

**HOMER SOIL & WATER CONSERVATION DISTRICT
&
COOK INLET KEEPER**

**Cook Inlet Citizens' Environmental
Monitoring Project
Annual Water Quality
Status Report**

OCTOBER 2000

Prepared by

**Joel Cooper
Research Coordinator
Cook Inlet Keeper**



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INTRODUCTION

Background

In 1996, Cook Inlet Keeper established its Citizens' Environmental Monitoring Program (CEMP) to actively involve citizens in collecting reliable water quality data in the Cook Inlet basin. With guidance from its Technical Advisory Committee, Keeper developed a Kachemak Bay Pilot Project as a working template that could be adopted by other groups interested in conducting citizen-based monitoring programs.

The Citizens' Environmental Monitoring Program has continued to show consistent growth. In 1998, Keeper formed a partnership with the Homer Soil & Water Conservation District to help support its citizen-based monitoring efforts. In 1999, 44 new volunteers were trained as monitors, and to-date over 220 citizens have been trained. Currently there are 36 active sites in and around Kachemak Bay, monitored by 34 active volunteers. On the Kenai River, nearly 60 volunteer monitors are working with the Kenai Watershed Forum, using Keeper's established monitoring protocols to collect water quality data.



Mike and Amy Stockburger learn to collect reliable water quality data.

In the summer of 1999, Keeper used the template developed through the Kachemak Bay Pilot Project to offer Citizen-Based Monitoring Support Services to other Cook Inlet communities. Keeper entered into an agreement with the Anchorage Waterways Council, Alaska Cooperative Extension, and the University of Alaska Anchorage's Environment & Natural Resources Institute, to maximize the unique resources of each group, and to facilitate citizen-based monitoring and assessment in the Anchorage Bowl. More recently, Keeper has begun working with the Wasilla Soil & Water Conservation District in a similar partnership to facilitate a citizen-based water quality monitoring program in the Mat-Su Valley. To date, these partnerships have facilitated training of at least 38 new volunteers and established 8 water quality monitoring sites in the Anchorage area and 6 sites in the Matanuska-Susitna Valley (Mat-Su).

Purpose and Scope

Cook Inlet Keeper (Keeper) is a 501(c)(3) nonprofit organization based in Homer, Alaska, which is dedicated to protecting the Cook Inlet watershed and the life it sustains. Because citizens are the true owners of public water resources, Keeper strives to involve them in hands on activities aimed at improving and protecting habitat and water quality, promoting resource stewardship, and establishing an environmental database for the Cook Inlet Basin. The objectives of Keeper's Citizens Environmental Monitoring Program are to:

- inventory baseline water quality in the waters of Cook Inlet Basin;

- detect and report significant changes and track water quality trends;
- raise public awareness of the importance of water quality through hands on involvement.

To promote these objectives Keeper has selected water quality parameters that will enhance understanding of overall environmental health and testing methods that have proven successful in citizen based programs throughout the United States.

Refinements in methods or additional testing parameters may be incorporated in this project in the future if it is determined that such changes would enhance efforts to achieve the project's goals; and assuming additional funding is available. Any such changes will be subject to review and approval by the project's Technical Advisory Committee, the U.S. EPA and Alaska Department of Environmental Conservation.

SAMPLING DESIGN AND METHODS

Sample Site Selection

In order to obtain useful baseline inventory and monitoring information, it is critical to select sampling sites which are representative of the various hydrologic, geographic, biologic, land use, and other conditions within the watershed. Because of the variability and distribution of human population densities in the Kachemak Bay area and the Cook Inlet region, an effort has been made to select sites which represent a balance between more impacted and less impacted areas. In the challenging climate of Southcentral Alaska, it was also necessary to select sites which are safely and reasonably accessible. Finally, to maintain volunteer involvement, it has been important to select monitoring sites in which volunteer team members have a personal interest.

To-date, Keeper volunteers have sampled water quality at a total of 82 estuarine and fresh water sites in the Kachemak Bay watershed and 2 sites on the west side of Cook Inlet (Figure 1). Keeper has also developed partnerships to provide training and support for other citizen-based water quality monitoring efforts around Cook Inlet. Keeper has worked with the Kenai Watershed Forum to establish 22 sites (17 currently active) in the Kenai River watershed. Through its partnerships with UAA's Environment and Natural Resources Institute, Alaska Cooperative Extension, the Anchorage Waterways Council, and the Wasilla Soil and Water Conservation District, Keeper has also helped to establish 8 sites in the Anchorage bowl and 6 sites in the Mat-Su Valley (Figure 2). This report focuses primarily on depicting data collected from the Kachemak Bay watershed.

Sampling Parameters and Collection Frequency

Testing parameters were selected based on their usefulness in inventorying water quality and projecting the general "health" of the water bodies in question. Due to cost concerns, only the more affordable sampling parameters have been selected to ensure the viability of long term monitoring. Primary sampling parameters include: water temperature, turbidity (clarity), pH, salinity, and dissolved oxygen; secondary parameters include: color, conductivity, oxidation-

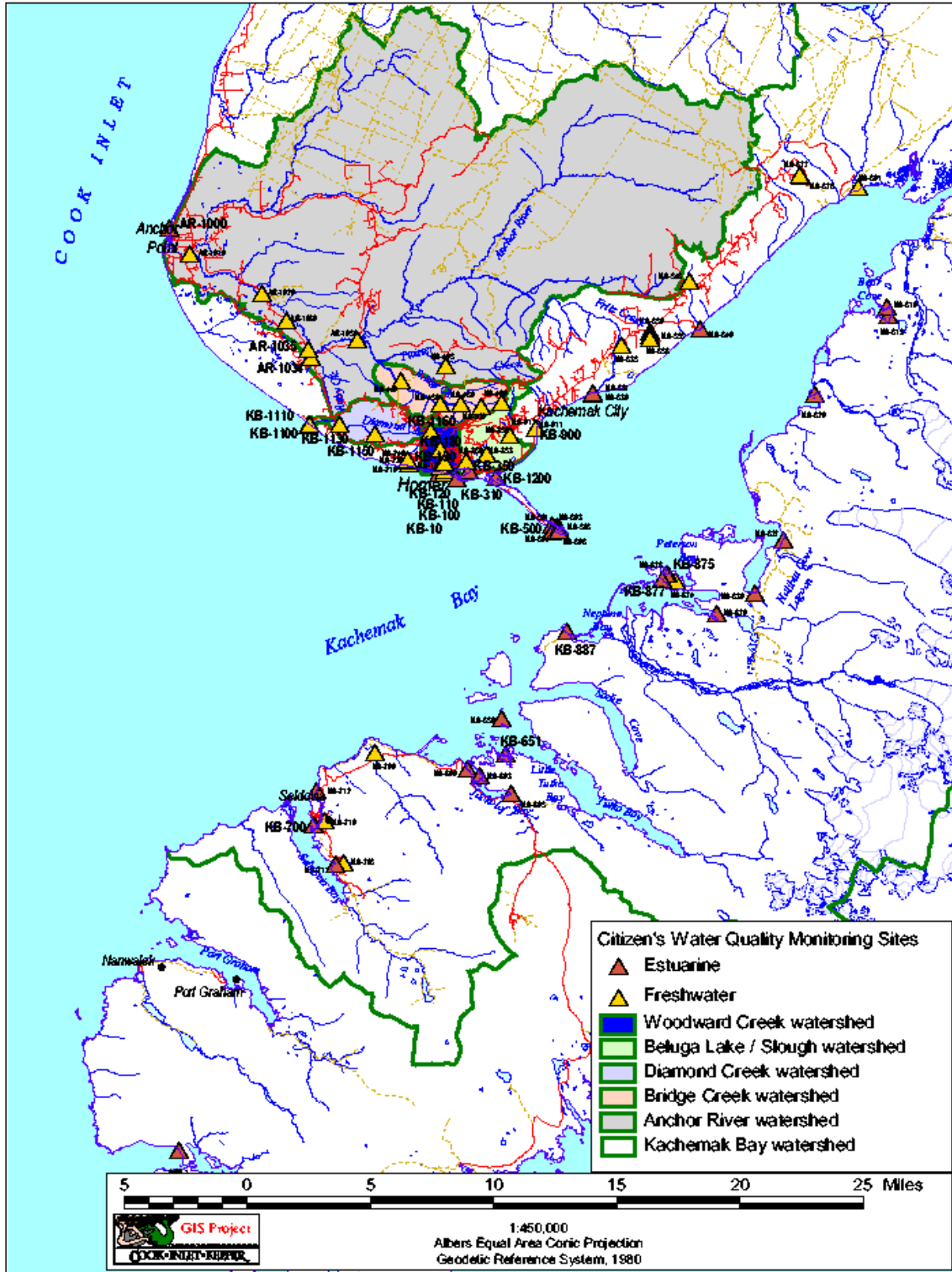
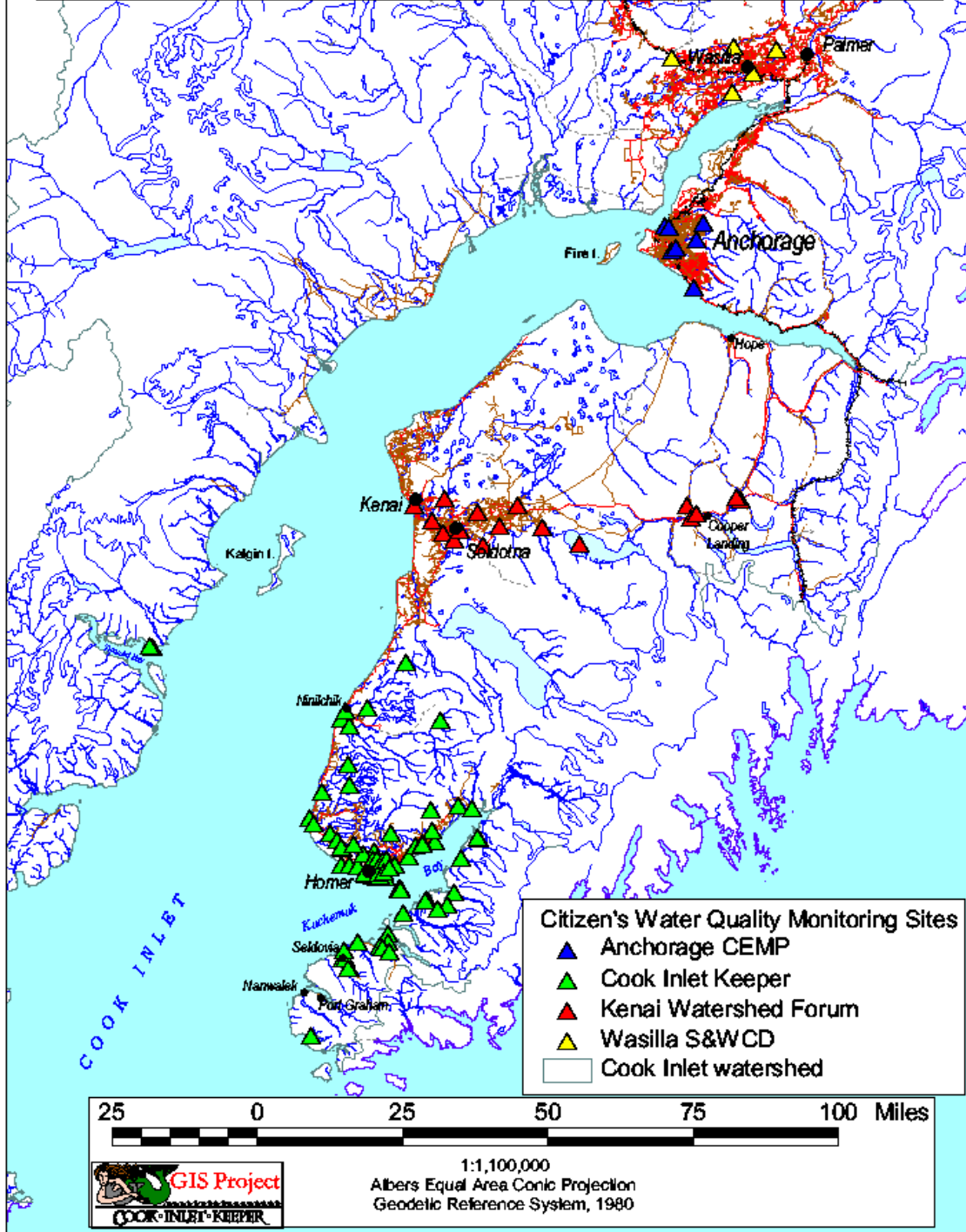


Figure 1. Citizen's water quality monitoring sites around Kachemak Bay

KEEPER SUPPORTED CITIZEN-BASED MONITORING IN COOK INLET



reduction potential, and screening test for nutrients (nitrate-nitrogen and ortho-phosphate), and bacteria (fecal and total coliform).

Surface water samples are taken at all monitoring stations monthly between September and April, and twice monthly from May through August for a total of 16 sampling events per site per year. The sampling period is designated as the last Sunday of each month (as well as the second Sunday of each month from May through August), plus or minus two days (i.e. Friday through Tuesday). The recommended time for sampling is 2:00 PM, and the time allowance range is from 1:00 PM to 5:00 PM, however, some sites need to adjust the sampling time according to the tides. Table 1 shows the frequency that site visits have occurred by weekday and time.

Table 1 Frequency of Site Visits by Weekday and Time

<i>Site ID</i>	(All Sites)							
<i>Data</i>	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Percent of Weekday	32%	13%	9%	9%	10%	11%	16%	100%
Count of Collection Date	267	106	79	73	87	95	135	842
Count of Collection Time	266	106	79	71	86	93	133	834
Max Collection Time	10:45 PM	11:20 PM	9:15 PM	9:52 PM	9:00 PM	7:55 PM	9:00 PM	11:20 PM
Min Collection Time	8:09 AM	7:30 AM	7:50 AM	7:00 AM	8:20 AM	7:30 AM	9:10 AM	7:00 AM
Average Collection Time	2:32 PM	2:27 PM	2:04 PM	2:25 PM	2:54 PM	2:01 PM	1:18 PM	2:15 PM

The impact of rain events on water quality is a factor considered in the Project. Monitors are asked to maintain a regular monitoring schedule regardless of precipitation and to document past and present weather conditions at the time of sampling. Given the climate of Southcentral Alaska some sites are not reasonably accessible on the appointed sampling date. Keeper staff try to reschedule samplings as weather allows, but since this is not always possible, a total of 12 sampling events per year at any one site is considered to be a complete set of data for that site.

General Sampling Procedures

Regular volunteer sampling in this program involves ambient measurements collected and processed in the field with the following possible exceptions: 1) the titration phase of the dissolved oxygen test (when necessary, DO samples may be collected and fixed on-site, then titrated within six hours after collection); 2) the bacteria screening test (coliscan plating and incubation is done off site up to 6 hours after collection, and the total Coliform and *E. coli* counting phases must be done 24 to 48 hours after plating), and 3) determination of nutrients (colorimetric tests for nitrates & phosphates may be performed up to 6 hours after collection). In the case of each of these parameters, sample temperature is maintained between +4°C to +10°C during storage.

Most volunteer monitors sample near shore stations or freshwater sites that have been established using GPS equipment and/or USGS 1:63,360 scale topographical maps. These sites are routinely located using recognizable natural features or nearby fixed structures. Preferably sites are located at easily identifiable features such as stream confluences or natural bends, bridges, piers, bulkheads, floats, jetties, docks, etc. In the case of estuarine waters, an effort has been made to locate sites where there is at least 3 meters of water at low tide. This preferred minimum water depth requirement allows a Secchi disk reading to be taken at almost any tidal stage. Unfortunately, requiring a strict minimum depth is not always feasible in the dynamic waters of Cook Inlet. Because of the limited number of accessible spots, and because consistency is also related to convenience, a number of near shore stations have been, and will continue to be sampled by wading-in from shore. The disadvantages are that Secchi disk readings cannot be taken (turbidity tubes are used in shallower water); and that these typically shallower inter-tidal areas can be more dynamic than sub-littoral areas and thus harder to characterize until large amounts of data can be collected over considerable time. The advantage is that at near shore stations, both shallow and inter-tidal and sub-littoral areas, can be close to important habitat zones and food sources for freshwater and marine organisms.



Willy Dunne collects a water sample at his monitoring site on McNeil Creek (KB-535).

Water samples are collected using a 2 1/2 - gallon plastic bucket with an attached cord if necessary. Volunteers are instructed to rinse the bucket (and all testing containers) three times with water from their site before taking the sample to be tested. Water quality testing is then performed on the sample in the bucket. While data quality for some parameters might benefit from in situ testing, the bucket method is used in the interest of volunteer safety. Sampling equipment and methods, as well as data quality objectives for sensitivity, precision and accuracy are outlined in Table 2.

Table 2: Data Quality Objectives

Parameter	Method/Range	Units	Sensitivity (a)	Precision	Accuracy	Calibration Method
Temperature	Thermometer -5.0 to +50.0°C	Degrees Celsius (°C)	0.5°C	±1.0°C (b)	±0.5°C (b)	NIST Certified Thermometer
	Hanna Meter 0.0 to 60.0 C	Degrees Celsius (°C)	0.1 C	±0.5 C (c)	±0.5 C (c)	NIST Certified Thermometer
pH	pH Octet Comparator (Wide-Range) 3.0 to 10.0 units	Standard pH units	0.5 units	±0.6 units (b)	±0.4 units (b)	Checked against Hach pH Meter
	pH Octet Comparator (Narrow-Range) 7.2 to 8.6 units	Standard pH units	0.1 units	±0.3 units (b)	±0.2 units (b)	Checked against Hach pH Meter
	Hanna pH Tester 0.0 to 14.0	Standard pH units	0.1 units	±0.2 units (c)	±0.2 units (c)	Standard Solutions Method
	Hach Model 5005 Electrometric Method -2.00 to 19.99 pH units	Standard pH units	0.01 units	±0.02 units	±0.05 units	Standard Solutions Method
Dissolved Oxygen	Micro Winkler Titration 0 to 20 mg/l	Milligrams per liter (mg/l)	0.1 mg/l	±0.9 mg/l (b)	±0.3 mg/l (b)	Checked against LaMotte DO Meter
	LaMotte Model DO 4000 0 to 19.99 mg/l	Milligrams per liter (mg/l)	0.1 mg/l	±0.05 mg/l	±0.1 mg/l	Saturated air calibration
Salinity	Hydrometer 0 to 42 ppt (1.0000 to 1.0700 SG)	Parts per thousand (ppt)	0.1 ppt (0.0005 specific gravity)	±1.0 ppt (b)	±0.82 ppt (b)	Standard Solutions Methods
Limit of Visibility	Secchi Disk Depth 0 to 30 m	Meters (m)	0.5 m	NA	NA	Line markings checked w/tape
Turbidity	Turbidity 0 to 200 JTU	Jackson Turbidity Units (JTU)	5 JTU	±3 units (c)	±3 units at 0 - 200 JTU (c)	Checked against LaMotte meter
	LaMotte Model 2020 0.00 to 100 NTUs	Nephelometric Turbidity Units	NTU Report to Nearest 0 to 1.0 then 0.05NTU 10 to 40 then 1NTU 40 to 100 then 5NTU 100 to 400 then 10NTU 400 to 1000 then 50NTU over 1000 then 100NTU	±2% for readings below 100 NTUs ±3% above 100 NTUs	±2% for readings below 100 NTUs ±3% above 100 NTUs	Standard Solutions Method
Conductance	Hanna TDS Meter (Total Dissolved Solids) 0 to 1999 microS/cm	Micro-Siemens/cm (µS/cm) (converted to 25 C)	1.0 x 10 ⁻⁶ S	±0.5 units (c)	2% full scale (c)	Standard Solutions Method
Oxidation- Reduction Potential	Hanna ORP Meter -1000 to +1000mV	Millivolts	1.0 mV	±0.5 units (c)	±5.0 mV (c)	Standard Solutions Method
Apparent Color	Compare to color chart 147 standard colors	Color index number	1 to 2 Color Numbers	NA	NA	Checked against Hach Spectrophotometer
	Hach Spectrophotometer Platinum-Cobalt Method 0-500 PC units	Platinum-Cobalt Units	NA	NA	NA	Standard Solutions Method
Nitrate-Nitrogen	Zinc reduction (Colorimetric) 0 to 15 ppm (15.0mg/L)	ppm (mg/L)	1.0 ppm	±0.5 ppm (c)	±0.5 ppm (c)	Standard Solutions Methods
Ortho-Phosphate	Ascorbic acid reduction (Colorimetric) 0 to 4 ppm (0 to 4.0mg/L)	ppm (mg/L)	0.2 ppm	±0.5 ppm (c)	±0.5 ppm (c)	Standard Solutions Methods
Coliforms (Total & E. coli)	Chromogenic agents in medium, detects E. coli & total coliform 0 to 60 CFU	Number of colony forming units (CFU) per 100 ml	1 CFU	NA	NA	Send water sample split to EPA/ADEC Certified Lab

NA = not available

- (a) Determined by the increments measurable with the stated method reflecting estimation where allowed.
- (b) Data taken from the Quality Assurance Project Plan for Friends of Casco Bay, 1995, p. 21; based on data taken from EPA Volunteer Water Monitoring: A Guide for State Managers, 1990, EPA 440/4-90-010, p. 39; and the Quality Assurance Project Plan for the Chesapeake Bay Citizen Monitoring Program, Section 5, p. 2.
- (c) Data taken from the manufacturer's instruction manuals.

Analytical Methods

Primary parameters (water temperature, turbidity, pH, salinity, & dissolved oxygen) are measured using standard EPA approved procedures and/or methods which are in use by established citizens volunteer monitoring programs (e.g., Friends of Casco Bay's Citizen's Water Quality Monitoring Program and Texas Watch's Volunteer Environmental Monitoring Program). Each of these procedures, as well as those used in measuring secondary parameters, is taken from the Volunteer Estuary/Lake/River/Stream Monitoring: A Method's Manual series published by U.S. EPA. All methods used are consistent with those recommended by the test kit manufactures (LaMotte, Hanna, Hach and Micrology Laboratories).

Water Temperature

Water temperature is tested using two separate instruments:

- 1) Armored alcohol-filled thermometer factory calibrated against thermometer standards traceable to N.I.S.T. (The National Institute of Standards and Technology); Model 545; range -5.0°C to $+45.0^{\circ}\text{C}$ in 0.5°C increments -- LaMotte Chemical Products; Cat. No. 1066.
- 2) Hanna "4-in-1" Water Test Meter; wide range 0.0°C to 60.0°C units in 1.0°C unit increments; accuracy $\pm 0.1^{\circ}\text{C}$ -- Hanna Instruments EN 50081-1.

Turbidity

Water clarity is tested by one or both of the following means:

- 1) Water with a depth of greater than 3 meters is tested using a 20 cm diameter Secchi disk with black and white quadrants attached to a 30 meter calibrated stretch-resistant line marked at 0.5 meter intervals -- LaMotte Chemical Products; Cat No. 0171-CL.
- 2) Shallower water is tested using turbidity columns (Jackson Turbidity Tube with 25ml/50ml levels noted); range 0 JTU to 200+ JTUs in 5 JTU increments; accuracy ± 3 Jackson Turbidity Units (JTUs) -- LaMotte Chemical Products Cat No. 7519 and Standard Turbidity Reagents; Cat No. 7520



Lynn Spence and Toby Tyler brush up on their testing procedures during an annual re-certification

pH

pH is tested and verified in both of the following ways:

- 1) Octet color comparator test kits; wide range 3.0 to 10.0 pH units in 1.0 unit increments and narrow range 7.2 to 8.6 pH units in 0.2 unit increments; accuracy ± 0.2 pH units -- LaMotte Chemical Products; Cat. Nos. 2117/P-3100 (3.0 to 10.0 units) and 2110/P-CR (7.2 to 8.6 units).
- 2) Hanna "4-in-1" Water Test Meter; wide range 0.0 to 14.0 pH units in 0.1 unit increments; accuracy ± 0.2 units -- Hanna Instruments EN 50081-1.

Salinity (estuarine sites only)

Specific gravity/salinity is tested using a LaMotte hydrometer with 500-ml hydrometer jar; range 1.0000 to 1.0700 specific gravity in 0.0005 increments (0 to 42ppt salinity) – LaMotte Chemical Products; Cat. Nos. 3-0011 (hydrometer) and 3-0024 (jar). LaMotte 1.000/1.070.

Dissolved Oxygen

Volunteers use precision dissolved oxygen two phase (fixation and titration) test kits; azide modification of Winkler titration method; range 0 to 20 mg/l in 0.1 mg/l increments; reagents sufficient for 25 tests at 0 to 20 mg/l range -- LaMotte Chemical Products; Cat. No. 5856/XDO.

Color

Water color is monitored by describing the apparent color of sample water and comparing the color to numbered color chips in the Borger Color System booklet – LaMotte Chemical Products; Cat. No. 1580

Conductivity

Hanna “4-in-1” Water Test Meter; range from 0 to 1999 micro-seimens/cm in 1 micro-seimens/cm increments; accuracy $\pm 2\%$ full scale units – Hanna Instruments EN 50081-1.

Oxidation-Reduction Potential

Hanna “4-in-1” Water Test Meter; wide range -1000 mV to +1000 mV in 1 mV increments; accuracy ± 5 mV – Hanna Instruments EN50081-1.

Nitrate-Nitrogen

Volunteers use a two tablet reagent Octa-Color Slide system to screen for nitrate-nitrogen from 0 to 15ppm (0 to 66ppm as nitrate) – LaMotte Chemical Products; Cat. No.3354.

Ortho-Phosphate

Monitors use ascorbic acid reduction and an Octet Comparator to screen for ortho-phosphate from 0 to 2.0ppm – LaMotte Chemical Products; Cat. No. 3121.

Fecal and Total Coliform Bacteria

Analysis is conducted using the Coliscan screening technique developed by Micrology Laboratories.¹ This method is currently in use by a number of volunteer monitoring organizations (e.g., Washington State Dept. of Ecology, Lower Colorado River Authority-River Watch, Global River Environmental Education Network, Indiana Dept. of Natural Resources-River Watch).

Method References

Table 3 references the methods used for each testing parameter. Most methods used in this Project are traceable to EPA-approved or EPA recommended methods.

¹ Micrology Laboratories LLC. 1996. Coliscan™Easygel™- *Procedures & Detection of Waterborne Coliforms and Fecal Coliforms*, 6p. RCS, Goshen, Indiana

Table 3: Methods Reference

Parameter	Method	Reference	Modification
Temperature	Thermometer	(a)	Alcohol-filled thermometer
	Electrometric	(b)	
pH	Colorimetric	(c)	
	Electrometric (Hanna)	(b)	
	Electrometric (Hach)	(d)	
Dissolved Oxygen	Azide Modified Winkler Titration	(e)	Micro method; 60 ml bottle
	Electrometric	(f)	
Salinity	Gravimetric	(g)	
Turbidity (Clarity)	Secchi Disk Depth	(h)	
	Jackson Turbidity	(c)	
	Electrometric	(i)	
Conductance	Electrometric	(b)	
Oxidation-Reduction Potential	Electrometric	(b)	
Apparent Color	Borger Color System	(c)	
Nitrate-Nitrogen	Colorimetric	(c)	
Ortho-Phosphate	Colorimetric	(j)	
Fecal Coliforms (Total & <i>E. coli</i>)	“Coliscan”	(k)	

- (a) U.S. EPA. 1979 (revised 1983). Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Method 170.1. Environmental Monitoring and Support Laboratory, Cincinnati, OH. ***In*** The Friends of Casco Bay. 1995 Quality Assurance Project Plan. Pg. 15. Friends of Casco Bay, South Portland, ME.
- (b) Hanna Instruments. 1996. The Water Analysis Handbook. Hanna Instruments, Woonsocket, RI. ***And*** manufacturer’s instructions.
- (c) Campbell, G. & Wildberger, S. 1992. The Monitor’s Handbook. LaMotte, Chestertown, MD.
- (d) Eaton, A., Clesceri, L., & Greenberg, A. (Editors). 1995. Standard Methods for Examination of Water and Wastewater, (19th Edition). American Public Health Association, Washington, D.C. Method 2580-B.
- (e) Eaton, A., Clesceri, L., & Greenberg, A. (Editors). 1995. Standard Methods for Examination of Water and Wastewater, (19th Edition). American Public Health Association, Washington, D.C. Method 4500-0C. ***And***, Campbell, G. & Wildberger, S. 1992. The Monitor’s Handbook. LaMotte, Chestertown, MD.
- (f) Eaton, A., Clesceri, L., & Greenberg, A. (Editors). 1995. Standard Methods for Examination of Water and Wastewater, (19th Edition). American Public Health Association, Washington, D.C. Method 4500-0G. ***And***, Campbell, G. & Wildberger, S. 1992. The Monitor’s Handbook. LaMotte, Chestertown, MD. ***And*** manufacturer’s instructions.
- (g) U.S. EPA. 1993. Volunteer Estuary Monitoring: A Methods Manual. EPA-842-B-93-004. USEPA, Washington, D.C. ***And***, Campbell, G. & Wildberger, S. 1992. The Monitor’s Handbook. LaMotte, Chestertown, MD.
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- (i) Eaton, A., Clesceri, L., & Greenberg, A. (Editors). 1995. Standard Methods for Examination of Water and Wastewater, (19th Edition). American Public Health Association, Washington, D.C. Method 2130-B. ***And***, Campbell, G. & Wildberger, S. 1992. The Monitor’s Handbook. LaMotte, Chestertown, MD. ***And*** manufacturer’s instructions.
- (j) U.S. EPA. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA-841-B-97-004. USEPA, Washington, D.C. ***And***, Campbell, G. & Wildberger, S. 1992. The Monitor’s Handbook. LaMotte, Chestertown, MD. ***And*** manufacturer’s instructions.
- (k) Micrology Laboratories, LLC. 1996. Coliscan® for Coliform and Fecal Coliform Testing. Micrology Laboratories, Goshen, IN.

TRAINING

Volunteer monitor training involves five phases. The volunteer begins monitoring after the completion of the first three phases, with phase III being conducted on site. Each volunteer must also attend an annual re-certification (phase IV). To become a Certified Monitor Trainer a



Laura Eldred, Barbara Wild, Catherine Moncrief, Bill Sobers, and Sabrina Peterson at a phase V workshop in Anchorage.

monitor can attend a two-day workshop (phase V) that teaches experienced monitors, and leaders of local organizations to design and run their own volunteer water quality monitoring programs coordinated with the Cook Inlet Keeper CEMP.

In 1999, 44 people went through at least one phase of monitor training. Of those, seven became certified monitor trainers, 22 are active volunteer monitors, and four were interns working with Cook Inlet Keeper. Of the remaining 11, two have moved from the area, and the other nine either dropped out of the training or completed training, but have not yet begun monitoring. In addition, six monitors were re-certified in 1999.

DATA MANAGEMENT

Cook Inlet Keeper has worked with the Anchorage Waterways Council and HDR Alaska, Inc to create the Citizens' Environmental Monitoring Program (CEMP) database. This relational MS Access database is designed to store and compute observational data, store and track volunteer training records and schedules, and track and maintain monitoring equipment and chemical reagents. It provides project officers, quality assurance officers and quality control coordinators with an efficient management tool that will help assure high quality data, efficient training and re-certification of volunteer monitors and timely replacement of chemical reagents and monitoring supplies. The database is also designed to calculate the raw data entered and print out summary reports by monitoring site. It will not accept data that is out of the expected range for a parameter.



Kachemak Bay Monitoring Coordinator, Tom Wallace, enters data into the database.

In the future, the CEMP database will be posted on Cook Inlet Keeper's web site (<http://www.inletkeeper.org>) the partnering groups will merge their data to make all volunteer

collected data available to government agencies, volunteer monitors and the general public. Project officers, quality assurance officers and quality control coordinators will be provided passwords to access the database for data entry, editing, and general database maintenance. Data will be available to all users for down loading and use. In addition the data will be put into EPA's STORET database. The new, modernized STORET is EPA's principal repository for marine and freshwater ambient water quality and biological monitoring information.



Alexie Basargin records observations at his monitoring site on nahodka creek, a tributary in the anchor river watershed.

DATA ANALYSIS

OVERVIEW OF COLLECTED DATA

As of April 2000, a total of 842 field observations had been made in the Kachemak Bay and Anchor River watersheds (Table 4). Over half (52.5%) of the observations were made at freshwater sites, while 47.5% were made at estuarine sites.

Table 4. Percent Total and Total Number of Observations by Site Type

	Estuarine	Freshwater	Total
Percent total of Observations	47.5%	52.5%	100%
Number of Observations	400	442	842

Table 5 shows the number of observations by parameter and site type. Observations by parameter may vary from the total number of collection dates (site visits) for the following reasons: the information was not collected; the parameter was not being measured for a given site type; the measurement was discontinued, data did not meet data quality objectives; equipment failure.

TABLE 5. TOTAL NUMBER OF OBSERVATIONS BY PARAMETER AND SITE TYPE

	Estuarine	Freshwater	Total
Count of Collection Date	400	442	842
Count of BCS# (25ml) Water Color Observations	365	388	753
Count of BCS# (50ml) Water Color Observations	262	309	571
Count of Turbidity Observations	355	407	762
Count of Water Temp Observations	385	432	817
Count of DO Observations	373	416	789
Count of Saturation Observations	373	414	787
Count of Salinity Observations	359	141	500
Count of Conductivity Observations	368	405	773
Count of ORP Observations	369	411	780
Count of Hanna Meter pH Observations	346	374	720
Count of Colorimetric pH Observations	384	425	809
Count of OrthoPhosphate Observations²	252	324	576
Count of Nitrate-Nitrogen Observations²	247	334	581
Count of 1ml Coliform (cfu/100ml) Observations³	163	214	377
Count of 3ml Coliform (cfu/100ml) Observations^{3, 4}	83	82	165
Count of 5ml Coliform (cfu/100ml) Observations³	139	202	341
Count of 1ml EColi cfu/100ml)³	161	214	375
Count of 3ml EColi (cfu/100ml) Observations^{3, 4}	85	83	168
Count of 5ml EColi (cfu/100ml) Observations³	139	202	341

Comparison of Site Types by Parameter

The analysis presented here shows the maximum, minimum and average readings for each parameter by site type. The averages are for all observations, although seasonal variations may exist and averages could be more weighted to the summer season due to the increase in sampling frequency. When possible, data was plotted over time and compared to state water quality standards.

Temperature

Temperature is a controlling factor for aquatic life: it controls the rate of metabolic activities, reproductive activities and therefore, life cycles (Murdoch and Choe, 1999). While temperature may be one of the easiest measurements to perform, it is also one of the most important parameters we test because it dramatically affects the rate of chemical and biological reactions within the water (Cook Inlet Keeper, 1998).

² Began collecting observations for this parameter in March 1997.

³ Began collecting observations for this parameter in June 1997.

⁴ Discontinued this dilution in Beginning January 1999.

There were five temperature measurements that exceeded state water quality standards. All were at KB-310, Beluga Slough Outflow. The maximum water temperature readings for each site type were 24.5° C at KB-310 (estuarine) and 20° C at KB-912 (freshwater) (Figure 3). Minimum temperatures were -2.0° C at KB-1200 (estuarine) and -1.1° C at KB-470 (freshwater). The average temperature readings for estuarine and freshwater sites were 8.8° C and 6.1° C respectively. Figure 4 shows seasonal temperature variations at selected monitoring sites.

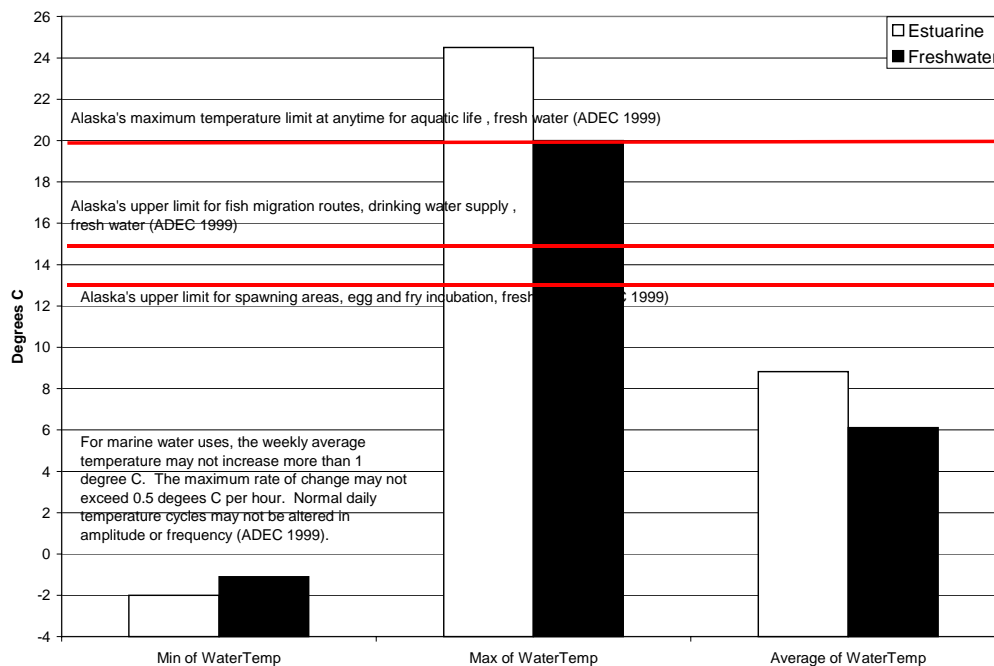


Figure 3. Minimum, maximum and average temperature readings at estuarine and freshwater sites

Dissolved Oxygen

Like land organisms, aquatic animals need dissolved oxygen (DO) to live. Fish, invertebrates, plants and aerobic bacteria all require oxygen for respiration. The amount of oxygen required varies according to species and stage of life. DO levels below 3 mg/l are stressful to most aquatic organisms. DO levels below 2 or 1 mg/l will not support fish: levels 5 to 6 mg/l are usually required for growth and activity (Campbell and Wildberger, 1992).

Most all the dissolved oxygen readings taken by volunteer monitors fell within healthy limits, although there were some measurements that were below state water quality standards (Figure 5). There were four readings that fell below the 7.0 mg/l state standard for fresh water. Two readings of 5.8 and 5.6 mg/l at KB-555, a 6.4 mg/l reading at KB-556, and a 5.5 mg/l reading at KB-912. One estuarine site, KB-1200, fell below the marine state standard of 5.0 mg/l with a reading of 4.4 mg/l. No site exceeded the state standard of 17.0 mg/l. The average DO for estuarine sites was 10.1 mg/l and 11.2 mg/l for freshwater sites. Figure 4 shows how dissolved

oxygen readings tend to vary with season and temperature with higher concentrations corresponding with lower temperature readings.

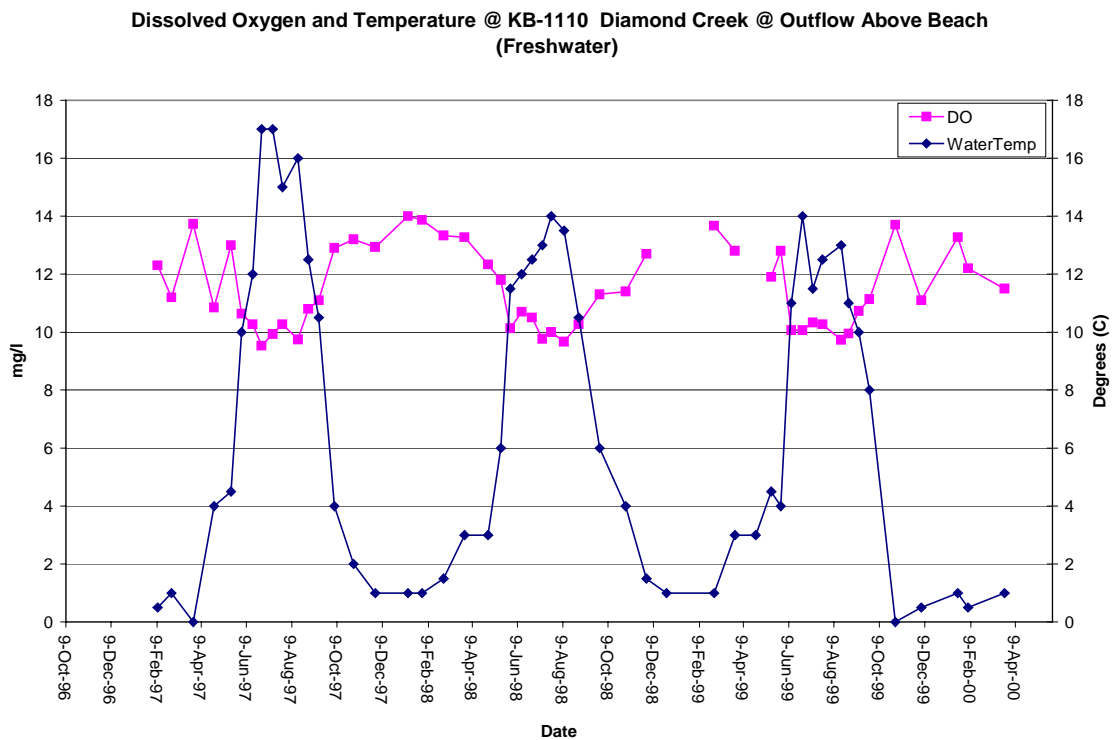
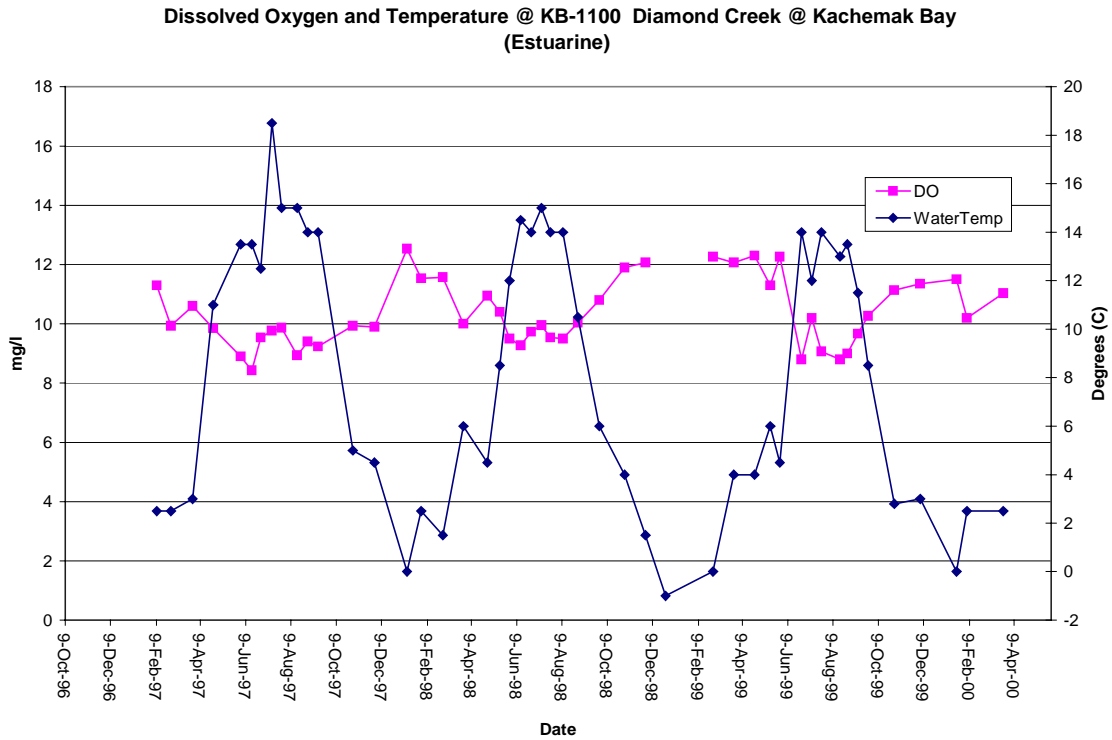


Figure 4. Dissolved oxygen and temperature readings at selected volunteer monitoring sites from February 1997 to April 2000

Dissolved oxygen levels may also be viewed in terms of "percent saturation" or the percent of the potential capacity of the water to hold oxygen that is present. Percent saturation can serve as a "scorecard" for oxygen levels on a scale of 0 to 100% of the potential level. However, high percent saturation can occur even at low DO levels, and living organisms require specific minimum levels of dissolved oxygen to survive (Campbell and Wildberger, 1992).



Miranda Weiss measures dissolved oxygen during annual recertification.

Percent saturation readings exceeded state water quality standards 23 times, 4 times at fresh water sites (KB-555 twice, and one time each at KB-556 and KB-912), and 19 times at estuarine sites, with the highest measurement of 135.7% occurring at KB-310 (Figure 6). Standards were exceeded six times at KB-310, 5 times at KB-700, 4 times at KB-1200, 2 times at KB-350, and one time each at KB-651 and KB-711. The average % saturation was 87.6% at estuarine sites and 90.6% at fresh water sites. The lowest readings were 53.4% and 40.6% at fresh water and estuarine sites respectively.

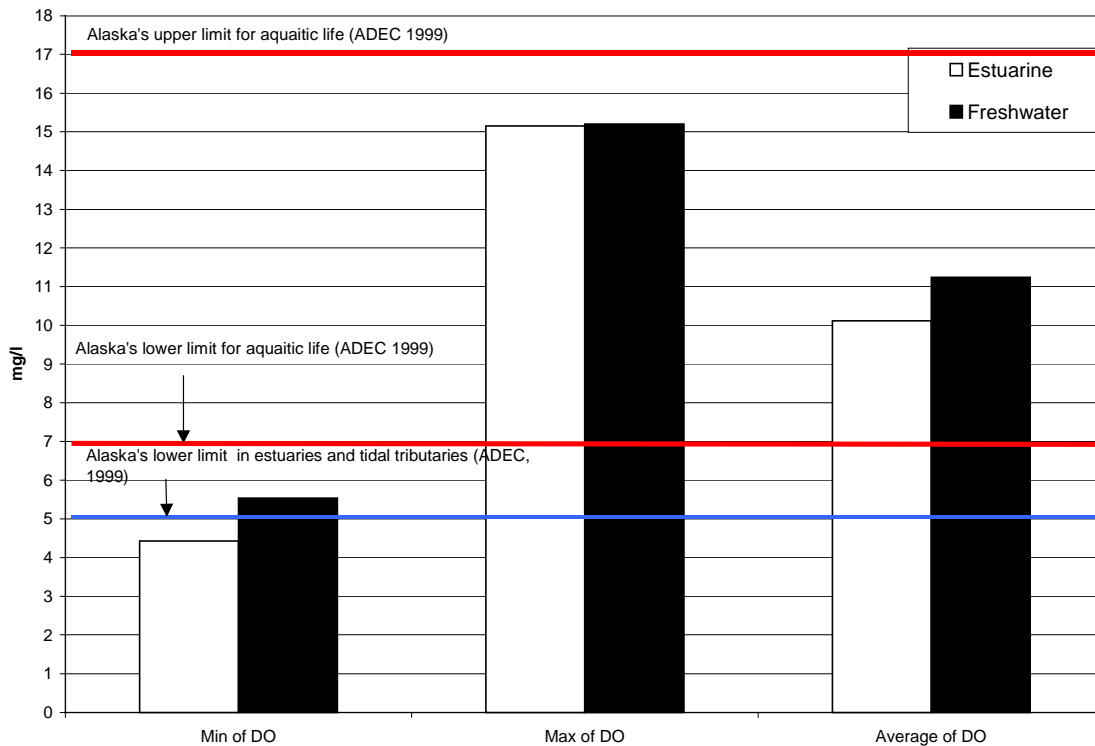


Figure 5. Minimum, maximum and average dissolved oxygen readings at estuarine and freshwater sites

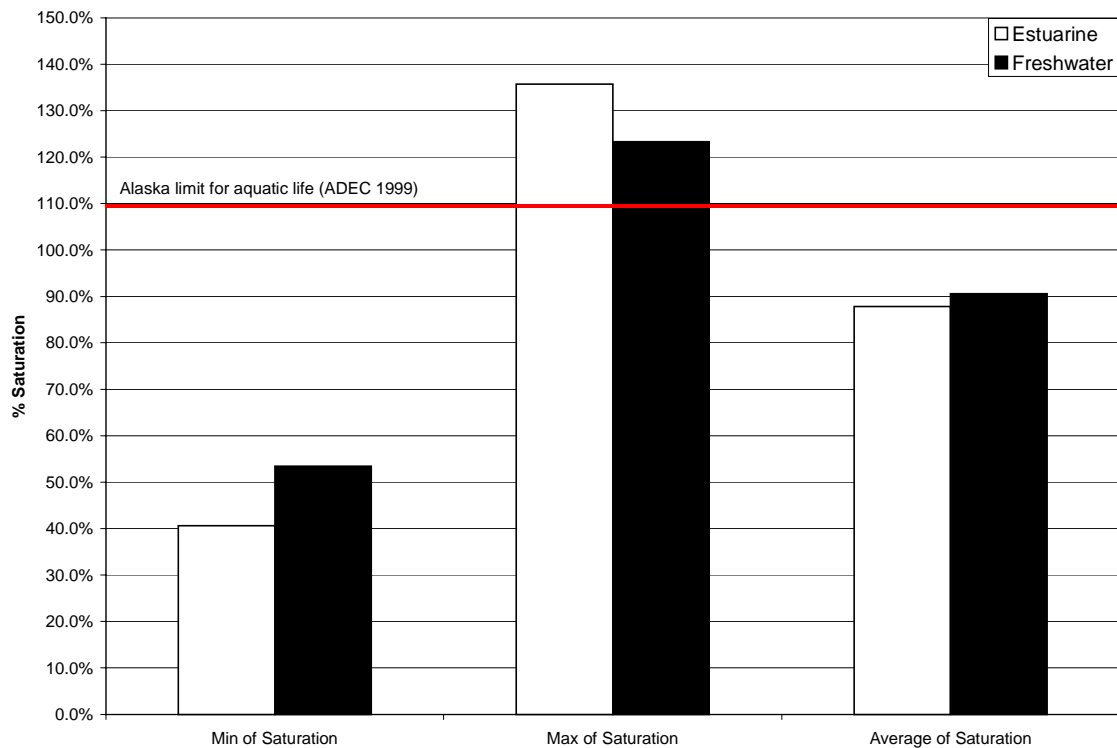


Figure 6. Minimum, maximum and average % saturation readings at estuarine and freshwater sites

Turbidity

Turbidity, or water clarity, is a measurement that pulls together many important features of an aquatic system. Turbidity is caused by suspended solid matter which scatters light passing through the water. Any material mixed and suspended in water will reduce its clarity and make the water turbid (i.e. muddy and cloudy). Such materials can come from many sources. In early spring, the water may become more turbid as silt is carried into the estuary with the spring thaw and run-off. At any time of year, silt-laden surface water can flow into the estuary from tributaries and storm drains during periods of heavy rain and associated runoff (Cook Inlet Keeper [Volunteer Training Manual], August 1998).



Turbidity readings ranged from 0 JTUs to >200 JTUs (outside range of the method) for both site

types (Figure 7). For data that was >200 JTUs the value of 210 was entered. It is difficult to determine the relationship between turbidity readings and state standards for freshwater sites because the standards are described in relation to natural conditions. Figure 8 shows seasonal variation of turbidity readings. Turbidity readings at estuarine sites taken from the beach exceed the marine state standard for turbidity more frequently than the sites from docks and open water (see Figure 8, sites KB-1200 and KB-651), which may be due to wave disturbance at the sampling location. The average turbidity readings were 27.0 (estuarine) and 19.3 (freshwater).

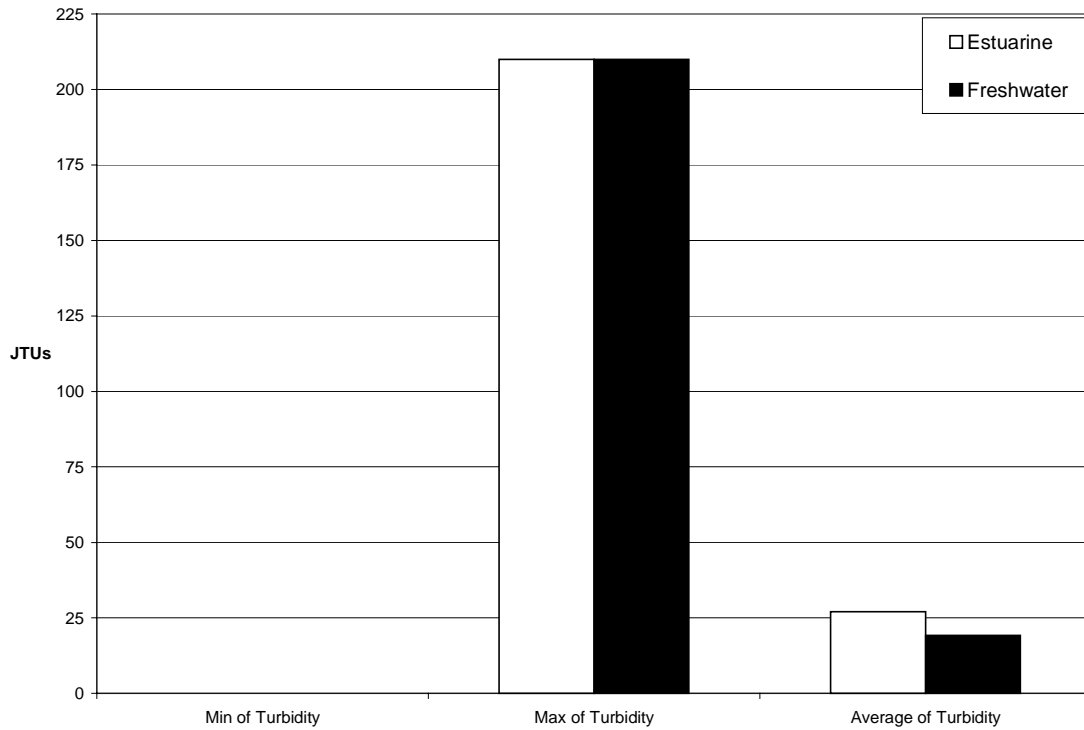


Figure 7. Minimum, maximum and average turbidity readings at estuarine and freshwater sites

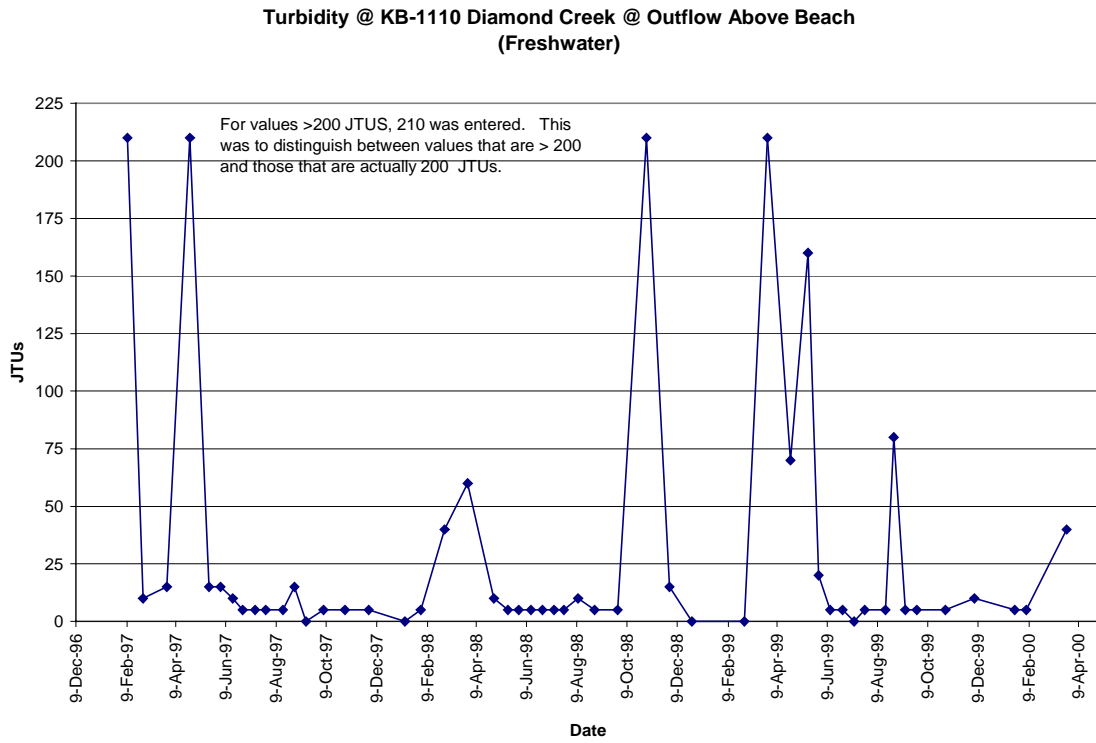
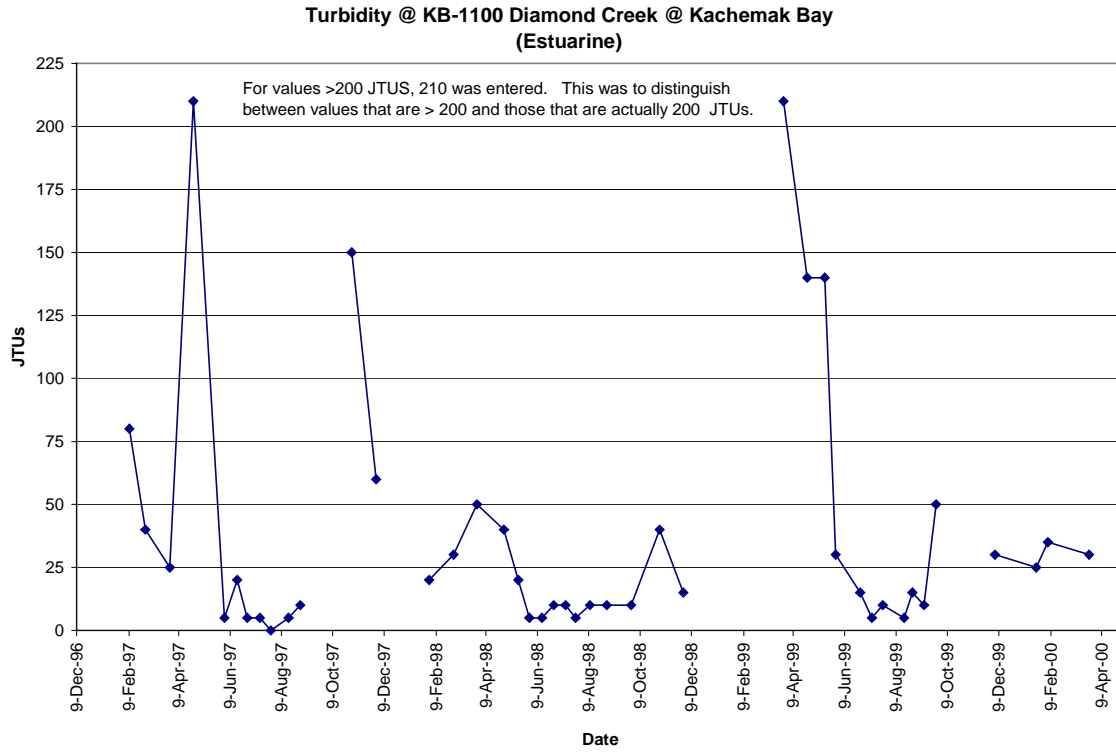


Figure 8. Turbidity measurements at selected volunteer monitoring sites from February 1997 to April 2000

Salinity

Perhaps the most important aspect of an estuary's salinity gradient is its effect on the distribution and well-being of the biological population that inhabits the area. Some species of fish, such as salmon, require the fresh water portion of the estuary to spawn, but live the rest of their lives in the marine portion. Some organisms are extremely tolerant of the changes in salinity and are found everywhere from the open sea to waters with only the slightest tinge of salt. Sessile (immobile) bottom-dwellers such as butter clams are tolerant of salinity variations, but salinity does affect their growth and spawning (Cook Inlet Keeper [Volunteer Training Manual], 1998). It is therefore important to get an understanding of the estuary's natural salinity backgrounds.

Salinity is tested at estuarine sites using a hydrometer to measure specific gravity. The specific gravity and water temperature readings are then entered into the database, which calculates salinity with the following expression:

$$\text{Salinity} = -1242.39 + 1241.726 * (\text{specific gravity reading}) - 3.69946 * (\text{water temperature reading}) + 0.00771211 * (\text{water temperature reading})^2 + 3.62136 * (\text{specific gravity reading}) * (\text{water temperature reading})$$

The maximum salinity reading was 38.6 ppt at KB-310 (Figure 9). There were 4 readings below the estimated detection limit of this method of 0. The average salinity at estuarine sites was 17.0 ppt. Figure 10 shows salinity compared to state standards at selected volunteer monitoring sites.

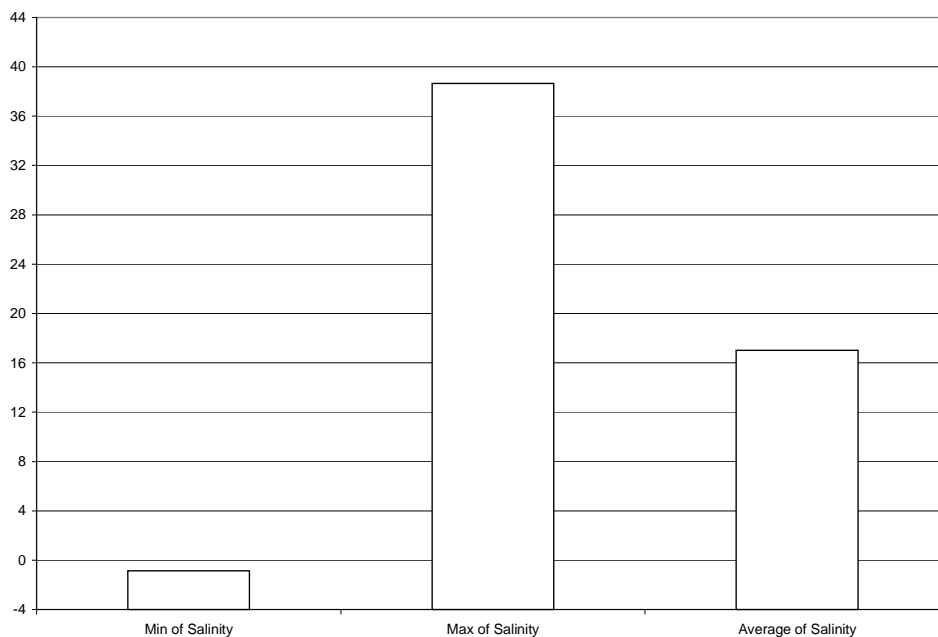


Figure 9. Minimum, maximum, and average salinity readings at estuarine sites

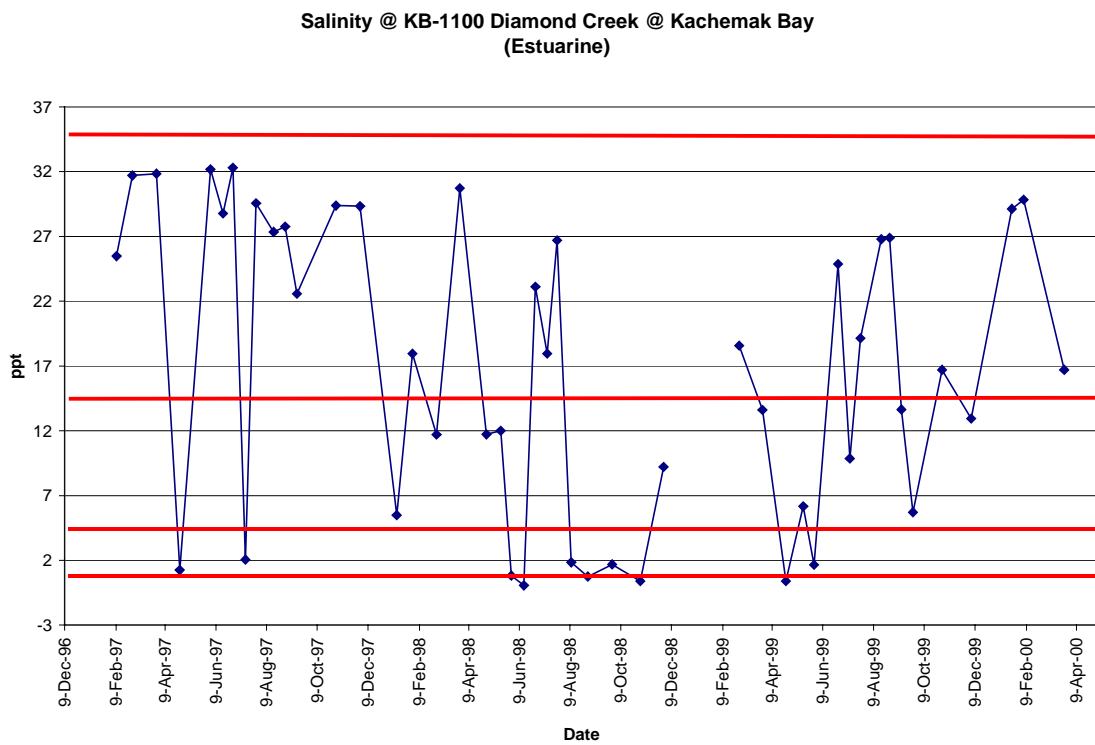
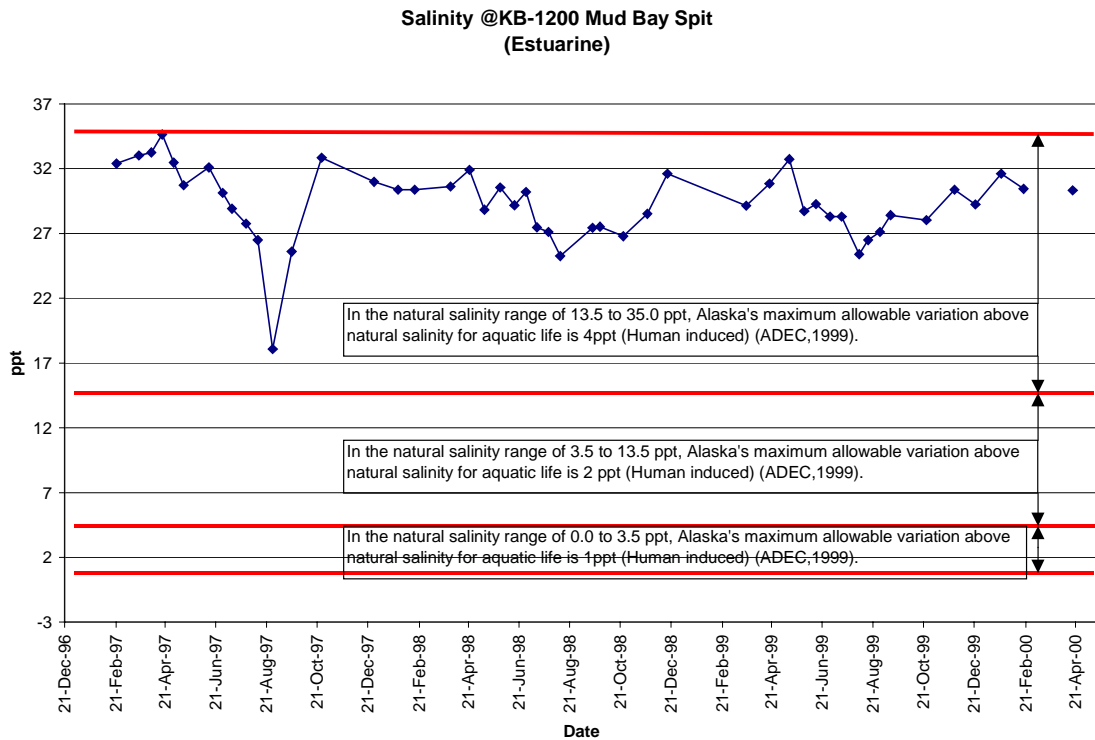


Figure 10. Salinity measurements at selected volunteer monitoring sites from February 1997 to April 2000

pH

The pH test is one of the most common analyses in water testing. An indication of the sample's acidity, pH is actually a measurement of the activity of hydrogen ions in the sample. pH measurements run on a scale from 0 to 14, with 7.0 considered neutral. Solutions with a pH below 7.0 are considered acids, those between 7.0 and 14.0 are designated as bases. A range of 6.5 to 8.2 is optimal for most organisms (Campbell and Wildberger, 1992).

Two different methods were used to measure pH. The electrometric method, using the Hanna meter, is more sensitive (0.1 units sensitivity) than the colorimetric method (0.5 units sensitivity). The average readings for the Colorimetric method were 8.1 (estuarine) and 7.1 (freshwater), while the more sensitive Hanna meter averaged 8.1 and 7.4 for estuarine and freshwater sites respectively (Figure 11). There were a total of 17 observations where both the Hanna meter and colorimetric tests together recorded readings above the state standard of 8.5. All were at estuarine sites, with 10 readings being at KB-350, 6 at KB-1200, and one at KB-700. The highest reading of 11.1 (Hanna meter) and 9.5 (colorimetric) occurred at KB-350, Beluga Lake Outflow (Figure 12). That High value could have been caused by an intense phytoplankton bloom (which raises pH), a likely event at a site downstream of a wetland in the middle of the summer (Cook Inlet Keeper, May 2000). One reading was below the 6.5 standard at a freshwater site at KB-490 with 6.3 (Hanna meter) and 6.0 (colorimetric) readings.

Although less sensitive the colorimetric method is more consistent than the Hanna Meter, which should be calibrated prior to each use, is temperature sensitive, is battery powered and can go dead in the field, and has electrodes that need to be cleaned regularly. Figure 12 depicts the difference in sensitivity of the two methods and shows the inconsistency of the Hanna Meter (i.e. lack of data due to problems listed above). Some of these problems are being addressed by training volunteers to calibrate Hanna meters prior to sampling.

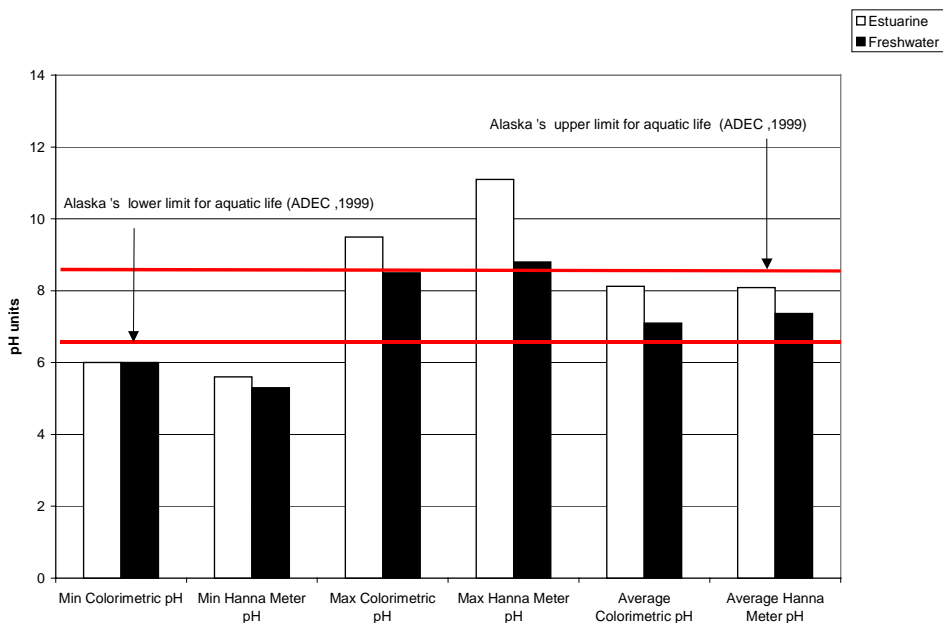


Figure 11. Minimum, maximum, and average pH Hanna Meter and Colorimetric readings at estuarine and freshwater sites

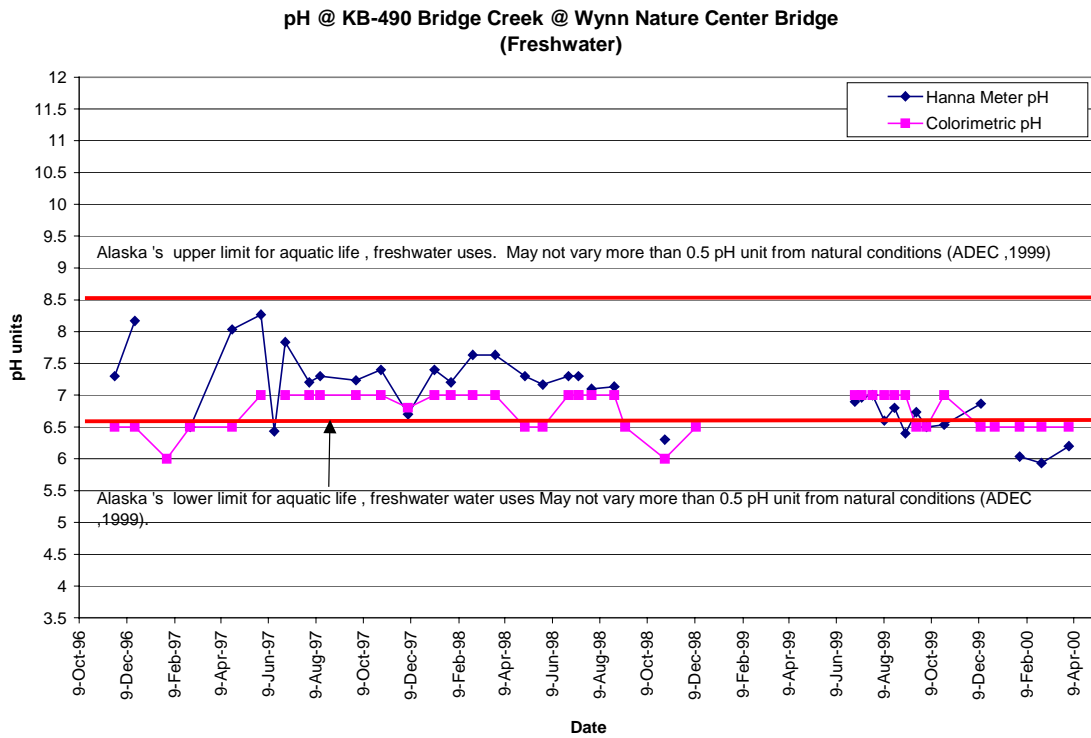
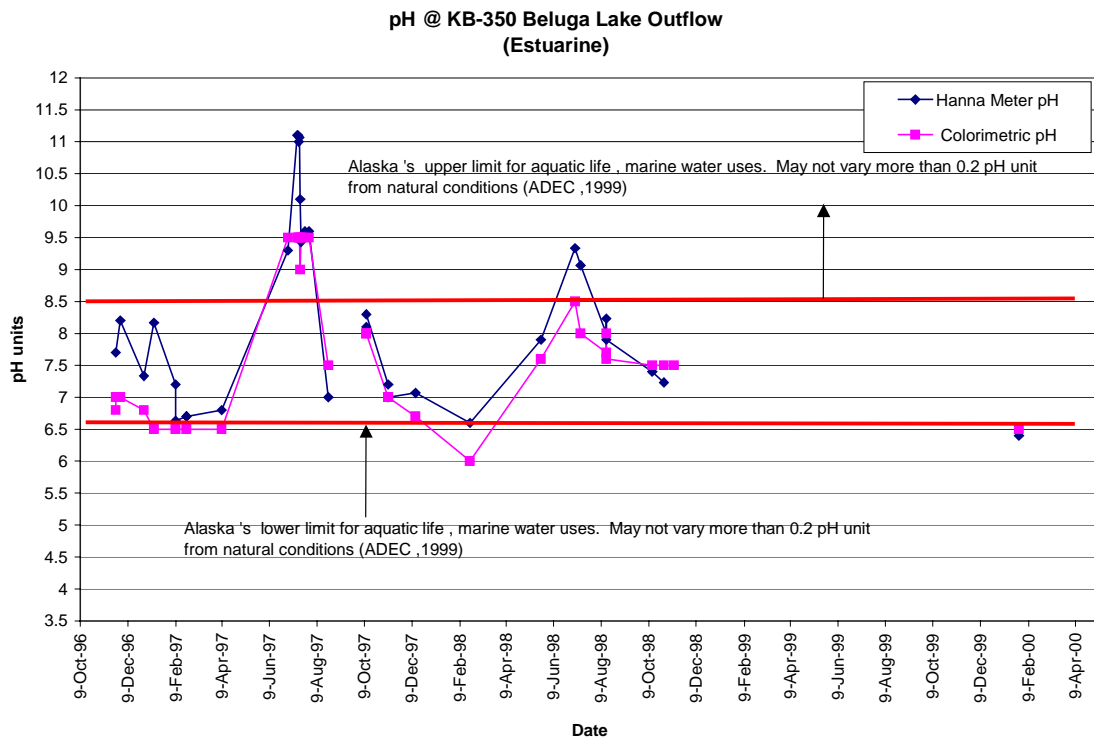


Figure 12. pH readings at selected volunteer monitoring sites from November 1996 to April 2000

Conductivity

Conductivity readings averaged 99 $\mu\text{S}/\text{cm}$ (freshwater) and 1667 $\mu\text{S}/\text{cm}$ (estuarine). The maximum reading for all sites was 1999 $\mu\text{S}/\text{cm}$ (exceeding the range of Hanna Meter) with KB-1110 and KB-535 having the high for the freshwater sites. The minimum readings were 0 $\mu\text{S}/\text{cm}$ at KB-440 (freshwater) and KB-350 (estuarine). Figure 14 shows conductivity readings at selected volunteer monitoring sites.

Oxidation-Reduction Potential

The highest oxidation-reduction potential (ORP) reading of 1085 mV was recorded at KB-310 an estuarine site and the high for the freshwater sites was 854 mV (Figure 13). Lows were -51 mV at KB-1100 (estuarine) and -1009 mV at KB-210 (freshwater). Average readings were 138 mV (estuarine) and 127 mV (freshwater). Figure 15 shows ORP readings at selected volunteer monitoring site.

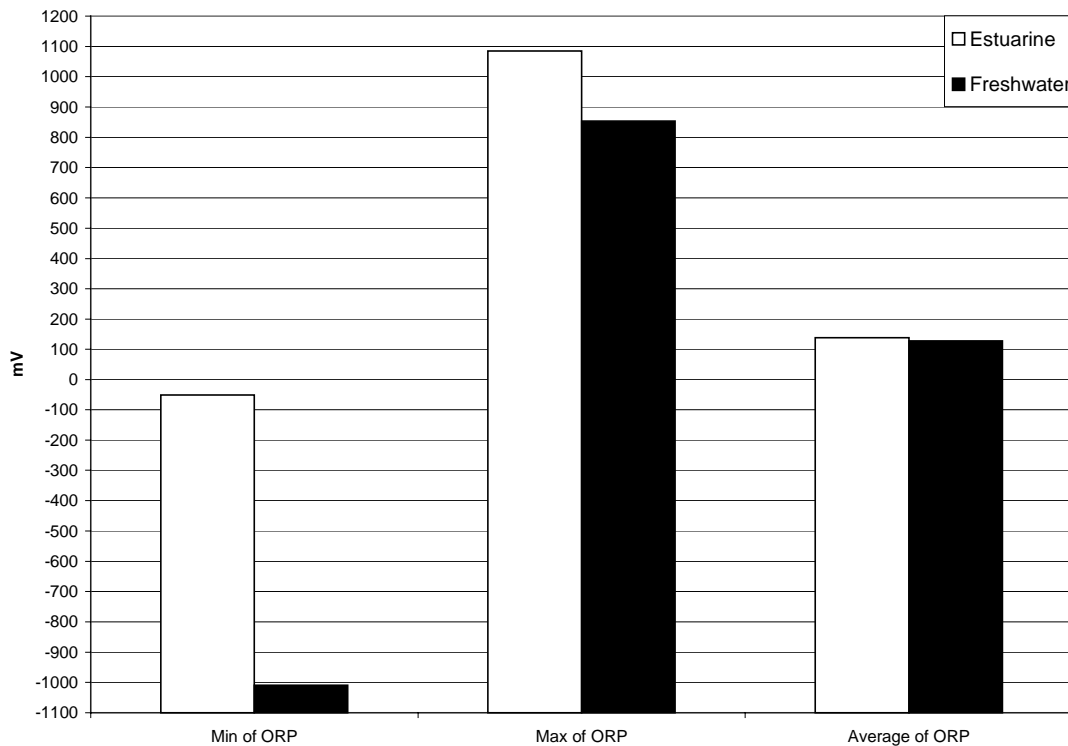


Figure 13. Minimum, maximum and average oxidation-reduction potential readings at estuarine and freshwater sites

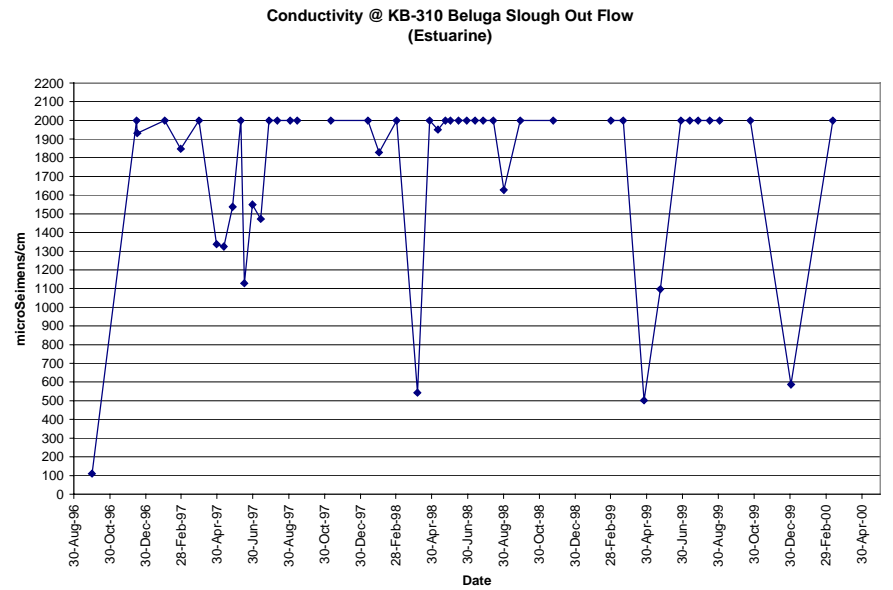
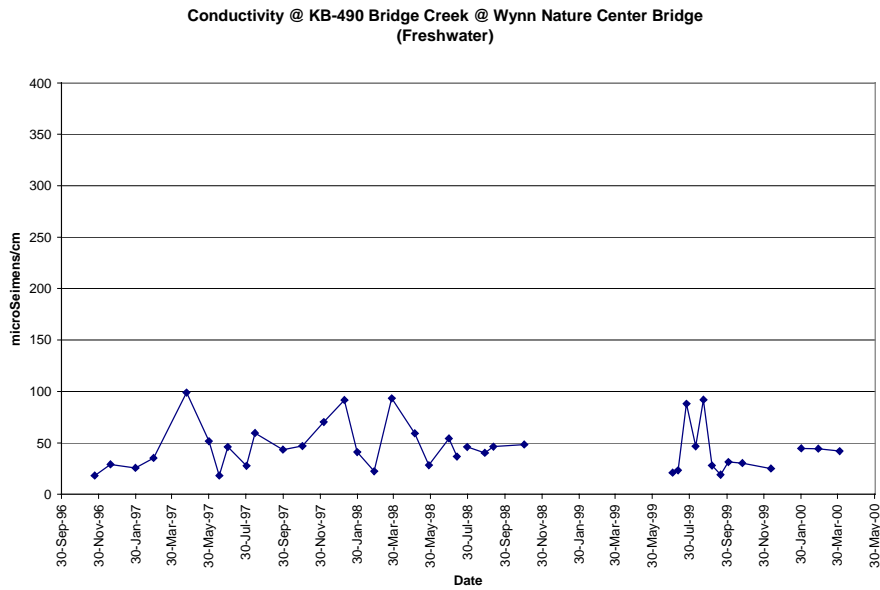
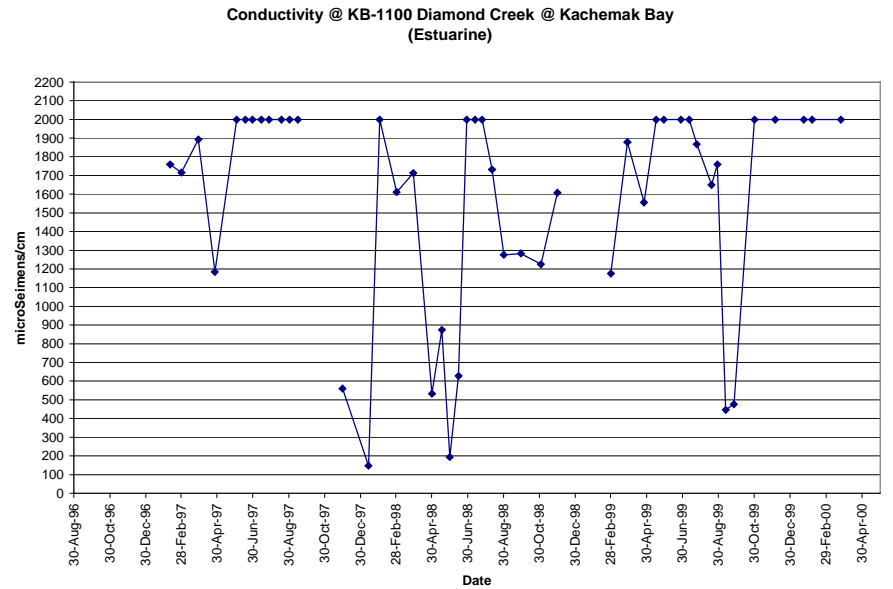
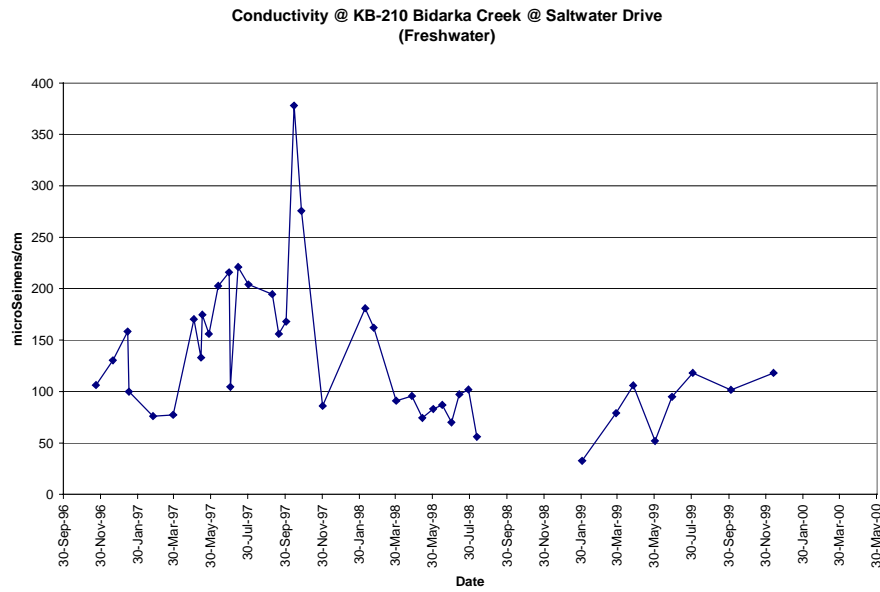


Figure 14. Conductivity measurements at selected volunteer monitoring sites from November 1996 to February 2000

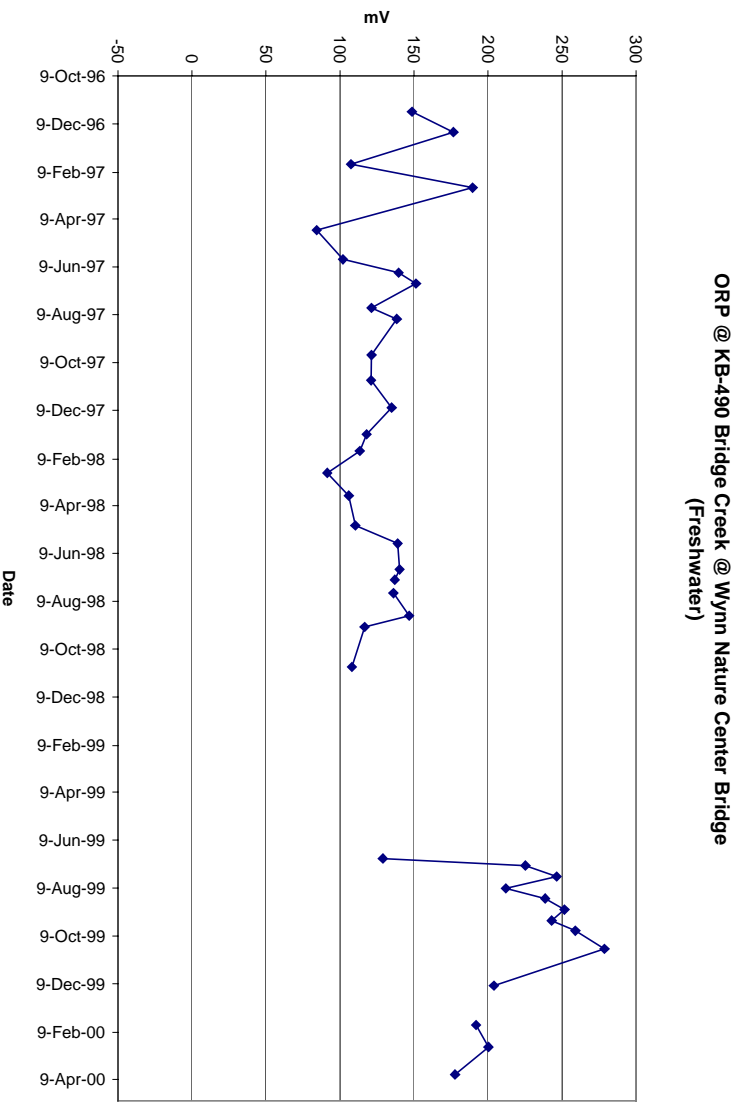
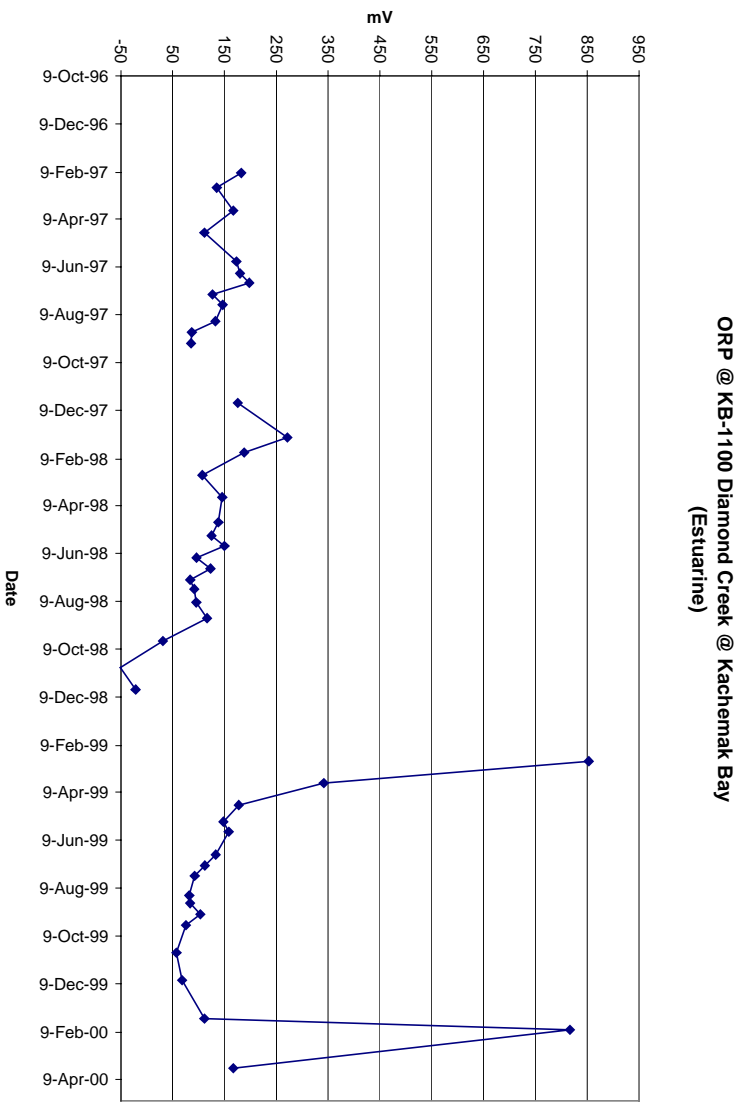


Figure 15. ORP readings at selected volunteer monitoring sites from November 1996 to February 2000

Apparent Color

Apparent color was measured using the Borgor color system. Observations are the average of two readings when two were taken. The high reading was 144.5 (2.5 gallon) and 120 (50 ml) at an estuarine site and the low reading was 1 (2.5 gallon) and 0 (50 ml) at both freshwater and estuarine sites (Figure 16). The average readings were 80.8 (2.5 gallon), 88.7 (50 ml) and 58.4 (2.5 gallon), 63.2 (50ml) at estuarine and freshwater sites respectively. Figure 17 shows color readings at selected volunteer monitoring sites.

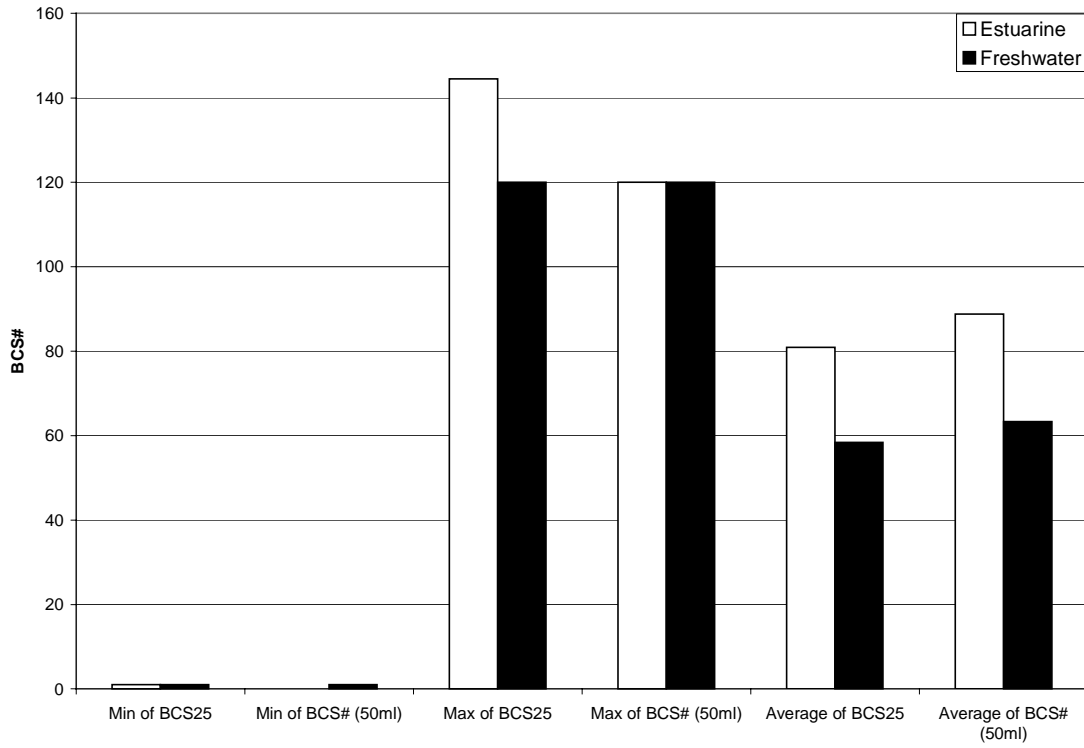
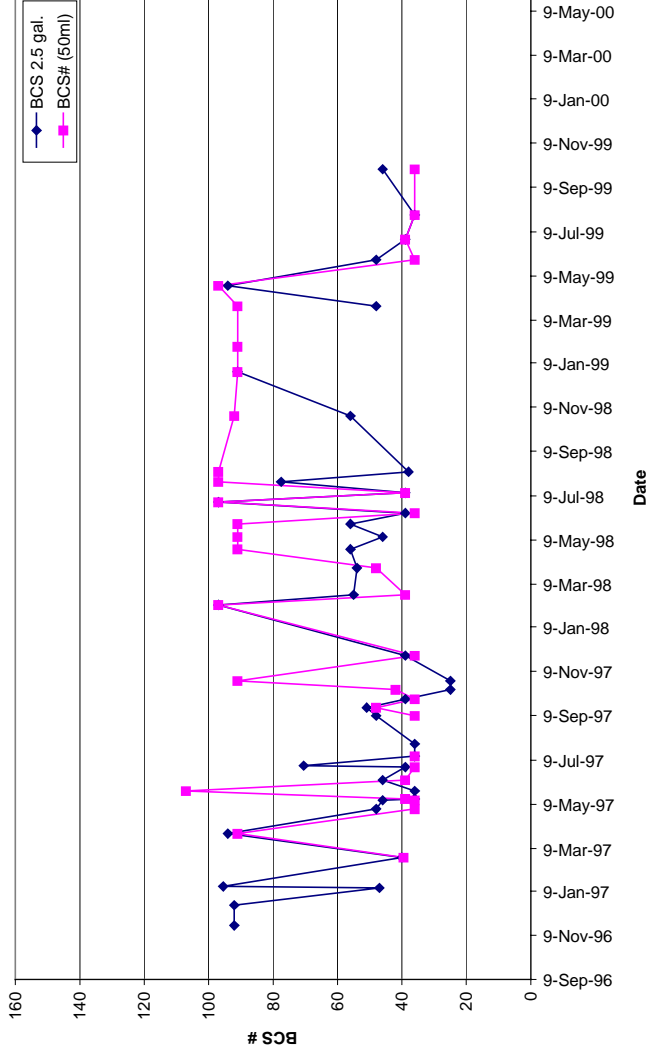


Figure 16. Minimum, maximum and average apparent color readings at estuarine and freshwater sites

Color @ KB-210 Bidarka Creek @ Saltwater Drive
(Freshwater)



Color @ KB-1100 Diamond Creek @ Kachemak Bay
(Estuarine)

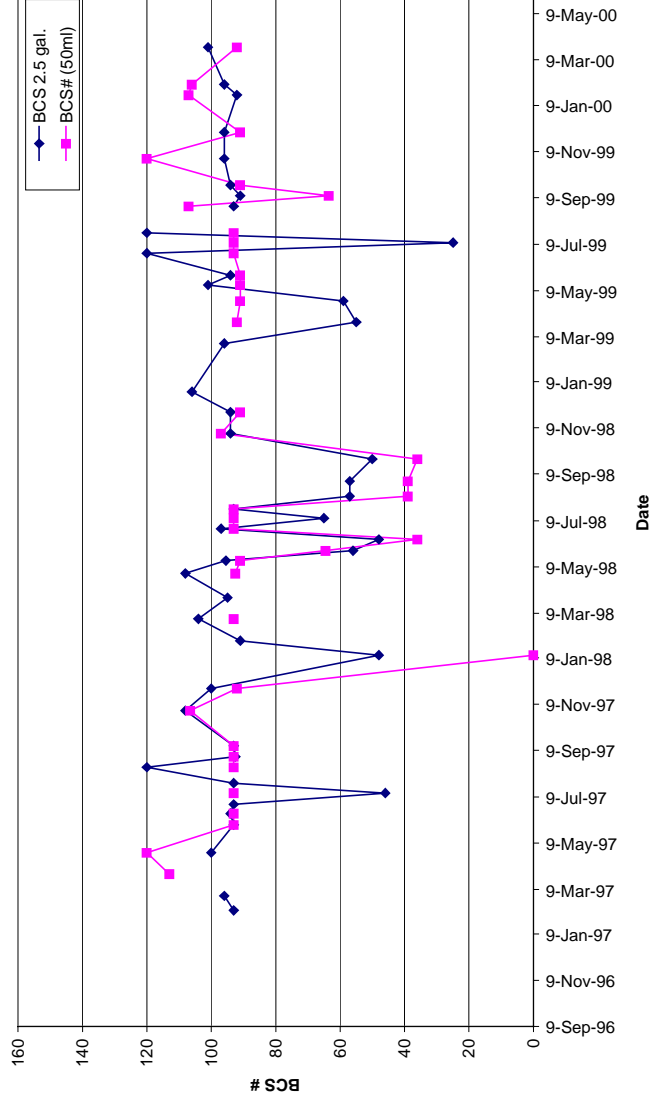


Figure 17. Color readings at selected volunteer monitoring sites from November 1996 to April 2000

Nitrate-nitrogen

The method used for nitrate-nitrogen is not sensitive enough to pick up background levels of nitrate-nitrogen, below 1.0 ppm (mg/l). There were 83 observations that measured nitrate-nitrogen. The highest reading of 5.0 ppm was measured at KB-110. A low of 0 ppm was measured at all sites where this test was performed. The average readings were 0.07 ppm at estuarine sites and 0.21 ppm at freshwater sites (Figure 18).

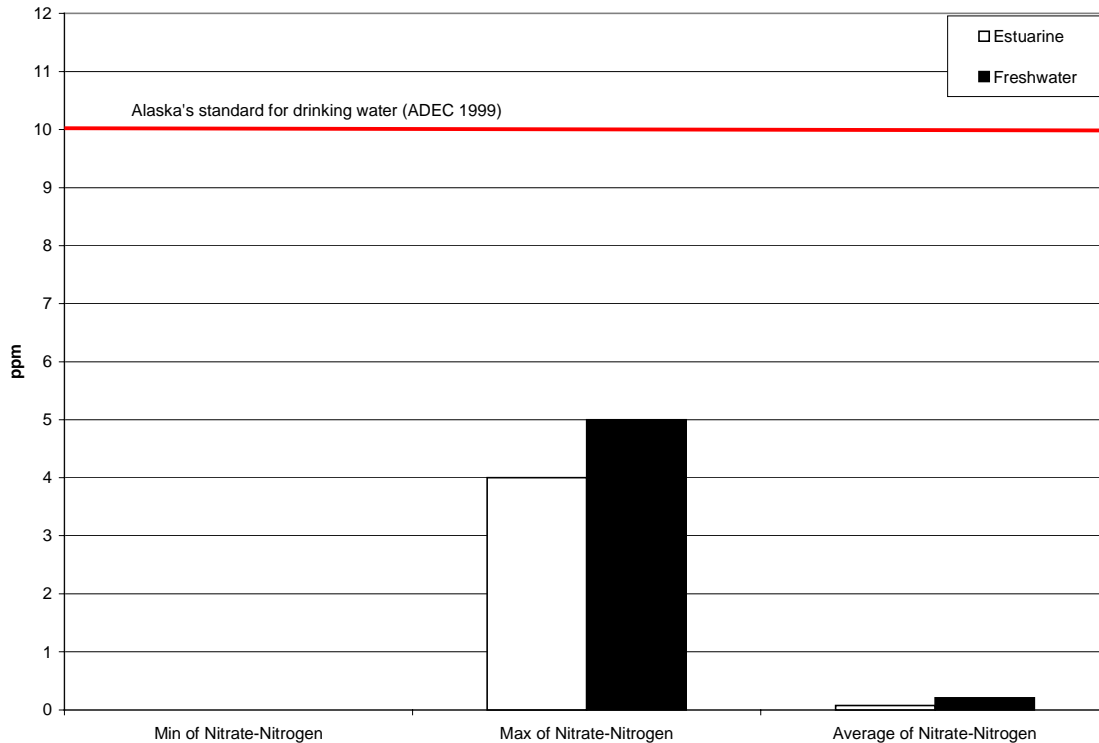


Figure 18. Minimum, maximum and average nitrate-nitrogen readings at Estuarine and freshwater sites

Orthophosphate

Although the method may be sensitive enough to pick up some background levels of orthophosphate, it is not sensitive enough to measure levels below 0.2 ppm (mg/l). There were 94 observations that measured orthophosphate. The highest reading of 0.50 ppm was measured at KB-545. A low of 0 ppm was measured at all sites where this test was performed. The average readings were 0.01 ppm at estuarine sites and 0.03 ppm at freshwater sites (Figure 19).

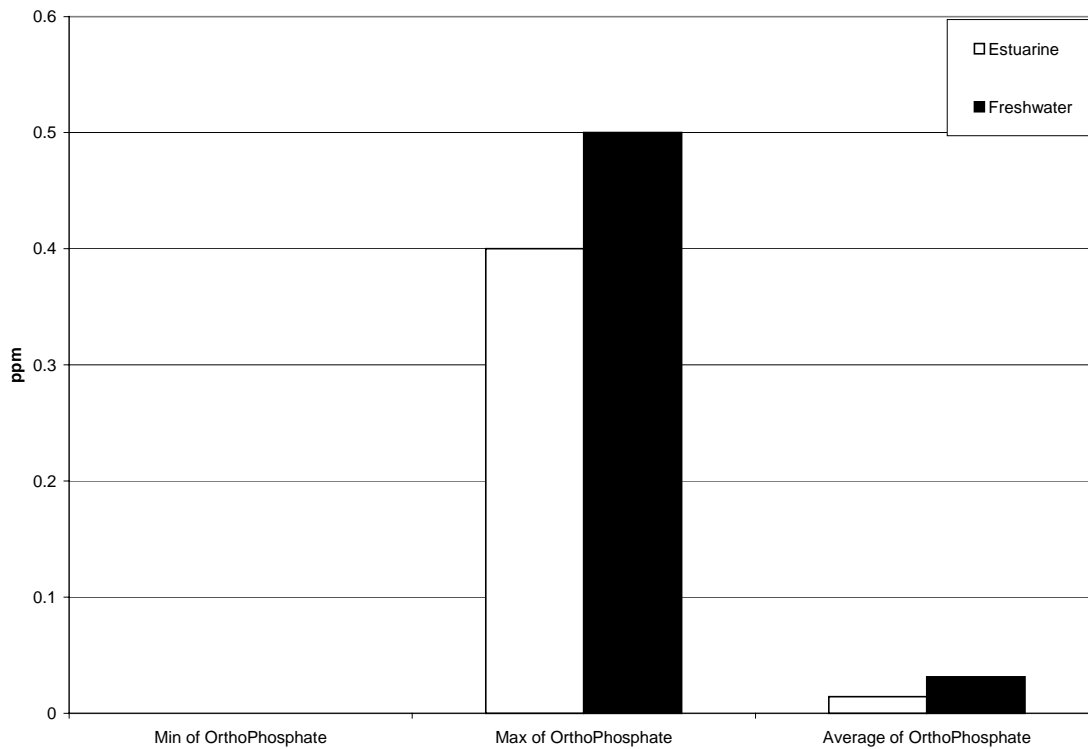


Figure 19. Minimum, maximum and average Ortho-Phosphate readings at estuarine and freshwater sites

Bacteria

The Coliscan® method is used to sample for both total and fecal coliform bacteria. A test sample (of 1, 3 or 5 ml) is added to the designated medium, then it is poured into a petri dish and incubated at a controlled temperature. Samples are generally counted after a 48-hour incubation period. General coliform will produce colonies that are pink in color, while *E. coli* coliforms will produce purple colonies in the medium. Monitors count the number of general and *E. coli* coliforms in their petri dishes and record their information on data sheets. While this method is a simple, accurate quantitative way to measure coliforms, inherent problems include contamination of supplies as well as personal perspective in identifying the color of the colonies. This test is used only as a screening tool and to get a sense of natural variability.

The average *E. coli* counts were 157 cfu/100ml (estuarine) and 233 cfu/100ml (freshwater) for the 1 ml dilution, 100 cfu/100 ml (estuarine) and 113 cfu/100ml (freshwater) for the 3 ml dilution and 124 cfu/100ml (estuarine) and 274 cfu/100ml (freshwater) for the 5 ml dilution. Average counts for total coliform with the 1ml dilution readings were 1031 cfu/100ml (estuarine), 4369 cfu/100ml (freshwater), 1463 cfu/100 ml (estuarine) and 3438 cfu/100ml (freshwater) for the 3 ml dilution. The 5ml dilution average readings were 1001 cfu/100ml (estuarine) and 3133 cfu/100ml (freshwater) (Figure 20).

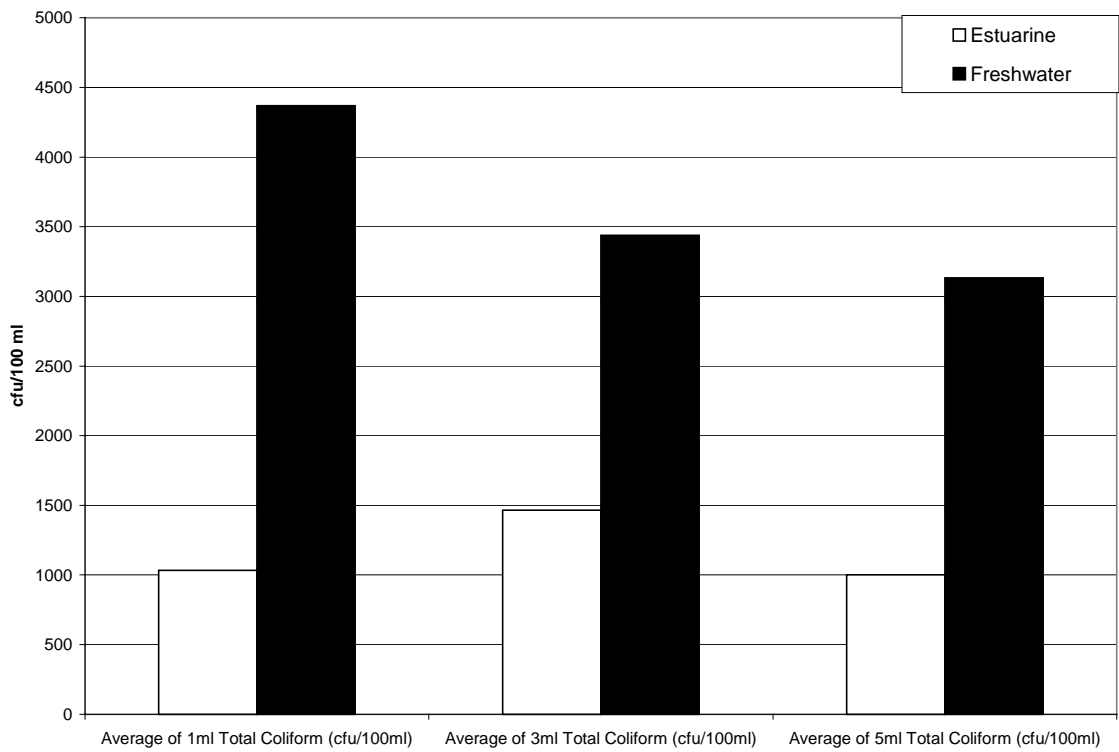
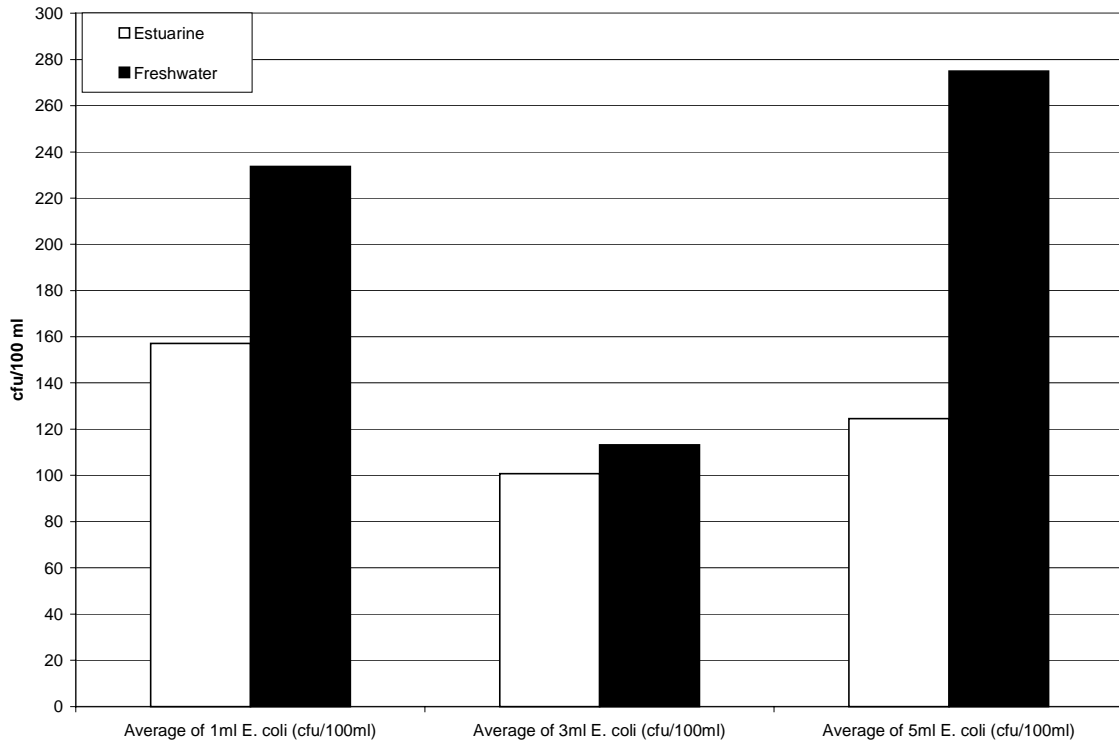


Figure 20. Average Ecoli and Total Coliform counts for 1ml and 5 ml dilutions at estuarine and freshwater sites

QUALITY CONTROL

Data Comparison

Comparing Project Results with Other Data for the Anchor River

Keeper compared water quality data from the Citizen's Environmental Monitoring Program with data collected from the Lower Kenai Peninsula Watershed Health Project (LKPWHP) and USGS at sites in the Anchor River watershed. Figure 21 shows the location of sites used for comparison as well as other monitoring sites in the watershed. The graphs in figure 22 compare CEMP volunteer data to USGS and LKPWHP data for water temperature, pH, and conductivity in the Anchor River watershed (Cook Inlet Keeper, January 2000).

Comparing Against Split Samples and Standard Solutions

Keeper's quality assurance officer randomly selects volunteer monitoring sites and accompanies monitoring teams during selected sampling periods to perform split sample analysis. The QA officer uses the same sample water from the same bucket and performs the same tests as the monitoring team. Tests are performed using the same monitoring equipment as the volunteer monitor. Additional tests are done using the same equipment and methods used in the Lower Kenai Peninsula Watershed Health Project. Some results are shown in Appendix 4.

Keeper also conducts performance standards comparisons during training and annual quality control sessions. Volunteer monitors are given a standard solution of known concentration. The monitor does not know the concentration while performing the test. Results are shown in Appendix 5.

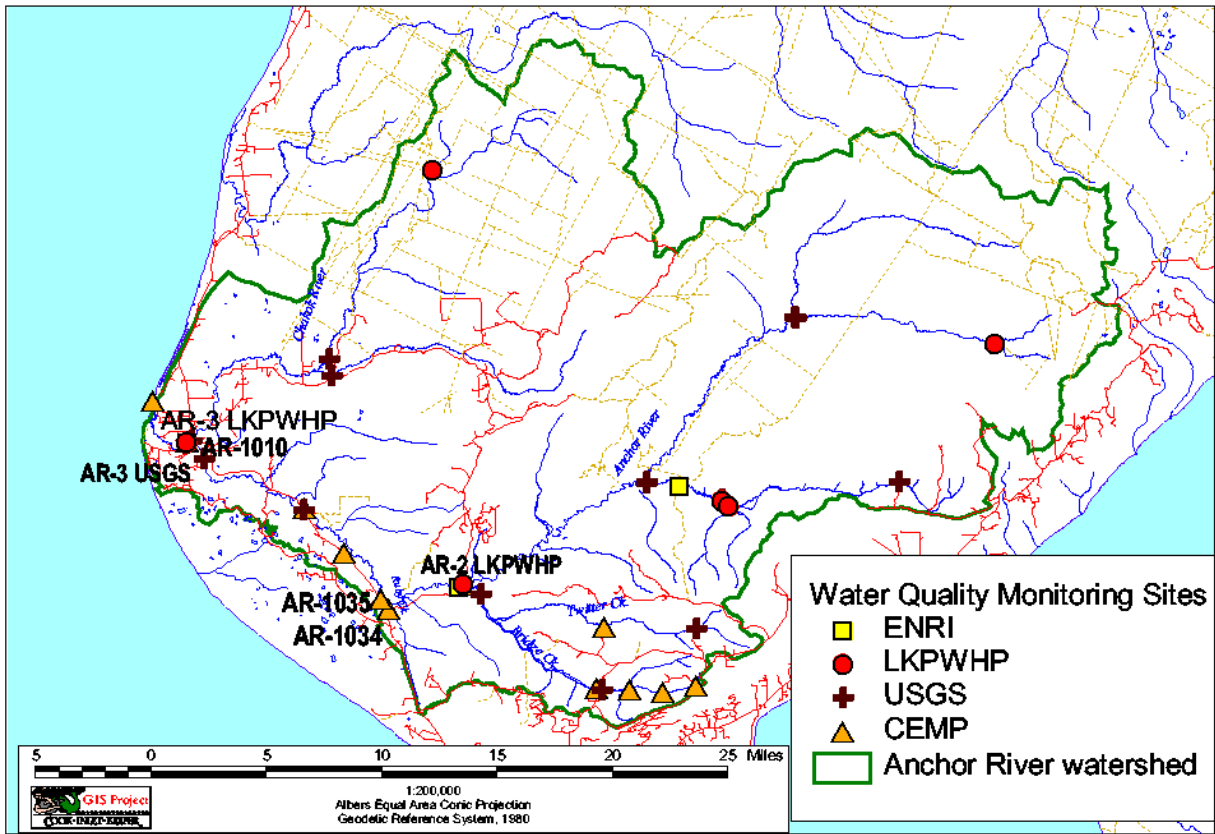
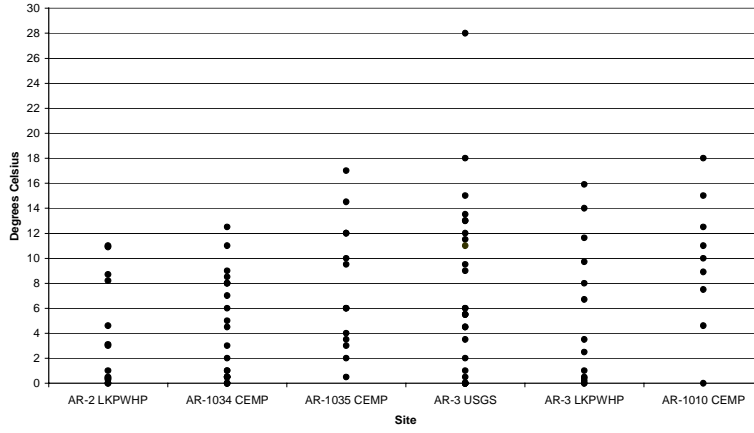
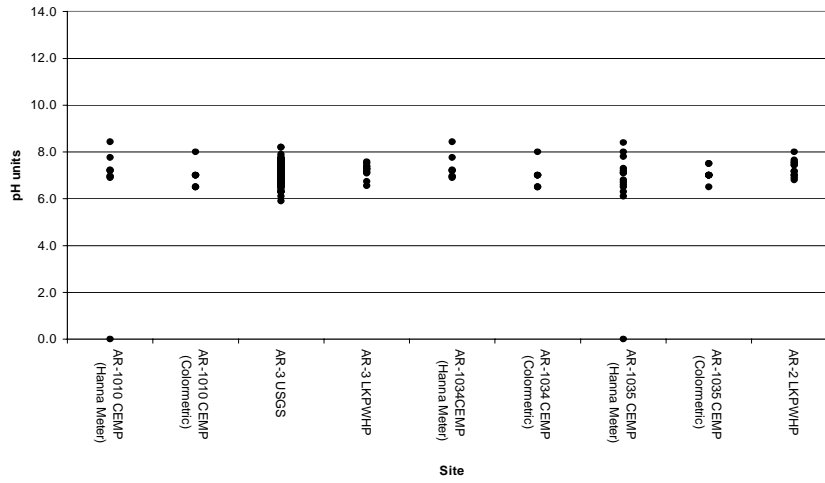


Figure 21. Water quality monitoring sites in the Anchor River watershed

Water Temperature Comparison (CEMP, USGS, LKPWHP)



pH Comparison (CEMP, USGS, LKPWHP)



Conductivity Comparison (CEMP, USGS, LKPWHP)

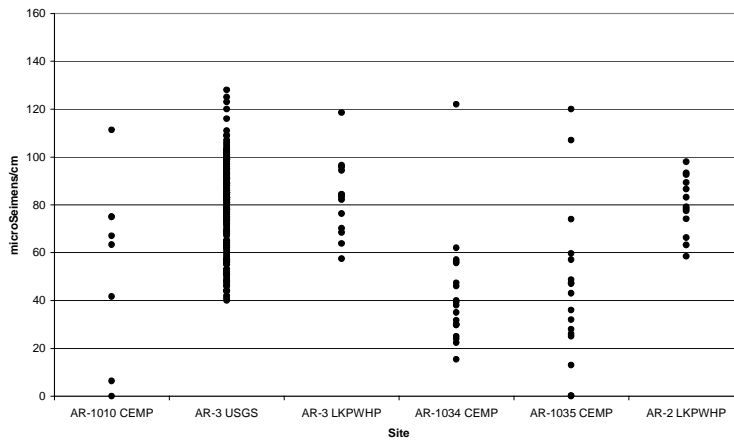


Figure 22. Comparisons of CEMP volunteer data for water temperature, pH, and conductivity to USGS and LKWHP data in the Anchor River watershed

Quality Assurance Project Plan

Review

The Quality Assurance Project Plan (QAPP) and Volunteer Training Manual have been essential guiding documents for implementing the Citizens' Environmental Monitoring Project. They have provided a template for organizations throughout the Cook Inlet watershed and beyond for developing sound water quality monitoring projects.

A good QAPP is inherently dynamic. It changes based on advances in technology, financial limitations, and what its implementers learn will work or not work. Through training, monitoring and discussion with technical experts many suggestions for improvement have come forth from volunteers, quality control coordinators⁵, quality assurance officers, technical advisory committee members, equipment technicians, project officers of other monitoring programs, and citizens.

Although the QAPP is technically sound, one of its greatest difficulties has been interpreting the duties, responsibilities, and procedures for those who are implementing the plan. The test procedures performed by the volunteer monitors are pretty straight forward, but when it comes to kit management, training, data management and other means of quality control more clearly defined instructions are needed. This information is explained in trainings and ongoing consultation but retaining it in an orderly fashion is somewhat difficult.

It has been suggested that certain parts of the plan could be broken down into stand-alone Standard Operating Procedure (SOP) documents that would be incorporated as appendices in the QAPP. The appendices would clearly outline the duties and responsibilities of the quality assurance officer, trained quality control coordinators and volunteer monitors and provide step-by-step procedures for carrying out each particular component of the plan. This format will allow for individual SOP review and revision while still maintaining the framework of the QAPP.

In addition to SOPs, Keeper is working to develop a Quality Management Plan (QMP) based on U.S. EPA guidelines. The purpose of the QMP will be to layout a formal framework for coordinating multiple monitoring projects and ensuring consistency. The QMP will further delineate the roles and responsibilities of the Technical Advisory Committee, Quality Assurance Officer, Quality Control Coordinators from each monitoring project, and others charged with ensuring the program's data quality objectives are met.

Proposed Revisions

SOPs are currently being developed for the following activities and procedures: training, re-certification, performance standards, data management, replicate analysis, kit management, waste management, sample split, response, and field procedures. Each of these SOPs will be included as appendices in the revised QAPP. Corresponding sections of the QAPP will reference appropriate SOPs in lieu of detailed information within the main body of the document. In addition to this significant change in format, the QAPP will be revised to reflect: changes in

⁵ The quality control coordinator is the suggested title for monitors who complete a Phase V training and will be taking part in coordinating volunteer monitors and implementing the QAPP.

personnel; a shift in the sampling schedule (changing from sampling twice to sampling once in May and from sampling once to sampling twice in September); and resolution of minor inconsistencies between the QAPP and the Volunteer Training Manual. The Volunteer Training Manual will be revised by shifting those sections which provide detailed descriptions of procedures into the Field Procedure SOP which will be included as an appendix to the Manual.

Cook Inlet Keeper is currently exploring more sensitive methods for measuring ortho-phosphate and nitrate-nitrogen as well as adding procedures for measuring ammonia and chlorophyll a and incorporating U.S. EPA's volunteer habitat assessment methods into this project. If Keeper and its Technical Advisory Committee determine that these or other new procedures are feasible and would benefit the project, appropriate SOPs will be revised accordingly and submitted to the U.S. EPA and the Alaska Department of Environmental Conservation for approval.

OTHER CITIZEN BASED MONITORING IN COOK INLET

The Citizens Environmental Monitoring Program continues to expand throughout the Cook Inlet basin (see figure 2), with over 100 sites having been monitored by over 120 active volunteers. To-date over 220 citizens have been trained since the start of the program. In and around Kachemak Bay, there are currently 36 active sites, monitored by 34 trained volunteers.

In the Kenai area, nearly 60 volunteer monitors are working with the Kenai Watershed Forum to monitor 17 sites on tributaries of the Kenai River, using Keeper's established monitoring protocols to collect water quality data.

In the Anchorage area more than 15 volunteers are monitoring eight sites with plans for new sites in the coming months. Keeper continues to provide support services to the Anchorage Waterways Council through trainer training's, technical support and data management.

Keeper recently began working with the Wasilla Soil & Water Conservation District and the University of Alaska Anchorage's Environment & Natural Resources Institute to expand monitoring efforts into the Mat Su Valley. A March, 2000 training saw 12 new monitors trained to monitor six new sites on the Little Susitna River and Cottonwood Creek.



Ole Anderson with the Kenai Watershed Forum at a Cook Inlet Keeper training.

Data from all of these efforts will be merged into a common database beginning later this year. Future editions of this report will include a broad discussion of this data.

CONCLUSION

The intent of this first report has been to present the data objectively, make comparisons to state standards when possible and plot the data over time to show natural conditions and trends, and to



Karl and Charles Pulliam, Susan Mumma, Joan Dunn, and Caren Graupe, -Seldovia volunteer monitors

gain an understanding of how well the monitors, equipment, and methods are performing. In future edition of this report, Cook Inlet Keeper will look to provide a more detailed data analysis. To date, data collected by this project have been utilized by the city of Homer, the Kenai Peninsula Borough, and the Kachemak Bay National Estuarine Research Reserve for planning and research.

The equipment and methods appear to be working to the best of their ability. As for the monitors, they are doing a tremendous job. Their dedication and commitment continues to amaze all who work with the program. The main limitations seem to be with the sensitivity of the methods and equipment, which are directly related to costs.

The Citizens' Environmental Monitoring Project is designed to raise public awareness of water quality issues and the watershed concept while collecting accurate baseline data. It strives to involve citizens in hands-on activities aimed at improving and protecting habitat and water quality, promoting resource stewardship, and establishing an environmental database. Since the inception of the monitoring program in the fall of 1996, CEMP has been accomplishing these goals and continues to improve and train more citizens.

Technical Advisory Committee member Dr. John Kelly said it well after reviewing a draft of this report:

"Citizen involvement in an environmental monitoring effort is not only cost-effective, but connects the stake holder to the stewardship of their environment rather than leaving the process to somebody else, thus disengaging themselves from both understanding the problems as well as solutions."

John J. Kelly, Ph.D. Professor of Marine Science at University of Alaska-Fairbanks.

In working with volunteer monitors, it is clear that these citizens are genuinely connecting with their environment on a regular basis. As they make these connections, monitors begin asking



Gravel pile that was spilling into McNeil creek at monitoring site KB-545. A volunteer monitor's response got the pile moved and the area re-vegetated.

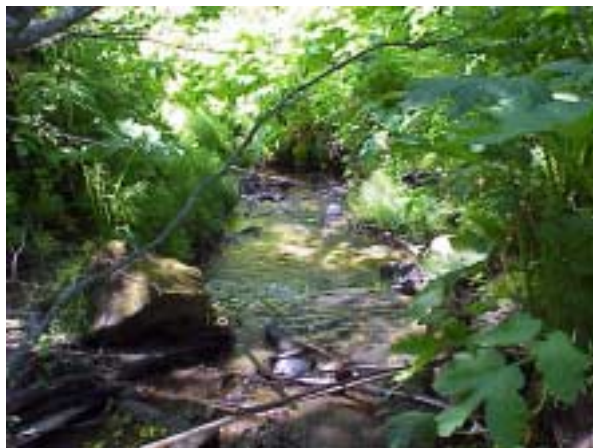
question about what's going on in their watershed. They want to assure that the habitat and water quality around them is protected and they are willing to do their part to make it happen.

Some monitors have taken extra steps. One volunteer noticed a gravel pile for a road construction project spilling over into the creek he was monitoring. He worked with Cook Inlet Keeper and the Alaska Department of Transportation to have the pile removed and the bank re-vegetated.

Another monitoring team was fed up with the trash that was being dumped around in the parking area near their monitoring site on Ruby Creek, a tributary to the Anchor River. Team members took the initiative and worked with the Alaska Department of Transportation to have a no littering sign placed at the site. The team has committed to help enforce it.

Yet another monitor has been concerned about a large a housing project being developed in her neighborhood. She has helped establish five monitoring sites in the creek running through the area, has talked with neighbors and the Alaska Department of Environmental Conservation. She wants to assure the project is done right and that proper septic systems are installed.

In addition to the valuable water quality data being collected, it is this citizen vigilance and stewardship that provides some of the projects most far-reaching benefits.



Volunteer monitoring site KB-180, Woodard Creek West of Hospital.



Road development taking place on steep slope above Woodard creek and monitoring site KB-180.

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