NATIONAL WATER-QUALITY ASSESSMENT PROGRAM

Cook Inlet Basin, Alaska

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U.S. Department of the Interior

U.S. Geological Survey

MAJOR WATER-QUALITY ISSUES IN THE COOK INLET BASIN

Water quality is an integration of physical, chemical, and biological components. The NAWQA study will provide increased understanding of water quality in the streams and ground water of the Cook Inlet Basin and identify factors that influence water quality. Water-resource managers will find this information valuable in determining effective water-quality management and evaluating long-term changes in water quality.

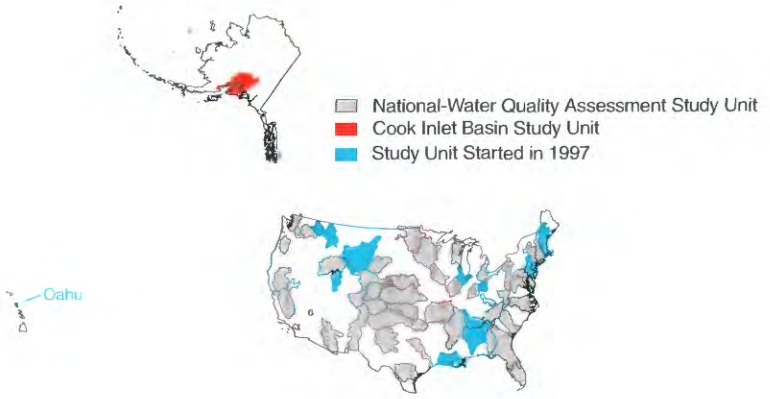
Water-quality issues in the Cook Inlet Basin are related primarily to salmon spawning and to documentation of conditions in relatively undeveloped environments. Currently, streams draining into Cook Inlet produce world-renown salmon runs. The Kenai River salmon runs alone generate annual revenues of about $70 million to the local economy. In the Pacific Northwest, many salmon runs have vanished because of habitat degradation or loss from dam construction, timber harvesting, mining, and suburbanization. Cook Inlet has abundant natural resources, and the development of these resources could adversely affect water quality, and, possibly, salmon populations. In addition, an opportunity exists to characterize water quality in undeveloped areas of the Cook Inlet Basin; this opportunity is not possible in most parts of the United States. The availability of pre-development data would offer resource managers a basis for evaluating potential changes in water quality.

Work in this NAWQA study unit will focus on how the following activities or settings influence water quality in general and the salmon fisheries in particular.

- *Suburbanization*
- *Intense recreational use*
- *Timber harvesting and associated road building*
- *Mining*
- *Petroleum and petrochemical development*
- *National parks and undeveloped areas*

WHAT IS THE NATIONAL WATER-QUALITY ASSESSMENT PROGRAM?

During the past 25 years, our Nation has sought to improve its water quality; however, many water-quality issues remain unresolved. To address the need for consistent and scientifically sound information for managing the Nation's water resources, the U.S. Geological Survey began a full-scale National Water-Quality Assessment (NAWQA) Program in 1991. This program is unique compared to other national water-quality assessment studies in that it integrates the monitoring of surface- and ground-water chemistry with the study of aquatic ecosystems. The goals of the NAWQA Program are to (1) describe current water-quality conditions for a large part of the Nation's freshwater streams and aquifers, (2) describe how water quality is changing over time, and (3) improve our understanding of the primary natural and human factors affecting water quality.



Assessing the quality of water in every location of the Nation would not be practical; therefore, NAWQA Program studies are conducted within a set of areas called study units. These study units represent the diverse geography, water resources, and land and water uses of the Nation. The Cook Inlet Basin, Alaska, is one such study unit designed to supplement water-quality information collected in other study units across the Nation while addressing issues relevant to the Cook Inlet Basin.

Salmon returning to spawn in one of the many streams in the Cook Inlet Basin (photo courtesy of Gary Liepitz, Alaska Department of Fish and Game).

STUDY UNIT DESCRIPTION

The Cook Inlet Basin is located in south-central Alaska. Geologically, the area is dominated by igneous rocks in the mountains and by continental shelf and alluvial deposits in the lowlands. Glaciation has dramatically altered the landscape, and glaciers are extensive on the southeastern and northwestern boundaries of the study unit. Five physiographic regions— grading from plains and lowlands to extremely high rugged mountains—are represented within the study unit. Altitude ranges from sea level to 20,320 feet, the highest point in North America at Mount McKinley. Rugged mountains surround Cook Inlet and include four active volcanos on the western side of the inlet. Precipitation is closely associated with altitude and ranges from about 15 to more than 200 inches annually.

Anchorage is the largest city in the study unit and in Alaska. Continued residential development may stress fisheries in suburban streams (photo courtesy of AeroMap U.S., Anchorage, Alaska).

Streams draining to Cook Inlet are important to the local and State economies. Five species of Pacific salmon spawn in the fresh waters of the Cook Inlet Basin. High-quality spawning and rearing habitats are crucial to the maintenance of these stocks at sustainable levels. Numerous river systems drain the 39,300 square-mile area, including the Susitna, Matanuska, and Kenai Rivers. The largest river, the Susitna, drains about half of the study unit and discharges an average of 50,400 cubic feet per second. Most rivers have relatively small drainages but yield large quantities of water due to substantial snowfall in the mountains.

Many streams are fed by glaciers and have different physical characteristics than streams that do not have glacial contributions. Glacier-fed streams have periods of sustained high flow during summers and are more turbid than streams lacking glacial contributions. Numerous wetlands and lakes also influence the physical and chemical characteristics of streams by moderating peak flows and trapping sediment and nutrients. Land cover is dominated by forests, accounting for 30 percent of the area. Glaciers cover 20 percent of the area, and lakes and wetlands cover another 12 percent. Less than 1 percent of the basin is used for agricultural purposes. The Municipality of Anchorage dominates the urban and residential features of the basin; however, the total urban and residential land cover is less than 1 percent of the basin.

More than half of the State's population lives in the metropolitan Anchorage area. Population in Anchorage has grown from about 30,000 in 1950 to more than 250,000 in the late 1990's. Expansion of suburban areas continues to the north of Anchorage and residential density is increasing throughout the municipality. Public water supply to the municipality is mostly from surface water, although some ground water is used as well. Water resources may be stressed as demand increases for drinking water and recreational uses. Potential water-quality effects in the Anchorage area are related to urban runoff delivering trace elements, volatile organic compounds, and bacteria to streams and shallow aquifers.

South of Anchorage, the Kenai Peninsula has become an increasingly popular sport-fishing area; the number of angler days on the Kenai River increased from 122,000 in 1977 to 378,000 in 1995. This intense recreational use has caused managers concern over resource degradation. The remainder of the basin is largely unpopulated; however, Native villages exist at a number of locations.

World-class salmon fishing concentrates anglers in accessible streams. Stream habitat has become degraded in areas with the most intense use (photo courtesy of Gary Liepitz, Alaska Department of Fish and Game).

Watersheds of the Cook Inlet Basin are largely undeveloped and contain parts of four national parks totalling about 6,300 square miles. Nearly 1,800 square miles of the Chugach National Forest, and the 3,000-square-mile Kenai National Wildlife Refuge also are within the boundaries of the study unit. Natural resources are abundant in these areas and will likely be developed to some degree. Public and private forest lands recently have been infested with spruce-bark beetles and these tracts have potential for large-scale salvage logging. Timber harvesting and the associated road building can increase erosion in the watershed, resulting in sedimentation of streams and deterioration of spawning habitat. Loss of riparian vegetation can degrade crucial salmonid rearing habitats and increase water temperatures.

Timber harvesting and the associated road building can be detrimental to salmon spawning and rearing habitat (photo courtesy of Joe Dorava, U.S. Geological Survey).

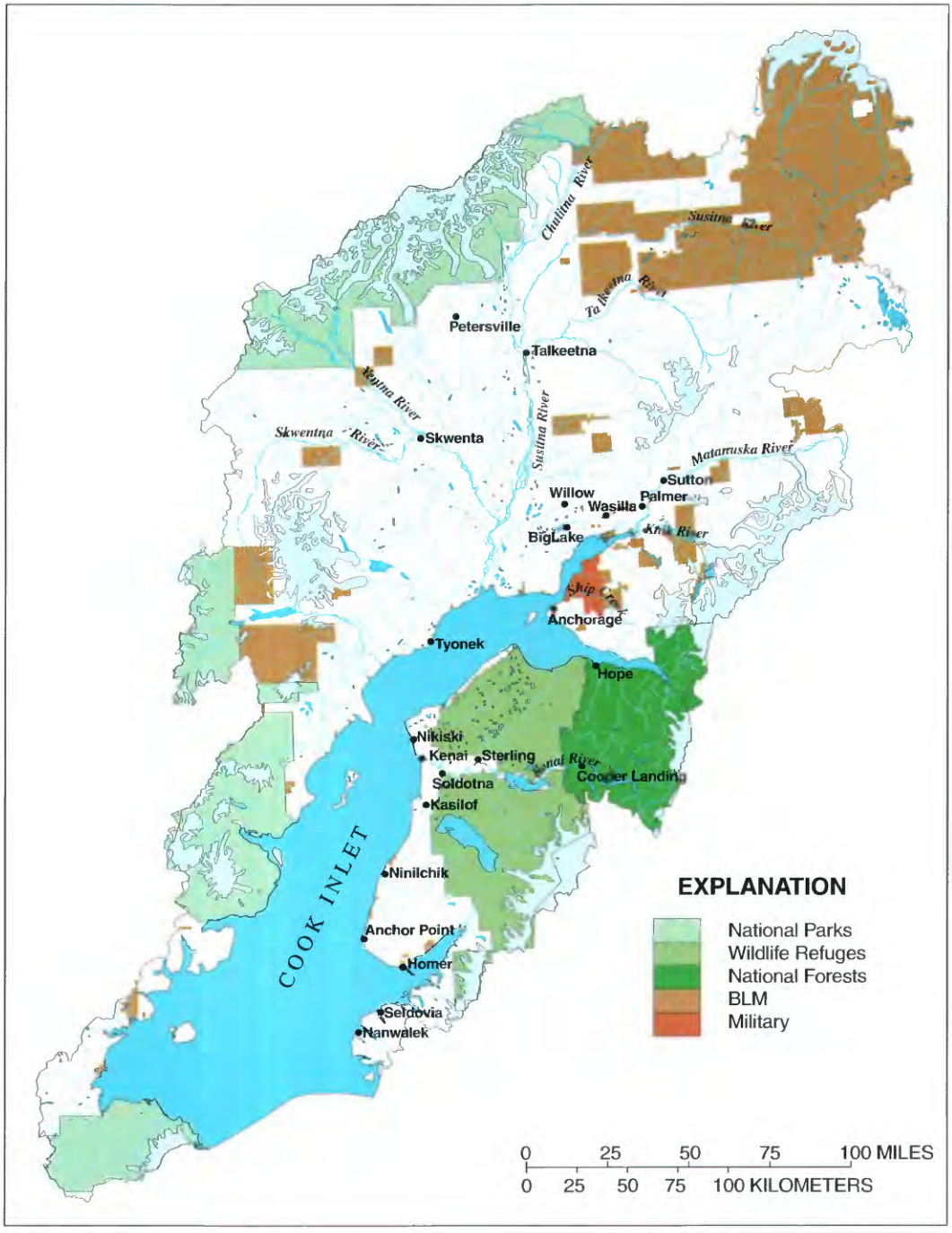
Precious ores and strategic mineral deposits are present in the Cook Inlet Basin. Although current mining activity is on a local scale, there is potential for large-area coal mining near the western shore of Cook Inlet. Water quality could be affected by mining through sedimentation and alteration of the water chemistry. Waters affected by mine drainage tend to have increased acidity and elevated trace-element concentrations. Such changes can result in conditions detrimental to aquatic organisms and water unfit for human consumption.

The State's oldest oil fields are located on the Kenai Peninsula within the Cook Inlet Basin. Exploration, transportation, processing, and storage of petroleum could adversely affect water quality through the introduction of volatile organic compounds.

SCHEDULE OF STUDY ACTIVITIES

The Cook Inlet Basin study is one of several NAWQA studies that began in Federal fiscal year 1997 (October 1996). Study planning and design, and analysis of existing data will be done during the first 2 years, which is consistent in all NAWQA studies. After the 2-year planning period, surface- and ground-water and biological data are collected intensively for 3 years (termed the "high-intensity phase"). A low-intensity phase follows for 6 years, during which water quality is monitored at a selected number of sites and areas that were assessed during the high-intensity phase. This combination of high- and low-intensity-monitoring phases allows the NAWQA Program to examine trends in water quality over time.

During the planning period, existing data and results from previous studies are reviewed to understand the primary physical, chemical, and biological factors that affect water quality in the study unit and to identify gaps in the current data. Descriptions of how land use and land cover, soils, geology, physiography, climate, and drainage characteristics may influence water quality are to be included in technical and nontechnical reports. Information obtained from reviews of previous studies, along with field checks of existing monitoring stations and candidate sampling sites, and field reconnaissance data, are used to design a sampling program for the study unit.



Cook Inlet Basin Study Unit

During the high-intensity phase, new chemical, physical, and biological data are collected for selected areas at local and regional scales to describe the quality of water throughout the study unit. Measurements are made to determine water chemistry in streams and aquifers; the quantity of suspended sediment and the quality of bottom sediments in streams; the variety and number of fish, benthic invertebrates, and algae in streams; and the presence of contaminants in fish tissues. Individual streams and aquifers, chemical constituents, and biological species are selected for sampling to represent the important water resources and water-quality concerns in the study unit and the Nation. A series of technical and nontechnical reports describing results of high- and low-intensity-phase data collection and analysis are planned.

Activity	97	98	99	00	01	02	03	04	05	06	07	08	09	10
Planning and study design														
High intensity monitoring														
Reports														
Low intensity monitoring														

ASSESSING WATER QUALITY IN THE COOK INLET BASIN STUDY UNIT

The NAWQA Program is designed to assess the status of and trends in the quality of the Nation's ground- and surface-water resources and to link the status and trends with an understanding of the natural and human factors that affect the quality of water. The design of the Program balances the unique assessment requirements of individual study units with a nationally consistent design and data-collection structure that incorporates a multi-scale, interdisciplinary approach. Surface- and ground-water studies are done at local (a few square miles to hundreds of square miles) and regional (thousands of square miles) scales to understand the water-quality conditions and issues within a study unit.

An Occurrence and Distribution Assessment is the largest and most important component of the first intensive study phase in each study unit. The goal of the Occurrence and Distribution Assessment is to characterize, in a nationally consistent manner, the broad-scale geographic and seasonal distributions of water-quality conditions in relation to major contaminant sources and background conditions. The following discussions describe the typical surface- and ground-water monitoring components of the Occurrence and Distribution Assessment. The Cook Inlet Basin NAWQA study will have a similar design.

Surface Water. The national study design for surface waters focuses on water-quality conditions in streams using three interrelated components – water-column studies, bed-sediment and fish-tissue studies, and ecological studies. Water-column studies monitor physical and chemical characteristics, which include suspended sediment, major ions, nutrients, organic carbon, and dissolved pesticides, and their relation to hydrologic conditions, sources, and transport. Most surface water is monitored at sites termed either basic-fixed sites or intensive-fixed sites, according to the frequency of the sampling. The sampling sites are selected to determine the quality of water in relation to important environmental settings in the study unit. Basic-fixed sites are sampled monthly and at high flows for 2 years of the 3-year high-intensity phase. Intensive-fixed sites are monitored more frequently (as often as weekly during key time periods) for at least 1 year, to characterize short-term variations of water quality. Sampled sites either can be indicative of relatively homogeneous areas associated with specific environmental settings and land uses or can integrate combinations of environmental settings and land uses. Such a sampling strategy can aid in determining important factors that affect water quality. Water samples also are collected as part of synoptic (short-term) investigations of specific water-quality conditions or issues during a specific hydrologic period (for example, following ice breakup) to provide greater spatial coverage and to allow investigators to assess whether the basic-fixed or intensive-fixed sites are representative of streams throughout the study unit. Bed-sediment and fish-tissue studies assess trace elements and hydrophobic organic contaminants at as many as 15-20 sites to determine their occurrence and distribution in the study unit.

Ecological studies evaluate relations among physical, chemical, and biological characteristics of streams. Aquatic biological communities at basic- and intensive-fixed sites are surveyed during the high-intensity-sampling phase. These surveys are done along a delineated stream reach and include a habitat assessment of the site and surveys of the fish, algal, and benthic invertebrate communities. These community surveys are used to determine whether a stream is supporting the assemblages of organisms that would be expected in relatively undisturbed environments. Additionally, ecological sampling can be integrated with surface water synoptic studies to assess whether the biological communities at basic- and intensive-fixed sites are representative of streams throughout the study unit.

Ground Water. The national study design for ground water focuses on water-quality conditions in major aquifers, with emphasis on recently recharged ground water associated with present and recent human activities. Ground-water samples are analyzed for major ions, nutrients, pesticides, volatile organic compounds, and trace elements. Study-unit surveys are used to assess the water quality of the major aquifer systems of each study unit. About 20-30 existing wells are randomly selected to be sampled in each of 2-3 aquifer subunits. Land-use studies focus on recently recharged shallow aquifer systems so that the influences of land-use practices and natural conditions can be assessed. Typically, about 20-30 new observation wells are randomly located within each land use and aquifer type. Results from the 2-4 land-use studies typically performed can be compared with results from the general study-unit survey to determine the effect of particular land uses on ground-water quality. Flow-path studies use transects and groups of clustered, multilevel observation wells to examine specific relations among land-use practices; ground-water flow; and contaminant occurrence, transport, and interactions between ground and surface water.

COMMUNICATION AND COORDINATION

Communication and coordination between the U.S. Geological Survey and other scientific and land- and water-management organizations are critical components of the NAWQA Program. A successful study depends on the advice, cooperation, and information from many Federal, State, regional, and local agencies, and the public concerned about water resources. The Cook Inlet Basin NAWQA study unit will establish and maintain a liaison committee that includes representatives from agencies and organizations that have water-resource responsibilities and interests. Committee activities include the exchange of information about regional and local water-quality issues, identification of sources of data and information, assistance in site selection and in the design and scope of study products, and the review of study planning documents and reports.

SUGGESTIONS FOR FURTHER READING

Dorava, J.M., and Moore, G.W., 1997, Effects of boatwakes on streambank erosion, Kenai River, Alaska: U.S. Geological Survey Water-Resources Investigations Report 97-4105, 84 p.

Gilliom, R.J., Alley, W.M., and Gurtz, M.E.,1995, Design of the National Water-Quality Assessment Program: Occurrence and distribution of water-quality conditions: U.S. Geological Survey Circular 1112, 33 p.

Leahy, P.P., Rosenshein, J.S., and Knopman, D.S., 1990, Implementation plan for the National Water-Quality Assessment Program: U. S. Geological Survey Open-File Report 90-174, 10 p.

FOR MORE INFORMATION

Information on technical reports and hydrologic data related to the Cook Inlet Basin study unit and the NAWQA Program can be obtained from:

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