the FWS has established a Marking, Tagging, and Recording Program under which all sea otter and polar bear hides and skulls, and all walrus tusks, are tagged by a FWS representative. In addition, the FWS monitors the annual spring walrus hunt in several Alaskan villages as part of its Walrus Harvest Monitoring Program. Tagging reports provide information on location, age class, and gender.

The ADFG publishes detailed habitat maps of nearshore waters including habitats of the Pacific walrus, spotted seals (*Phoca largha*), Steller sea lions, harbor seals (*Phoca vitulina*), beluga whales (*Delphinapterus leucas*), and northern sea otters. These maps identify haulouts for walrus, seals, and sea lions, as well as feeding and calving areas for whales. Map coverage includes the shores of southeastern Bristol Bay, including the north shore of the Alaska Peninsula and Aleutian Islands, the south shore of the Alaska Peninsula, and islands of the Gulf of Alaska.

Observations and census of pinnipeds and cetaceans by direct observation and remote sensing have provided information on distribution patterns and migratory routes, as well as population estimates. In 1996, North Pacific right whales were discovered to still be present in the southeastern Bering Sea. Subsequent studies by shipboard observations, aerial surveys, and acoustic analysis have established the relatively regular presence of these whales in the southeastern Bering Sea, including the North Aleutian Basin, during most years.

Recent studies of changes in the distribution of cetaceans (North Pacific right whale, fin whale, western gray whale [*Eschrichtius robustus*], and humpback whale [*Megaptera novaeangliae*]) have been evaluated with respect to climate change. Studies published from 1996 to 2006 discuss the relationship of cetacean, pinniped, walrus, and sea otter distributions to bathymetry, oceanic and coastal circulation, sea ice, productivity, and food abundance.

Observations of Steller sea lions and cetaceans have been related to biophysical variables for the Alaska Peninsula, Aleutian Islands, and the Gulf of Alaska.

While marine mammals are relatively well studied in the Bering Sea compared with other taxonomic groups, little of this information applies specifically to the areas of the North Aleutian Basin where oil and gas development could occur. In order to assess the impacts of development in the Basin, further study of marine mammal movement, habitat use, reproduction, population dynamics, and diet is needed.

Visual observations, radiotelemetry, remote sensing, tagging, capture, and passive acoustics have been used to monitor the populations of cetaceans, pinnipeds, walrus, and sea otters in the Bering Sea, Bristol Bay, and Aleutian Islands. Population parameters studied include stock identification, population genetics, population size, population trends, stock productivity, reproduction, and sources of mortality. These studies provide a historical perspective on population size and change and have been used to predict future population trends and recovery. Decreasing numbers of some species such as Steller sea lions have been investigated from the perspectives of nutrition, prey availability, natural and hunting mortality, disease, and pollution. Various modeling techniques have been developed to assist with assessing population dynamics and proposed recovery measures for cetacean species of regulatory concern, such as bowhead whales. Remote sensing techniques have been developed for some species, such as the Pacific walrus (using airborne thermal sensors) and the spotted seal (using satellite-linked transmitters). Few of these data are specific to the North Aleutian Basin, but they could be used for assessments if the population sizes and distributions of marine mammals in the Basin have been determined.

Recent studies of diet and trophic relationships of marine mammals include analyses of temporal and geographic variation. Diets of northern fur seals (*Callorhinus ursinus*), Steller sea lions, and sea otters have been investigated to try to better understand observed geographic patterns and recent population changes. Levels of organic pollutants in marine mammals have been interpreted on the basis of diet. In recent years, food webs have undergone major changes in the Bering Sea. Changes in ecosystem structure have been implicated in changes in marine mammal body condition, growth, and population size. Declines of prey species and changes in ecosystem structure have been hypothesized to be related to interdecadal changes in climate, major climate events, and a trend of increasing temperature. Studies of variability in sea ice, circulation patterns across the Bering Shelf, and circulation through Aleutian passes have been interpreted as affecting selected marine mammal populations. These recent changes in the Bering Sea ecosystem create a need for continued study of marine mammal seasonal habitat use, seasonal diet, condition, and health status.

Oil spill impacts on marine environments have been extensively studied in Prince William Sound, including population trends, body condition, and survival of sea otters following the *Exxon Valdez* oil spill in Prince William Sound. Other potential impacts from oil and gas development include disturbance by activities on the Outer Continental Shelf, including drilling, transportation, and exploration. Contaminants in marine mammals have been studied from the perspectives of human health, marine mammal population effects, and food chain transfer.

Information about the subsistence harvest of seals, sea lions, whales, and sea otters has been monitored by the ADFG, FWS, and NMFS (depending on the species).

Human activities such as oil and gas exploration and production, commercial fisheries, Naval activities, and whale watching may affect marine mammals as a result of increases in noise and disturbance from breaking ice, vessel traffic and ship strikes, harassment, illegal shooting, research seismic surveys, and pollution. Behavioral changes of marine mammals due to disturbance by these activities needs further study. Oil and gas exploration, development, and production activities will generate noise to which cetaceans and pinnipeds are sensitive. Studies of acoustic effects on species that inhabit the North Aleutian Basin should be implemented.



**TABLE 4. Publications from 1996 to 2006 Related to Marine Mammals of the North Aleutian Basin.**

Authors	Date	Location	Topic	Species	Document Content
ADFG	1997a	Togiak Bay	Distribution	Pacific walrus, harbor seal, spotted seal, Steller sea lion	Map of Togiak Bay showing haulout areas for walrus, harbor and spotted seals, and sea lions.
ADFG	1997b	Nushagak Bay	Distribution	Harbor seal, spotted seal, beluga whale	Map of Nushagak Bay showing beluga whale calving and harbor and spotted seal haulout areas.
ADFG	1997c	Kvichak Bay	Distribution	Harbor seal, beluga whale	Map of Kvichak Bay showing beluga whale calving and feeding areas and haulout areas for harbor seals.
ADFG	1997d	Egigik Bay	Distribution	Harbor seal, beluga whale	Map of Egigik Bay showing beluga whale feeding areas and harbor seal haulout areas.
ADFG	1997e	Ugashik Bay	Distribution	Harbor seal	Map of Ugashik Bay showing harbor seal haulout areas.
ADFG	1997f	Cinder River area	Distribution	Harbor seal	Map of the Cinder River area showing harbor seal haulout areas.
ADFG	1997g	Port Heiden area	Distribution	Harbor seal	Map of the Port Heiden area showing harbor seal haulout areas.
ADFG	1997h	Kujulik Bay area	Distribution	Steller sea lion, northern sea otter	Map of the Kujulik Bay area showing areas of northern sea otter concentration and Steller sea lion haulout areas.
Agler and Kendall	1997	Prince William Sound	Impacts	Sea otter	Report describes trends in sea otter population abundance of Prince William Sound following the <i>Exxon Valdez</i> oil spill.
Alaska Fisheries Science Center	2006	Alaska	General	Marine mammals	A searchable database of all Alaska Fisheries Science Center and National Marine Mammals Library publications.
Alaska Science Center	2004	Bering Sea, Chukchi Sea	Ecology	Pacific walrus	Website maintained by the Alaska Science Center with links to the Pacific walrus international database.
Alaska Sea Life Center	2006	Alaska	General	Marine mammals	Website with a bibliography of more than 175 peer-reviewed publications.
American Cetacean Society	2004	Worldwide	General	Pacific white-sided dolphin	Fact sheet describing the biology, distribution, life history, and status of the Pacific-white-sided dolphin. A bibliography is included.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
American Cetacean Society	2005a	Worldwide	General	Dall's porpoise	Fact sheet describing the biology, distribution, life history, and status of the Dall's porpoise. A bibliography is included.
American Cetacean Society	2005b	Worldwide	General	Harbor porpoise	Fact sheet describing the biology, distribution, life history, and status of the harbor porpoise. A bibliography is included.
Angliss and Outlaw	2005	Alaska	General	Marine mammals	Detailed descriptions are provided for each regional stock of marine mammals in Alaskan waters. The stock assessments are updated to 2005. Descriptions include stock definitions and geographic range, population size and trends, stock productivity, fisheries, subsistence/native harvest, other sources of mortality, stock status, and habitat concerns.
Angliss et al.	2002	Worldwide	Regulation	Blue whale, North Pacific right whale, Steller sea lion, humpback whale	This report presents the results of a February 2001 workshop on developing recovery criteria for large whale species. The workshop reviewed regulatory history and developed a general framework for recovery criteria.
Antonelis et al.	1997	Bering Sea	Ecology	Northern fur seal	Reports studies of the interisland variation in the diet of female northern fur seals in the Bering Sea.
Baker et al.	2005	North Pacific	Population	Steller sea lion	Genetic analyses of individuals from all known significant rookeries found no evidence of genetic bottleneck effects, and found significant divergence between eastern and western stock animals and between Asian rookeries and other western stock rookeries. Recommends three stocks be recognized.
Bengtson et al.	1999	Bering Sea	Ecology	Seals	Discusses the life history of seals in term of interdecadal changes in Bering Sea ecosystems.
Brownell et al.	2001	North Pacific	Conservation	North Pacific right whale	Discusses the conservation status of North Pacific right whales.
Brueggeman	1998	North Aleutian Basin	Distribution	Marine mammals	Discusses marine habitat use in the MMS planning areas of the North Aleutian Basin, St. George Basin, and the Gulf of Alaska.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Buckland and Breiwick	2002	Eastern Pacific	Population	Gray whale	Discusses trends in abundance of eastern Pacific gray whales estimated from shore counts from 1967-1968 to 1995-1996.
Burek et al.	2005	Gulf of Alaska, Aleutian Islands	Population	Steller sea lion	Serologic data were examined to determine whether infectious disease may have played a role in the decline of Steller sea lions in the Gulf of Alaska and Aleutian Islands.
Burn	1998	Bering Sea	Regulation	Pacific walrus	Estimates hunter compliance with the Marine Mammal Marking, Tagging and Reporting Program for walrus.
Burn and Perryman	1999	Bering Sea	Population	Pacific walrus	Discusses application of remote sensing to walrus studies in Alaska.
Burn et al.	2003	Bering Sea	Population	Pacific walrus	This paper reports on tests of airborne thermal imagery of Pacific walrus to determine if this technology can be used to detect walrus groups on sea ice and estimate the number of walruses present in each group. The study identified a significant linear relation between walrus group size and the amount of heat measured by the thermal sensor. Results of this study indicate that an aerial survey using a thermal sensor can cover as much as 4 times the area per hour of flight time with greater reliability than visual observation.
Butterworth et al.	2002a	Bering Sea	Population	Gray whale	Discusses dynamic response analysis for the North Pacific gray whale population.
Butterworth et al.	2002b	Bering Sea	Population	Gray whale	Discusses modeling of the North Pacific gray whale population.
Calambokidis et al.	1996	North Pacific	Population	Humpback whale	Discusses interchange and isolation between humpback whales off California and other North Pacific feeding grounds.
Calkins et al.	1998	Alaska	Population	Steller sea lion	Evaluates nutritional stress as a cause for the decline in numbers of Steller sea lions in the Gulf of Alaska, the Aleutian Islands, and the Bering Sea.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Call and Loughlin	2005	Aleutian Islands, Gulf of Alaska	Ecology	Steller sea lion	This paper presents a broad ecological characterization of rookeries for the western stock of Steller sea lions to inform management decisions for their recovery. Data on habitat, diet, and population trends were used to group sea lion rookeries into ecologically related regions. Five distinct classes of rookeries (potential management regions) were identified.
Cascadia Research	2006	North Pacific	Abundance, population, impacts	Humpback whale	This website presents the results of the “Structure of Populations, Levels of Abundance, and Status of Humpbacks” (SPLASH) project that examined population structure, abundance, and human impacts for humpback whales in the North Pacific.
Castellini et al.	1996	Alaska	General	Harbor seal	Reports annual investigations on harbor seals in Alaska.
Chadwick et al.	1996	Chukchi Sea	Impacts	Pacific walrus	Reports preliminary research on the potential effects of disturbance in the Outer Continental Shelf.
Chivers	1999	North Pacific	Population	Pacific walrus	This report discusses biological indices using models to monitor the population status of walrus.
Chivers et al.	2002	North Pacific	Population	Harbor porpoise	Molecular genetic analysis is used to evaluate small-scale population structure of eastern North Pacific harbor porpoises.
Clark and Ellison	2000	Bering, Chukchi, & Beaufort Seas	Distribution	Bowhead whale	Acoustic location methods for bowhead whales are calibrated and compared.
Clarke and Moore	2002	Bering Sea, Chukchi Sea	Distribution	Gray whale	Report of observations of gray whales in the southern Chukchi and northern Bering Seas during August–November 1980–1989.
Clark et al.	1996	Bering Sea, Chukchi Sea, Beaufort Sea	Distribution	Bowhead whale	An acoustic study was conducted off Point Barrow, Alaska, in spring 1993 as part of the continuing effort to census the Bering-Chukchi-Beaufort Sea bowhead whale population. The offshore distribution of acoustically located whales indicates that throughout the 1993 migration period, 86% of the vocalizing animals were within 4 km of the nearshore ice edge.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Coffing et al.	1998	Yukon-Kuskokwim Delta	Impacts	Bearded seal, ribbon seal, ringed seal, spotted seal, Steller sea lion	The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskowim Delta during 1997–1998 is reported.
Coffing et al.	1999	Yukon-Kuskokwim Delta	Impacts	Bearded seal, ribbon seal, ringed seal, spotted seal, Steller sea lion	The subsistence harvest of seals and sea lions by Alaska Natives in three communities of the Yukon-Kuskowim Delta during 1998–1999 is reported.
Coombs et al.	2003	Bering Sea	Ecology, impacts	Marine mammals	This paper assesses the impact of contaminants on marine mammals and human health in the eastern Bering Sea.
Da Silva et al.	2000	General	Population	Bowhead whale	Capture-recapture techniques using photo-identification were used to estimate bowhead whale population size.
Dahlheim et al.	2000	Bristol Bay, Gulf of Alaska	Population	Harbor porpoise	Aerial surveys were used to estimate harbor porpoise abundance.
Dehn et al.	2002	Alaska	Ecology, impacts	Ringed seal, spotted seal, bearded seal	Discusses feeding ecology of arctic phocids to evaluate implications for heavy metal dynamics.
Dehn et al.	2003	Alaska	Ecology, impacts	Ringed seal, spotted seal	Heavy metals in renal and hepatic tissue of ringed, bearded, and spotted seals was evaluated in relation to age and diet.
DeMaster et al.	1996	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Seals	This paper evaluates data on ice-associated seals from 1975 to 1991.
DeMaster et al.	1997	Alaska	Population	Ringed seal	This paper presents observations on the distribution and abundance of ringed seals in northern Alaska in May 1996.
DeMaster et al.	2001	Norton Sound	Population	Beluga whale	This paper evaluates the effect of sea condition on estimates of beluga whales, and makes recommendations for survey methods.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
DOC	2002	Bering Sea, Beaufort Sea	Ecology, habitat, regulation	Bowhead whale	In this Federal Register notice, NMFS concludes not to act on a petition to designate certain areas of the Beaufort Sea as critical habitat for the Beaufort Sea stock of bowhead whales. The determination summarizes the state of knowledge of bowhead ecology in the Bering and Beaufort Seas.
DOC	2006	Bering Sea, Gulf of Alaska	Regulation, habitat	North Pacific right whale	In this Federal Register notice, NMFS designates areas of the Bering Sea and the Gulf of Alaska as critical habitat for the North Pacific right whale. The determination includes a summary of the status of the species.
DOD	1999	Beaufort Sea	Impacts	Marine mammals	This final EIS assesses the impact of oil and gas development for the Northstar project.
DOI	2000	Aleutian Islands	Regulation	Northern sea otter	This 2000 determination is a notice of designation of the northern sea otter in the Aleutian Islands as a candidate species.
Eberhardt et al.	2005	Aleutian Islands, Gulf of Alaska	Population	Steller sea lion	This paper attempts to project trends of Steller sea lion populations in six subdivisions of the western Alaska population. Populations were predicted to increase in three areas, decrease in two areas, and be relatively stable in another area.
Estes et al.	1997	Aleutian Islands	Ecology, impacts	Northern sea otter	This paper evaluates organochlorines in northern sea otters from the Aleutian Islands.
Evans et al.	1997	Aleutian Islands	Population	Northern sea otter	This report discusses the distribution and relative abundance of northern sea otters in the Aleutian Islands.
Fadely et al.	2005	Aleutian Islands	Ecology	Spotted seal	This paper evaluated the extent that oceanographic features and bathymetry influenced the diving activity of 30 immature sea lions in the eastern Aleutian Islands. Locations associated with diving to >4 m were within 10 nautical miles of shore and associated with onshelf waters <100 m deep. Diving activity varied coincidentally with increases in sea surface temperature and chlorophyll a concentrations and sea lion age. Immature sea lions developing into independent foragers in the relatively shallow pass areas did so at a time of rapid changes in oceanography and prey availability.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Fay et al.	1997	Alaska	Population	Pacific walrus	This paper evaluates the status of the Pacific walrus population from 1950 to 1989.
Fedoseev	2000	North Pacific	Ecology	Seals	This report discusses the biology of ice-associated seals and their role in North Pacific ecosystems.
Ferrero	1996	North Pacific	Population	Pacific white-sided dolphin	This report discusses growth patterns of the Pacific white-sided dolphin in the central North Pacific.
Ferrero and Walker	1996	North Pacific	Population	Pacific white-sided dolphin	This paper measures age, growth, and reproductive patterns of the Pacific white-sided dolphin taken in high-seas driftnets in the central North Pacific Ocean.
Folkens	2003	General	Population, climate	Marine mammals	This paper discusses global climate change and implications for marine mammal survival.
Forney and Brownell	1996	Aleutian Islands	Population	Marine mammals	This paper gives a preliminary report of a 1994 Aleutian Island marine mammal survey.
Fritz and Hinckley	2005	Gulf of Alaska, Aleutian Islands, Bering Sea	Population	Steller sea lion	This study evaluated the nutritional stress hypotheses for explaining the decline in the western Steller sea lion population. Little support was found for the hypothesis.
FWS	2006a	Alaska	Population, habitat, impacts, regulation	Polar bear, northern sea otter, Pacific walrus	FWS Alaska Endangered Species Listing Program website. This website provides information on a variety of species listed under the ESA, and links to a variety of species-specific information.
FWS	2006b	Alaska	Ecology, population, harvest	Polar bear, northern sea otter, Pacific walrus	FWS Alaska marine mammals management website with some downloadable reports and a publication listing.
FWS	2006c	Alaska	Population, subsistence hunting	Sea otter and walrus	Annual Marking, Tagging, and Reporting Program and the Walrus Harvest Monitoring Program tagging reports provide location, age class, and sex data for sea otters and walrus harvested by Alaskan Natives.
FWS	2006d	Alaska	Population, habitat, impacts, regulation	Northern sea otter	FWS website providing information on listing of the Southwest Alaska Distinct Population Segment of the northern sea otter; includes access to all listing documents and special rules.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Garlich-Miller	1997	Bering Strait	Population	Pacific walrus	This report presents data on age, gender, and reproductive status of the Pacific walrus harvested in the Bering Strait region from 1994 to 1996.
Garlich-Miller and Burn	1999	Alaska	Population	Pacific walrus	This paper reports the results of surveys of harvest of the Pacific walrus in Alaska and Chukotka, including communities in the Bering Sea, Chukchi Sea, and Gulf of Alaska.
Garlich-Miller and Jay	2000	Alaska	Population	Pacific walrus	This report is the proceedings of a workshop concerning walrus survey methods.
Garlich-Miller and Pungowiyi	1999	Alaska	Population, impacts	Pacific walrus	This report is the proceedings of a workshop concerning walrus harvest in Alaska and Chukotka.
Garlich-Miller et al.	2006	Bering Strait	Population	Pacific walrus	This paper reports age and population structure of walrus harvested in the Bering Strait over the past 50 years.
Gelatt	1996	Aleutian Islands	Ecology	Northern sea otter	This thesis presents studies of activity patterns and time budgets of sea otters at Amchitka Island.
George et al.	2001	Bering Sea, Chukchi Sea, Beaufort Sea	Ecology	Bowhead whale	This paper looks at energetic adaptations of the bowhead whale.
George et al.	2002	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	This paper reports the population size of the Bering-Chukchi-Beaufort Sea stock of bowhead whales, based on the 2001 census off Point Barrow.
Givens	2000	General	Population	Bowhead whale	Gives an example of strike limit algorithm optimization.
Givens	2003	General	Population, impacts	Bowhead whale	Estimates safe aboriginal whaling limits for bowhead whales.
Givens and Bravington	1996	General	Population	Bowhead whale	Evaluates sensitivity and adequacy of modeling of bowhead whale stocks.
Goddard and Rugh	1998	Bering Sea	Distribution	North Pacific right whale	This paper reports a siting of a group of right whales in the Bering Sea in July 1996.



**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Greene et al.	2003	Alaska	Population	Bowhead whale	This report discusses the use of DIFAR sensors to locate calling bowhead whales and monitor their migration.
Gudmundson et al.	2006	Bering Sea	Ecology	Northern fur seal	The diet of northern fur seals was studied by examining scat or spews to determine size and age composition of prey.
Hastings	2001	Bering Sea	Impacts	Harbor seal	Data from Alaska were compared with data on harbor seals from other areas to evaluate the need for further study.
Hill and DeMaster	1999	Alaska	Population, impacts	Cetaceans	This report provides information on the marine mammal stocks of Alaska under the jurisdiction of the NMFS, and includes a description of the stock's geographic range, a minimum population estimate, current population trends, current and maximum net productivity rates, optimum sustainable population levels and allowable removal levels, and estimates of annual human-caused mortality and serious injury
Hill et al.	1997	Alaska	Population, impacts	Cetaceans	This report provides information on the marine mammal stocks of Alaska under the jurisdiction of the NMFS. Each stock assessment includes a description of the stock's geographic range, a minimum population estimate, current population trends, current and maximum net productivity rates, optimum sustainable population levels and allowable removal levels, and estimates of annual human-caused mortality and serious injury through interactions with commercial fisheries and subsistence hunters.
Hills	2001	Alaska	Ecology	Pacific walrus	This paper discusses movements and behavior of male Pacific walruses in spring and early summer.
Hirons	1996	Bering Sea, Gulf of Alaska	Ecology	Steller sea lion, northern fur seal, harbor seal	This paper reports the use of stable carbon and nitrogen isotope analysis to investigate the trophic relations of Alaska pinnipeds in the Bering Sea and Gulf of Alaska.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Hirons et al.	2001	Bering Sea, Gulf of Alaska	Ecology	Steller sea lion, northern fur seal, harbor seal	This paper reports the use of stable carbon and nitrogen isotope analysis to investigate the trophic relations of Alaska pinnipeds in the Bering Sea and Gulf of Alaska. It examines the hypothesis that trophic changes were related to declines of certain populations.
Hobson and Sease	1998	Alaska	Ecology	Steller sea lion	This paper used stable isotope analyses to examine dietary records of the Steller sea lion.
Hoekstra et al.	2002a	Alaska	Ecology	Bowhead whale	This paper discusses the trophic ecology of bowhead whales as determined from carbon, nitrogen, and sulfur isotope signatures.
Hoekstra et al.	2002b	Beaufort Sea	Ecology, impacts	Bowhead whale	This paper reports investigations of the bioaccumulation of organochlorine contaminants in bowhead whales.
Houck and Jefferson	1999	General	General	Dall's porpoise	This chapter describes the life history and biology of Dall's porpoise.
Hunt et al.	2001	Bering Sea	Ecology	Pinnipeds, cetaceans, and northern sea otter	This data gives quantitative data on abundance and estimates of energy requirements, diet, and prey consumption for marine mammals in the continental shelf and pelagic regions of the Bering Sea.
International Whaling Commission	2006	Worldwide	Management	Whales	This report presents reports of International Whaling Commission observers at various meetings addressing whale management. It also summarizes activities of the International Whaling Commission.
Ivashchenko et al.	2003	Russia	Impacts	Gray whale	This paper discusses the reactions of western gray whales to seismic surveys.
Jamison	2001	Bering Sea, Gulf of Alaska	Ecology	Harbor seal	Scat and stomach contents were analyzed in order to provide data on the diet of harbor seals. Regional differences in diet were noted.
Jamison et al.	2001	Bristol Bay	Population	Harbor seal	Harbor seals were surveyed in Nunvak Bay and analyzed with respect to time, weather, and sea conditions. Trends were compared with those in other populations in Alaska.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Jay et al.	1998	Bristol Bay	Impacts	Pacific walrus	Responses of Pacific walruses to disturbance during capture and handling activities associated with tagging were measured at a haulout location at Cape Pierce.
Kasuya	2002	General	General	Beaked whales	A general description of the natural history and biology of beaked whales.
Kelly et al.	1999	Bering Sea	Population	Pacific walrus	This paper discusses evidence of a declining population of the Pacific walrus.
Kim et al.	1996	Alaska	Impacts	Steller sea lion	This paper presents results of research on the specific accumulation and distribution of butylin compounds in organs and tissues of the Steller sea lion. Comparisons with organochlorine accumulation are made.
Krahn et al.	1997	Alaska	Impacts	Seals	Organochlorine contaminants in the blubber of four seal species were discussed in terms of integrated biomonitoring and specimen banking.
Krahn et al.	1999	Alaska	Impacts	Beluga whale	Concentrations and patterns of persistent organochlorine contaminants were measured in three Alaska stocks of beluga whales.
Krahn et al.	2001	North Pacific	Impacts	Gray whale	Organochlorine contaminant concentrations and lipid profiles in the eastern North Pacific gray whale were measured.
Kucey and Trites	2006	General	Impacts	Sea lions	This paper provides a review of the potential effects of disturbance on sea lions, including both response and recovery.
Le Boeuf et al.	2000	Bering Sea, Pacific	Ecology	Gray whale	This paper evaluates the starvation hypothesis, among others, to explain high gray whale mortality. Declining amphipod populations in the Bering Sea are implicated.
LeDuc et al.	2000	North Pacific	Population	North Pacific right whale	This report discusses the progress of research on the eastern North Pacific right whale during July 1999.
LeDuc et al.	2001	Bering Sea, Bristol Bay	Population	North Pacific right whale	This note discusses surveys for right whales in the southeastern Bering Sea.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
LeDuc et al.	2002	North Pacific	Population	Gray whale	This paper discusses genetic differences between western and eastern North Pacific gray whale populations.
Lee et al.	1996	Bering Sea, Alaska	Impacts	Steller sea lion	This paper discusses persistent organochlorines in Steller sea lions in Alaska, including the Bering Sea, from 1976 to 1981.
Lesage et al.	1999	St. Lawrence River	Impacts	Beluga whale	This report presents observations on the behavior and primarily vocalizations of beluga whales when in the presence of noise from a ferry and a small boat.
Loughlin and Yorke	2000	Aleutian Islands, Gulf of Alaska	Population, impacts	Steller sea lion	This paper examines sources of mortality for the western population of Steller sea lion that account for decline of the population. Mortality of sea lions is estimated for subsistence harvest, incidental to fishing, illegal shooting, research, and predation by sharks and killer whales.
Lowry et al.	1998	Bering Sea, Chukchi Sea	Population	Spotted seal	This paper monitored the movements and behavior of satellite-tagged spotted seals caught in Kasegaluk Lagoon in the Chukchi Sea. Movements and proportion of time spent at haulouts or at sea were monitored for 12 individuals. Seals range as far south as the Bering Sea sites of Providenya Bay on Chukchi Peninsula and Golovin Bay on the Seward Peninsula.
Lowry et al.	2000a	Bering Sea	Distribution	Spotted seal	This paper examines habitat use and selection by spotted seals in both Alaskan and Russian waters of the Bering Sea. Seals were fitted with satellite-linked tags and followed for August to June during several years.
Lowry et al.	2000b	Bering Sea	Ecology	Spotted seal, bearded seal, ringed seal, Pacific walrus, bowhead whale, beluga whale	Discusses the relationship of marine mammals to sea ice and evaluates potential changes in habitat, food availability, and interspecies relationships due to changes in sea ice.
Maldini et al.	2005	Alaska	Population	Northern sea otter	This report presents papers from a workshop addressing the decline of the southwestern Alaska sea otter population.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Marine Mammal Commission	2001	General	Population, habitat, impacts, regulation	North Pacific right whale, gray whale, Steller sea lion, Pacific walrus, harbor seal, northern sea otter	This report addresses the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA.
Marine Mammal Commission	2002	General	Population, habitat, impacts, regulation	North Pacific right whale, gray whale, Steller sea lion, Pacific walrus, harbor seal, northern sea otter, humpback whale, killer whale	This report addresses the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA.
Marine Mammal Commission	2003	General	Population, habitat, impacts, regulation	North Pacific right whale, gray whale, Steller sea lion, Pacific walrus, harbor seal, northern sea otter, humpback whale, killer whale	This report addresses the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA.
Marine Mammal Commission	2004	General	Population, habitat, impacts, regulation	Killer whale, northern sea otter, beaked whales	This report addresses the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA.
Marine Mammal Commission	2005	General	Population, habitat, impacts, regulation	North Pacific right whale, beaked whales	This report addresses the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA.
Marine Mammal Commission	2006	General	Population, habitat, impacts, regulation	North Pacific right whale, killer whale, ice seals, harbor seal, Steller sea lion, northern fur seal, northern sea otter	This report addresses the regulation, conservation, management, status, and human impacts to marine mammals listed as threatened and endangered under the ESA or depleted under the MMPA. This edition gives special attention to Alaska marine ecosystems.
Matkin et al.	2001	Alaska	Ecology	Steller sea lion, killer whale	This paper estimates the predation of killer whales on Steller sea lions. It examines whether diet or predation contributes to the continuing decline and lack of recovery of sea lions, and concludes that predation may be an important source of mortality, but that better data are needed to quantify the extent to which predation contributes to the lack of recovery.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
McDonald and Moore	2002	Bristol Bay	Population	North Pacific right whale, fin whale, killer whale, sperm whale	Calls from North Pacific right whales were recorded during visual and acoustic surveys in Bristol Bay north of the Aleutian Peninsula in July 1999. Acoustic detections numbered 26, and 511 calls were detected. Calls were also detected from fin whales, killer whales and a sperm whale.
Merrick and Calkins	1996	Gulf of Alaska	Ecology	Steller sea lion	This paper discusses the importance of juvenile walleye pollock in the diet of Gulf of Alaska Steller sea lions.
Merrick et al.	1997	Alaska	Ecology	Steller sea lion	Investigates the hypothesis that diet is related to the decline of the Steller sea lion.
MMS	2006a	Beaufort Sea, Chukchi Sea	Impacts	Bowhead whale, fin whale, humpback whale	This evaluation of the potential effect of oil and gas leasing in the Beaufort Sea and Chukchi Sea includes the topics of acoustic effects, harassment, oil spill effects, and development activities. The species considered include bowhead whales, fin whales, and humpback whales. The report also reviews the literature on distribution, life history, ecology, and human interactions for the species.
MMS	2006b	Bering Sea	Population	Pacific walrus	This report presents a final study plan for estimating the size of the Pacific walrus population. The study will include aerial photography, infrared imaging, and satellite tagging of both western and eastern Bering Sea populations.
Moore	2000	Bering Sea	Population	Whales	This paper discusses estimates of baleen whale abundance on the central Bering Sea shelf in 1999.
Moore	2002	Bering Sea	Population	Cetaceans	The use of acoustics in detecting cetaceans is discussed.
Moore	2005	General	Impacts	Marine mammals	This book chapter discusses the potential effects of long-term environmental change on marine mammals.
Moore	2006	Bering Sea	Distribution	Fin whale, humpback whale, gray whale, North Pacific right whale	General overview of cetacean distribution and abundance in the Bering Sea.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Moore and Clarke	2002	General	Impacts	Gray whale	This paper reviews information on the effects of human activities on the western gray whale. Offshore oil and gas drilling, commercial fishing and vessel traffic, and whale watching and scientific research are discussed.
Moore et al.	2000	Bering Sea	Population	Whale	This paper discusses baleen whale abundance and associations with prey on the central Bering Sea shelf.
Moore et al.	2001	General	Population	Gray whale	Abundance of gray whales is discussed with respect to carrying capacity.
Moore et al.	2002	Bering Sea	Population	Whales, porpoises	Discusses associations of the distribution of cetaceans in the central and southeastern Bering Sea with bathymetry and prey.
Moulton et al.	2003	Beaufort Sea	Impacts	Ringed seal	Discusses the effects of offshore oil development with abundance and distribution of ringed seals in the Beaufort Sea.
National Marine Mammals Laboratory	2006	Alaska	General	Marine mammals	National Marine Mammal Laboratory library website contains an extensive collection of marine mammal literature.
NMFS	2001	Bering Sea, Aleutian Islands	Impacts	Steller sea lion	This report provides a detailed discussion of past and potential effects of fishing and other human activities on Steller sea lions. It discusses fishing, status and management, life history and ecology, and cumulative effects, and contains an extensive bibliography.
NMFS	2003	Alaska	Impacts	Steller sea lion	This report supplements the 2001 Biological Opinion on the pollock, cod, and mackerel fisheries off Alaska, updates the status of the Steller sea lion, and summarizes Steller sea lion conservation measures. Changes in the spatial and temporal distribution and the possible effects of groundfish fisheries on the prey field for sea lions are discussed.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
NMFS	2005	United States	General	Northern right whale	This presentation at a scoping meeting discusses the EIS on Northern right whale research planned to be completed in August 1997.
NMFS	2006a	Worldwide	Population, habitat, impacts, regulation	Fin whale	Draft recovery plan for the fin whale.
NMFS	2006b	Alaska	Population, habitat, impacts, regulation	North Pacific right whale	Proposed rule to list the North Pacific right whale as endangered and designate critical habitat in the Gulf of Alaska and Bering Sea.
NMFS	2006c	Alaska	Population, habitat, impacts, regulation	Steller sea lion	This map shows designated critical habitat for the Steller sea lion.
NMFS	2006d	Worldwide	Population, habitat, impacts, regulation	Fin whale	This report is a draft recovery plan for the Antarctic, Atlantic, and North Pacific populations of the fin whale. Taxonomy, species description, population structure, zoogeography, life history, and ecology are described. The report discusses all sources of threats, both human and natural, and defines a recovery program.
NMFS	2006e	Alaska	Population, habitat, impacts, regulation	Steller sea lion	This draft recovery plan for the western population of the Steller sea lion describes the species, its population structure, life history, and ecology. The report describes all sources of threats, both human and natural, and defines a recovery program.
NMFS	2006f	Alaska	Population, habitat, impacts, regulation	Marine mammals	NOAA website with information on latest status and activities related to protected species and their habitats, such as new fisheries regulations for protection of Steller sea lion critical habitat.
NMFS	2006g	Alaska	Habitat, regulation	Steller sea lion	Website providing information on Steller sea lion critical habitat and no-entry zones.



**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Nordeen and Lien	2001	General	Impacts	Baleen whales	This report discusses the effects of high-amplitude acoustics on the distribution, abundance, and behavior of baleen whales.
Pauly et al.	1998	World	Ecology	Pinnipeds, cetaceans, and northern se otter	Standardized diet compositions were derived for 97 species of marine mammals from published accounts of stomach contents, as well as from morphological, behavioral, and other information. Diet was apportioned among eight categories of prey types (benthic invertebrates, large zooplankton, small squids, large squids, small pelagic fishes, mesopelagic fishes, miscellaneous fishes, and higher invertebrates). Trophic levels were estimated for each species of marine mammal and compared with published estimates derived using stable isotope ratios.
Perryman and Lynn	2002	Pacific	Population	Gray whale	This paper evaluated the nutritive condition and reproductive status of migrating gray whales using photogrammetric data.
Poole and Givens	2001	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	Assessment of the Bering-Chukchi-Beaufort Seas population of bowhead whales.
Punt and Butterworth	1996	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	Discusses a Bayesian approach to assessing of the Bering-Chukchi-Beaufort Seas population of bowhead whales.
Punt and Butterworth	1997	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	Discusses maximum likelihood and Bayesian approaches to assessing bowhead whale populations in the Bering-Chukchi-Beaufort Seas.
Punt and Butterworth	1999	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	Presents a Bayesian approach for modeling bowhead whale populations.
Punt and Butterworth	2000	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	Discusses differences in maximum likelihood and Bayesian approaches to assessing bowhead whale populations.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Punt and Butterworth	2002	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Gray whale	Discusses assumptions used in assessing the status of gray whale stocks.
Punt et al.	1997	Bering Sea, Chukchi Sea, Beaufort Sea	Population	Bowhead whale	Comparison of strike limit algorithms for the Bering-Chukchi-Beaufort Seas stock of bowhead whales.
Read and Wade	2000	Bering Sea, Gulf of Alaska	Population, regulation, impacts	Steller sea lion, harbor seal	This report lists marine mammals for which the take exceeds the potential biological removal level set under the MMPA. Steller sea lion and Gulf of Alaska harbor seals are listed.
Ream et al.	2005	Bering Sea, North Pacific	Population, impacts	Northern fur seal	This paper reports results of monitoring the movements of 13 female northern fur seals tagged at St. Paul Island during November 2002. Seals migrated through the Bering Sea through Unimak into the North Pacific as far as the California coast and oceanic transition zone. Two seals were tracked until they returned to St. Paul Island after journeys of more than 9,000 km. Dive characteristics of fur seals, relationship to oceanographic features, and detailed diet data for fur seals at sea are also presented.
Reeves et al.	1998	Atlantic and North Pacific Ocean	Regulation, impacts	Fin whale, sei whale	This report is a draft recovery plan for the Atlantic and North Pacific populations of the fin whale and the North Pacific population of the sei whale. It describes taxonomy, species description, population structure, zoogeography, life history, and ecology. The report discusses all sources of threats, both human and natural, and defines a recovery program.
Richardson	1996	Beaufort Sea	Impacts	Bowhead whale	This paper reports the response of bowhead whales to disturbances from vessels, dredging, and drilling activities. This paper is followed by other papers on acoustics and response of whales.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Rugh et al.	1997	Alaska	Distribution	Spotted seal	This paper discusses the spotted seal in Alaska.
Rugh et al.	1999	North Pacific	Population, habitat, impacts, regulation	Gray whale	This document reviews the status of the eastern population of gray whale 5 years after removal from the list of endangered and threatened wildlife and plants in 1994. It describes abundance, distribution, population trends, reproduction, habitat use, and anthropogenic concerns.
Rugh et al.	2001	Pacific	Distribution	Gray whale	This paper discusses the timing of the western gray whale southbound migration.
Schell	2000	Bering Sea	Ecology	Bowhead whale	Isotope ratios in baleen from bowhead whales were used to estimate the marine productivity and the carrying capacity of the Bering Sea ecosystem.
Scribner et al.	1997	General	Population	Northern sea otter	A review of genetic studies was used to differentiate populations of sea otters.
Seagars and Garlich-Miller	2001	Bering Sea	Ecology, impacts	Pacific walrus	This study reported analyses of organochlorine compounds and aliphatic hydrocarbons in Pacific walrus blubber.
Sheffield et al.	2001	Bering Sea	Ecology	Pacific walrus	Controlled digestion studies were used to determine differential digestion rates of walrus prey. The objective was to evaluate biases in diet data based on stomach contents.
Shelden and Rugh	2002	Worldwide	Population, habitat, impacts, regulation	Bowhead whale	This report describes the historic and current status of the bowhead whale. The study supports decision making on bowhead whale management under the ESA.
Shelden et al.	2001	General	Population, habitat, impacts, regulation	Bowhead whale	This paper discusses considerations involved in reviewing the status of marine mammals proposed for listing under the ESA. The bowhead whale is used as a case study.
Shelden et al.	2005	Bering Sea, Gulf of Alaska	Distribution, habitat	North Pacific right whale	This paper uses siting data to evaluate historic and current habitat use by North Pacific right whales.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Shelden et al.	2006	Bering Sea, Gulf of Alaska	Distribution	North Pacific right whale	This presentation presents historic and recent data on the distribution of North Pacific right whales in the eastern north Pacific, with emphasis on the southeastern Bering Sea and the Gulf of California.
Simpkins et al.	2003	Bering Sea	Ecology	Bearded seal, ringed seal, ribbon seal, spotted seal, Pacific walrus	Aerial surveys of ice-associated pinnipeds were evaluated with respect to ice habitat type and benthic community.
Sinclair et al.	2005	Bering Sea, Gulf of Alaska	Distribution	Steller sea lion, humpback whale, minke whale, killer whale, sperm whale	Biophysical variables were analyzed with respect to locations of Steller sea lions and cetaceans. The most significant correlations were depth and proximity to the nearest measured pass for Steller sea lions and all cetaceans, respectively; frequencies of herring and salmon in Steller sea lion diet with population trend; fluorescence in the top 50 m with occurrence of humpback, minke, and killer whales; and surface temperature with occurrence of humpback, killer, and sperm whales.
Small	2001	Bristol Bay	Distribution	Harbor seal	Seal haulouts were identified on the north side of the Alaska Peninsula during 1998–1999.
Small et al.	2003	Bristol Bay, Gulf of Alaska	Population	Harbor seal	Trends in abundance of harbor seals were evaluated for the years 1983–2001.
Strick et al.	1997	Aleutian Islands	Population	Steller sea lion	Aerial and ship-based surveys of Steller sea lions were conducted from southeast Alaska to the Aleutian Islands in June and July 1994.
Taylor	2003	Beaufort Sea, Bering Sea, Chukchi Sea	Population	Bowhead whale	This paper discusses modeling that is related to the issue of whether the Beaufort-Chukchi-Bering Sea population of bowhead whales should be listed as endangered.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Trites and Heise	1996	Gulf of Alaska	Ecology	Pinnipeds, cetaceans	This report estimates the consumption of food by 13 populations of marine mammals found in the Alaskan Gyre of the Gulf of Alaska. The model of food consumption is based on population numbers, mean body weight, and gender. Prey composition is also noted.
Trites et al.	2006	World	Ecology, impacts, population	Steller sea lion	This report presents papers from a symposium on sea lions of the world. The following topics are included: physiological ecology, foraging ecology, population ecology and dynamics, and conservation and management. The following topics on the Steller sea lion are included: contaminants, maternal behavior, prey type, prey abundance, prey variability, diving and feeding behavior, spatial dynamics, population trends, management, and response to disturbance and noise.
Tynan	1999	Bering Sea	Distribution	Fin whale, sei whale, humpback whale, minke whale, North Pacific right whale	Visual surveys during transects of the Bering Sea were used to monitor the distribution of five whale species during unusual oceanographic conditions associated with El Niño in 1997. Whale distribution was associated with shifts in production plankton.
UBC	1999	Bering Sea	Ecology	Marine mammals	This report describes the application of mass balance ecosystem models to the ecosystem of the Bering Sea in order to compare results from 1950 with 1980. The results are interpreted with respect to changes in marine mammal exploitation, changes of fisheries, and ecosystem production.
USGS	2004	Bering Sea, Chukchi Sea	Population	Pacific walrus	The Pacific Walrus International Database is a comprehensive set of Pacific walrus biological data collected in the Bering and Chukchi Seas by several participating organizations. Data categories include: land and ice haulout counts, gender/age composition, reproduction, mortality, harvest statistics, and morphometry.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Wade	1998	Alaska	Population, impacts	Cetaceans, pinnipeds	This paper discusses calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds.
Wade	2002	Alaska, Bering Sea	Population	Gray whale	Stock assessment for the eastern Pacific gray whale using Bayesian analyses.
Wade et al.	2006	Bering Sea	Distribution	North Pacific right whale	Reports on the use of sonobuoys and satellite radio tags to identify and track right whales in the Bering Sea, and on results of photographic and genetic analyses of some of these whales.
Waite 1998	1998	Alaska	Distribution	North Pacific right whale	Paper discusses sighting of North Pacific right whales off Alaska.
Waite et al.	2002	Bering Sea	Distribution, population	Killer whale	Reports on the distribution and abundance of killer whales in the central and southeastern Bering Sea in 1999 and 2000.
Weller et al.	2002	Sea of Okhostk	Impacts	Western gray whale	Study evaluated the effects of 3D seismic testing on the distribution of gray whales on known feeding areas. Results show a relationship between seismic survey operations and an observed change in distribution of whales.
Wiggins et al.	2004	Bering Sea	Distribution	North Pacific right whale	Waveguide propagation used to estimate range of North Pacific right whales in the Bering Sea.
Winship and Trites	2006	Gulf of Alaska, Aleutian Islands	Population	Steller sea lion	Study used population viability analysis to estimate the risk of the Steller sea lion becoming extirpated in western Alaska. Results suggest that the overall predicted risk of extirpation of Steller sea lions as a species in western Alaska was low in the next 100 yr under all scenarios explored. However, most subpopulations of Steller sea lions had high probabilities of going extinct within the next 100 years if population trends observed during the 1990s were to continue.
Winship et al.	2001	Gulf of Alaska, Bering Sea	Growth	Steller sea lion	Growth models (mass and length) were constructed for male (1 year old), female (1 year old), and pregnant female Steller sea lions shot on rookeries or haulouts, or in coastal waters.

**Table 4 (Cont.)**

Authors	Date	Location	Topic	Species	Document Content
Wolfe and Mishler	1996	Alaska	Impacts	Harbor seal, Steller sea lion	This report provides detailed information on the subsistence take of harbor seals and Steller sea lions by Alaska natives in the previous year.
Wolfe and Hutchinson-Scarborough	1999	Alaska	Impacts	Harbor seal, Steller sea lion	This report provides detailed information on the subsistence take of harbor seals and Steller sea lions by Alaska natives in the previous year.
Wolfe et al.	2002	Alaska	Subsistence	Harbor seal, Steller sea lion	This report provides detailed information on the subsistence take of harbor seals and Steller sea lions by Alaska natives in the previous year.
Wolfe et al.	2003	Alaska	Impacts	Harbor seal, Steller sea lion	This report provides detailed information on the subsistence take of harbor seals and Steller sea lions by Alaska native in the previous year.
Wolfe et al.	2004	Alaska	Impacts	Harbor seal, Steller sea lion	This report provides detailed information on the subsistence take of harbor seals and Steller sea lions by Alaska natives in the previous year.
Wolfe et al.	2005	Alaska	Impacts	Harbor seal, Steller sea lion	This report provides detailed information on the subsistence take of harbor seals and Steller sea lions by Alaska natives in the previous year.
Zeh et al.	2002	Alaska	Population	Bowhead whale	Annual survival probability of bowhead whales was estimated using both Bayesian and maximum likelihood implementations of Cormack and Jolly-Seber models for capture-recapture estimation in open populations and reduced-parameter generalizations of these models. Aerial photographs of naturally marked bowheads collected between 1981 and 1998 provided the data.





## 6 SOCIOECONOMICS AND SUBSISTENCE

Presentations at the Planning Meeting included overviews of (1) community socioeconomics by Ed Glazier of Impact Assessment, Inc. (IAI) and (2) subsistence research by Brian Davis, formerly of the ADFG, Division of Subsistence. The presentations, which can be found in the Planning Meeting report, summarize available information and information needs on these topics relevant to an impact assessment of oil and gas development in the Basin.

Socioeconomic trends and current conditions have been summarized in a report prepared by IAI in preparation for the Planning Meeting (IAI 2007).<sup>3</sup> The report provides an excellent overview of socioeconomics and subsistence activities for the communities adjacent to the North Aleutian Basin. It can be used as a source document for preparation of impact assessments for oil and gas development in the North Aleutian Basin. References from the report are included in Section 7.5.

Descriptive and quantitative information is presented in IAI (2007) for the following geographical regions in the vicinity of the North Aleutian Basin:

- Aleutian East Borough and Unalaska/Dutch Harbor, including the communities of Akutan, Cold Bay, False Pass, King Cove, Nelson Lagoon, Sand Point, and Unalaska/Dutch Harbor;
- Bristol Bay Region, including Goodnews Bay, King Salmon, Naknek, South Naknek, Togiak, Manokotak, New Stuyahok, Clark's Point, and Dillingham;
- Lake and Peninsula Borough, including Newhalen, Pilot Point, Port Heiden, Egegik, Chignik, Chignik Lake, Chignik Lagoon, Ivanoff Bay, Perryville, Port Moller, and Pauloff Harbor.

For each of these regions, a socioeconomic overview is provided in the IAI report that describes population trends, demographic conditions, patterns of out-migration, employment, seasonal workers, nonresident employment, income, and the dominant economic activities in the region, including commercial fisheries, sport fisheries, and subsistence. Location, history, conditions, and trends are provided for the communities in each region.

The following is a brief overview of socioeconomic and subsistence trends and conditions in the communities of the North Aleutian Basin as presented in IAI (2007).

The economy of communities in the North Aleutian Basin region is based primarily on commercial fisheries and associated services, including harvest, processing, and distribution of seafood. Salmon fisheries are most important in communities in the northern portion of the Basin, while groundfish, crab, and salmon fisheries are prevalent in the southern portion.

Detrimental socioeconomic effects have occurred in communities throughout the North Aleutian Basin as a result of recent downturns in the salmon fishery and other commercial

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<sup>3</sup> The IAI 2007 report is available at: [www.mms.gov/alaska/reports/2007rpts/akpubs07.htm](http://www.mms.gov/alaska/reports/2007rpts/akpubs07.htm).

fisheries. Many households in the region were living in conditions of poverty at the time of the year 2000 Census. There are few employment alternatives to fishing and associated industries in the Basin. Sport fish guiding is a possible alternative, but the decline in salmon populations has resulted in an apparent decrease in demand. Government employment opportunities are limited, but do provide important sources of income for some individuals.

Subsistence fishing and hunting are critically important to many residents of the Basin, both as a source of food and for the maintenance of cultural traditions. While many persons of all ethnic groups engage in hunting and fishing activities, the majority of participants are Alaska natives who continue centuries-long traditions of gathering wild foods. Food-sharing and trade are common throughout the area and buffer participants from changes in the modern economy. However, hunting and fishing activities have come to rely, at least in part, on the availability of cash. Generations of Alaska natives have supported their hunting and fishing activities with money obtained through commercial fishing, and, consequently, problems in commercial fisheries can have cascading effects for subsistence practitioners.

Options for employment and income are limited in the North Aleutian Basin area. In addition, recent warm winters have hindered transportation and subsistence activities throughout much of the region. Residents throughout the Basin are confronting a range of challenges at the start of the 21st century. A meaningful assessment of economic opportunities in this region needs to examine both traditional interests and the social and economic challenges that are characteristic of rural Alaska today.

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