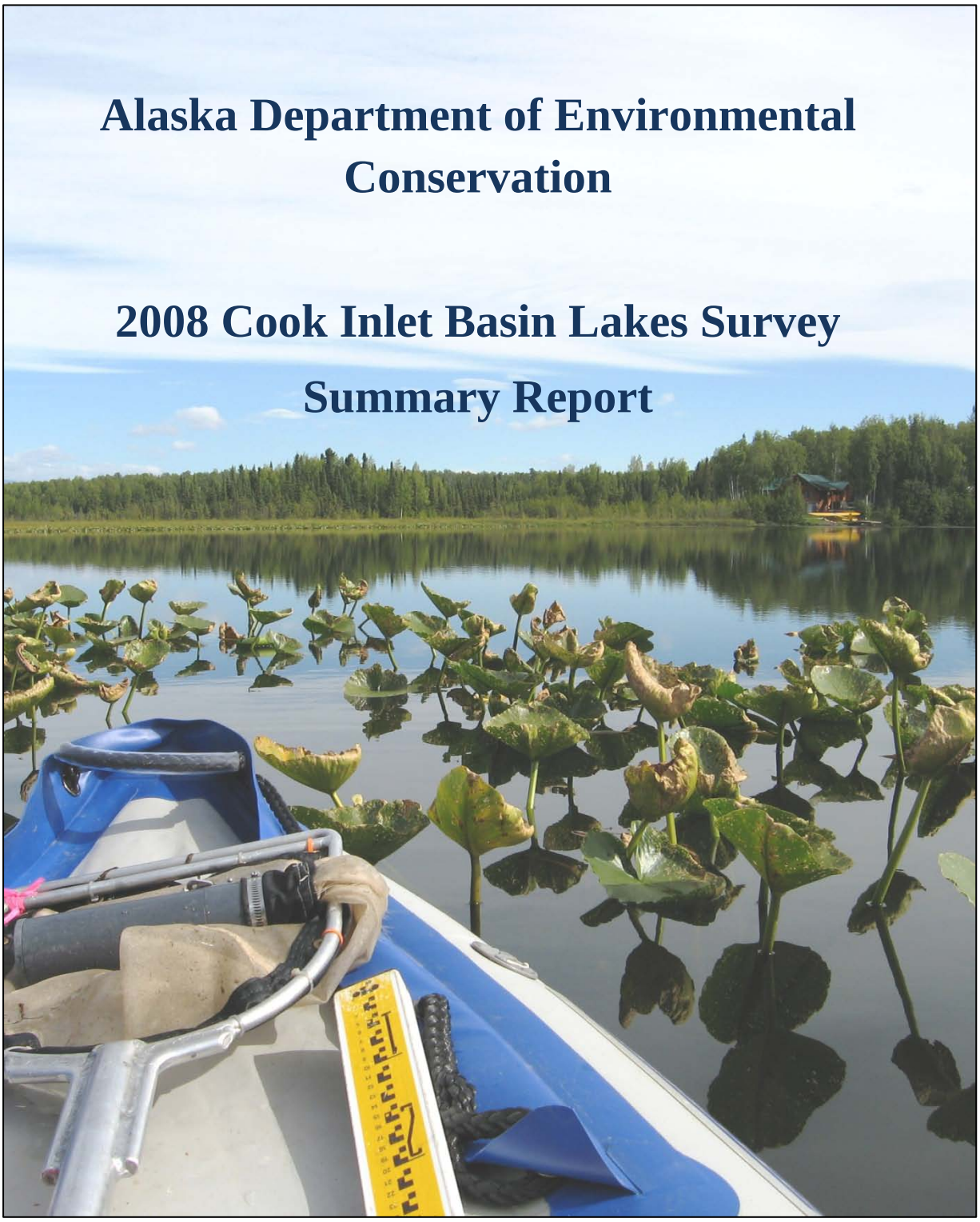
Alaska Department of Environmental Conservation

2008 Cook Inlet Basin Lakes Survey Summary Report



ALASKA Department of Environmental Conservation

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Acknowledgements

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Background

The Environmental Protection Agency (EPA) completed a comprehensive "State of the Lakes" assessment for lakes, ponds, and reservoirs across the United States in 2007. The Alaska Department of Environmental Conservation (ADEC) took part in this effort on a regional scale. The program, known as the Survey of the Nation's Lakes, is part of an EPA research initiative that develops tools to assess and monitor the status and trends of national ecological resources. During 2007 and 2008, ADEC staff with collaborators from the University of Alaska Anchorage's Environment and Natural Resources Institute (ENRI), sampled 50 randomly selected lakes in the Cook Inlet basin for Alaska's portion of the Survey. The Cook Inlet basin located in southcentral Alaska is 39,325 mi^2, slightly smaller than Kentucky. Although it supports more than half of Alaska's population, large portions of the region's natural environment remain intact.

The Cook Inlet basin spans the western Kenai Peninsula, Matanuska and Susitna valleys, and the west side of Cook Inlet as far south as Katmai National Park (Figure 1), lakes in this region represent a large range in morphometry, size, climate, and elevation. As in other areas of the United States, the Survey focuses on a population of randomly selected lakes in order to draw statistically valid conclusions about the ecological conditions occurring at broad spatial scales. In Alaska, the main causes of water body pollution are urban runoff and natural resource development.

An extensive array of chemical, physical, and habitat measurements were collected in addition to sampling zooplankton, littoral macroinvertebrates, and sediment core diatoms. Taken together, the data will provide a thorough characterization of the current ecological conditions while the sediment core diatoms enable researchers to infer how conditions have changed over time. The Alaska data, as well as the data collected across the rest of the country, provide a benchmark against which future ecological changes can be detected. Additionally, the data provide a spatially extensive dataset for exploring hypotheses regarding the structure and function of lake ecosystems. This report summarizes the overall field collection protocols, data collected and provides the complete data sets as appendices.

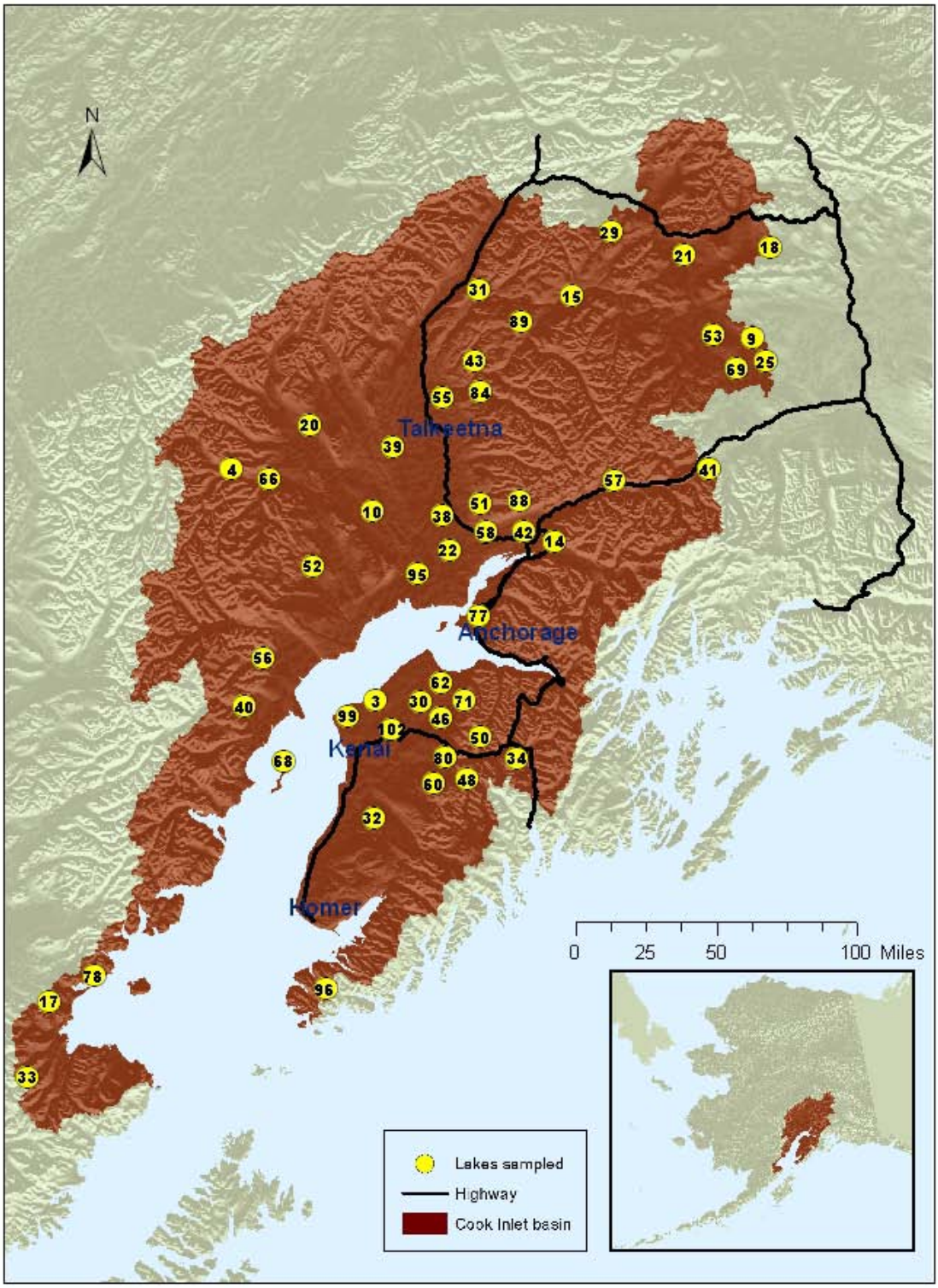


Figure 1. 50 Lakes sampled in the Cook Inlet Basin.

Methods

The methods outlined in this report give a brief summary of the work conducted. For more detail on field methods, lab methods, and QA/QC procedures, see the following documents:

- Survey of the Nation's lakes: quality assurance project plan (EPA 841-B-07-003)
- Survey of the Nation's lakes: lake evaluation guidelines (EPA 841-B-06-003)
- Survey of the Nation's lakes: field operations manual (EPA 841-B-07-004)
- Survey of the Nation's lakes: laboratory methods manual (EPA 841-B-07-005)

Site Selection

To identify the target population of lakes the USGS/EPA National Hydrography Database was used to provide the sampling frame. To be included in target population the lake had to be a natural or man-made freshwater lake, pond or reservoir, greater than 10 acres, at least 1 meter deep, and have a minimum of a quarter acre open water. Glacially fed lakes were not included in the survey, nor were commercial treatment and/or disposal ponds, brackish lakes, or ephemeral lakes.

There are an estimated 8,419 target lakes with 5,562 ha of target lake surface area in the Cook Inlet Basin. An initial selection of 50 randomly selected lakes stratified across the basin was selected, with an additional 150 identified as over-sample. The main factor determining lake selection was the ability to safely land a floatplane; half of the initially selected lakes were excluded due to inaccessibility or safety concerns. Lakes excluded were replaced with lakes identified in the oversample population. The final selection and sampling of 50 lakes represents 31% of the total lake numbers or 2,571 lakes, and 82% or 4,555 ha of the total lake surface area in the basin.

Field data collection

At each lake site, crews collected samples at a single station located at the deepest point (Z or index site) in the lake and at ten stations around the lake perimeter (Figure 2). At the index station, depth profiles for temperature, pH, and dissolved oxygen were taken with a calibrated water quality probe meter or multi-probe sonde. A Secchi disk was used to measure water clarity and depth at which light penetrates the lake (the euphotic zone). Single grab water samples were collected to measure nutrients, chlorophyll-*a*, and phytoplankton. Zooplankton samples were collected using a fine mesh (80µm) and course mesh (243µm) conical plankton net.

A 15-40 cm sediment core was taken at the index site to provide data on sediment diatoms and mercury levels. The top and bottom layers of the sediment core were analyzed to detect possible changes in diatom assemblages over time.

Along the perimeter of the lakes, crews collected data and information on the physical characteristics that affect habitat suitability. Information on substrate composition was recorded along the ten pre-determined stations. Benthic macroinvertebrates, collected with a 500 μm D-frame net, and water samples for pathogen analysis were collected at the first and last station, respectively. Filtering and other sample preparations took place on shore. Crews completed one or two lake surveys a day. Lakes were accessed via the road network or air by floatplane.

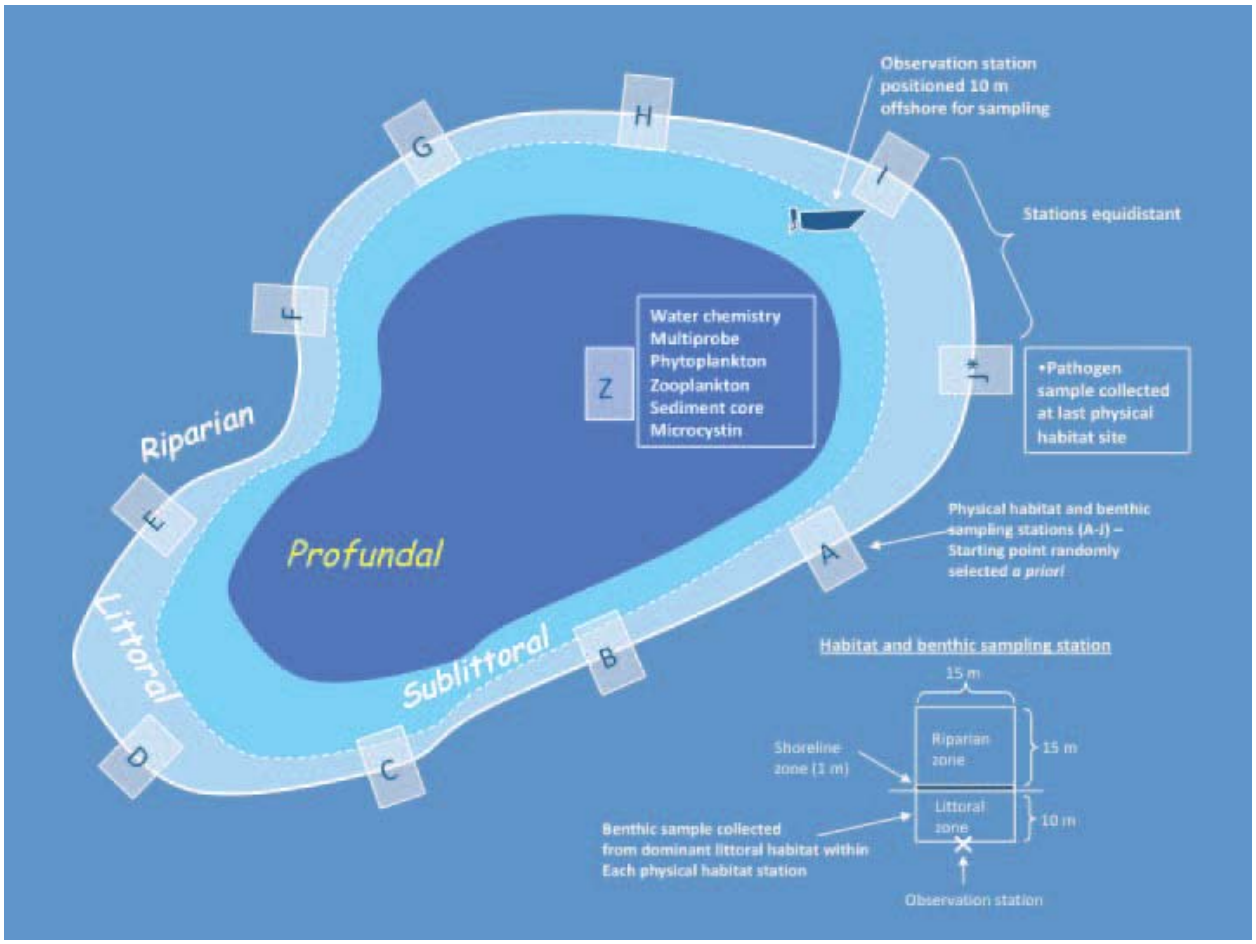


Figure 2. Schematic of Lake sampling activities (USEPA 2007).

Index site sampling

For road-accessible lakes, we used an inflatable boat for index site sampling and for fly-in lakes we generally worked from the airplane floats. Prior to sampling, the deepest point of the lake (i.e., index site) was located using hand-held sonar and the aid of bathometric maps, when available.

At the index site, the boat/airplane was anchored; the GPS coordinates were recorded, and Secchi disk transparency was recorded. A Sea-Bird SBE19plus CTD profiler was used to record water column temperature, dissolved oxygen concentration, pH, and conductivity averaged into 0.5-m vertical bins. Using a 2m depth-integrated sampler, water for laboratory chlorophyll-a and chemistry analysis was collected. Prior to leaving each lake, the chlorophyll-water samples were filtered, and the filter paper was retained for laboratory analysis. Vertical plankton tow using a 243-µm Wisconsin net was conducted for laboratory analysis of zooplankton communities. The vertical plankton tow using the 80- µm Wisconsin net was dropped nationally due to unexpected species diversity. A modified KB corer was utilized to collect a 15 to 40cm sediment core. From each core we preserved 1 cm of material from the top and bottom (representing current and past conditions, respectively) for laboratory analysis of diatom communities; a 1mm plug of sediment was also removed from the top of the core for laboratory analysis of total and methyl mercury. Sediment cores were not dated but top core samples were assumed to be post-industrial and bottom core samples pre-industrial based on sediment accumulation rates in Alaska.

Littoral and riparian habitat data collection

Littoral and riparian data collection was based on 10 habitat stations equally spaced around the lakeshore (Figure 2). Prior to travelling to each lake, digital maps were used to plot the locations of the 10 habitat stations and entered the coordinates of each into a handheld GPS. In the field, we circumnavigated each lake by inflatable boat (occasionally on foot) and conducted the littoral and riparian habitat data collection at each of the 10 GPS points. Much of the habitat data collection involved classifying the areal coverage of riparian habitat components (e.g., vegetation, substrates, fish cover), and, for this, the following cover classes were used: absent, sparse (<10%), moderate (10-40%), heavy (40-75%), and very heavy (>75%).

Littoral habitat characterization was based on a 15 m-wide plot that extended 10 m into the lake at each habitat station (Figure 2). Water depth was measured 10 m from the shoreline; noted the presence of any surface scum, algal mats, or oil slicks; and noted the sediment color and any odor. Within the plot we characterized the coverage of inorganic and organic substrates, aquatic macrophytes, and fish cover. Inorganic substrate coverage was classified separately for each of 6 particle size classes: bedrock (>4000 mm), boulder (250–4000 mm), cobble (64–250 mm), gravel (2–64 mm), sand (0.06–2 mm, gritty), and fines (<0.06 mm, not gritty). For organic substrates coverage of both woody debris and other organic detritus was classified. Aquatic macrophyte coverage was classified for each of 3 growth forms: submergent, emergent, and

floating. For fish cover, the coverage of inundated herbaceous vegetation, woody debris, inundated live trees, overhanging vegetation, ledges or drop-offs, boulders, and human-made structures were each classified.

Shoreline habitat classification was based on a 15 m-wide plot that extended for 1 m above the shoreline (Figure 2). Within each plot, we characterized the slope of the bank as flat (<5°), gradual (5–30°), steep (30–75°), or near vertical/undercut (>75°). We also characterized the coverage of inorganic and organic substrates in a fashion similar to that described above for littoral habitat.

Riparian vegetation was characterized for a 15 m x 15 m plot adjacent to the water's edge (Figure 2). Within each plot, vegetation was classified in both the canopy (vegetation >5 m high) and understory (vegetation 0.5–5 m high) as deciduous, coniferous, mixed, or absent. For the canopy, we then classified the coverage of both big trees (>0.3 m diameter at breast height [dbh]) and small trees (<0.3 m dbh). In the understory, coverage of both woody (shrubs and saplings) and non-woody (herbs, grasses, and forbs) plants was classified. Ground cover (features < 0.5 m high) of woody plants, non-woody plants, standing water/inundated vegetation, and barren surfaces/buildings was classified.

In addition to the above activities, several other parameters were recorded or documented. The vertical and horizontal distance between the current lake level and the high water mark was estimated. Invasive plant and invertebrate species were identified. Also, the presence of any human influence (e.g., buildings, docks, revetments, roads, lawns, etc.) within or near each riparian vegetation plot was noted.

Benthic macroinvertebrates were collected from the dominant habitat type within each littoral habitat plot. For the purposes of macroinvertebrate sampling, 4 habitat types were considered: (1) rock/cobble/large woody debris, (2) macrophyte beds, (3) organic fine muds or sand, and (4) leaf packs. Each plot was sampled by sweeping a 500-µm-mesh D-frame net through 1 linear m of habitat, making sure to disturb the substrate enough to dislodge the animals. For each lake, sweeps from each of the 10 plots were combined into a single composite sample, and the samples were returned to the laboratory for analysis of macroinvertebrate communities.

At the final sampling station on each lake, a water sample was collected within the littoral habitat plot for laboratory analysis of *Enterococci* concentration. *Enterococci* is an indicator of fecal contamination. *Enterococci* samples were filtered within 8 hours of collection, and the filter papers were retained for analysis.

Laboratory Analysis

Laboratory or desktop analysis was conducted through several entities. GIS analysis of basin attributes was conducted by the University of Alaska Anchorage Alaska Natural Heritage Program. Sediment diatom, zooplankton, and benthic macroinvertebrate communities were analyzed in the ENRI Aquatic Ecology Lab. Water chemistry was analyzed by local NELAP certified commercial labs and sediment metal and fish tissue analysis was performed by the Environmental Health Laboratory, Alaska Department of Environmental Conservation.

Geographic Information Systems analysis

UAA Natural Heritage Program GIS analyst used ESRI ARC GIS software to analyze landscape features. Shapefiles used to analyze parameters included: Alaska Geospatial Climate Animation, National Hydrograph Database, State of Alaska boundaries and road networks, EPA/USGS ecoregion boundaries, Alaska HUC codes, NRCS soil shapefiles, and USGS Digital Elevation Models.

Water chemistry

From each index site, water quality samples were collected and stored on ice in the field. Once received in the laboratories samples were refrigerated at 4^{o}C until analysis. Chlorophyll-a samples were filtered in the field; the filter was retained and placed in a centrifuge tube which was then wrapped in aluminum foil. Samples were kept on dry ice the field until delivery at the lab. Upon receipt by the laboratory Chlorophyll-a samples were kept frozen until analysis.

Water Chemistry analysis performed

Parameter	Analysis Method
Alkalinity	SM 20 2320B
Ammonia-N	SM20 4500-NH3
Calcium	SW6020
Chloride	EPA 300.0
Chlorophyll A	SM10200H
Color	SM20 2120B
Conductivity	SM20 2510 B
Magnesium	SW6020
Ortho Phosphorus	SM20 4500P-E
Potassium	SW6020
Settleable Matter	SM20 2540F
Silica	SM20 4500-SiG
Sodium	SW6020
Sulfate	EPA 300.0
Total Kjeldahl Nitrogen	SM20 4500-N D
Total N/Nitrite-N	SM20 4500NO3-F
Total Organic Carbon	SM 5310B
Total Organic Carbon, dissolved	SM 5310B
Total Phosphorus	SM20 4500P-B,E
Total Recoverable Silicon	EPA 200.7/200.7
Total Suspended Solids	SM20 2540D
Turbidity	SM20 2130B

Sediment metal analysis

From each index site, the top 1 cm and bottom 1 cm slice from the sediment core was analyzed for metals. A 1 mm plug was removed from the center of the top core and field frozen on dry ice for analysis of Mercury by the EPA contract laboratory. Top and bottom core samples were analyzed for the metals by the State of Alaska Environmental Health Laboratory. Samples were stored on wet ice in the field, and refrigerated at 4^{o}C by the laboratory until analysis.

Sediment analysis performed	
Parameter	Analysis Method
Aluminum	SW6020A
Antimony	SW6020A
Arsenic	SW6020A
Cadmium	SW6020A
Chromium	SW6020A
Copper	SW6020A
Iron	SW6020A
Lead	SW6020A
Lithium	SW6020A
Manganese	SW6020A
Mercury	SW7473
Nickel	SW6020A
Selenium	SW6020A
Silver	SW6020A
Tin	SW6020A
Zinc	SW6020A

Fish tissue analysis

Sixty-nine fish were collected using a floating gill net or hook and line from 17 lakes. Whole fish were labeled and kept on wet ice in the field. Processing of fish samples occurred each day after field activities. Samples were identified by species and sexed (if possible), measured for length and weight, any anomalies or tags were noted, and then frozen until laboratory analysis. The laboratory de-skinned, and filleted each sample. Fillets were then homogenized and analyzed by the DEC Environmental Health Laboratory.

Fish tissue analysis performed	
Parameters	Analysis Method
Arsenic	SW6020A
Cadmium	SW6020A
Copper	SW6020A
Lead	SW6020A
Selenium	SW6020A
Mercury	SW7473

Sediment diatom communities

From each sample (i.e., top and bottom of each sediment core) approximately 1 cc of sediment was heated in nitric acid to digest any diatom protoplasm and other organic material for easier sample identification. UAA ENRI then neutralized the acid-digested samples by a succession of dilutions, concentrated the cleared diatom valves by allowing them to settle, and slide mounted the valves using NAPHRAX mounting medium. For each sample, UAA ENRI identified a fixed count of 500 diatom valves to species or lowest practical taxon. The primary taxonomic references were Krammer and Lange-Bertalot (1986-1991) and Patrick and Reimer (1975).

Zooplankton communities

Zooplankton samples were halved using a Folsom splitter; one half was reserved for later QA/QC while laboratory analysis proceeded with the other half. A fixed-count subsample of ≥ 200 organisms was isolated from the sample (using a Hensen-Stempel pipette) to standardize taxonomic effort across all lakes. Using dissecting and compound microscopes, we identified zooplankton in the subsample to the taxonomic levels given in USEPA (2006). In addition, UAA ENRI conducted a 1- to 2-minute dissecting microscope search of the remaining sample for large and/or rare taxa that were missed in the subsample. Primary taxonomic references were Pennak (1989) and Alberti et al. (2007).

Macroinvertebrate communities

UAA ENRI subsampled each macroinvertebrate composite sample to a fixed count of 500 ±20% organisms (using a Caton subsampler) to standardize the taxonomic effort across all lakes. In addition, UAA ENRI conducted a 5–10-minute search through the remaining sample to select any large and/or rare taxa that may have been missed during subsampling. Using dissecting and compound microscopes, we identified insects to genus (or lowest taxon practical) except for midges, which were identified to subfamily or tribe. Non-insects were generally identified to higher taxa (usually family or order). Primary taxonomic references were Wiggins (1996), Smith (2001), Stewart and Oswood (2006), and Merritt et al. (2008).

Physical habitat analysis

Physical habitat metrics were evaluated at each transect and as a basin wide assessment. Evaluations were based on either mapping software or physical observations. Physical habitat observations were part of an effort to characterize lake stressors.

Physical habitat parameters recorded	
Littoral Zone	Surface film
	Bottom substrate
	Aquatic macrophytes
	Fish cover
Riparian Zone	Canopy
	Understory
	Ground cover
	Shoreline substrate
	Human influence
Littoral Fish Macro-habitat Classification	Human disturbance
	Cover class
	Cover type
	Dominant substrate
Bank Features	Angle
	Vertical height to high water mark
	Horizontal height to high water mark
Lake Catchment	Residential
	Recreational
	Agricultural
	Industrial
	Lake Management
General Info	Hydrologic Type
	Outlet Dams
	Bottom substrate
	Motor Boat Density
	Swim-ability
	Lake Level Changes
Shoreline Characteristics	
Invasive Plants and Invertebrates	
Quality Macrophyte survey	
Waterbody Character	
Qualitative Assessment of Environmental Values	

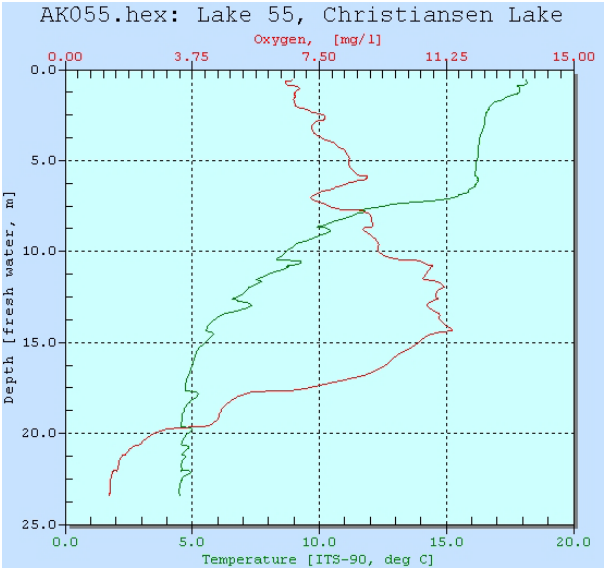
Results

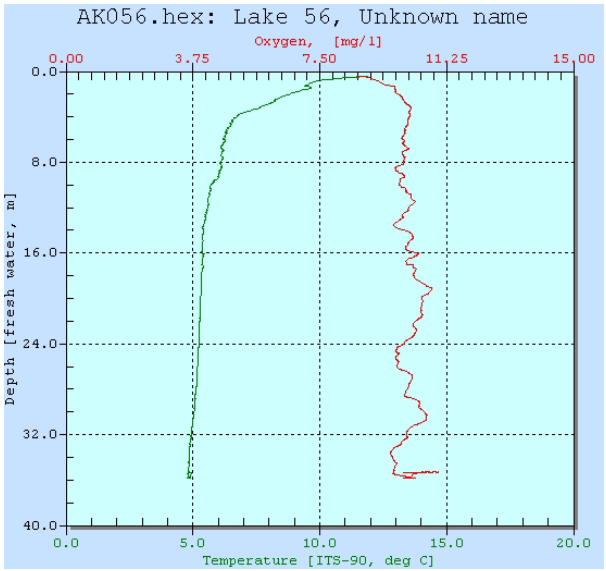
Results of in-situ and laboratory water chemistry, sediment metal, fish tissue, GIS, sediment diatom, zooplankton, and benthic macroinvertebrate analyses are summarized below. At the time of publication sediment mercury and *Enterococci* have not been provided by EPA. Physical habitat analysis, recently provided by EPA has not been evaluated.

Water chemistry; in-situ and laboratory

In- situ water sampling consisted of depth, temperature, dissolved oxygen (DO), pH, conductivity, photosynthetically active radiation (PAR), and fluorescence. State of Alaska Water Quality Standards (WQS) are generally met for temperature, pH and DO. Site 055 (Christiansen Lake) and 088 (Reed Lake) exhibited DO levels below state standards of 5 mg/L. Both lakes thermally stratified and the DO lag was observed in the hyplimnion (the bottom layer). Although Reed and Christiansen Lake are considered urban lakes due their road density the observed DO is generally considered naturally occurring and not a result of urbanization. Lake pH levels exceeded WQS at seven lakes. Sites 003, 014, 018, 039, 055, 057 and 058 exhibited pH levels either below 6.5 or greater than 8.5. The highest pH levels were recorded at site 018 (unknown name), a shallow remote lake in the northeast corner of the basin. This site recorded levels from 10.2 to 9.4; this is assumed to naturally occurring due to the lack of anthropogenic influences in the lake catchment. Incidentally lake 018 also exhibited the highest levels of total phosphorus and Chlorophyll-*a*. Although there are not currently WQS for conductivity, PAR and fluorescence we did not observe any values perceived to be anomalous.

Lake profiles were created for each lake. These profiles display temperature versus dissolved oxygen on a depth integrated scale. The examples below are site 55 (Christiansen Lake in Talkeetna), and site 56 (unknown lake on west side of Cook Inlet).





Two local commercial laboratories were used to analyze water samples. Both laboratories are NELAC certified and met QA/QC requirements. Results were compared at various categories: urban vs. remote, deep (>6m) vs. shallow (<6m) and all sites. One example of this comparison is below.

		Min Valid	Avg	Median	Max Valid	# of detects	# of lakes sampled
Total N / Nitrite-N (ug/L)	All	160	430	394	691	11	50
	Deep	160	487	396	961	9	31
	Shallow	*	*	*	*	1	19
	Urban	ND	ND	ND	ND	0	8
	Remote	160	455	395	961	10	42
Total Phosphorus (ug/L)	All	10.00	24.09	16.70	32.33	31	50
	Deep	10.00	16.82	16.10	33.19	14	31
	Shallow	10.80	28.32	16.70	27.40	17	19
	Urban	10.40	16.93	17.60	23.80	6	8
	Remote	10.00	24.61	15.40	32.20	25	42
Chlorophyll A (mg/M^3)	All	0.18	6.56	2.75	13.09	39	50
	Deep	0.18	4.04	1.61	7.36	24	31
	Shallow	0.28	10.02	3.58	12.10	16	19
	Urban	0.96	3.18	2.75	6.30	7	8
	Remote	0.18	7.12	2.58	13.42	33	42
*Only one sample had detectable levels, statistics were not calculated.							

Sediment metal analysis

Top and bottom sediment core results were combined to provide an overall representation of sediment conditions. Results were then compared with NOAA Squirt Table values. The NOAA values represent screening concentrations for inorganic media. TEL values are threshold effects level, the maximum concentration allowable for repeated exposure without producing adverse effects; PEL is the probable effect level, the minimum concentration likely to produce adverse effects. Median values of core samples are below NOAA Squirt Table background values, with the exception of Arsenic and Mercury. Arsenic median values are above the TEL as well. The high levels of Arsenic in this region are derived from natural weathering of soils and rocks. Studies of the Cook Inlet Basin public and domestic wells yield Arsenic water concentrations above EPA recommendations (Glass 2002). Mercury median values are above NOAA background levels but below TEL and PEL values. The primary sources of Mercury in Alaska are naturally occurring mineral deposits, rocks, volcanic eruptions, mining tailings and emissions, and coal incinerations. The majority of maximum values were detected at site 57, Rush Lake. Rush Lake is remote lake north of the Chugach Mountain Range. The maximum

values are considered to be naturally occurring as there were no observed anthropogenic influences.

					NOAA Squirt Table[1]		
	Median	Max	Min	# of detects	Background	TEL	PEL
Aluminum	240,000	300,000	770	77			
Arsenic	8.1	1400	0.95	85	1.1	5.9	17
Cadmium	0.325	2.4	0.089	50	0.1-0.3	0.596	3.53
Chromium	17	220	1.9	86	7.0-13.0	37.3	90
Copper	21	690	1.5	83	10-25.0	35.7	197
Iron	38,000	1,700,000	1300	85			
Lead	6.5	130	0.26	83	4.0-17.0	35	91.3
Lithium	18	170	2.4	85			
Manganese	620	58,000	26	86	400		
Mercury	0.135	2.7	0.0081	66	0.004-0.051	0.174	0.486
Nickel	14	210	0.66	80	9.9	18	36
Selenium	0.88	12	0.14	43	0.29		
Silver	0.21	0.26	0.13	7	<0.5		
Tin	0.32	1	0.096	5	5		
Zinc	59	430	4.1	79	7.0-38.0	123	315
All concentrations in ppm dry weight.							
1. Buchman, M.F., 2007. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle WA. Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.							

Fish tissue analysis

ADEC Environmental Health Laboratory skinned, filleted and homogenized the fillet for analysis of arsenic, cadmium, copper, lead, selenium and total mercury as part of the Fish Monitoring Program. The majority of fish had very low concentrations or below detection limits for arsenic, cadmium and selenium. The table below summaries the median levels of metals found during the survey. Current data from the Fish Monitoring Program indicate Alaskan seafood do not warrant concerns for consumption, the exception being women who are pregnant or can become pregnant and children under 12. All levels detected in the 2008 Cook Inlet Lakes Survey are below the World Health Organization recommendation for total mercury.

	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Lead, ppm	Selenium, ppm	Total Mercury, ppm
Median	0.12	ND	0.40	ND	0.20	0.084
Max	0.32	ND	0.54	ND	2.10	0.740
Min	0.08	ND	0.27	ND	0.08	0.016
# of detects	9	0	46	0	64	68
Results are based on wet weight.						

GIS analysis

Road density ranged from 0 (i.e., no mapped roads) at 39 lakes to 2.7 km of road per km^2 basin at Reed Lake (site 088). Basin perimeter ranged from 2.1 km (Shirley Lake, site 004) to 126.7 km (Coal Lake, site 052), with an overall average of 22.7 km. Basin area ranged from 0.2 km^2 (Goose Lake, site 077) to 343 km^2 (Coal Lake, site 052), with an average of 29 km^2. The lowest mean basin elevation was 35 m (site 068 on Kalgin Island), the highest was 1,227 m (site 029), and the average was 407 m. The lowest lake elevation was 15m (site 095), the highest was 1128 m (site029), and the average was 316 m. Mean annual precipitation ranged from 432 mm (sites 9, 25, 53, and 69, all near Lake Louise) to 2794 mm (site 096, Seldovia Lake) and averaged 873 mm.

Sediment diatom communities

In total, 50,520 diatom valves were identified. *Staurosirella pinnata* was the commonest diatom species, comprising 11.8% of all diatoms identified. Other common diatoms were *Staurosira construens* (7.3%), *Discostella pseudostelligera* (5.3%), *Staurosira construens* (5.1%), and *Pseudostaurosira brevistriata* (3.9%). Relative abundances of these diatoms were very similar between the top and the bottom of the sediment core. Taxa richness ranged from 10 to 85 in core bottoms and from 16 to 88 in core tops. Taxa richness in core tops was strongly correlated with that in core bottoms (R = 0.80), suggesting some continuity in diatom community structure over time.

Zooplankton communities

Zooplankton are data missing from some lakes due to lost sampling equipment. In total, 8,854 zooplankters were identified. Zooplankton abundance ranged widely, with a minimum of 8×10^{-5} organisms per liter to a maximum of 4.4 organisms per liter. Of all samples combined, the commonest taxa were Diaptomidae (37.2% of all individuals), *Microcyclops* (15.6%), *Daphnia longiremis* (10.5%), *Cyclops* (9.5%), and *Bosmina longirostris* (7.2%). Zooplankton were sparse in some samples due to the relatively small diameter of the Wisconsin net used to collect the earlier samples. Among 29 samples where zooplankton abundance met data quality objectives, taxa richness ranged from 2 (lakes 018, 029, and 053) to 8 taxa (lake 022, West Papoose).

Results were determined using the coarse (243µm) Wisconsin zooplankton net; the fine (80µm) was discarded nationally due to unexpected diversity.

Macroinvertebrate communities

A total of 27,418 macroinvertebrates were identified. Total abundance among the composite macroinvertebrate samples ranged from <400 (lake 084) to >16,000 (lakes 038 and 078, Vera and Kirschner, respectively). Total richness ranged from 12 (site 033, Little Kamishak Lake) to 39 taxa (site 025). Of all samples combined, true flies (Diptera) were the most common macroinvertebrate order, comprising 45.2% of all individuals. Worms (class Oligochaeta) were the second commonest group, comprising 15.2% of all individuals. Snails (group Baommatophora), scuds (order Amphopoda), and caddisflies (order Trichoptera) were also relatively common, each comprising ≥ 5% of total individuals.

Discussion

The mission of DEC's Division of Water is to improve and protect the quality of all Alaskan waters and under the Clean Water Act (CWA) Sections 303(d) and 305(b). Alaska has the responsibility to report and identify causes and sources of water quality impairment by "*characterizing the waters in Alaska*". One way the division carries out this mission is to monitor and report on water quality. The Alaska Monitoring & Assessment Program (AKMAP) fulfills this responsibility through stratified random sampling.

The 50 lakes surveyed represent 31% of the total lake numbers in the Cook Inlet Basin or 2,571 lakes, and 82% or 4,555 ha of the total lake surface area in the basin. The lakes sampled in this basin are considered healthy due to the lack of anthropogenic influences on the majority of lakes, minimal impacts from urbanization and results are considered to be within expected ranges for natural conditions.

Recommendations

AKMAP was implemented to assess and describe baseline condition and develop long term trends of Alaska's water resources. To meet these goals data collected from this study as well as other studies in this basin would be useful in guiding resource managers in the development of scientifically based decisions. The application of this data has proven to be valuable to other resource agencies as well; one example is the National Park Service utilizing dissolved organic carbon results as one input into a U.S. Geologic Survey model on methyl mercury susceptibility. Recommendations for future studies or in-depth analysis of existing data include:

- Correlations with the DEC 2007 Nutrient Criteria Study in the Matanuska-Susitna Valley, Matanuska-Susitna Borough Lake Monitoring Program, studies by

USGS, AK Department of Fish & Game, the ADEC Non-Point Source Program would be informative of the natural variability found seasonally and annually for many of the water quality parameters studied;

- Use of existing data for the development of cumulative distribution functions for nutrients, and in the development of background dissolved oxygen levels for lakes;
- Evaluation of physical habitat measurements;
- Evaluation of underlying geology of lakes in relationship with sediment metals data;
- Pursue lab techniques for low level nutrient analysis;
- Additional lake surveys incorporating targeted impacted sites to aid in the determination of the variability of reference condition;
- Once we receive sediment mercury and *Enterococci* data and complete evaluation this report will be updated;
- Completion of scientific technical report on 2008 Cook Inlet Lakes Survey.

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