Alaska Environmental Monitoring and Assessment Program
EMAP

2002 Southcentral Alaska Survey

ALASKA Department of Environmental Conservation

COOK INLET RCAC

2002 Southcentral Alaska EMAP Survey

Summary Report

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The sampling conducted in this program is designed to estimate the percent of estuarine area in varying conditions. Many of the figures in this report illustrate environmental measurements made at specific locations that specifically represent the value of the indicator at the time of sampling. Additional sampling may be required to define variability and to confirm impairment or the lack of impairment at specific locations.

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EMAP-WPCM Partnerships and cooperating groups: EPA/ORD/NHEERL, NOAA/NMFS, EPA 10, DEC, CIRCAC

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Sediment Analysis: Washington Department of Ecology- Manchester Laboratory
Fish Tissue Analysis: Washington Department of Ecology- Manchester Laboratory
Infaunal Processing: University of Alaska School of Fisheries and Ocean Sciences
Amphipod Bioassay: Northwestern Aquatic Sciences
Fish Pathology: NMFS-Northwest Fisheries Science Center

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Introduction

The Alaska Depament of Environmental Conservation's (DEC) Water Division along with the Cook Inlet Regional Citizen Advisory Council (CIRCAC) collaborated to conduct the first of five segments of the Alaska Coastal Assessment. They used EMAP or Environmental Monitoring and Assessment Program protocols for random sampling. The EMAP technique is a cost and time efficient way of obtaining a snap-shot status of the conditions of Alaska's coastal waters and estuaries.

This project required the assistance of a variety of specialists from other states, organizations and countries while DEC grows its staff and expertise in this type of coastal analysis. The Southcentral region of the state was selected for the first survey because of the importance of the major estuarine resources in the region (Prince William Sound and Cook Inlet) to the local and state economy, as well as to aquatic living resources. During the 2002 Southcentral survey, varieties of parameters were explored; dissolved oxygen, pH, nutrients, sediment and other biological conditions. These parameters are the same across the nation and assist in making a

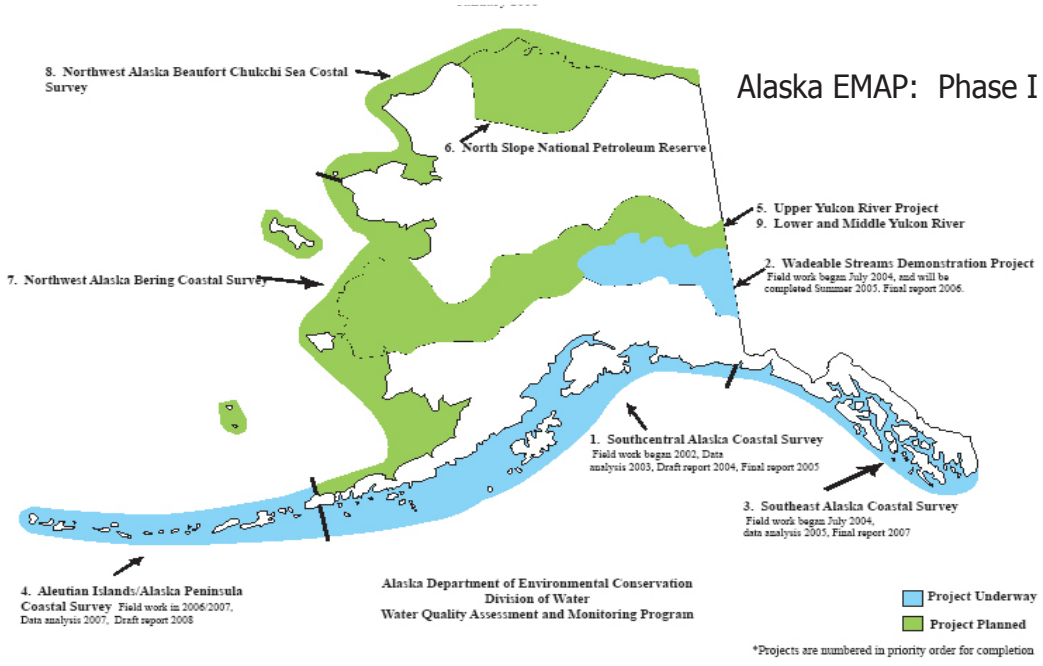
Principal Operational Objectives for DEC, Division of Water EMAP

1) Estimate current status, trends and changes in selected indicators of Alaska's aquatic ecological resources on a regional and statewide basis with know statistical confidence;

2) Estimate geographic coverage and extent of Alaska's aquatic ecological resources within a know statistical confidence interval;

3) Seek to establish associations between selected indicators of natural and anthropogenic stresses and indications of the condition of aquatic ecological resources;

4) Provide for statistical summaries and periodic assessments of Alaska's aquatic ecological resources.
(Adapted from EPA, 1997)



comparable analysis of coastal region conditions nationally. The survey collected data at a total of 55 sites, with depths ranging from 3.9 to 352 meters. Many of the shallowest stations occurred in nearshore areas of Cook Inlet, areas known for wide intertidal depth fluctuations and extensive sediment depositional zones. The deepest stations occurred in Prince William Sound.

DEC and the EPA will utilize this information to create more up to date and technically sound regulations and laws to conserve the biological integrity of Alaska's waters. The EMAP surveys, if EPA funds all the coastal surveys proposed, will provide the first "big picture" of the status of water quality Alaska. Repeated EMAP assessments on the order of every 5 years can help detect trends or changes in environmental conditions. This report summarizes major findings obtained in the 2002 southcentral survey. A more detailed technical review (Saupe, *et al*) is available to assist resource managers, scientists and other interested parties.

Study Design

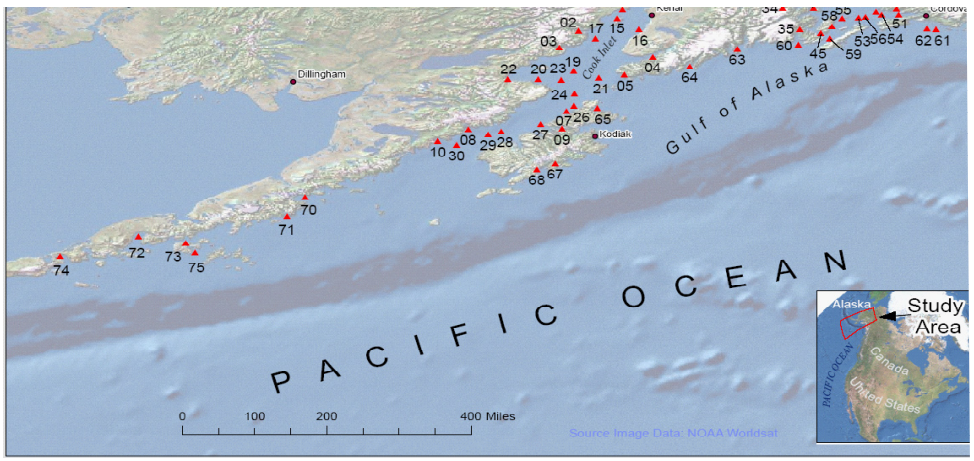
Probability-based sampling with a statistical survey design provides an unbiased estimate over a large geographic area from a small number of samples. Each of the samples must have a set of qualifying elements:

- every element in population has the opportunity to be sampled with a known probability
- sample selection is carried out by a random process
- samples taken at regular intervals from a random start (systematic random)
- grid positioned randomly
- ensures spatial separation
- equal chance
- potential for stratifying (weighted design)

There were 50 base sites selected for Alaska using the EMAP sampling approach of probabilistically generating sampling locations within three coastal strata; estuary/bay < 100 km^2, estuary/bay >100 km^2 and <250 km^2; and estuary/bay >250 km^2. These strata were selected within three systems; Cook Inlet [Cook Inlet and Shelikof Strait], Alaska [Peninsula and Kodiak Island], and Prince William Sound. Cook Inlet was defined to include areas immediately downstream and incorporated Shelikof Strait sampling.

Samples were collected between June 14 and August 2, 2002. Data from a total of 55 stations were combined for analyses of the coastal bays and estuary populations. No comparisons are made between or among strata or between base and intensive sites.

The 2002 Alaska sampling frame comprised all bays and estuaries within the Alaska province and included the coastal waters ranging from Unimak Pass in the southwest to Icy Bay in the northeast. The sampling frame utilized six hexagonal grid sizes to cover the size range of estuaries and to ensure that some level of sampling occurred in each of the estuarine size classes.



Measurements Taken

The required EMAP core habitat, benthic, and pollutant exposure indicators were measured using methods comparable to other coastal EMAP programs shown below. These describe the core environmental indicators for the southcentral Alaska EMAP program and reflects whether the parameter is an indicator of habitat, biotic, or abiotic/pollutant exposure conditions. The field crew used GPS to locate the sampling site longitudes and latitudes of the target sites that were provided by EPA.

At most sites, the vessel was not at anchor due to the depth and the potential swing of the vessel in the strong tidal currents found throughout the area. Instead, the vessel held the station using the engine powered into the current. In many instances, the current was so strong that the vessel was allowed to "drift" with the bow held into the current to minimize the wire angle during equipment deployments.

Habitat Indicators:

Parameter	Type and Depth
Dissolved Oxygen concentration	continuous water column profiles
Salinity	continuous water column profiles
Water Depth	continuous water column profiles
pH	instantaneous on the surface
Water Temperature	continuous water column profiles
Total Suspended Solids	instantaneous on the surface
Chlorophyll a concentration	instantaneous on the surface
Transmittance	instantaneous on the surface
Secchi Depth	composite sample
Percent silt-clay of sediment	instantaneous on the surface
Nutrient concentrations (nitrates, nitrites, ammonia, phosphate)	composite sample
Percent Total Organic Carbon (TOC) in sediments	composite sample

Benthic Condition Indicators:

Infaunal species composition	composite sample
Infaunal abundance	composite sample
Infaunal species richness and diversity	composite sample
Fish species composition	composite sample from trawls
Fish abundance	composite sample from trawls
Fish species richness and diversity	composite sample from trawls
External pathological anomalies in fish	visual assessment

Exposure Indicators:

Sediment contaminants	composite sample
Fish tissue contaminants	composite sample from trawls
	composite sample

FINDINGS

Water Quality; habitat indicators

Water Clarity

Water clarity in southcentral Alaska estuaries is rated fair. Water clarity was rated poor at a sample site if light penetration at 1 meter was less than 10% of surface illumination. Approximately 12% of estuarine area in the Alaska survey received less than 10% of surface illumination at 1 meter.

Only four sites, located in Upper Cook Inlet area, had light penetration at 1 meter less than 10% of surface illumination. At these locations very high loadings of glacial river sediments occur during the summer peak flow period. Thus, the low levels of light penetration observed at the four sampling sites are indicative of naturally occurring conditions representing summer high-flow input of suspended sediments at the time of sampling. During winter low flow suspended sediment loading significantly decrease due to greatly reduced glacial river inputs.

Samples are prepared for analysis on the Ocean Cape Vessel

Chlorophyll a

Chlorophyll *a* concentrations in southcentral Alaska estuaries are rated good. There were no cases observed in which concentrations of chlorophyll *a* exceeded 5 µg/L. Although almost no areas within Southcentral Alaska estuaries showed high concentrations of water column chlorophyll *a*, this may not indicate low land-based loading of nitrogen and phosphorus. Many Alaska estuaries have large intertidal areas, so nutrient utilization by benthic algae may be of greater importance than nutrient uptake by phytoplankton. Data are not available to address this issue.

The Primary water quaity measurements colleced for the Alaska SC EMAP were:

- dissolved oxygen
- water clarity
- nutirents (nitrates, ammonia and phosphates
- pH
- Cholorphyll *a*

Dissolved Oxygen

Dissolved oxygen conditions in Alaska estuaries are good. There were no cases in which concentrations of dissolved oxygen fell below 5 ppm. Although conditions in the southcentral Alaska region appear to be generally good for dissolved oxygen, measured values reflect daytime conditions, and it does not preclude seasonal, depth or other conditions resulting in hypoxic or very low oxygen levels.

Nutrients

Dissolved Inorganic Nitrogen (DIN) concentrations in Southcentral Alaska estuaries are rated good. There were no cases in which concentrations of DIN in surface waters exceeded the threshold to be rated poor. The threshold for a West Coast EMAP study site to be rated poor for nitrogen was a concentration in excess of 1 mg/L. Historical data suggests that there is a significant upwelling influence of deeper Gulf of Alaska waters, on a seasonal basis, that supply nutrients to the lower waters of Cook Inlet.

Dissolved Inorganic Phosphorus concentrations in Southcentral Alaska estuaries are rated fair. Whereas high concentrations of DIN were not prevalent in Alaska surface waters, mid-level concentrations of DIP occurred in 66% of surface waters of the estuarine area of Alaska sampled. Only 34% of sites received a rating of good for DIP, in contrast with 100% of sites for DIN. The threshold for a West Coast EMAP study site to be rated poor for phosphorus was a concentration in excess of 0.1 mg/L. As with nitrogen, upwelling may be an important contributing factor to the high DIP concentrations in Alaska during the summer.

Sediment Quality; exposure indicators

Sediment Index

The overall condition of Alaska estuarine sediment is good, with only 1% of the area exceeding thresholds for sediment toxicity, sediment contaminants, or sediment TOC (total organic compounds). There were very few instances where any of the component indices exceeded the thresholds for being rated even in fair condition.

Sediment Contaminants

To assess the degree of sediment contamination in southcentral Alaska estuaries, the sediment concentrations of contaminants were compared with both the ERM and ERL guidelines (Long et al., 1995). Sites with values exceeding an ERM for any pollutant were classified as having poor condition. The analysis of the Alaska estuaries excluded nickel. Nickel was excluded because the ERM value has a low reliability for West Coast conditions where high natural crustal concentrations of nickel exist (Long et al., 1995).

Sediment Toxicity

Sediment toxicity for Southcentral Alaska estuaries is rated good. Sediment toxicity was determined using a static 10-day acute toxicity test with the amphipods Ampelisca abdita. While use of Ampelisca standardizes the sediment toxicity test within the EMAP National Coastal Assessment process, this test may or may not reflect actual response of specific benthic organisms indigenous to Alaska. The State of Alaska has yet to develop specific benthic species for use in sediment toxicity studies, but considers the EMAP work important in supporting future efforts to develop an Alaska sediment toxicity test. Sediment was deemed toxic if the amphipods had less than an 80% control-corrected mean survival rate. Sediments in 1% of the estuarine area of southcentral Alaska. were toxic to amphipods.

EMAP Crew member retrieves a Young-modified VanVeen grab with a sediment sample.

Two stations, had amphipod survival rates less than 80%. Station AK02-005 had the highest chromium and nickel sediment levels of any of the EMAP Southcentral sites sampled. These trace metals are likely elevated due to the historic chromium mining occurring in this area. Station AK02-0038 had the highest % total organic carbon (6.43%) of any site sampled, which was influenced by the large amount of decomposing eelgrass mixed in with this sediment sample. Elevated trace metal and TOC levels have been shown to be detrimental to some benthic organism.

Sediment Contaminant Criteria (Long et al., 1995)
ERM (Effects Range Median)—Determined for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.
ERL (Effects Range Low)—Determined values for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

Sediment Total Organic Carbon

Another measure of sediment condition is the percent TOC: values exceeding 5% ranked poor, values between 2% and 5% ranked fair, and values less than 2% ranked good. The estuaries of southcentral Alaska are rated good for the TOC index. One site representing,1% of the area of southcentral Alaska estuaries was ranked poor, which was influenced by the large amount of decomposing eelgrass mixed in with this sediment sample. Another 5 sites were ranked fair. In total, these sites represent 7% of the estuarine areas of southcentral Alaska. The sites with elevated TOC levels are spatially separated and span a range of depths, and may represent elevated levels of organic matter deposited from natural rather than human derived sources.

Fish Tissue Contaminants Index

Estuarine condition in Southcentral Alaska estuaries as measured by concentrations of contaminants in fish tissues is rated good. There were no sites sampled where fish were caught with tissue contaminant levels that exceeded human risk-based criteria guidelines using whole-fish contaminant concentrations. Fish that feed along the bottom, such as flatfishes, were selected as target species for the West Coast and Alaska EMAP assessments.

Typically, these consisted of arrowtooth flounder, flathead sole, yellowfin sole, species that live on or within sediments much of the time. Subsistence species, such as salmon, were not sampled as part of the EMAP water quality assessment because their contaminant levels could not specifically be related to the local site sediment and water quality data collected. Whole fish contaminant concentrations are applicable to human risk assessments for populations consuming whole fish and for ecological risk assessments.

Benthic Index; biological indicators Benthic Communities

Sediment condition in southcentral Alaska estuaries as measured by a benthic index could not be evaluated. Although several efforts are under way and indices of benthic community condition have been developed for regions of the West Coast (e.g., Smith et al., 1998), there is currently no benthic community index applicable for southcentral Alaska. Attempts to estimate species richness as an approximate indicator of condition were unsuccessful. Currently, we do not have a good applicable benthic index to use for Alaska. This finding indicates the importance of utilizing the Alaskan EMAP coastal program, as one of the first large scale statewide efforts, to help obtain data for starting the evaluation process for developing benthic indices for Alaska.

Summary

Based on the indices used in this report, ecological conditions in Southcentral Alaska estuaries are considered good. The NCA data show that only 2% of estuarine sediments exceed either the ERL or ERM guidelines for sediment contaminants. There was little indication of elevated levels of organic matter in the sediments or of sediment toxicity from amphipod bioassays. Dissolved oxygen, chlorophyll *a* concentrations, and levels of nitrogen are considered good for southcentral Alaska estuaries. Based on the water clarity indicator, same areas of southcentral Alaska estuaries have poor light penetration, but the naturally occurring high inputs of suspended sediments from the glacial rivers in this region will require a re-evaluation of the threshold levels used for this indicator in this area.

Future of Alaska's Coastal EMAP Assessments

In response to Congress, in the mid-1990s the Environmental Protection Agency (EPA) embarked upon a National Coastal Assessment Environmental Monitoring and Assessment Program (EMAP) to survey the environmental condition of the Nation's coastal water resources. EMAP's probabilistic survey sampling provides a practical, cost effective method to characterize Alaska's coastal and surface waters. EMAP's survey design is an important tool to help resource managers, elected officials and the public see the "big picture" for large regions, with known statistical confidence, and to report on the status of Alaska's ecological resources. No similar probabilistic sampling survey studies are underway within Alaska to provide regional, ecological information on such a large scale.

Baseline EMAP surveys have been completed for the coastal areas of the contiguous states and some areas are being re-surveyed to evaluate trends.

Alaska, which contains over 50% of the nation's coastline, was not included in the survey efforts until 2001 and is working on completing five Alaska EMAP biogeographically coastal survey regions. Using funding from various EPA grant sources, DEC has worked to help EPA begin to meet its National Coastal Assessment needs for Alaska.

DEC has surveyed the southcentral region in 2002, and southeast region in 2004 and is working on implementing an Aleutian Island survey in 2006 and 2007. Data quality assessment and control is currently ongoing for the data collected from the southeast survey in 2004, with a final report planned for 2007. The support of many volunteers and people believing in the need for an unbiased status survey of these critical resources has been vital to the success of the program.

Many of Alaska's current and future resource development activities and growing population centers are located along or near the Alaskan coast. This is the time to establish current status conditions for Alaska's coastal regions and freshwater aquatic resources in these regions. These benchmarks will be an important tool for resource managers monitoring impacts from future resource development and key to building an adaptive management strategy. These surveys are critical to EPA's completion of the National Coastal Assessment, DEC's management of Alaska's coastal and freshwater resources, and responsible resource development.

Even though EMAP coastal assessment are critical to helping understand and protect the important coastal and on a larger scale the freshwater resources of Alaska funding has yet to be provide by EPA for completion of the assessments of the Northwest Alaska Bering and Northwest Alaska Beaufort Chukchi Sea Coastal surveys. Increasing boat cost may limit the ability of completion of a full survey of 50 sites within the Aleutian Islands. DEC is working to see that funding is provided for completion of these initial EMAP status surveys and that we have a long term program established to assess status trends in water quality. This work is critical to the proper assessment and management of these coastal ecosystems, which support the people and fisheries of Alaska.

References

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Saupe, S., Gendron, J. and Dasher, D. (2006) National Coastal Assessment Program: The Condition of Southcentral Alaska's Bays and Estuaries Technical Report and Statistical Summary. Alaska Department of Environmental Conservation, Juneau, Alaska.