AKMAP 2006 – 2007 Aleutian Islands Coastal Survey
Environmental Condition Summary






Prepared by:
Alaska Department of Environmental Conservation,
Alaska Monitoring and Assessment Program (AKMAP)
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Cover Photo Credits & Description

Terri Lomax – Dive team member readying to conduct a survey.	Mandy Lindeberg – R/V Norseman I and water quality sampling team in Boston Whaler.
Douglas Dasher – Crested Auklets (*Aethia cristatella*) flying across the water near Kiska Island.	Shawn Harper – Dive team sampling soft sediment quadrat.
Héloïse Chenelot – Bull Kelp (*Nereocystis luetkeana)*	Shawn Harper – Atka Mackerel (*Pleurogrammus monpterygius*)

Additional Photo Credits

Page 7 - Douglas Dasher – Bering Sea looking southeast towards Atka Island and Korovin volcano.
Page 11- Héloïse Chenelot – Swimming Sea Anemone (*Ptychodactis aleutiensis*).
Page 12- Mandy Lindeberg – Haycock Rock off Kiska Island, AK.
Page 14- Max Hoberg, Golden V Kelp (*Aureophycus aleuticus*).
Page 16- Alaska Dept. of Fish and Game, M/V Selendang Ayu shipwrecked of coast of Unalaska.
Page 18- Nick Dallman, R/V Norseman off-shore of Rat Island in 2007.

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Preface

The Alaska Department of Environmental Conservation (DEC) and University of Alaska Fairbanks (UAF) School of Fisheries and Ocean Sciences (SFOS) conducted an Alaska Monitoring and Assessment Program (AKMAP) survey of the Aleutian Islands in 2006 and 2007. This survey focused on near shore waters in the 6 to 20 meter depth around the Aleutian Islands. The ecological condition of this area was assessed using a spatial probabilistic survey design, developed under the U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program. Over the two summers 51 stations were surveyed. Results of the survey provide representative condition indices for water quality, benthic, and fish tissue contaminants. Many new species of marine algae and invertebrates were discovered.

The suggested citation for this report is:

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The document can be downloaded at the following URL:

http://dec.alaska.gov/water/wqsar/monitoring/06-07Aleutian.htm

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Note that the design supports probability based estimates of the percent area of the target population surveyed for particular ecological condition defined by measured values of assessment indicators. However, this design does not provide for detailed assessments of ecological condition within a particular Aleutian Island estuary or coastal area.

Acknowledgements

The EPA Office of Research and Development (ORD) supported this study through Cooperative Agreement #R-82911501. Walt Nelson, Dixon Landers, Tony Olsen, and others with USEPA ORD enthusiastically supported our efforts and understood the importance of this pioneering endeavor in Alaska. We appreciate NOAA allowing Mandy Lindeberg on our team in 2006 and 2007 to act as the resident phycologist. Her enthusiasm over marine algae was contagious none the more so when we discovered the Golden V kelp a new genus and species. University of Alaska Fairbanks Sea Grant allowed Reid Brewer, its Unalaska advisor, to provide his scientific diving skills and knowledge of octopus to join the team in 2006 and 2007. We thank the members of the 2006-07 AKMAP dive team including: Reid Brewer, Héloïse Chenelot, Roger Clark, Roger Deffendall, Shawn Harper, and Max Hoberg for sampling, photography, and videography. Héloïse Chenelot's assistance with the benthic analyses is greatly appreciated. The staff at the National Wetlands Research Center / Gulf Breeze Project Office (NWRC/GBPO, 2005) did great work in helping us re-design the Aleutian Islands survey from an open ocean to a near shore design. Finally, Captain Paul Tate and the crew of the Norseman provided their knowledge and expertise to help make the survey a success and to bring everyone home safely.

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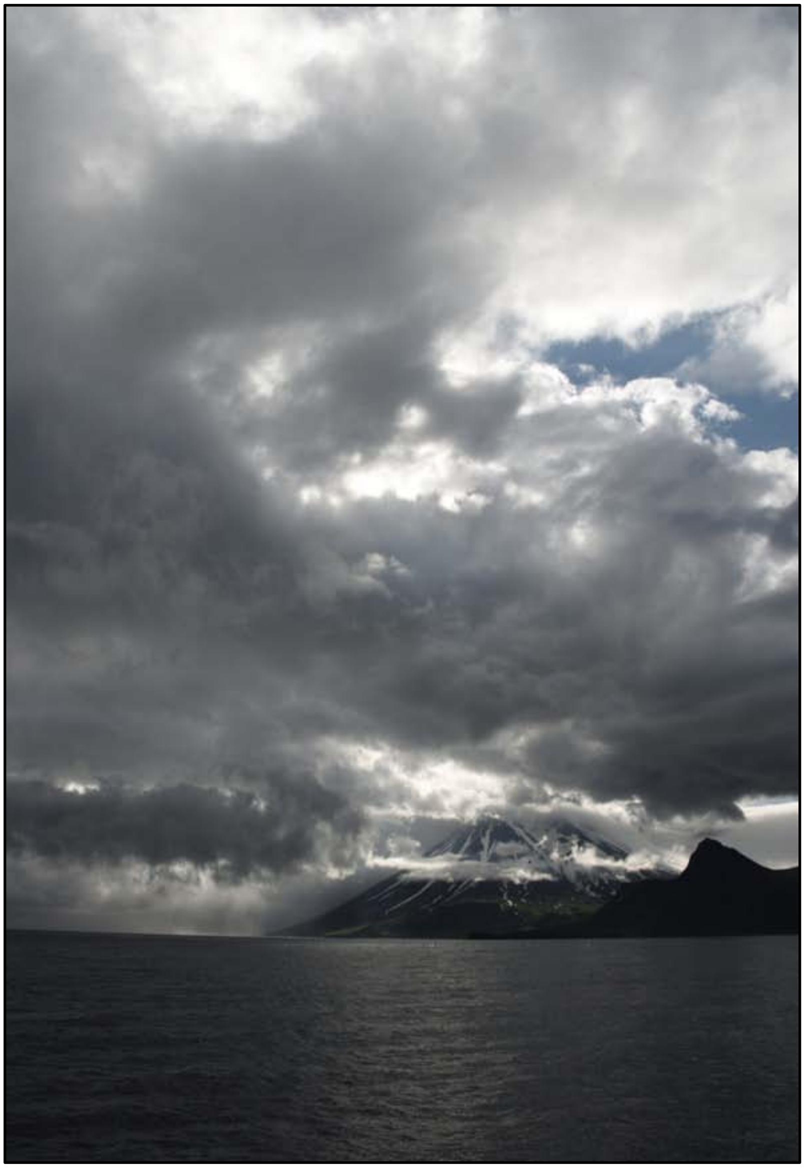

Chapter 1

Environmental Condition of Aleutian Islands Coastal Waters

1. Environmental Condition of Aleutian Islands Coastal Waters

In 2006 and 2007, the Alaska Department of Environmental Conservation (DEC) Alaska Monitoring and Assessment Program (AKMAP) and the University of Alaska Fairbanks (UAF) School of Fisheries and Ocean Sciences (SFOS), surveyed the Aleutian Islands (Figure 1-1). A detailed set of maps with coordinates is included in Appendix A. This report applies the index and ranking scheme, with some modifications, as used by the U.S. Environmental Protection Agency (EPA) National Aquatic Resource Survey (NARS) National Coastal Assessment (NCA) 4 to evaluate environmental condition (EPA, 2012).

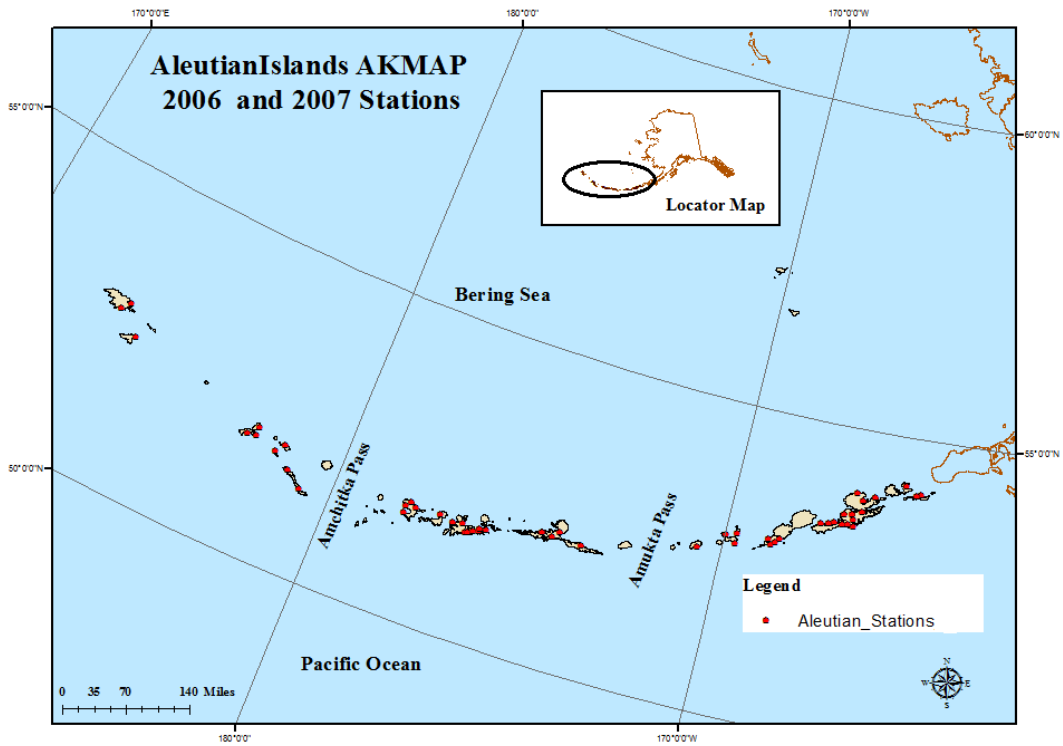

Figure 1-1: Aleutian Islands 2006 and 2007 Coastal Survey Stations

Overall condition of Aleutian Islands coastal near shore waters (6 to 20 meter depth) is rated good, with an overall condition score of 5.0 (Figure 1-2). This is based on the water quality, costal habitat, and benthic habitat indices rating of good, with a fish tissue rating of fair. Sediment quality index was not evaluated as hard and soft bottom types were encountered and no index was established for mixed habitats. This environmental data was collected from 51 stations over 2 summers. Some rankings are based on fewer stations due to inability to collect all samples at every station or data/sample loss. Chapter 3 provides a discussion of the indices and ranking method. As this is an initial AKMAP coastal survey no trends can be inferred, but this underscores the importance of continuing these surveys at future times to assess environmental change and trends in this important ecosystem.

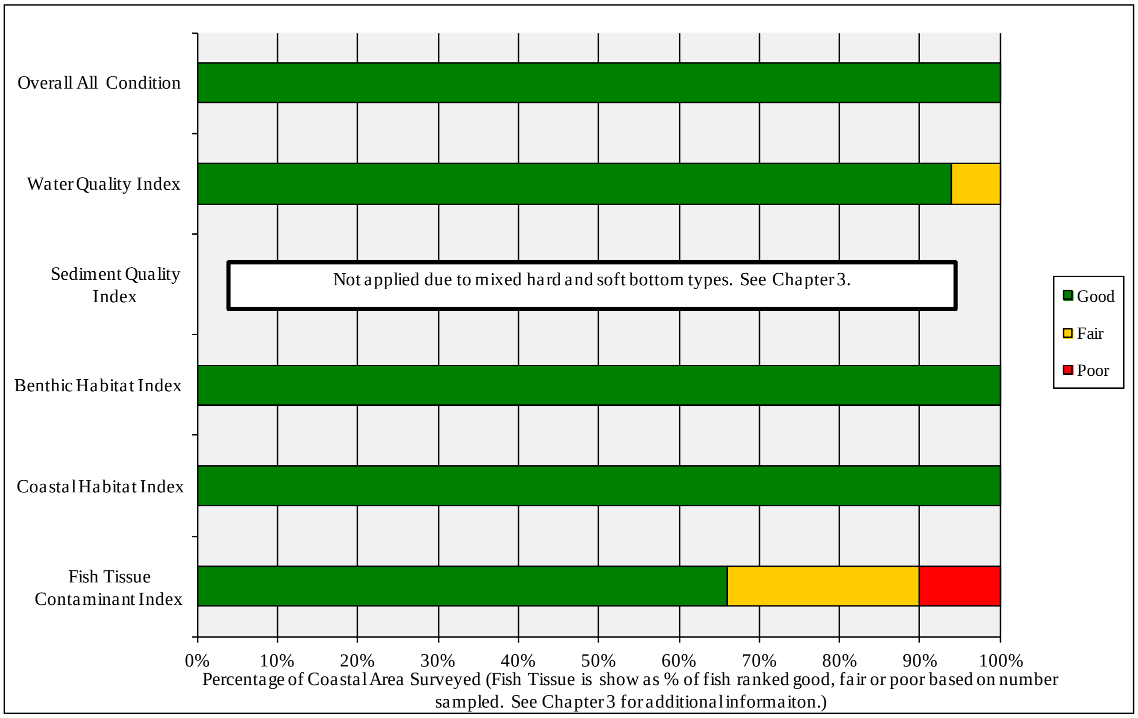

Figure 1-2: Overall of Aleutian Islands coastal waters is rated good.

Water Quality Index

The water quality index for the Aleutian Islands coastal waters is rated good. The index is based on the measurement of five indicators: Dissolved inorganic phosphate (DIP) as phosphorus, Dissolved Inorganic Nitrogen (DIN) as nitrogen, dissolved oxygen, water clarity, and chlorophyll a.

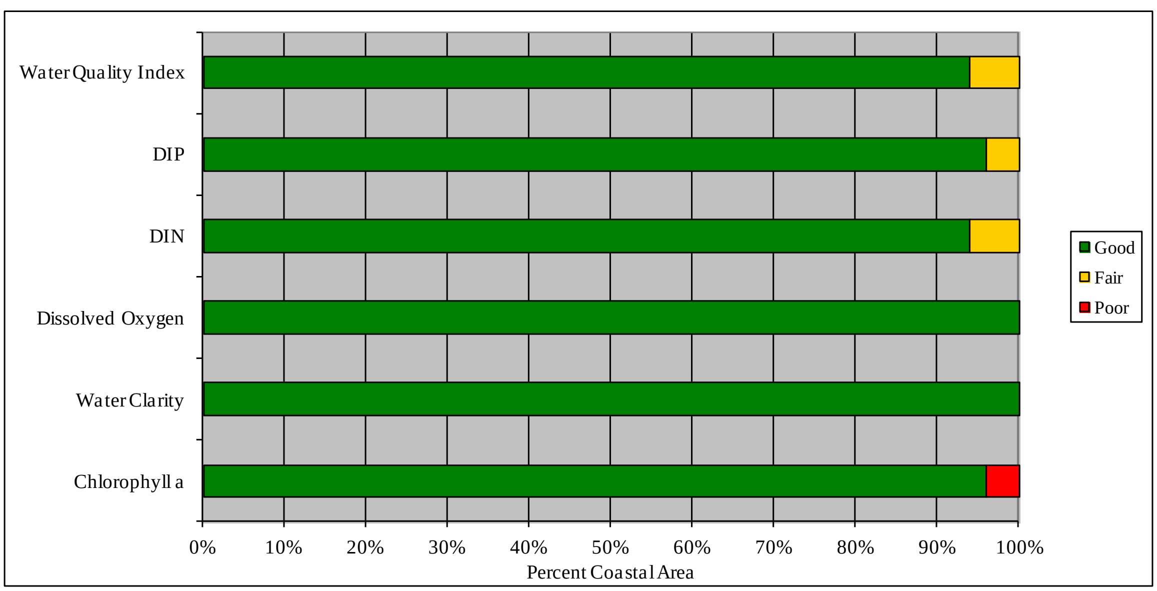

Figure 1-3: Water Quality Index with percentage rankings for indices

The water quality was rated good over 94% of the coastal area surveyed and the remainder was rated fair (Figure 1-3). Overall fair conditions were due to higher DIN, DIP or chlorophyll a observed at several locations. As the index rankings for these indicators were based on cutpoints developed in coastal regions outside of Alaska for the National Coastal Assessment program, further work is needed to determine if these are the best to apply to Aleutian Islands coastal waters. Given the small human population density and no known significant human regional sources of nutrients near the stations the observed fair and poor values likely reflect natural conditions, rather than human influences.

Nutrients: Nitrogen and Phosphorus

Aleutian Islands coastal waters are rated good for DIN, with 94% of the coastal area rated good, and 6% rated fair. For DIP 96% of coastal waters were rated good, with 4 % rated fair.

Dissolved Oxygen

A 100% of the Aleutian Islands coastal surface and bottom waters were rated good for dissolved oxygen. This was expected in sampling these shallow well mixed coastal waters with little direct human input of wastewaters or organic materials.

Water Clarity

A 100% of the Aleutian Islands coastal waters (top 1 meter) are rated good.

Chlorophyll a

The chlorophyll a concentrations in the Aleutian Islands coastal surface waters was rated as good, with 96% rated good and 4% poor.

Sediment Quality Index

The sediment quality index was not rated for this assessment as less than half the stations were in soft sediments and no inferences could be made to the overall target population. Results of the sediment sampling will be reported separately in the AKMAP 2006 and 2007 Aleutian Islands Coastal Survey Statistical Summary.

Benthic Habitat Index

Benthic habitat index for the Aleutian Islands coastal waters was rated a good for a 100% of this component indicator based on professional judgment of species abundance and diversity. A total of 35 animal phyla have been recorded from the entire world’s ocean, all habitats, depths, latitudes, and longitudes combined (Groombridge and Jenkins 2002). The AKMAP survey encountered a total of 16 benthic marine phyla or 707 taxa of invertebrates. Considering the relatively narrow bathymetry (6-20 m) explored, short coastal distance travelled (1,900 km), and relatively modest number of sites surveyed (50), the species richness of this Aleutian region is high.

Alaska does not currently have established benthic indices criteria for ranking benthic habitat quality. The data sets gathered during this survey provide information that can help with future development of benthic indices for the various marine ecosystems in Alaska.

Coastal Habitat Index

Costal habitat index for the Aleutian Islands is rated good for a 100% of this component indicator. No specific Aleutian Islands data was available and this ranking is ranked based on the overall condition for Alaska. From 1990 to 2000 Alaska coasts experienced a loss of 900 acres (0.04%) of coastal wetlands (EPA, 2012), with a state longer average decadal wetland loss rate of 0.01%. Climate change may be expected to increase the loss of coastal wetlands due to coastal erosion and increased thawing of coastal permafrost in the Arctic (Jones et al., 2009).

Fish Tissue Contaminant Index

The fish tissue contaminants index based on percentage condition of fish sampled is rated fair, with 66 % rated good, 24% rate fair and 10% poor. Fish were collected at 50 stations and analyzed for a set of metals, PCBS, and organochlorine pesticides. Preferred target fish were Black or Dusky Rockfish, with secondary targets being Rock or Kelp Greenling. If these fish were not present or limited in abundance other fish were collected, such as Irish Lords. The Aleutian Islands AKMAP condition report compared contaminant concentrations in whole-body fish samples to EPA advisory guidance values. Additional information on this ranking is discussed in Chapter 3.

New Species

There are numerous unknown animals in this little studied ecosystem. The AKMAP scientific team has so far confirmed 16 new species of algae and 20 new species of invertebrates in the near shore regions. The Golden V kelp (*Aureophycus aleuticus*) shown on the Chapter 2 page and the swimming sea anemone (*Ptychodactis aleutiensis*) in Figure 1-4 are two examples of the new species discovered.

Figure 1-4: Swimming sea anemone (*Ptychodactis aleutiensis***)**

Intertidal Site Summaries

The AKMAP surveys provided a unique opportunity to visit this remote area where few intertidal surveys have been done. During 2006 and 2007, when it could be safely done, we surveyed and provided brief descriptions of the intertidal habitats adjacent our coastal waters stations. Figure 1-5 shows biobands at Haycock Rock near Kiska Island. Overall 31 intertidal sites across the Aleutian Archipelago are provided in a companion report *Aleutian AKMAP Intertidal Site Summaries* available on the DEC AKMAP web site. These summaries, with photographs and maps, highlight the intertidal sites geomorphology, biobands, marine algae, and invertebrates.

Figure 1-5: Haycock Rock off Kiska Island, Alaska.

Discussion

Results of this survey for summers of 2006 and 2007 provide "snapshot" of the near shore environmental condition, but do not address changes or trends in environmental condition. This ecosystem is very complex and is currently recovering from ecosystem impacts from sea otter harvesting in the 1800's and World War II occupation. Recent studies have reported declining sea otter populations, which if they continue may impact the nearshore marine ecosystem. Contaminants at levels of concern to wildlife, including in our assessment, have been observed in fish and other animals sampled in the Aleutians. Climate change has the potential to affect the near shore ecosystems through water temperature change, variations in upwelling nutrient input, and ocean acidification. Heavy ship traffic introduces the risk of hydrocarbon or other type spills that can impact the near shore ecosystems. Commercial fishing is being managed under a pilot ecosystem plan developed by the North Pacific Fishery Management (NPFMC, 2007).

AKMAP future Aleutian Islands surveys and other ecosystem studies are important to DEC's understanding of possible changes and for the development of appropriate responses to protect this important ecosystem. Future AKMAP assessments will incorporate new research findings and work with decision makers and coastal experts to improve the assessment methods, indicators, and interpretation of the Aleutian Islands coastal environmental condition.

AKMAP Program Highlight
NOAA Mussel Watch Program – AKMAP Aleutian Island Study

In 2007 the Aleutian Islands AKMAP collected blue mussels (M*yltius trossulus*) from Unalaska/Dutch Harbor to Attu Islands for the NOAA Mussel Watch Program. Figure 1-6 shows the islands sampled. This was the first time that blue mussels were collected in one season across the breath of the Aleutian Islands. The blue mussel tissues were analyzed for over 100 organic contaminants, such as PCBs, DDT, chlorinated pesticides and other contaminants.

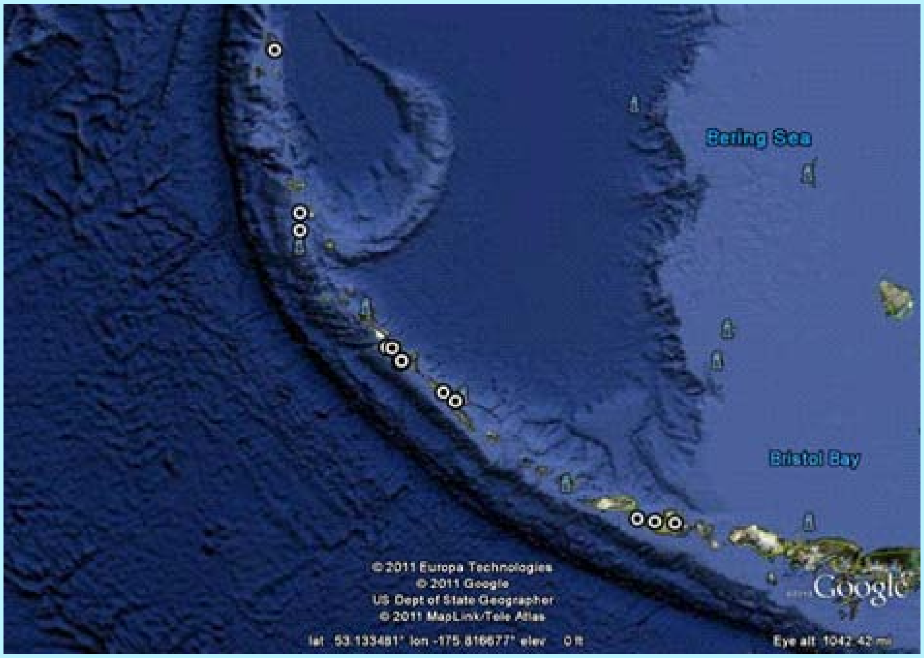

Figure 1-6: AKMAP Program Highlight – NOAA Mussel Watch Program

These results have not been analyzed with the AKMAP fish tissue data sets or other Aleutian Island contaminant datasets to examine patterns, yet results provide important additional information to assess the patterns and potential distribution of contaminants in the Aleutian Islands coastal waters.

Copies of the dataset can be downloaded from the NOAA Mussel Watch web site at –

http://ccma.nos.noaa.gov/about/coast/nsandt/download.aspx

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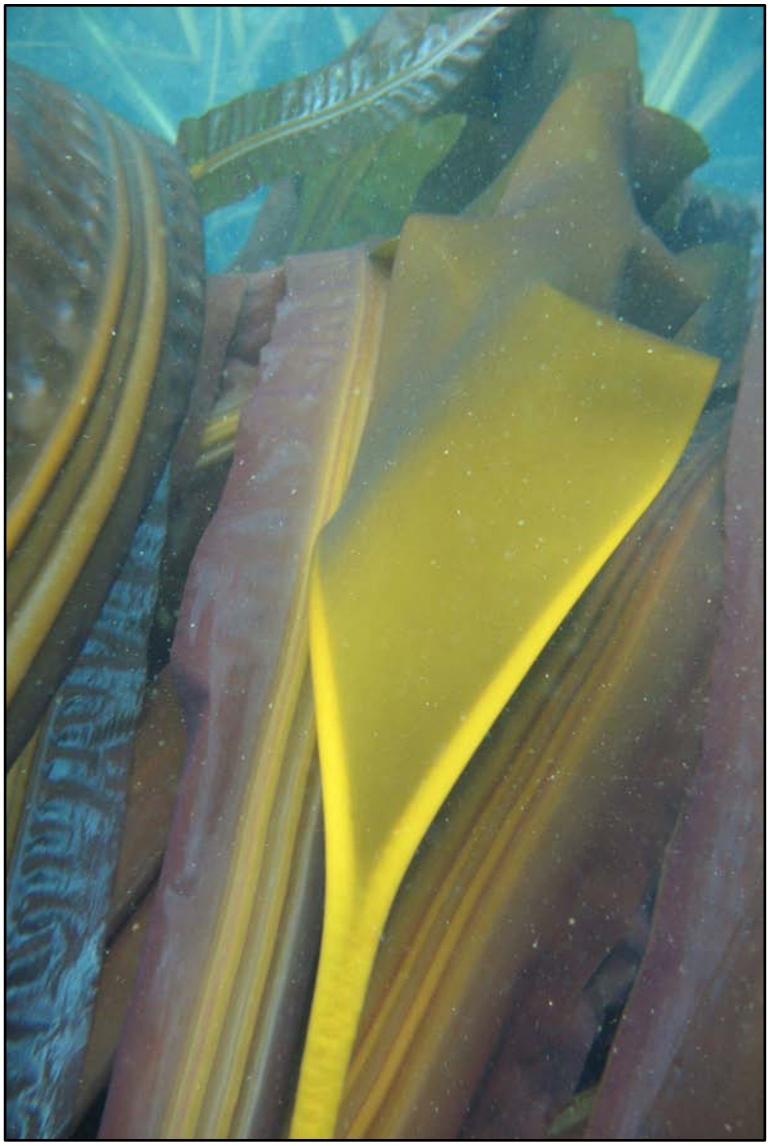


Chapter 2
Aleutian Islands AKMAP Survey Background

2. Aleutian Islands AKMAP Survey Background

Survey Background

The Aleutian Islands extends westward from Unimak Island to Attu Island over a distance of more than 1, 900 km (Figure 2-1). Over 200 Aleutian Islands form an arc that separates the North Pacific Ocean from the Bering Sea (Banks et al., 2000).

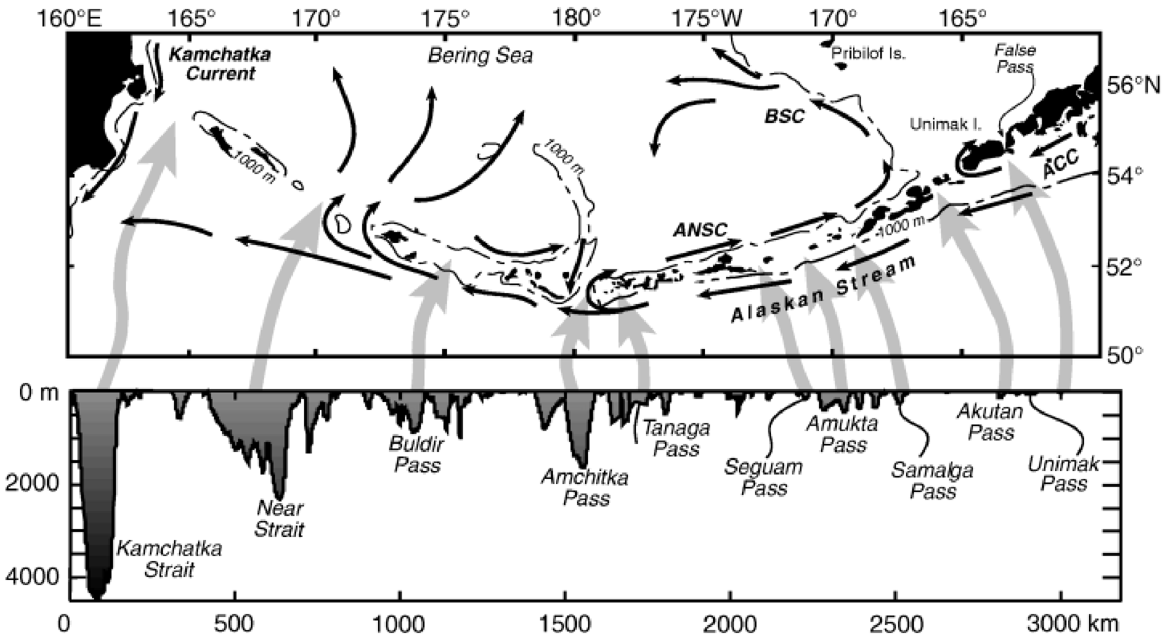


Figure 2-1: Mean circulation along Aleutian Arc and pass geographic names with the pass depths shown in the lower panel (NPFMC, 2007).

The Aleutian Islands have been occupied by Aleuts for over 10,000 years, who lived off the rich marine life. Over time other people and events, such as the Russians in the 18th century and World War II, altered and impacted the Aleut culture (APIA, 2012; NPFWC, 2007). Aleut subsistence users still harvest fish, marine mammals and other subsistence foods from around the Aleutian Islands. Gathering of subsistence foods is an important part of Aleut culture.

The Aleutian Islands rose from the volcanic activity driven by the convergence of the Pacific and North American plates. Today the Aleutian Islands remain one of the most volcanically active regions in the world. Topographically the region consists of steep hillsides, shoreside cliffs, glacially carved basins, and volcanic peaks as high as 2,080 meters.

Some of the most productive and biologically diverse marine ecosystems in the world occur within the marine zones around the Aleutian Islands. Significant upwelling occurs in this region bringing nutrients to the surface creating a “green belt” region of high levels of primary and secondary production along the Aleutian Arc (Springer et al., 1996). Numerous species of fish, mollusks and crustaceans, birds and marine mammals live in this region (NOAA, 1998).

Fisheries harvests in this region, Aleutian Islands and Bering Sea, provide over 50% of the US and around 10% of the global marine harvest of fish and shellfish (NPFMC, 2007). Much of the processing occurs throughout the Aleutians, western Alaska and the Gulf of Alaska. The fisheries and seafood processing industries employ thousands of Alaskans and many small communities are completely dependent upon the income from commercial fishing.

Near the end of the 20th Century, large scale ecosystem impacts were documented in the Aleutian Island and Bering Sea region, which have been attributed to climate change and human impacts on the system (Barron et al., 2003; Johnson, 2003; Anthony et al., 1999; Bacon et al., 1999; NOAA, 1998; Estes et al., 1997). Numerous contaminated areas, consisting principally of petroleum products with PCB's and heavy metals, exist in this region, with many sites related to World War II and Cold War activities (Stout, 2001). Besides local contaminant inputs, both marine and atmospheric transport routes have been identified as pathways for the transport of contaminants from Pacific Rim countries (Nilsson et al., 2002). Effects of numerous anthropogenic stressors, ranging from commercial fisheries to invasive species, need to be understood if resource managers are to develop and practice adaptive management.

A major pacific shipping route transits hundreds of ships a year between the US West Coast and Asia through the Aleutian Islands. In 2004, the M/V Selendang Ayu, was ship wrecked losing more than 321,000 gallons of oil, in addition to 66,000 tons of soy beans (Anchorage Daily News, 2005). As the Arctic ice pack recedes due to climate change a major increase in shipping through this region is expected to occur as the Northern Sea routes open up (Johnson, 2003).

Figure 2-2: M/V Selendang Ayu 2004

The AKMAP near shore coastal survey in the Aleutian Islands provides DEC a better understanding of the condition and, as future assessments are done, trends in contaminant levels and ecosystem changes in the region.

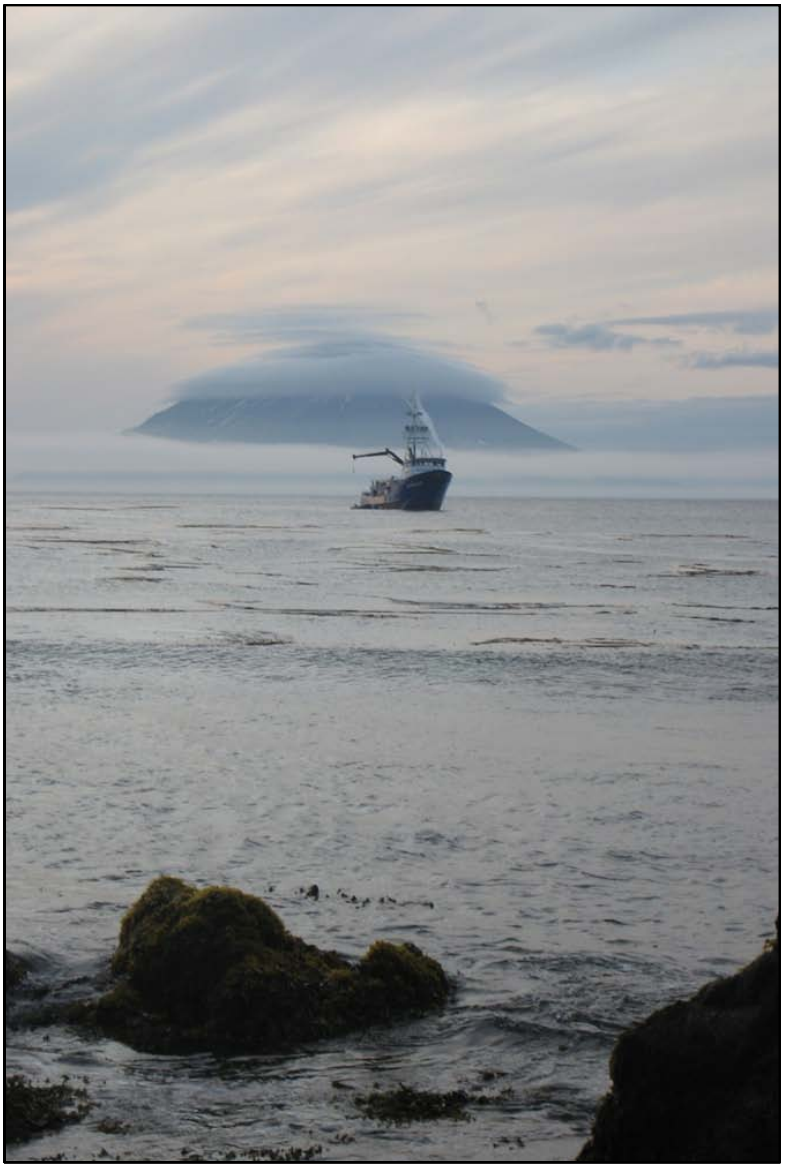
Study Design

Station locations were provided by the staff at the National Wetlands Research Center/Gulf Breeze Project Office (NWRC/GBPO, 2005). Survey station locations are based on a probabilistic sampling scheme based on a target population of waters less than or equal to (≤) 20 meters deep around the Aleutian Islands. The target population was broken into two strata; (1) Estuary waters ≤ 20 meters and (2) Open marine waters ≤ 20 meters. Estuary sites comprise 60% of the total sites.

NCA protocols are designed for traditional soft sediment sampling methods, but the Aleutian Island consists of primarily rocky benthic habitat which required a modification in survey methodology. Characterization of the coastal waters required the use of divers to conduct field surveys of rocky bottom habitat. AKMAP sampling in the Aleutians used modified versions of the methods adopted by Hawaii and Guam for soft and rocky bottom habitat (Jewett, et al., 2008).

The benthic survey assessment survey design incorporates the use of a transect line with three quadrats randomly placed along a transect line, collection of biological specimens and sediments, if present, occurred within a quadrat. Fish were collected typically by hook and line at each station. Water column profiles for temperature, salinity, dissolved oxygen, fluorescence (chlorophyll a); photosynthetically active radiation (PAR) and pressure were collected at each station. Water samples for total suspended solids, nutrients, chlorophyll a, pH, and dissolved oxygen were also taken at 1 meter below the surface, mid-depth and approximately 1 meter off the bottom.

Additional details on the methods and quality assurance/quality control (QA/QC) may be found in the 2006 – 2007 Quality Assurance Program Plan (DEC, 2007) and the NCA 2001 -2004 QAPP (EPA, 2001).



Chapter 3

Aleutian Islands Condition Indices and Characterization

3. Aleutian Islands Condition Indices and Characterization

AKMAP's Aleutian Island survey condition report is based on ecological indices and component indicators for which consistent data sets were obtained during the summers of 2006 and 2007. Ranking of good, fair or poor are used to support estimates of ecological condition survey target population. Appendix B contains maps showing the targeted survey population design. The indices and cutpoints used in this report are described below. These water quality indices descriptions are taken from NCA IV report (EPA, 2012) and other referenced documents.

Water Quality Index

The water quality index is based on measurements of five component indicators: DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen. It does not isolate a particular agent of degradation, nor does it consistently identify sites experiencing occasional or infrequent low dissolved oxygen conditions, nutrient enrichment, or decreased water clarity. Some nutrient inputs to coastal waters (such as DIN and DIP) are necessary for a healthy estuarine ecosystem; however, when nutrients from various sources, such as sewage, are introduced, concentrations can increase above natural background levels. This increase in the rate of supply of organic matter is called eutrophication and may result in a host of undesirable water quality conditions.

Nutrients: Nitrogen and Phosphorus

Nitrogen and phosphorus are necessary and natural nutrients required for the growth of phytoplankton, the primary producers that form the base of the food web in coastal waters; however, excessive levels of nitrogen and phosphorus can result in large, undesirable phytoplankton blooms. DIN is the nutrient type most responsible for eutrophication in open estuarine and marine waters, whereas DIP is more likely to promote algal growth in the tidal–freshwater parts of estuaries.

Dissolved Oxygen

Dissolved oxygen is necessary for all aquatic life. Often, low dissolved oxygen conditions occur as a result of large algal blooms that sink to the bottom, where bacteria use oxygen as they degrade the algal mass.

Water Clarity

Water clarity index was based on submerges aquatic vegetation, such as sea grass, light requirements. Results of the Secchi disk depth were used to provide an estimate of the light attenuation coefficient (k) at 1 meter to evaluate water clarity (Smith et al., 2006). While local variability in water clarity occurs between the different areas due to tides, storm events, wind mixing, and changes in incident light the probabilistic nature of the NCA study design accounts for this local variability when the results are assessed on the regional scales (EPA, 2012). Using the index developed by Smith et al., 2006, Table 3-1 provides the cutpoints used for k.

Chlorophyll a

One of the symptoms of degraded water quality condition is the increase of phytoplankton biomass as measured by the concentration of chlorophyll *a*. Chlorophyll *a* is a measure used to indicate the amount of microscopic algae (or phytoplankton) growing in a waterbody. High concentrations of chlorophyll *a* indicate the potential for problems related to the overproduction of algae. For this report, surface concentrations of chlorophyll *a* were determined from a filtered portion of water collected at each site.

Table 3-1: – Aleutian Islands AKMAP survey water quality indices cutpoints

For Nitrogen and Orthophosphate
For Dissolved Inorganic Nitrogen (DIN ug/L) (EPA, 2008; Bricker et al., 2003)
Good if Dissolved Inorganic Nitrogen as Nitrogen (DIN_N) (ug/l) < 500 ug/l
Fair if DIN_N (ug/l) > 500 and < 1000 ug/l
Poor if DIN_N (ug/l) > 1000 ug/l
For Orthophosphate as Phosphorus (PO4_P ug/L) (EPA, 2012)
Cutpoints based on West Coast cutpoints for PO4_P (Walt Nelson, EPA ORD, Proposed NCCR 4)
Good if PO4-P (ug/l) < 70 ug/l
Fair if PO4-P (ug/l) > 70 and < 100 ug/l
Poor if PO4-P (ug/l) > 100 ug/l
For DO – (EPA, 2008)
Good if DO > 5 mg/L
Fair if DO ≥ 4 - < 5 mg/L
Poor if DO < 4 mg/L
For Water Clarity – Use NCA 1 cutpoints for "sites in coastal waters that support sea grass" using light attenuation coefficient (k) calculated from Secchi disk readings (Smith et al., 2006).
Good if ≤ 0.92
Fair if ≥ 0.92 and ≤ 1.61
Poor if ≥ 1.61
For Chlorophyll a – (Kelp bed cutpoints based on Chl a μg/L levels based on 2 standard deviations from mean for good and fair based on data from Fielding et al., 1991)
Good if ≤ 6 ug/l
Fair if > 6 and ≤ 8 ug/l
Poor if > 8 ug/l

Table 3-2: Water quality index (EPA, 2012)

Ecological Condition by Site	Ranking by Region
Good: No component indicators are rated poor, and a maximum of one is rated fair.	**Good:** Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
Fair: One component indicator is rated poor, or two or more component indicators are rated fair.	**Fair:** Between 10% and 20% of the coastal area is in poor condition, or 50% or less of the coastal area is in good condition.
Poor: Two or more component indicators are rated poor.	**Poor:** More than 20% of the coastal area is in poor condition.

Sediment Quality Index

The sediment quality index was not rated for this assessment as less than half the stations were in soft sediments and no inferences could be made to the overall target population. Results of the sediment sampling will be reported separately on a station basis in the *Alaska Monitoring and Assessment Program 2006 and 2007 Aleutian Islands Coastal Survey Statistical Summary*.

Benthic Habitat Index

Benthic invertebrates are frequently seen as good indicators for the overall health of the environment where they reside because of their sensitivity to environmental disturbance and pollution. The AKMAP survey assessed and compared the invertebrate communities throughout the Aleutian Islands. Alaska does not currently have benthic indices criteria for ranking benthic habitat quality. For this survey the results were assessed using professional judgment to rank the benthic habitat current condition.

A total of 35 animal phyla have been recorded from the entire world's ocean, all habitats, depths, latitudes, and longitudes combined (Groombridge and Jenkins 2002). The AKMAP survey encountered a total of 16 benthic marine phyla or 707 taxa of invertebrates. Considering the relatively narrow bathymetry (6-20 m) explored, short coastal distance travelled (1,900 km), and relatively modest number of sites surveyed (50), the species richness of this Aleutian region is high. A technical summary of the benthic work is included in the statistical summary document referenced under sediment quality index. Benthic habitat index for the Aleutian Islands coastal waters was rated a good for a 100% of this component indicator based on professional judgment of species abundance and diversity.

Coastal Habitat Index

Coastal wetlands provide an interface between the aquatic and terrestrial compartments of coastal ecosystems and help filter and process residential, agricultural, and industrial wastes, thereby improving surface water quality. Wetlands buffer coastal areas against storm and wave damage. This habitat is critical to the life cycles of fish, migratory birds, and other wildlife.

From 1990 to 2000 Alaska coasts experienced a loss of 900 acres (0.04%) of coastal wetlands (EPA, 2012), with a state longer average decadal wetland loss rate of 0.01%. The regional value of the coastal habitat index was calculated as the average of two loss rates (historic and recent).

Table 3-3 shows the rating cutpoints used for the Alaska coastal habitat index for the EPA National Coastal Assessment 4. Although a 1% loss rate per decade may seem small (or even acceptable), continued wetland losses at this rate cannot be sustained indefinitely. Climate change is expected to increase the loss of Alaska coastal wetlands due coastal erosion and increased thawing of coastal permafrost in the Arctic (Jones et al., 2009).

Table 3-3: Coastal habitat cutpoints (EPA, 2012)

Rating State Wide Scale	Cutpoints
Good	The index value is less than 1.0.
Fair	The index value is between 1.0 and 1.25.
Poor	The index value is greater than 1.25.

Fish Tissue

EPA risk-based advisory guidance values for recreational fishers were used to assess the results of contaminants in whole-body fish samples (EPA, 2012). These values serve as surrogate benchmark values for fish health in the absence of comprehensive ecological thresholds for contaminant levels in juvenile and adult fish. Table 3-3 only shows the values for total PCBs and mercury as these were the only contaminants that exceeded guidance values.

Table 3-4: EPA fish advisory guidance values (U.S. EPA, 2000)

Risk-Based EPA Advisory Guidance Values for Recreational Fishers (U.S. EPA, 2000)		
Contaminant	EPA Advisory Guidelines Concentration Range (ppm)[a]	Health Endpoint
Mercury (methlymercury)[b]	0.12 – 0.23	Non-cancer
Total PCB	0.023 – 0.047	Non-cancer

a) Range of concentrations associated with non-cancer and cancer health endpoint risk for consumption of four 8-ounce fish meals a week.
b) The conservative assumption was made that all mercury is present as methylmercury.

Index ratings are applied to each fish sampled regardless of species for total PCB and mercury on measured concentrations using cutpoints based on the fish advisory guidance concentrations. For example, the guidance values for mercury range from 0.12 to 0.23 parts per million (ppm) of mercury in fish tissue. If the concentration in fish that was less than 0.12 ppm of mercury, then the monitoring station from which the fish were caught was rated good. If the contaminant concentration was within the guidance value range, the fish was rated fair, and if the mercury concentration exceeded 0.23 ppm, then the fish was rated poor.

The results are presented as percentage of fish caught in good, fair or poor condition relative to Total Hg concentration. Total Hg was the prevalent contaminant in the fish tissue sampled. Our rating was not applied to percentage area estimates due to differences in fish species.

Table 3-5: Fish tissue contaminants index (modified EPA, 2012)

Condition by Fish	Ranking for Region
Good: For all chemical contaminants listed in Table 3-3, the measured concentrations in tissue fall below the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.	**Good:** Less than 10% of the fish caught are in poor condition, and more than 50% of the fish caught are in good condition.
Fair: For at least one chemical contaminant listed in Table 3-3, the measured concentration in tissue falls within the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.	**Fair:** 10% to 20% of the fish caught are in poor condition, or 50% or less of the fish caught are good condition.
Poor: For at least one chemical contaminant listed in Table 3-3, the measured concentration in tissue exceeds the maximum value in the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.	**Poor:** More than 20% of the fish caught are in poor condition.

The AKMAP Aleutian Islands survey was designed as an ecological assessment evaluating contaminant concentrations in fish tissue in a variety of target species, with both juvenile and adult fish analyzed as whole fish. This is the way fish would be typically consumed by predator species. Whole-fish samples can result in higher concentrations of certain contaminants, such as DDT, that are stored in fatty tissues and lower concentrations of contaminants, such as mercury, that accumulate primarily in the muscle tissue (EPA, 2012). In contrast, analyzing fillet samples can result in higher concentrations of those contaminants that tend to concentrate in the muscle tissue and lower concentrations of those contaminants that are typically stored in fatty tissues, which are not included in a fillet sample.

How the Indices Are Summarized

Overall condition for the Aleutian Islands coastal near shore waters was calculated by summing the scores for the available indices, sediment quality was not available, and dividing by the number of available indices, where good equals ≥ 4.5; fair equals 4.4 to 2.5; and poor equals ≤ 2.4 (Table 3-6).

Table 3-6: Overall environmental status indices summary (EPA, 2012)

Indices	Score
Water Quality Index	5
Benthic Index	5
Coastal Habitat Index	5
Fish Tissue Contaminants Index	3
Total Score Divided by 4 = Overall Alaska Score	18/4=4.5

References

Aleutian Pribilof Island Association. (2012) History & Culture – History. Available at: http://www.apiai.com/history.asp?page=history

Anchorage Daily News, February 10, 2005. Shipwreck cleanup deferred. Anchorage, AK. Archived articles available at www.adn.com

Anthony, R.G., Miles, A.K., Isaacs, R., and Estes, J.A. (1999) Diet and contaminant levels in bald eagles in the western Aleutian Islands. Environ. Toxic. Chem.

Bacon, C.E., Jarman, W.M., Estes, J.A., Simon, M., and Norstrom, R.J. (1999) Comparison of organochlorines contaminants among sea otters (Enhydra lutris) populations in California and Alaska. Environmental Toxicology and Chemistry, Vol. 18, pp. 452-458.

Banks, D., Williams, M., Pearce, J., Springer, A., Hangenstein, R., and Olson, D. (2000) Ecoregion-Based Conservation in the Bering Sea – Identifying Important Areas for Biodiversity Conservation. World Wildlife Fund, URL: www.worldwildlife.org/wildplaces/bs/pubs/main_book.pdf.

Barron, M.G., Heintz, R. and Krahn, M.M. (2003) Contaminant exposure and effects in pinnipeds: implications for Steller sea lion declines in Alaska. The Science of the Total Environment, Vol. 311, pp. 111-133.

Bricker, S.B., Ferreira, J.G., Simas, T., 2001. An integrated methodology for assessment of estuarine trohic status. Ecological Modeling, Vol. 169, pp. 39-60.

DEC, 2007. Alaska Aleutian Island Coastal Alaska Monitoring & Assessment Program (AKMAP) Near Shore Dive Transect & Water Quality Sampling Field Quality Assurance Project Plan for 2006 and 2007. Alaska Department of Environmental Conservation, Fairbanks.

EPA, 2012. National Coastal Condition Report IV. U.S. Environmental Protection Agency, Office of Research and Development, Office of Water, Washington, D.C., EPA-842-R-10-003. Available at: http://www.epa.gov/nccr.

EPA, 2008. National Coastal Condition Report III. U.S. Environmental Protection Agency, Office of Research and Development, Office of Water, Washington, D.C., EPA/842-R08-002. Available at: http://water.epa.gov/type/oceb/assessmonitor/downloads.cfm.

EPA, 2001. National Coastal Assessment – Quality Assurance Project Plan 2001 – 2004. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C., EPA/620/R-01/002 May 2001.

Estes, J.A., Bacon, C.E., Jarman, W.M., Nordstrom, R.J., Anthony, R.G., and Miles, A.K. (1997) Organochlorines in sea otters and bald eagles from the Aleutian Archipelago. Marine Pollution Bulletin, Vol. 34, pp. 486-490.

Fielding, P.J., Seiderer, L.J. 1991. A fresh look at kelp bed phytoplankton populations in an updwelling area. Marine Ecology Progress Series, 72:167-177.

Groombridge, B., Jenkins, M.D., 2002. World Atlas of Biodivesity – Earths Living Resources in the 21st Century. University of California Press, 352 pages.

Jewett, S.C., R. Brewer, H. Chenelot, R. Clark, D. Dasher, S. Harper, & M. Hoberg. 2008. Scuba techniques for the Alaska Monitoring and Assessment Program (AKMAP) of the Aleutian Islands, Alaska. *In:* Bruggeman, P. and N.W. Pollock, (Eds), Diving for Science 2008. Proceedings of the 27th American Academy of Underwater Science Symposium, Dauphin, Island, AL: AAUS, 71-89.

Johnson, T. (2003) The Bering Sea and Aleutian Islands: regions of wonders. Edited by Byers, K. Alaska Sea Grant College Program, Fairbanks, AK, pp. 191.

Jones, B.M., C.D. Arp, M.T. Jorgenson, K.M. Hinkel, J.A. Schmutz, and P.L. Flint. 2009. Increase rate and uniformity of coastline erosion in arctic Alaska. *Geophysical Research Letters 36*:L03503.

NOAA, (1998) DRAFT – Bering Sea Ecosystem Research Plan: Proceedings from December 1997 NOAA, USDOI, and ADF&G, Bering Sea Ecosystem Workshop, Anchorage, AK. URL: www.afsc.noaa.gov/refm/reem/doc/science.pdf.

North Pacific Fishery Management Council, 2007. Aleutian Islands Fishery Ecosystem Plan. Available at: http://www.fakr.noaa.gov/npfmc/conservation-issues/aifep.html

NWRC/GBPO. (2005) Survey Design for NCA - Alaska, Aleutian Province 2005. National Wetlands Research Center / Gulf Breeze Project Office (NWRC/GBPO).

Smith, L.M., Engle, V.D., and Summers, K.J. 2006. Assessing Water Clarity as a Component of Water Quality in Gulf of Mexico Estuaries. Environmental Monitoring and Assessment 115:291-305.

Springer, A.M., McRoy, C.P., and Flint, M.V. (1996) The Bering Sea Green Belt: Shelf-edge processes and ecosystem production. Fisheries Oceanography, Vol. 5, pp. 205-233.

Stout, J. (2001) Contaminated military sites on Refuges of southwestern Alaska. Society of Environmental Toxicology and Chemistry, 2001 meeting poster presentation. United States Fish and Wildlife Service. URL: library.fws.gov/posters/militarysites_alaska.pdf

Appendix A - Aleutian Islands AKMAP Station Maps

Table 0-1- Informaiton on stations locations

AKMAP Aleutian Islands Survey Stations for 2006 and 2007

Sorted by Stations Progressing East to West Across Aleutians

STATIONID	Station #	DATE	Year	LatDD	LongDD	ESTUARY	Location Name
AKALE06-0039	1	7/3/2006	2006	54.13	-165.11	Bering Sea	Tigalda Is., Tigalda Bay
AKALE06-0026	2	7/4/2006	2006	54.11	-165.21	Avatanak Strait	Tigalda Is., Avantanak Strait
AKALE06-0002	3	7/5/2006	2006	54.24	-165.54	Akun Bay	Akun Is., Heliathus Cove
AKALE06-ALT0002	4	7/22/2006	2006	53.97	-166.3	Kalekta Bay	Unalaska Is., Kalekta Bay
AKALE06-0021	5	7/7/2006	2006	53.89	-166.61	Unalaska Bay	Unalaska Is., Unalaska Bay, Nateekin Bay
AKALE06-0044	6	7/8/2006	2006	53.99	-166.82	Bering Sea	Unalaska Is., Driftwood Bay
AKALE06-0030	7	7/22/2006	2006	53.71	-166.59	Kisselen Bay	Unalaska Is., Beaver Inlet, Kisselen Bay
AKALE06-0007	8	7/9/2006	2006	53.64	-166.85	Naginak Cove	Unalaska Is., Makushin Bay, Naginak Bay
AKALE06-0028	9	7/21/2006	2006	53.56	-166.78	Usof Bay	Unalaska Is., Usof Bay
AKALE06-0020	10	7/10/2006	2006	53.62	-167.06	Skan Bay	Unalaska Is., West Arm Scan Bay
AKALE06-0023	11	7/21/2006	2006	53.45	-166.76	Usof Bay	Unalaska Is., Usof Bay
AKALE06-ALT0006	12	7/20/2006	2006	53.47	-166.92	Eagle Bay	Unalaska Is., Eagle Bay
AKALE06-ALT0012	13	7/20/2006	2006	53.45	-167.05	Kuliliak Bay	Unalaska Is., Kuliliak Bay
AKALE06-0012	14	7/13/2006	2006	53.46	-167.28	Kismaliuk Bay	Unalaska Is., Kismaliuk Bay
AKALE06-ALT0018	15	7/12/2006	2006	53.43	-167.41	Aspid Bay	Unalaska Is., Aspid Bay
AKALE06-0027	16	7/14/2006	2006	53.4	-167.61	Umnak Pass	Unalaska Is., Peacock Pt.
AKALE06-0043	17	7/19/2006	2006	53.02	-168.6	North Pacific Ocean	Umnak Is., Lookout Pt.
AKALE06-0025	18	7/18/2006	2006	52.95	-168.69	Traders Cove	Umnak Is., Traders Cove
AKALE07-0029	19	7/21/2007	2007	52.98	-168.87	Nikolski Bay	Umnak Is., Nikolski Bay
AKALE06-ALT0034	20	7/18/2006	2006	52.91	-168.8	North Pacific Ocean	Umnak Is., Cape Udak
AKALE06-0024	21	7/15/2006	2006	52.95	-169.71	Kagamil Pass	Kagamil Is., Kagamil Pass
AKALE06-0010	22	7/16/2006	2006	52.8	-169.71	Samalga Pass	Chuginadak Is., Samalga Pass
AKALE06-0011	23	7/15/2006	2006	52.9	-169.99	Carlisle Pass	Carlisle Is., Carlisle Pass
AKALE06-0037	24	7/17/2006	2006	52.6	-170.64	North Pacific Ocean	Yunaska Is.

AKMAP Aleutian Islands Survey Stations for 2006 and 2007
Sorted by Stations Progressing East to West Across Aleutians

STATIONID	Station #	DATE	Year	LatDD	LongDD	ESTUARY	Location Name
AKALE07-0035	25	7/18/2007	2007	52.12	-173.54	Bering Sea	Amlia Is., S. of Cape Idalug
AKALE07-0008	26	7/17/2007	2007	52.22	-174.16	Nazan Bay	Atka Is., Nazan Bay
AKALE07-0032	27	7/16/2007	2007	52.12	-174.32	North Pacific Ocean	Atka Is., Vasilief Bay
AKALE07-0031	28	7/15/2007	2007	52.14	-174.61	Bering Sea	Atka Is., Deep Bay
AKALE07-0013	29	7/14/2007	2007	51.89	-175.97	Umak Bight	Umak Is., Umak Bight
AKALE07-0018	30	7/14/2007	2007	51.87	-176.15	Umak Pass	Little Tanaga Is., Umak Pass
AKALE07-A0005	31	7/13/2007	2007	51.83	-176.15	Chisak Bay	Little Tanaga Is., Chisak Bay
AKALE07-A0019	32	7/12/2007	2007	51.79	-176.29	Little Tanaga Strait	Kagalaska Is.
AKALE07-0047	33	7/10/2007	2007	51.74	-176.45	Bering Sea	Adak Is., SE
AKALE07-A0021	34	7/10/2007	2007	51.76	-176.42	Kagalaska Strait	Adak Is., S. Kagalaska Strait
AKALE07-A0014	35	7/12/2007	2007	51.87	-176.61	Kuluk Bay	Adak Is., Kuluk Bay, Gannet Rocks
AKALE07-0005	36	7/9/2007	2007	51.82	-176.84	Bay of Islands	Adak Is., Bay of Islands
AKALE07-A0028	37	7/8/2007	2007	51.88	-177.2	Kanaga Sound	Kanaga Is.
AKALE07-0050	38	7/6/2007	2007	51.84	-177.85	Bering Sea	Tanaga Is.
AKALE07-0042	39	7/6/2007	2007	51.91	-178	Bering Sea	Tanaga Is.
AKALE07-A0016	40	7/5/2007	2007	51.82	-178.12	Tanaga Pass	Tanaga Is.
AKALE07-DD003	41	7/7/2007	2007	51.71	-178.1	Bering Sea	Tanaga Is.
AKALE07-0016	42	7/2/2007	2007	51.43	179.22	Kirilof Bay	Amchitka Is., Kirilof Bay
AKALE07-DD002	43	7/3/2007	2007	51.64	178.75	Ogala Pass	Amchitka Is.
AKALE07-A0031	44	7/1/2007	2007	51.83	178.28	Bering Sea	Rat Is.
AKALE07-0045	45	7/1/2007	2007	51.97	178.45	Bering Sea	Little Sitkin Is., near Finger Pt.
AKALE07-0046	46	6/29/2007	2007	51.94	177.67	North Pacific Ocean	Little Kiska Is., E of Yug Pt.
AKALE07-A0048	47	6/30/2007	2007	52.08	177.67	Bering Sea	Kiska Is., Haycock Rock
AKALE07-0017	48	6/29/2007	2007	51.91	177.45	Vega Bay	Kiska Is., Vega Bay
AKALE07-0034	49	6/28/2007	2007	52.49	173.77	North Pacific Ocean	Not named
AKALE07-0019	50	6/25/2007	2007	52.93	173.25	Chichagof Harbor	Attu Is., Chichagof Harbor
AKALE07-0004	51	6/26/2007	2007	52.8	173.07	Temnac bay	Attu Is., Temnac Bay

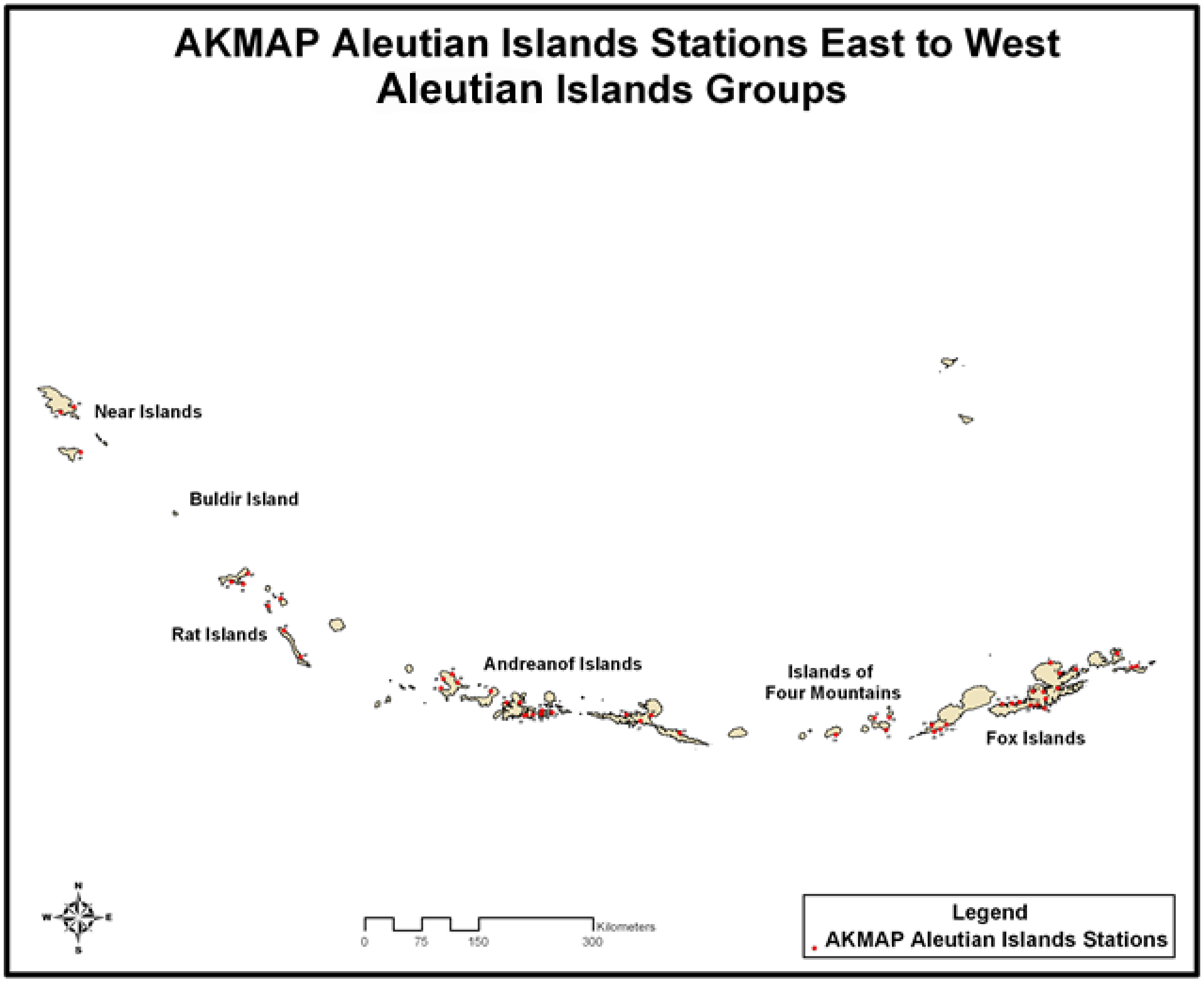


Figure 0-1- Main Aleutain Island Groups

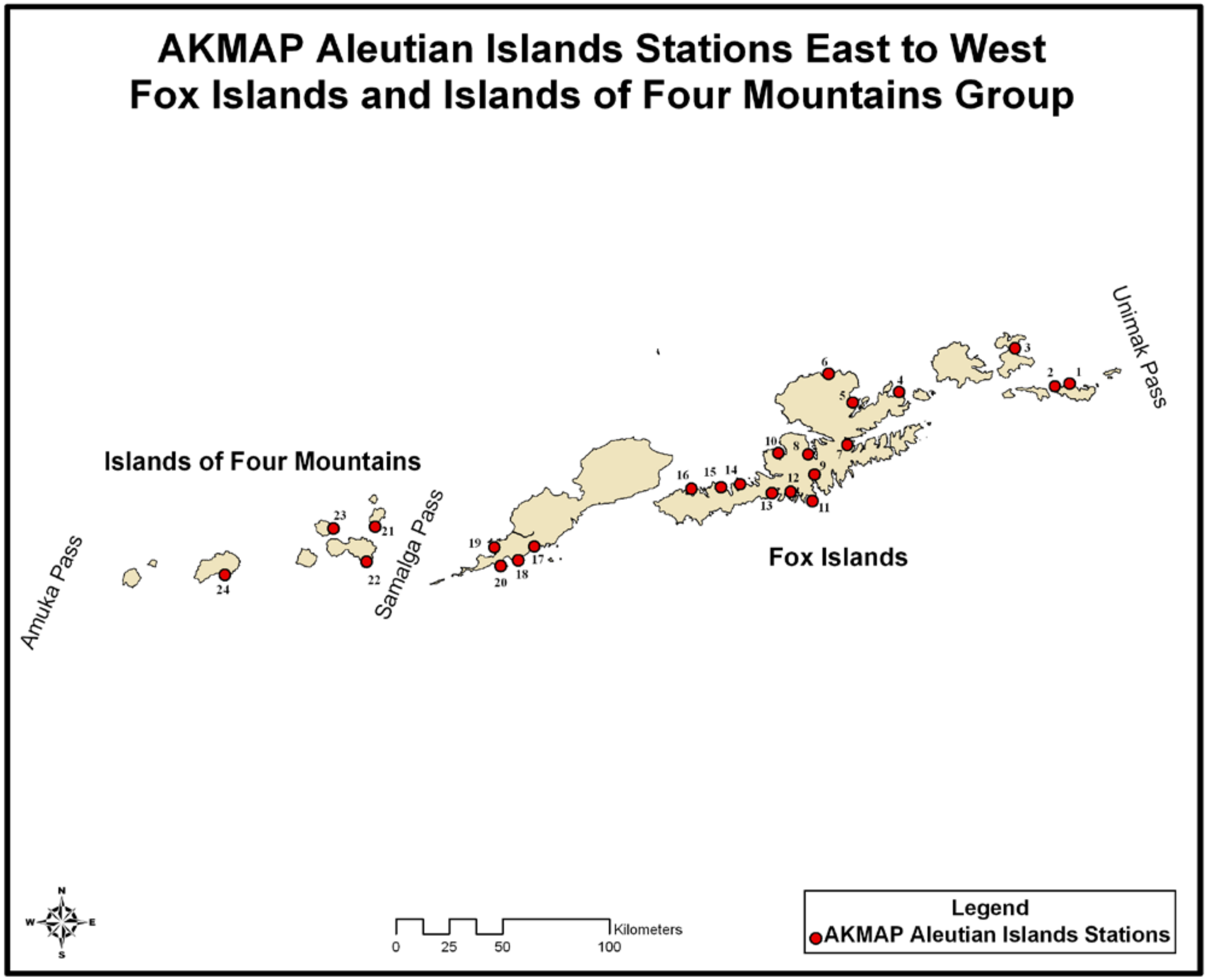
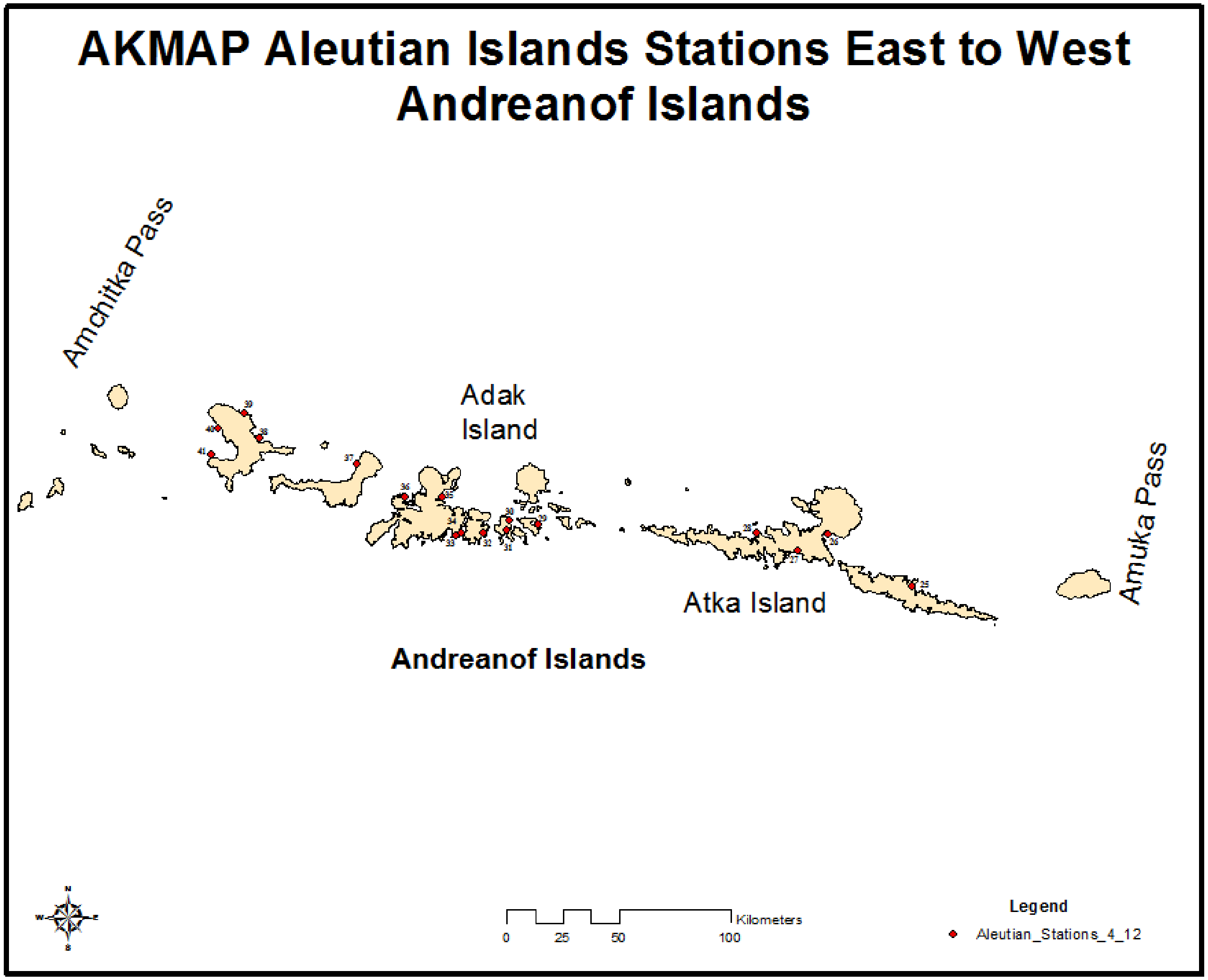


Figure 0-2 – Fox and Isle of Four Mountains Islands Group


AKMAP Aleutian Islands Stations East to West
Andreanof Islands
Amchitka Pass
Adak
Island
Atka Island
Andreanof Islands
Amuka Pass
Kilometers
0
25
50
100
Legend
Aleutian_Stations_4_12

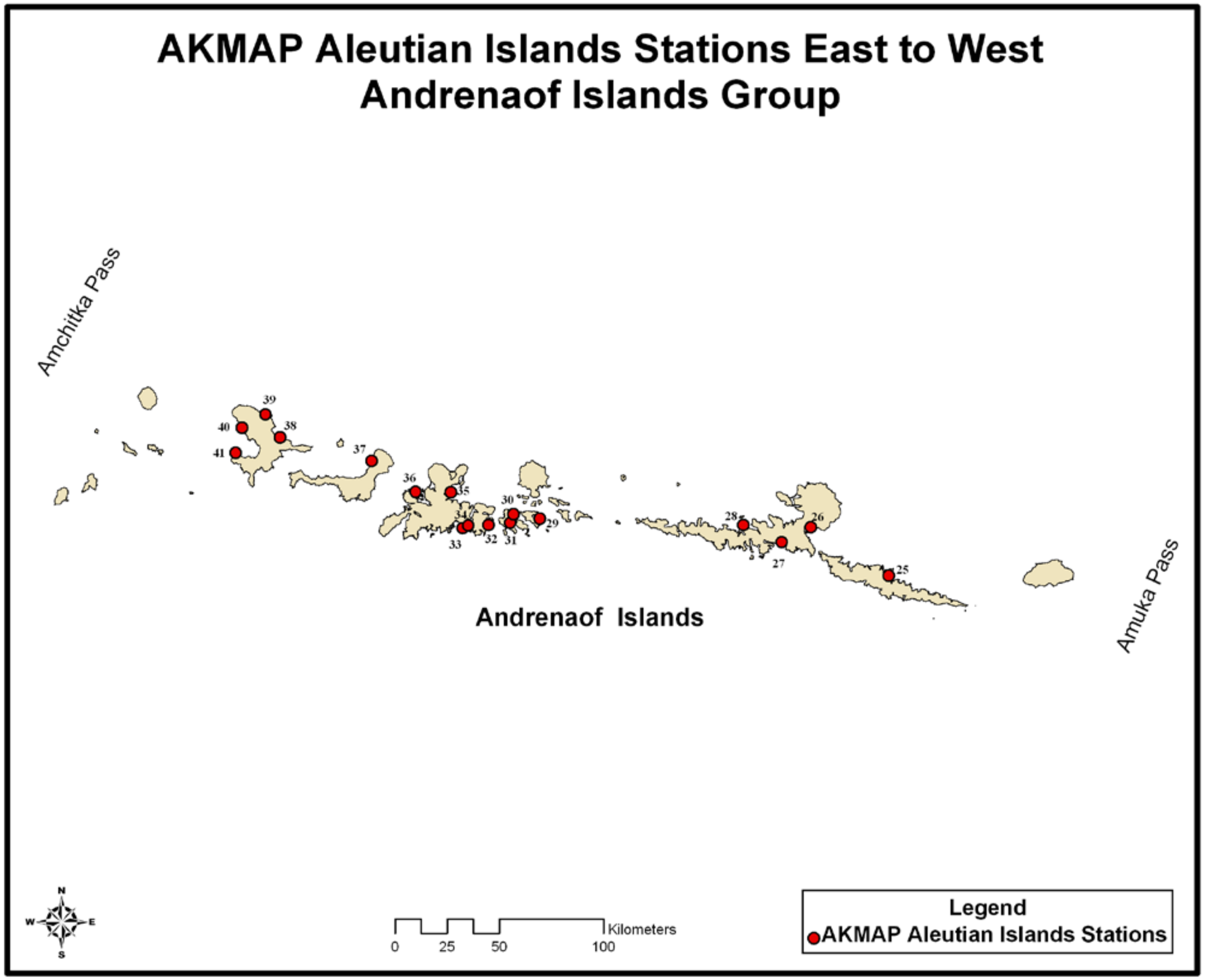


Figure 0-3 – Andrenaof Islands Group

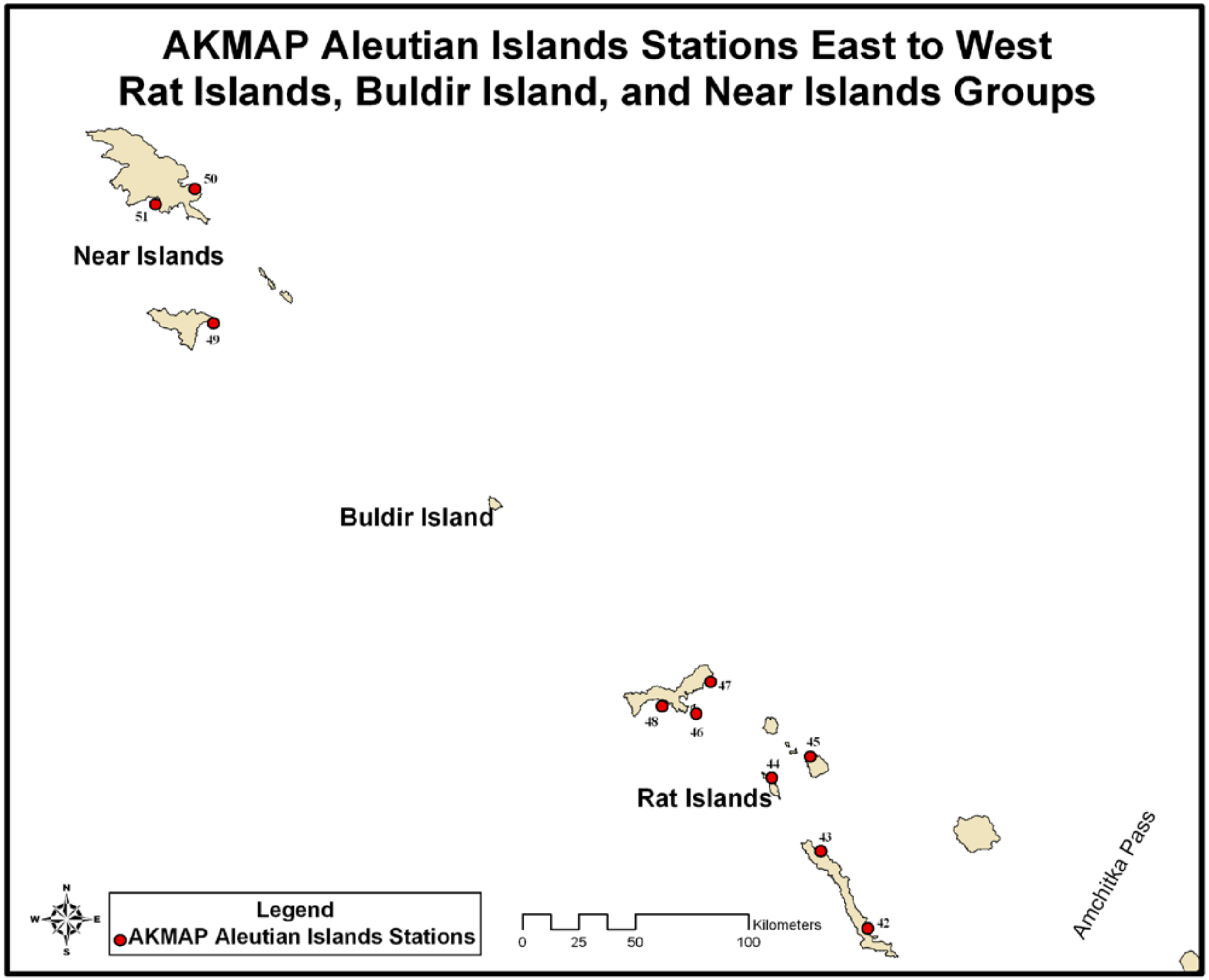


Figure 0-4 - Rat, Buldir and Near Islands Group-

Appendix B - Target Population Design Map

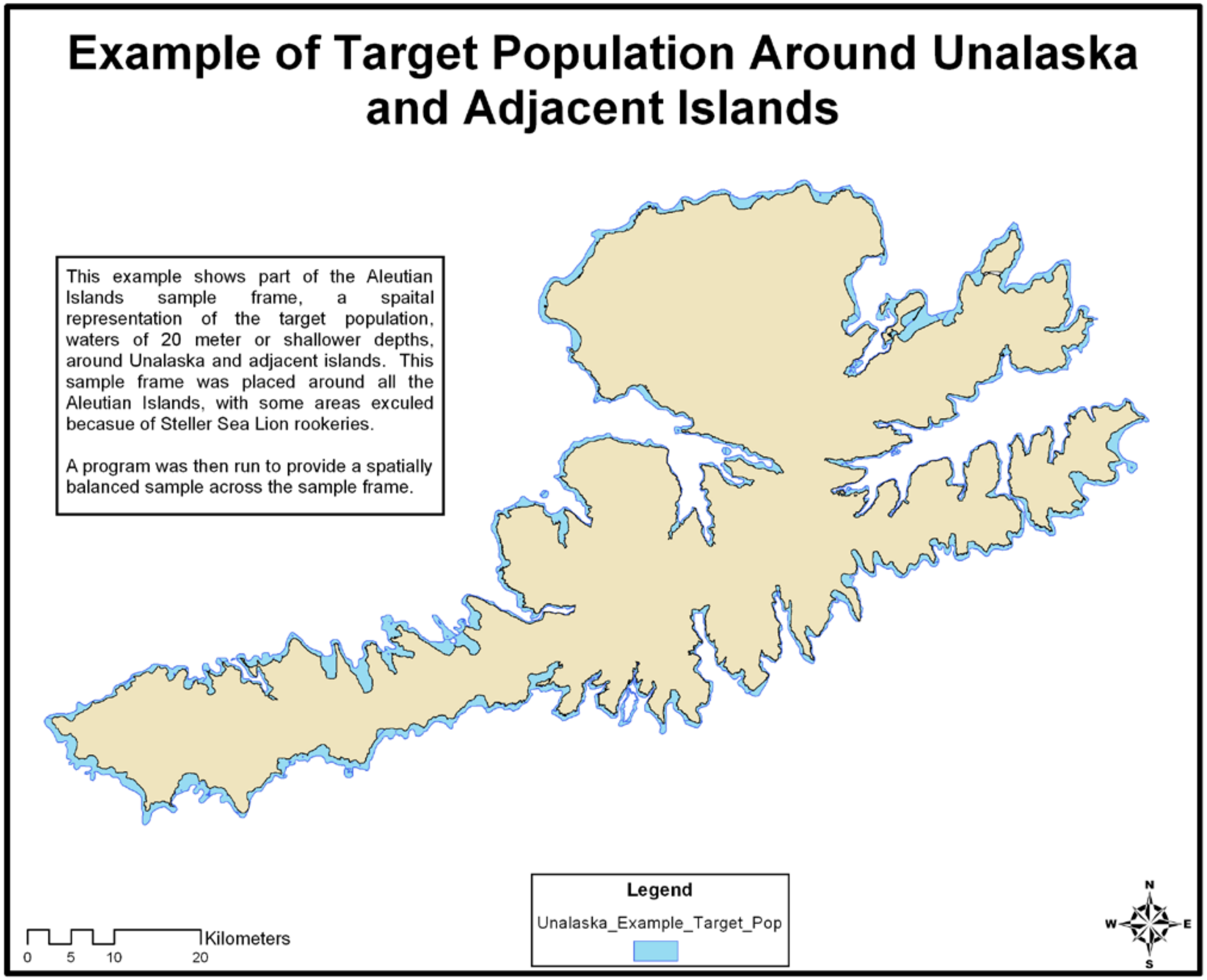


Figure 0-1 – Example Target Population Frame around Unalaska

Appendix C - List of Books and Papers

Book from the AKMAP Aleutian Island's project

Brewer, R., Chenelot, H., Harper, S., Jewett, S., 2011. Sea Life of the Aleutians – An Underwater Exploration. Alaska Sea Grant College Program, University of Alaska Fairbanks; SG-ED-71.

Some Papers from the AKMAP Aleutian Island's project

Jewett, S.C., R.N. Clark, H. Chenelot, S. Harper, & M.K. Hoberg. In Prep. Seastars of the nearshore Aleutian Archipelago. *In:* D.L. Steller and L. Kerr-Lobel (Eds), Diving for Science 2012. Proceedings of the 31st American Academy of Underwater Sciences Symposium, Dauphin Island, AL: AAUS. 144-172.

Jewett, S.C. & R.N Clark, with assistance from R. Brewer, H. Chenelot, S. Harper, & M. Hoberg. In Prep. Seastars of the nearshore Aleutian Islands. Alaska Sea Grant.

Jewett, S.C. & R.N. Clark. 2011. Discoveries of new nearshore plants and invertebrates of the Aleutian Islands. *In*: N.W. Pollock, (Ed), Diving for Science 2011. Proceedings of the 30th American Academy of Underwater Sciences Symposium, Dauphin Island, AL: AAUS, 91-109.

Clark, R.N. & S.C. Jewett. 2011. Three new sea stars (Asteroidea: Solasteridae & Pterasteridae) from the Aleutian Islands. Zootaxa 3051: 1-13.

Clark, R.N. & S.C. Jewett. 2011. A new genus of *Hippasteria* (Asteroidea: Goniasteridae) from the Aleutian Islands. Zootaxa 2963: 48-54.

Brewer, R., H. Chenelot, S. Harper & S.C. Jewett. 2011. Sea Life of the Aleutians – an underwater photo journey. Alaska Sea Grant, SG-ED-71, Fairbanks, 156 p.

Chenelot, H., Jewett, S.C., & M.K. Hoberg. 2011. Macrobenthos of the nearshore Aleutian Archipelago, with emphasis on invertebrates associated with *Clathromorphum nereostratum* (Rhodophyta, Corallinaceae). Marine Biodiversity. 41: 413-424.

Eash-Loucks W., Jewett, S., Fautin, D., M. Hoberg & H. Chenelot. 2010. *Ptychodactis aleutiensis*, a new species of ptychodactiarian sea anemone (Cnidaria: Anthozoa: Actiniaria) from the Aleutian Islands, Alaska. Marine Biology Research 6(6): 570-578.

Clark, R.N. & S.C. Jewett. 2010. A new genus and thirteen new species of sea stars (Asteroidea: Echinasteridae) from the Aleutian Island Archipelago. Zootaxa 2571: 1-36.

Chenelot, H., S. Jewett, & M. Hoberg. 2008. Invertebrate communities associated with various substrates in the nearshore eastern Aleutian Islands, with emphasis on thick crustose coralline algae. *In*: Bruggeman, P. and N.W. Pollock, (Eds), Diving for Science 2008. Proceedings of the

27th American Academy of Underwater Sciences Symposium, Dauphin Island, AL: AAUS, 13-36 pp.

Jewett, S.C., R. Brewer, H. Chenelot, R. Clark, D. Dasher, S. Harper, & M. Hoberg. 2008. Scuba techniques for the Alaska Monitoring and Assessment Program (AKMAP) of the Aleutian Islands, Alaska. *In*: Bruggeman, P. and N.W. Pollock, (Eds), Diving for Science 2008. Proceedings of the 27th American Academy of Underwater Sciences Symposium, Dauphin Island, AL: AAUS, 71-89 pp.

Kawai, H., T. Hanyuda, M. Lindeberg, & S.C. Lindstrom. 2008. Morphology and molecular phylogeny of *Aureophycus aleuticus* Gen. et sp. Nov. (Laminariales, Phaeophyceae) from the Aleutian Islands. Journal of Phycology 44: 1013-1021.