Citizens' Environmental Monitoring Program

2007-2008 Report




CLEAN WATER • HEALTHY SALMON

COOK•INLETKEEPER

Cook Inletkeeper

Cook Inletkeeper is a community-based nonprofit organization that combines advocacy, education and science toward its mission to protect Alaska's Cook Inlet watershed and the life it sustains. Inletkeeper's monitoring and science work build credibility with scientists and resource managers, its education and advocacy efforts enhance stewardship and citizen participation, and together, these efforts translate into Inletkeeper's ability to effectively ensure a vibrant and healthy Cook Inlet watershed.

MISSION

To protect Alaska's Cook Inlet watershed and the life it sustains.

Cook Inletkeeper board and staff, 2008

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Cover Photos:

Beaver Creek, part of the Anchor River watershed, through the seasons. CEMP volunteers have been sampling at Beaver Creek, off of Hutler Road, since 2002. Kyra and Neil Wagner have been monitoring Beaver Creek since January 4, 2003. All photos were taken by either Neil or Kyra through the years.

Table of Contents

Citizens' Environmental Monitoring Program

Alaska's streams and rivers serve as sources for food and drinking water, navigation, and recreation. Human health and welfare are tied directly to water resources and the environment. Monitoring water quality informs us about the health of local streams, as well as the quality of water entering into our local bays and oceans. Monitoring baseline water quality can also give us a better understanding of the potential impacts climate and land use changes may have on our water resources.

The task of assessing the water quality in all of the Alaska's waters is immense. This has led to an overwhelming inadequacy of water quality information on many local and regional watersheds. The 2008 Integrated Water Quality Monitoring and Assessment Report, put out by the Alaska Department of Environmental Conservation, states:

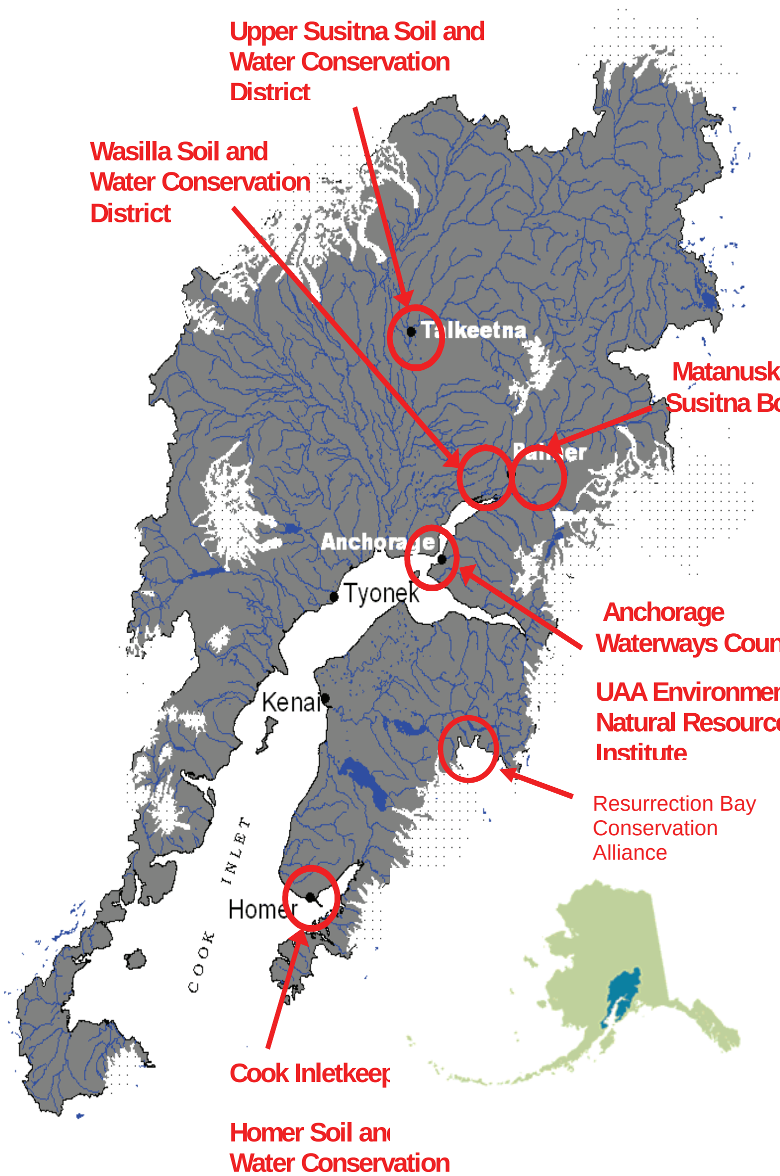
> "*Because of Alaska's size, sparse population, and its remote character, the vast majority of Alaska's water resources are in pristine condition. More than 99.9% of Alaska's waters are considered unimpaired*. *With more than 3 million lakes, 714,004 miles of streams and rivers, 36,000 miles of coastline, and approximately 176,863,000 acres of freshwater and tidal wetlands, less than 0.1% of Alaska's vast water resources have been identified as impaired. Historically, Alaska's water quality assessments focused on areas with known or suspected water quality impairments."*

With nearly a million miles of streams and rivers in the State, there is a concern that a lack of baseline water quality information—especially in populated regions such as Southcentral Alaska, home to the vast majority of Alaskans– will result in a lack of oversight on future development. In response to this gap in knowledge, Cook Inletkeeper's volunteer water quality monitoring began in 1996 with the formation of the Citizens' Environmental Monitoring Program, known by many by its acronym—CEMP. **Baseline data collection** is a primary aim of the CEMP model. Many of the waterbodies in Alaska have not been polluted, and we rely on these systems to support our fish, wildlife, and human communities. Inletkeeper believes that as a community we have the tools needed to be active stewards of our water and clean water for future generations. By training citizen volunteers to monitor water quality we are empowering the community to keep its eyes and ears on changes that may impact and threaten Alaska's water quality.

This report summarizes Cook Inletkeeper's data collection efforts in 2007-2008 on streams in the Kachemak Bay and Anchor River watersheds. CEMP volunteers are at the heart of this program and continue to inspire and motivate Inletkeeper staff towards our vision of "Clean Water, Healthy Salmon".

CEMP Partnership

Citizen-based water quality monitoring is a cost-effective and robust model for collecting water quality data where state and federal efforts are lacking. Beginning in 1997, organizations throughout Cook Inlet forged partnerships to train citizens in effective water quality monitoring methods to ensure resource protection. These partnerships formally became the Citizens' Environmental Monitoring Program Partnership of the Cook Inlet Watershed (CEMP Partnership). Cook Inletkeeper currently coordinates this partnership which consists of eight organizations within Southcentral Alaska. The CEMP Partnership recognizes the need for performance uniformity among the numerous volunteer water quality monitoring projects throughout the region. Only through collaborate management and consistent training can scientifically defensible data be collected for valid comparisons and interpretations.



CEMP Partnership Priority Objectives

While each organization has a unique program, the CEMP Partnership has several priority objectives that all partners strive to meet:

- Inventorying baseline water quality data in the waterways of the Cook Inlet basin;
- Detecting and reporting significant changes and tracking water quality trends;
- Raising public awareness of the importance of water quality and stewardship through hands-on involvement.

Since 1997, over 1,000 citizens have been trained through organizations in the CEMP Partnership. These citizens have collected over 5,000 observations at nearly 300 stream, wetland, lake, and estuarine sites in Southcentral Alaska.

Kachemak Bay & Anchor River CEMP

Inletkeeper's efforts to implement volunteer monitoring in Cook Inlet have focused on surface water monitoring in the Kachemak Bay and Anchor River watersheds. To assist with the initial phases of developing and refining its Citizens' Environmental Monitoring Program, Inletkeeper convened a Technical Advisory Committee (TAC), comprised of water quality experts from across Alaska and beyond. To translate the recommendations of the TAC into workable implementation strategies, Inletkeeper convened a Citizens Advisory Panel (CAP), comprised of residents of the Southern Kenai Peninsula concerned about water quality. Together, the TAC and CAP provided Inletkeeper with invaluable input for shaping and implementing its monitoring program.

To meet its primary goal of baseline data collection in these watersheds, CEMP monitoring is focused on obtaining 5 years of complete datasets at individual sites within key sub-watersheds that flow into Kachemak Bay and the Cook Inlet via the Anchor River. The CEMP sampling schedule includes 16 site visits; a "complete dataset" has 75% of these, or at least 12 site visits during the course of the year. Alternatively, a minimum of 80 site visits over the course of monitoring at a site may be used for baseline data. See the section titled Baseline Status at the end of this report for an overview of datasets at our current CEMP sites.

Cook Inletkeeper's CEMP has trained over 300 volunteer water quality monitors since 1996. As of January 2009, nearly 3,000 observations have been made in the Kachemak Bay and Anchor River watersheds. In the past two years volunteers have dedicated 682 hours of their time to monitoring our water quality. These hours include water quality monitoring as well as bioassessment monitoring in 5 CEMP streams that occurs twice per summer.

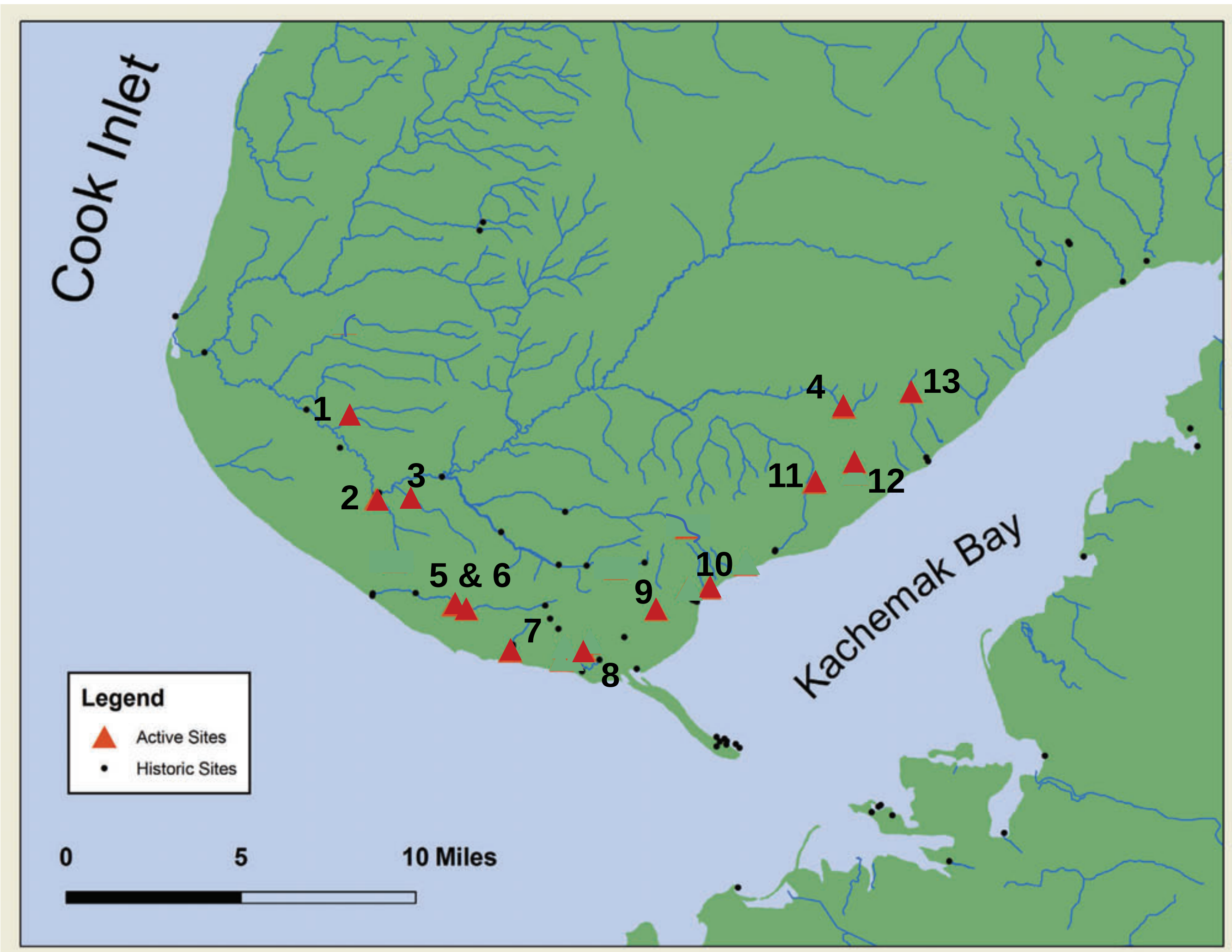
2007
32 sites
175 observations
33 volunteers
372 volunteer hours

2008
15 sites
154 observations
23 volunteers
310 volunteer hours

Active CEMP Sites

Anchor River Watershed:
1) Two Moose Creek (AR-1015)
2) Ruby Creek (AR-1034)
3) Anchor Tributary (AR-1040)
4) Beaver Creek (AR-1090)

East End Streams:
11) Fritz Creek @ East End (KB-535)
12) Rice Creek (KB-556)
13) McNeil Creek (KB-545)



Diamond Creek Watershed:
5) Above the landfill (KB-1150)
6) Below the landfill (KB-1140)

City Streams:
7) Bidarka Creek (KB-210)
8) Woodard Creek @ Pratt (KB-150)
9) Palmer Creek (KB-356)
10) Miller Creek (KB-952)

Water Quality Parameters

Cook Inletkeeper's CEMP tracks biological and chemical stream health indicators and reports exceedences of state or federal standards. The stream parameters currently monitored were selected by a Technical Advisory Committee based on both EPA's federal water quality standards and Alaska Department of Environmental Conservation's state standards.

Monitoring In Our Streams

Parameter	About	Common Natural Impact Sources	Common Human Impact Sources
Temperature	A crucial aspect of aquatic habitat. Aquatic organisms are adapted to live within a certain temperature range.	Solar radiation, shade, groundwater contributions	Removal of riparian vegetation
Dissolved oxygen	Needed by fish and other aquatic organisms to live. Can be expressed as concentration in milligrams per liter (mg/l), or as percent saturation: the amount of oxygen the water holds compared to what it could absorb at that temperature.	Turbulence, interaction with air	Decaying plant and animal material, sewage, effluent wastewater
pH	A measure of the level of activity of hydrogen ions in a solution, resulting in the acidic or basic quality of the solution. Most natural streams range from 6.5 to 8.0 pH units.	Decaying wetland plants, geology	Agricultural runoff, algae blooms
Turbidity	An optical property of water that refers to the amount of light scattered or absorbed by water. Silt, clay, organic material, and colored organic compounds can all contribute to turbidity.	Discharge, natural erosion	Road building and erosion, wastewater or storm water discharges, forest harvest, mining, grazing
Coliform Bacteria	Many coliforms are normally founding soil and water and do not necessarily indicate the presence of fecal contamination, but *E.coli* is a primary bacterium in the human and animal intestinal tract and its presence in water indicates fecal contamination.	Decaying animal material, animal waste, soils	Human waste, sewage, septic tanks
Conductivity	The ability of water to conduct an electrical current, measured in microsiemens per centimeter. The presence of ions in a sample of water gives it its ability to conduct electricity; thus, conductivity is a measure of dissolved solids in a stream.	Geology, discharge	Pollution, road and fertilizer runoff

Water Quality Test Methods

Volunteer monitors are trained in a three-phase program including standard EPA-approved procedures. These procedures can be found in Volunteer Estuary/Lake/Stream Monitors: A Methods Manual (EPA 1992) and Inletkeeper's Quality Assurance Project Plan (QAPP), available on our website. Volunteers attend classroom sessions and field workshops as well as an annual recertification to review monitoring procedures. Once trained, volunteer monitors collect samples bi-monthly during summer months (May – August) and monthly during the remainder of the year. Volunteers perform tests to measure coliform bacteria, dissolved oxygen, conductivity, temperature and pH. At 6 CEMP sites we deploy data loggers which record water temperature every 15 minutes from May through October.

Monitors perform replicate analysis for each parameter measured during each site visit. They also collect samples for analysis at Cook Inletkeeper's laboratory for turbidity and coliform bacteria. Replicate samples are also collected for analysis in the lab. All measurements must meet data quality objectives established by the Technical Advisory Committee and CEMP Partnership for sensitivity, precision, and accuracy.

Department of Environmental Conservation Alaska Statewide Water Quality Standards 18AAC 70					
Water Use	**Water Temperature**	**Dissolved Oxygen**	**pH**	**Fecal Coliform Bacteria (FC)**	**Turbidity**
Water Supply: drinking, culinary, and food processing	May not exceed 15°C	Dissolved Oxygen (DO) must be > or = 4.0 mg/l	May not be < 6.0 or > 8.5	In a 30-day period, the geometric mean may not exceed 20 FC/100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml	Not to exceed 5 NTU above natural conditions when the turdbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 25 NTU
Water Supply: Growth and propogation of fish, shellfish, aquatic life, and wildlife	May not exceed 20°C. May not exceed where applicable: Fish migration routes: 15°C Fish spawning areas: 13°C Fish rearing areas: 15°C Egg & fry incubation: 13°C	DO mus be > or = 7.0 mg/l. The concentration of DO may not exceed 110% of saturation in any samples collected	May not be < 6.0 or > 8.5	Not applicable	Not to exceed 25 NTU above natural conditions
Water recreation: contact recreation (freshwater)	May not exceed 30°C	DO must be > or = 4.0 mg/l	May not be < 6.0 or > 8.5	In a 30-day period, the geometric mean may not exceed 100 FC/100 ml, and not more than one sample, or more than 10% of the samples if there are more than 10 samples, may exceed 200 FC/100 ml	Not to exceed 5 NTU above natural conditions when the turdbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 15 NTU

Anchor River Watershed

The Anchor River watershed is located north of Homer and Kachemak Bay. This watershed drains over 200 square miles before emptying into Cook Inlet. Populations of four salmon species, as well as Dolly Varden and rainbow trout are documented to rear and spawn in this watershed. Four sites were monitored in 2007-2008 in the Anchor River watershed: Two Moose Creek, Ruby Creek, an unnamed tributary to the Anchor River off of the North Fork Road, and Beaver Creek. Beaver Creek has had the most consistent monitoring over the years, with a total of 93 site visits as of December 2008. All four CEMP sites in the Anchor River watershed provide habitat for salmon and are listed in the Alaska Department of Fish & Games Anadromous Waters Catalog.

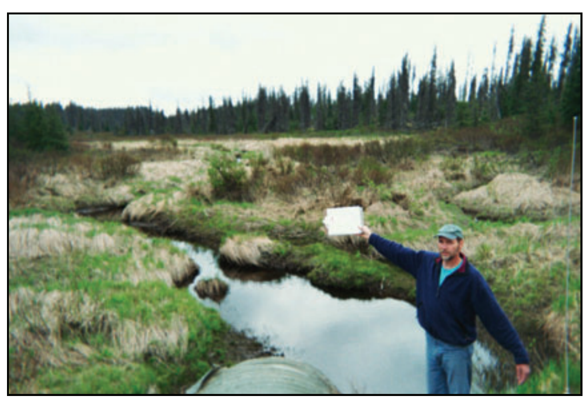
Number of Observations			
	2007	2008	All Years
Two Moose Creek	4	9	38
Ruby Creek	3	4	66
Anchor Tributary	8	9	58
Beaver Creek	12	13	93

Figure 1. Site observations in the Anchor River watershed.

Two Moose Creek
Lynda Elaine, Marcus York (2009)

Ruby Creek
Jeremiah Parsons, Carla Milburn (2009)

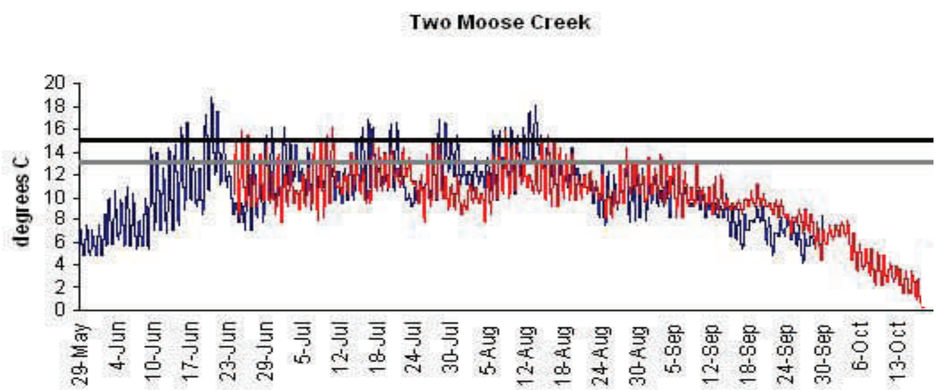
Anchor Tributary
Jim Levine

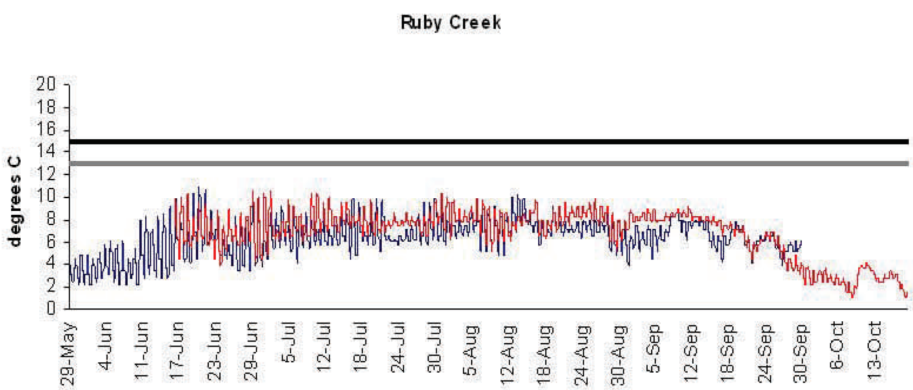


Beaver Creek
Kyra & Neil Wagner

Water Temperature

Temperature data loggers were put in at three Anchor River tributaries—Two Moose Creek, Ruby Creek, and Beaver Creek. No continuous temperature data were taken in Beaver Creek after 2007. Two Moose Creek is listed by the Alaska Department of Fish and Game (ADFG) as providing habitat for spawning coho and king salmon as well as resident steelhead. Water temperature in Two Moose Creek exceeded state water quality standards for spawning areas and egg and fry incubation (13°C) on 59 days in 2007 and on 44 days in 2008. Water temperatures in Two Moose Creek exceeded state water quality standards for migration routes and rearing areas (15°C) on 28 days in 2007 and 9 days in 2008. There were three 6– to 7-day long stretches of temperature exceedences in 2008. The highest temperatures recorded at Two Moose Creek in 2007 and 2008 were 18.7°C and 16.1°C, respectively. The high temperatures in the past have ranged from 19°C in 2004 and 2005 to 17°C in 2006. Ruby Creek is listed as supporting spawning and resident coho salmon as well as a resident Dolly Varden population. There were no exceedences in Ruby Creek in either 2007 or 2008. Upper Beaver Creek may support spawning coho salmon in addition to resident Dolly Varden populations. In 2007, state standards for spawning areas were exceeded at Beaver Creek on 17 days and exceedences for migration occurred on 4 days.





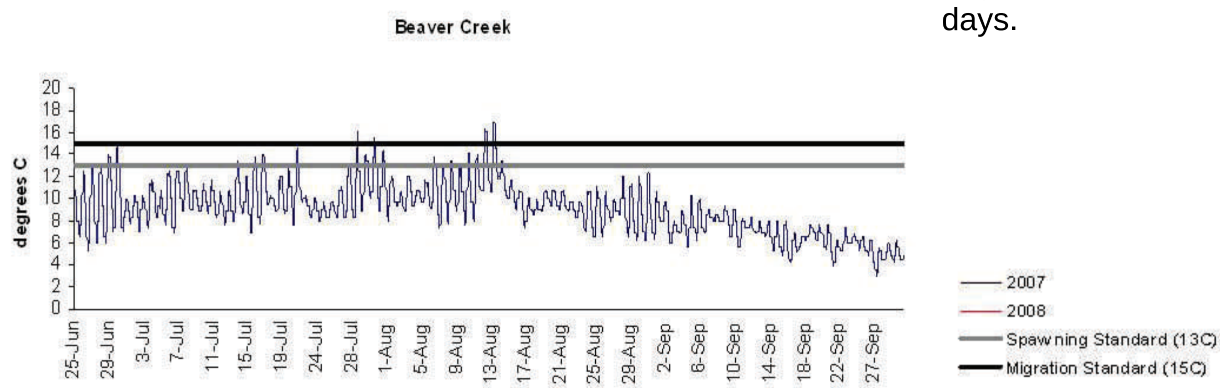


Figure 2. Water temperature recorded every 15 minutes from the Anchor River watershed. Two Moose Creek (5/29/07-9/30/07 and 6/23/08-10/14/08), Ruby Creek (5/29/07-9/30/07 and 6/17/08-10/14/08), and Beaver Creek (6/25/07-9/27/07). Note the different start date (June 26) for Beaver Creek..

Anchor River Watershed

Bacteria & Turbidity

There were no exceedences of bacteria (>100cfu/100mL of *E.coli*) at any CEMP sites in the Anchor River watershed during 2007 or 2008. There were 5 site visits in 2007 (2 at Ruby Creek, 1 at the Tributary, and 2 at Beaver Creek) and 3 in 2008 (1 at Two Moose Creek, 1 at the Tributary, and 1 at Beaver Creek) where the *E.coli* count was 100 cfu/100mL, just at the edge of compliance with water quality standards. In the past Ruby Creek has had one of the highest exceedences rates of all CEMP sites. Two Moose Creek has had consistent low levels of *E.coli.* With continued monitoring we hope to see persisting low levels of bacteria in these Anchor River tributaries.

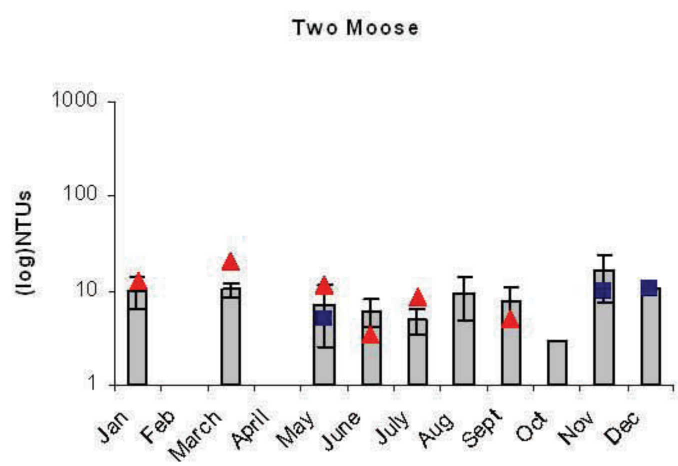
% of visits with bacteria exceedences

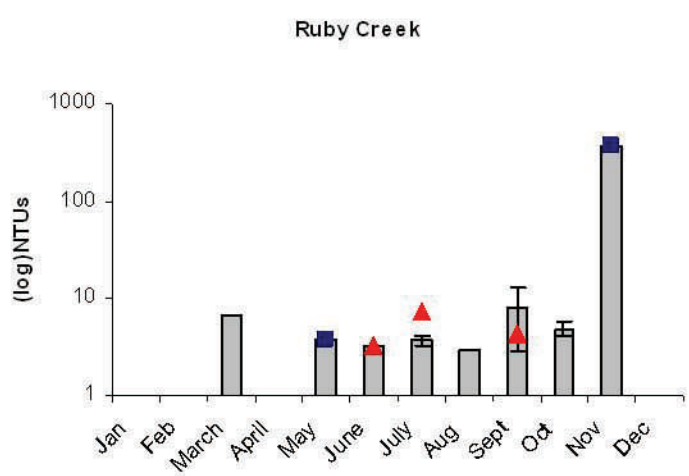
	2007	2008	All Years
Two Moose Creek	0%	0%	6%
Ruby Creek	0%	0%	16%
Anchor Tributary	0%	0%	2%
Beaver Creek	0%	0%	3%

Figure 3. Percentage of water samples where *E.coli* colony counts exceeded the state water quality standards in 2007 and 2008 in the CEMP Anchor River watershed sites.

Turbidity data for Anchor River tributaries are shown below in Figure 4. Gray bars represent the monthly average value for all years of sampling. Error bars represent one standard deviation.

Winter at Beaver Creek with Neil and Kyra.



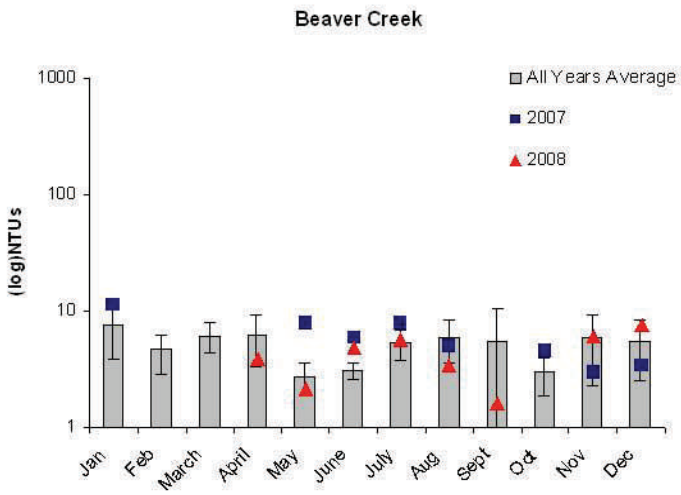


Anchor River Watershed

Blue squares and red triangles are values for each month in 2007 and 2008, respectively. No symbol for the corresponding year indicates that no sampling was done in that particular month and year. For example, there were no samples taken at the 'Anchor Tributary' site in 2008.

Turbidity on Anchor River tributaries is generally low throughout the year, ranging from 2—10 NTUs. The high turbidity values in November 2007 at Ruby Creek (372 NTU), the Anchor Tributary (35 NTU), and Two Moose (10 NTU) were taken during a period of high water after several days of heavy precipitation. During this sampling event it was recorded in the comments from the data sheet at Ruby Creek that, "Bank flooded ~10 feet high".

Anchor River Tributary, November 2007. Photo: Jim Levine



While regular monitoring of turbidity helps detect trends that might indicate increasing erosion, turbidity is closely related to stream volume and velocity (stream flow) and should be looked at in relation to these factors. CEMP does not currently monitor flow levels or discharge in its streams; thus a thorough evaluation of turbidity data is not possible.

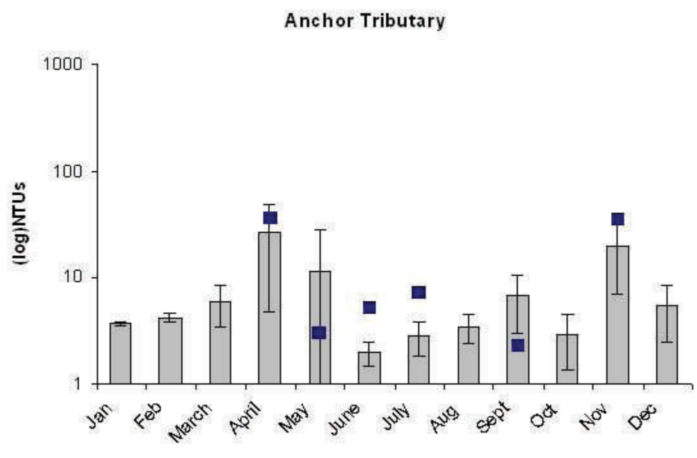


Figure 4. Average turbidity (gray bars) for all years of sampling by month in CEMP Anchor River watershed streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Turbidity is measured in nephelometric turbidity units (NTUs) and are graphed here as the log of the NTU value. Error bars represent standard deviation.

Anchor River Watershed

Conductivity & pH

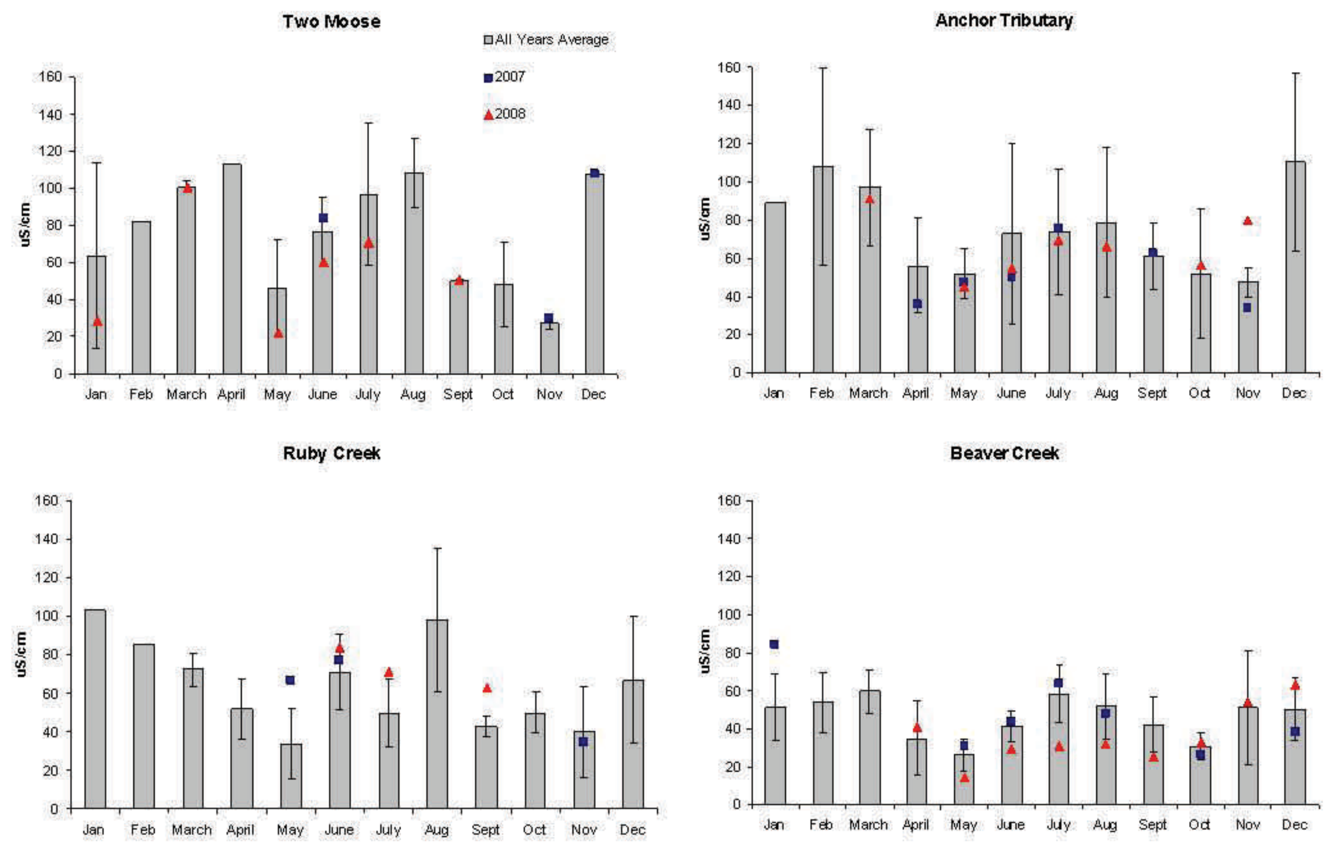


Figure 5. Average conductivity (gray bars) for all years of sampling by month in CEMP Anchor River watershed streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Conductivity is measured as microseimens, abbreviated as µS/cm. Error bars represent standard deviation.

Conductivity values at all Anchor River sites ranged from 50—150 µS/cm. Highest conductivity values occur in the late-winter and early-spring (December-March) and mid-Summer (July-August) as expected when groundwater, which has higher conductivity than surface or rain water, dominates the systems. Periods of higher flow, with increased rain water influence such as May and September through November, generally show lower conductivity values. Conductivity at Beaver Creek remained consistently below 75 µS/cm except in January 2007, when turbidity levels were also higher than average.

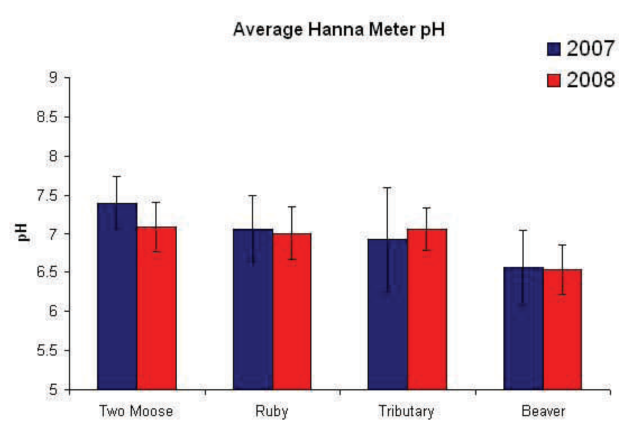


Figure 6. Average pH values for 2007 (blue) and 2008 (red) at Anchor River watershed streams, as measured by the Hanna Combo Meter. Error bars represent standard deviation.

pH values were between 6.5 and 8.5 at Two Moose and Ruby Creeks in 2007 and 2008. Beaver Creek has a lower average pH, 6.5, than the other three Anchor streams. The pH in Beaver Creek was below the state standard of 6.5 four times in 2007 and 6 times in 2008. The Anchor Tributary was below pH standards twice in 2007.

Dissolved Oxygen

# of visits with DO exceedences (< 7.0mg/l)	2007	2008	All Years
Two Moose Creek	0	0	0
Ruby Creek	0	0	1
Anchor Tributary	1	0	4
Beaver Creek	0	0	4

Figure 7. Number of site visits where the dissolved oxygen levels were below the lower limit set by state water quality standards in 2007, 2008, and in all years of sampling in the CEMP Anchor River watershed streams.

Dissolved oxygen can be expressed as a concentration (mg/L) or as a percent saturation. Because of the salmon populations, Anchor River tributaries are compared to Alaska's water quality standards for the growth and propagation of aquatic life and wildlife. Based on these standards, the lower limit for dissolved oxygen is 7.0 mg/l. The Anchor Tributary (on July 22, 2007) was the only CEMP site in the Anchor River watershed that fell below this threshold in 2007-2008.

Dissolved oxygen saturation tends to be lower in Beaver Creek than in the other Anchor River tributaries—Beaver Creek also has the largest consistent variation in dissolved oxygen saturation values from month-to-month, ranging from 50% to 85%. Lowest DO Saturation tends to occur in the spring and winter when often times samples are taken through holes cut in the ice.

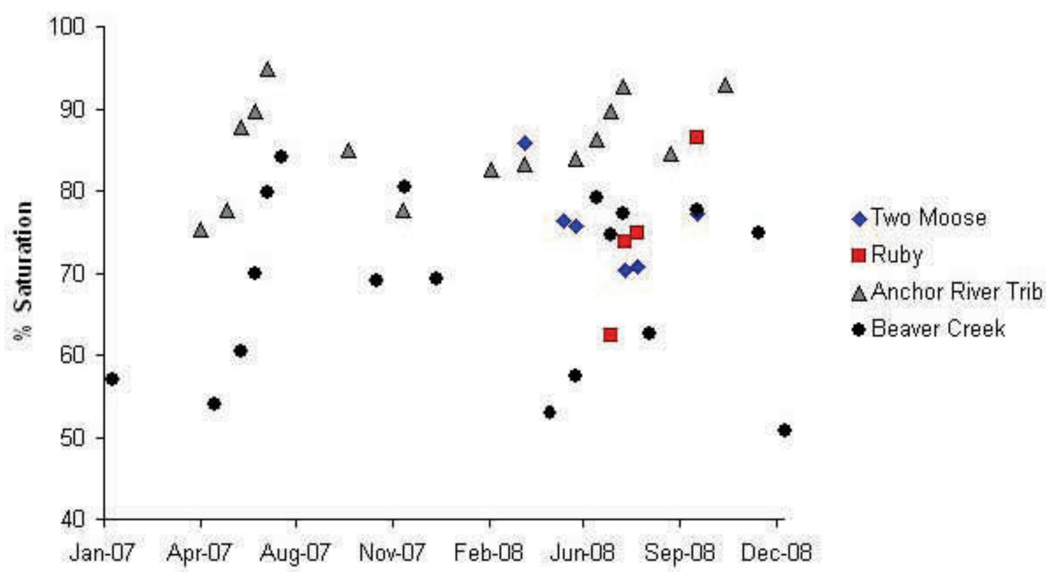


Figure 8. Dissolved oxygen saturation levels in Anchor River watershed CEMP streams between 2007 and 2008. DO saturation indicates how much oxygen is in water relative to how much the water could hold at a given temperature.

Diamond Creek Watershed

Diamond Creek is located northwest of Homer City limits. It runs east to west for approximately 5 miles, originating in the upper West Hill area and draining 5.35 square miles of land before emptying into Cook Inlet. It was known to support Dolly Varden and a population of beavers before the 2002 floods. Diamond Creek is not currently listed as supporting anadromous fish populations, however small fish have been seen in the stream. This watershed acts as a wildlife corridor and is the center of a highly-used ski and hiking trail system. Diamond Creek runs adjacent to the Homer Baling Facility (the local landfill). There are currently 2 sites monitored in the Diamond Creek watershed, one above and one below the landfill site. CEMP uses the state water quality standards for contact recreation (bacteria) and for the growth and propagation of fish, aquatic life, and wildlife populations when looking at water quality data from Diamond Creek sites.

Number of Observations

	2007	2008	All Years
Above the landfill	9	10	96
Below the landfill	1	7	69

Figure 9. Site observations in the Diamond Creek watershed.

Diamond Creek above the landfill
Tom Collopy & Mary Frische

Diamond Creek below the landfill
Jonas Akers, Lee Dewees (2009)

Water Temperature

A temperature data logger was put in Diamond Creek, below the landfill, in both 2007 and 2008 from June 4 to September 30, 2007 and from June 26 to October 21, 2008. The average water temperature in 2007 was 7.6°C and in 2008 was 7.3°C. The state water quality standards for spawning areas and egg and fry incubation were exceeded on one day, June 20, in 2007 with temperatures of 13.8°C. Currently, however, there are no documented fish populations in Diamond Creek. The temperature limit for general aquatic life and wildlife habitat is 20.0°C and was not exceeded during 2007 or 2008.

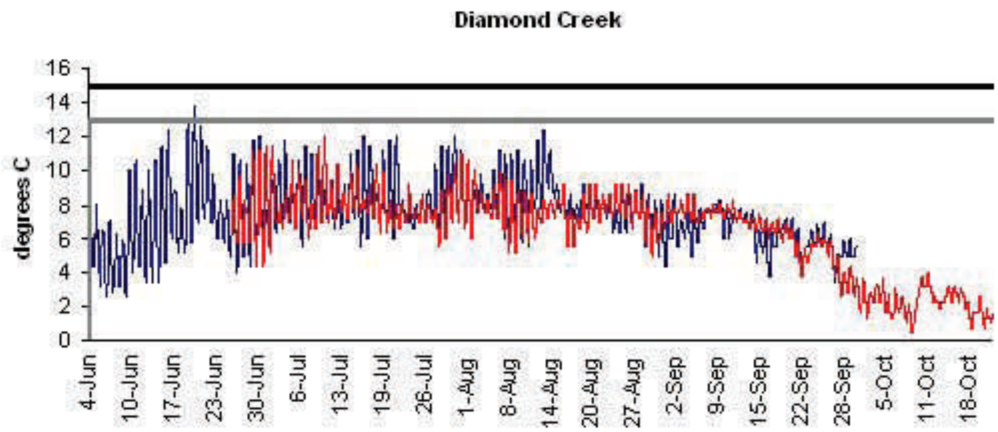


Figure 10. Water temperature recorded every 15 minutes from below the landfill in Diamond Creek (6/4/07-9/30/07 and 6/26/08-10/21/08).

The Sea to Ski Triathalon is held in part on the trails in the Diamond Creek Watershed.
Photo from the Homer News, 04/03/03

Diamond Creek Watershed

Bacteria & Turbidity

Diamond Creek watershed is a popular recreational area and, although contact recreation in Diamond Creek isn't a typical activity, it is not entirely unlikely. To be safe CEMP monitors Diamond Creek for bacteria under Alaska water quality standards for contact recreation. Levels of *E.coli* above state standards (a single sample > 200 CFU/100 ml) were found in Diamond Creek above the landfill during 2 of 7 site visits in 2007. No exceedences occurred in 2008. During the single sampling event at the Diamond Creek site below the landfill in 2007 there was not a bacteria exceedence. In 2008, 1 out of 5 visits had bacteria levels above the state standard. Although the Homer Baling Facility is located in between these sites, years of monitoring have not shown evidence of consistent leeching effects on bacteria in the water. However, more consistent monitoring is important as the Diamond Creek area is utilized by an increasing number of residents and visitors.

% of visits with bacteria exceedences

	2007	2008	All Years
Above the landfill	29%	0%	9%
Below the landfill	0%	20%	10%

Figure 11. Percentage of water samples where *E.coli* colony counts exceeded the state water quality standards in 2007 and 2008 in the CEMP Diamond Creek watershed.

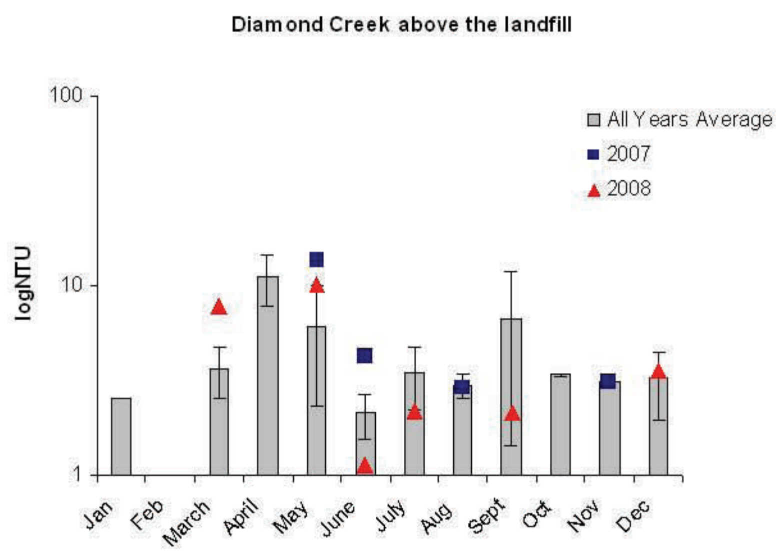
Tom Callopy, at Diamond Creek above the landfill

Diamond Creek, below the landfill

Diamond Creek Watershed

Turbidity in Diamond Creek is generally low. Similar seasonal trends are generally seen above and below the landfill site, however there is more variation in turbidity values in the lower Diamond Creek site, below the landfill, in the spring and fall (when water levels are higher). Turbidity was particularly high in May 2008 below the landfill, where the average turbidity was 30 NTUs. Comments on May 11, 2008 say, “Creek higher than last time. A bit of erosion happening.” This turbidity event, 23 NTUs above the average turbidity level in May during all years of sampling (7 NTUs) was very close to exceeding the water quality standard which states that the turbidity levels are “Not to exceed 25 NTU above natural conditions”. Elevated turbidity levels can result in decreased habitat availability for fish and aquatic invertebrates by increasing the sedimentation in streams.

While regular monitoring of turbidity helps detect trends that might indicate increasing erosion, turbidity is closely related to stream volume and velocity (stream flow) and should be looked at in relation to these factors. CEMP does not currently monitor flow levels or discharge in its streams; thus a thorough evaluation of turbidity data is not possible.



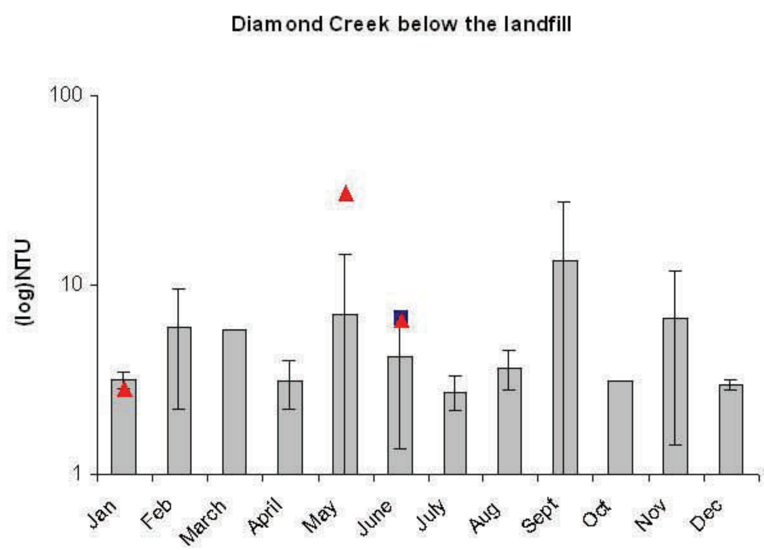
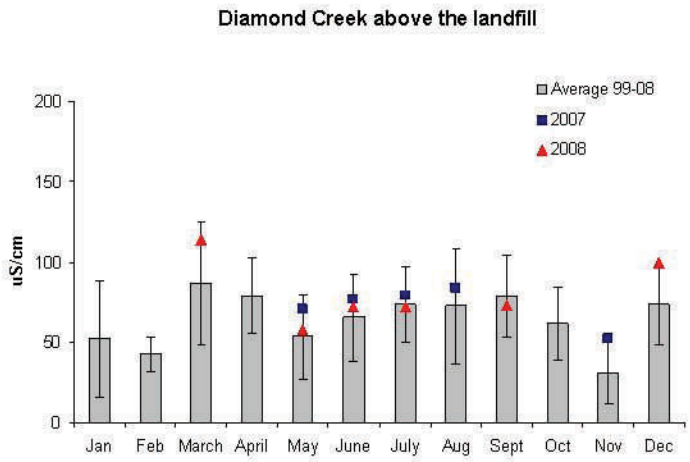
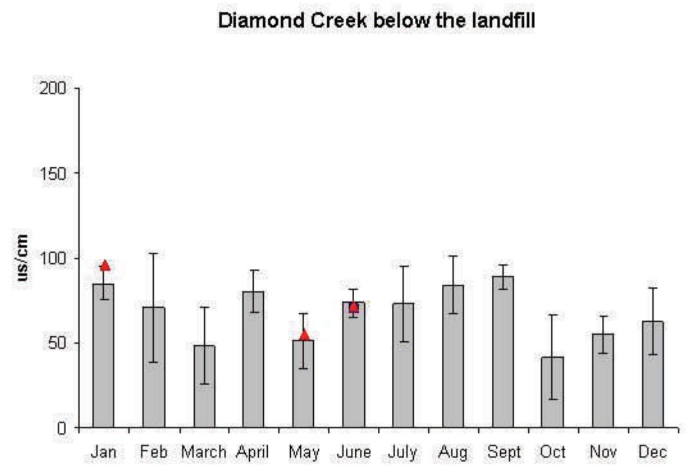


Figure 12. Average turbidity (gray bars) for all years of sampling by month in CEMP Diamond Creek watershed streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Turbidity is measured in nephelometric turbidity units (NTUs) and are graphed here as the log of the NTU value. Error bars represent standard deviation.

Diamond Creek Watershed

Conductivity & pH





Both Diamond Creek CEMP sites have conductivity levels that range from 50—100µS/cm. Similar seasonal trends are seen at both sites, with higher conductivity levels in the late spring (March-April) and again in the early fall (August-September). Increases in conductivity can be generally attributed to either decreased influence from surface and rain water (and a corresponding increase in groundwater influence), or increased runoff from impervious surfaces such as pavement.

Figure 13. Average conductivity (gray bars) for all years of sampling by month in CEMP Diamond Creek watershed. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Conductivity is measured as microseimens, abbreviated as µS/cm. Error bars represent standard deviation.

The average pH in 2007 above the landfill was 7.3; in 2008 the average pH was 6.0. The colorimetric pH averaged 6.7 throughout 2008; this measure of pH is more subjective than the Hanna meter but can be used as a quality assurance check. We will continue to monitor pH at this site to track any potential long-term changes in pH. Below the landfill the average pH in 2007 was 7.2; in 2008 the average pH was 7.0. There were no pH exceedences below the landfill in 2007 or 2008.

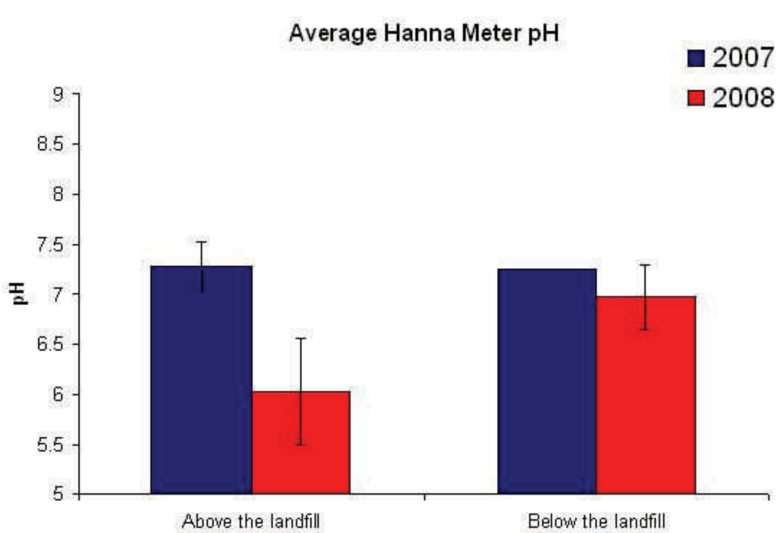


Figure 14. Average pH values for 2007 (blue) and 2008 (red) at Diamond Creek streams, as measured by the Hanna Combo Meter. Error bars represent standard deviation.

Dissolved Oxygen

Dissolved oxygen can be expressed as a concentration (mg/L) or as a percent saturation. Throughout all years of CEMP sampling at Diamond Creek, there have been no exceedences of dissolved oxygen levels below the state standards. Above the landfill DO levels in 2007 and 2008 ranged from 9.1—12.7 mg/l. Below the landfill the amount of dissolved oxygen in the water ranged from 8.3—12.1 mg/l.

# of visits with DO exceedences (< 7.0mg/l)			
	2007	2008	All Years
Above the landfill	0	0	0
Below the landfill	0	0	0

Figure 16. Number of site visits where the dissolved oxygen levels were low enough to exceed the state water quality standards in 2007, 2008, and in all years of sampling in Diamond Creek.

Dissolved oxygen saturation has been generally lower below the landfill, but still has ranged from 70—90%. In May 2008, a time with high water levels and correspondingly high turbidity, dissolved oxygen saturation below the landfill fell to 60%. By the end of May and the beginning of June DO saturation was back up to about 75%.

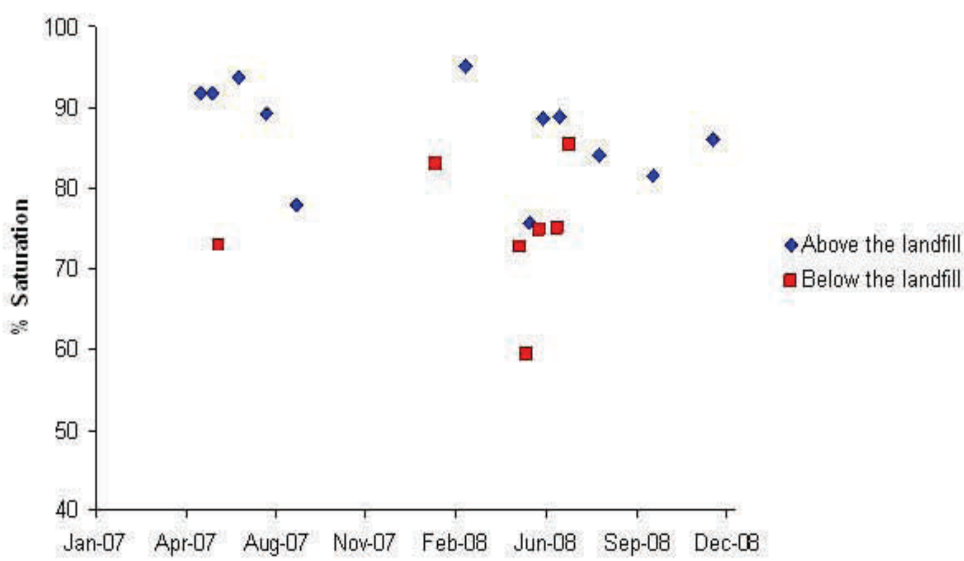


Figure 17. Dissolved oxygen saturation levels in Diamond Creek CEMP Streams between 2007 and 2008. DO saturation indicates how much oxygen is in water relative to how much the water could hold at a given temperature.

City Streams

CEMP monitors 4 streams within Homer City limits: Bidarka Creek, Woodard Creek, Palmer Creek, and Miller Creek. Bidarka Creek runs south from Highland Drive parallel to West Hill Road until crossing under the Sterling Highway and emptying into Kachemak Bay. Woodard Creek is an urban stream that flows approximately 2 miles through downtown Homer before emptying into Kachemak Bay. At many spots it is routed underground through Homer's commercial district. Palmer Creek is part of the Beluga Slough watershed, draining into Kachemak Bay at Bishop's Beach. Located just east of downtown Homer, the Slough is the largest parcel of undeveloped land in town. Beluga Slough is recognized to be important feeding and stopover habitat for migrating waterfowl and shorebirds. Miller Creek is the largest of several small streams that flow off the Homer Bench and into Kachemak Bay at the Miller's Landing area. Miller Creek drains approximately 0.35 square miles. All four streams run through fairly dense residential areas and have been used by kids for playing. CEMP uses the state water quality standards for contact recreation (bacteria) and for the growth and propagation of fish, aquatic life, and wildlife populations when looking at water quality data from City streams sites.

Number of Observations

	2007	2008	All Years
Bidarka Creek	15	16	89
Woodard Creek	9	14	90
Palmer Creek	11	14	47
Miller Creek	12	11	97

Figure 18. Site observations in the CEMP City streams.

Bidarka Creek
Frank Vodersaar

Woodard Creek @ Pratt
Will Schlein, Heather Beggs

Palmer Creek
Karen West, Laura Brooks

Miller Creek
Lani Raymond, Duane Howe, Bob Burns (2009), Judi Nestor (2009)

Water Temperature

A temperature data logger was put in Woodard Creek, behind the Pratt Museum, in both 2007 and 2008 from May 29 to September 30, 2007 and from June 16 to October 17, 2008. The average water temperature in 2007 was 10.1°C and in 2008 was 9.4°C. The maximum temperature in 2007 was 14.6°C and in 2008 was 13.5°C.

The state water quality standard for aquatic life is 20°C. Woodard Creek had no exceedences of this standard in 2007 or 2008.

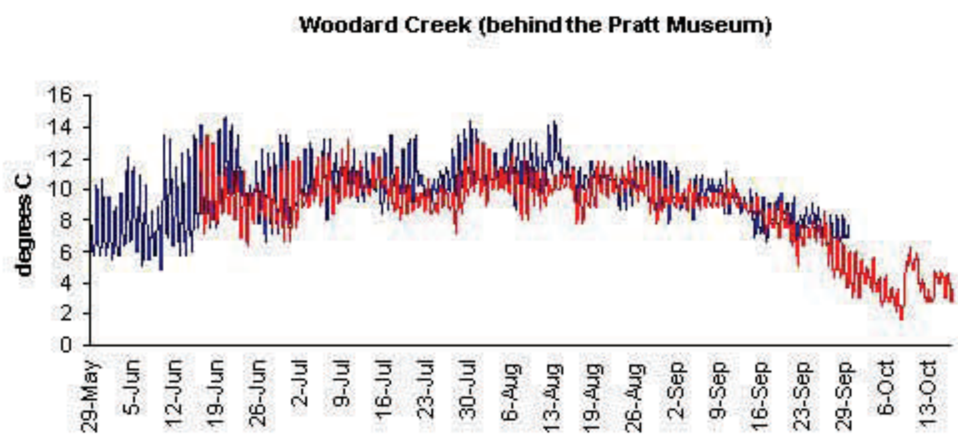


Figure 19. Water temperature recorded every 15 minutes from Woodard Creek, behind the Pratt Museum (5/29/07-9/30/07 and 6/16/08-10/17/08).



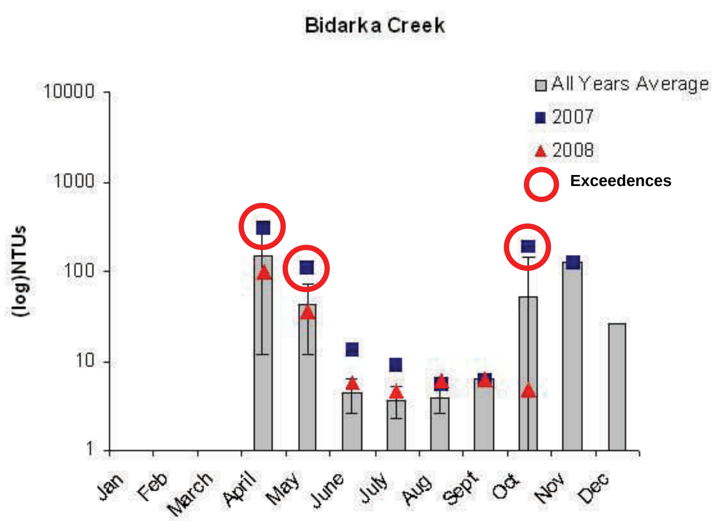
City Streams

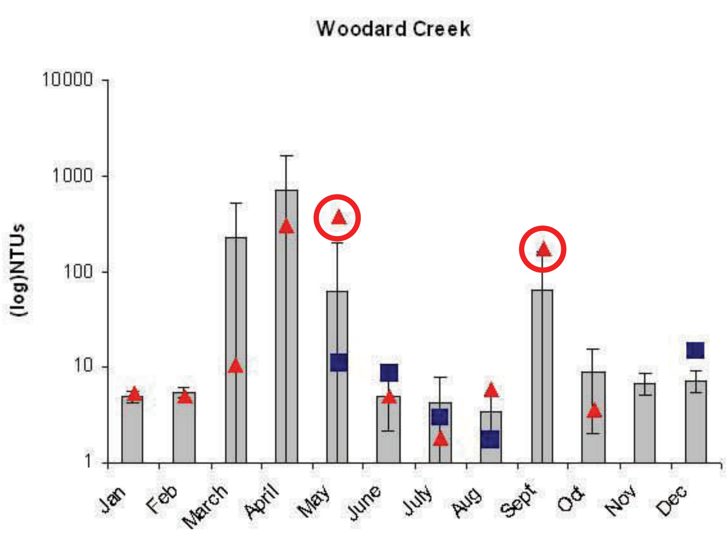
Bacteria & Turbidity

In all of the City streams that CEMP monitors, there were fewer visits with high bacteria levels in 2008 than in 2007 or in all years of sampling. Palmer Creek, flowing out of Bear Canyon and into Beluga Slough, has consistently higher bacteria counts than the other city streams. In 2008, Woodard Creek had no bacteria exceedences—a significant decrease from nearly 40% of visits having exceedences in 2007.

% of visits with bacteria exceedences			
	2007	2008	All Years
Bidarka Creek	0%	9%	14%
Woodard Creek	13%	0%	14%
Palmer Creek	9%	8%	14%
Miller Creek	0%	0%	16%

Figure 20. Percentage of water samples where *E.coli* colony counts exceeded the state water quality standards in 2007 and 2008 in the CEMP City Streams.

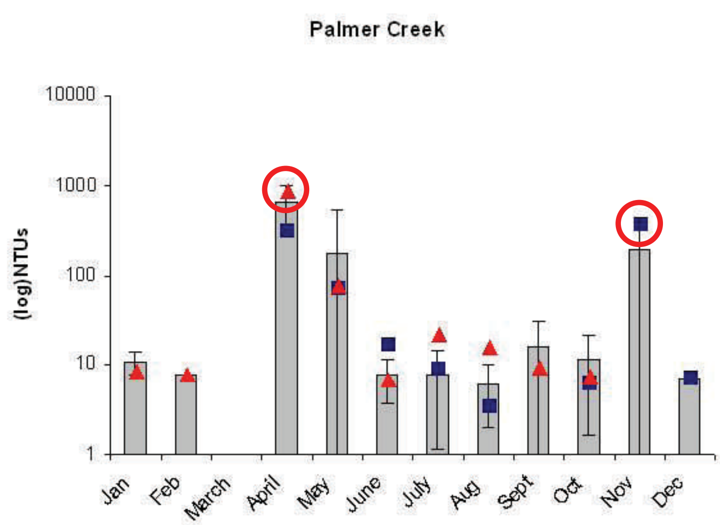


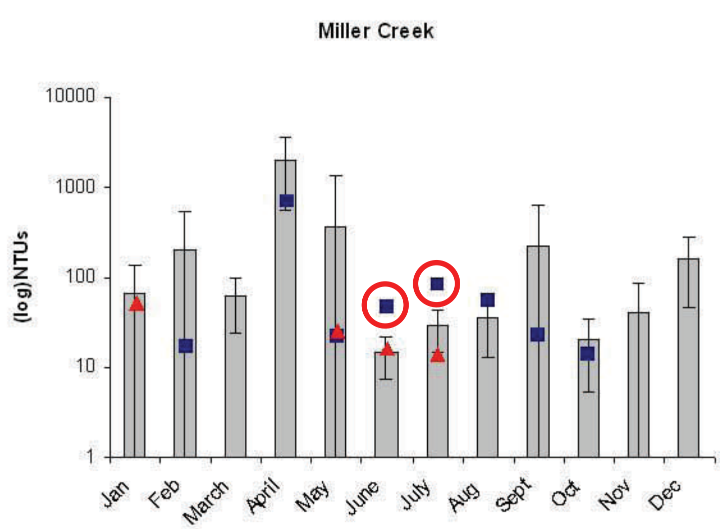


City Streams

City streams have consistently higher turbidity values than any other CEMP streams. There were 6 exceedences of turbidity water quality standards in 2007 and 4 in 2008 from all CEMP sites. All of the 2007 exceedences were in City streams, and 3 of the 4 exceedences in 2008 were also in City streams. This is likely due to the higher percentage of impervious cover in the corresponding watersheds, and therefore higher urban runoff especially during storm events. The spring and fall showed peaks in turbidity at all four streams in 2007 and 2008, similar to patterns we've seen in these streams over the years. Miller Creek, just east of Kachemak Drive on the way out East End Road, has the highest average year-round turbidity, with many months having average turbidity values above 100 NTUs. High turbidity is often correlated with decreases in dissolved oxygen and potentially increased sediment loading in the streambed. Both of these conditions can lead to decreases in habitat for aquatic insects.

While regular monitoring of turbidity helps detect trends that might indicate increasing erosion, turbidity is closely related to stream volume and velocity (stream flow) and should be looked at in relation to these factors. CEMP does not currently monitor flow levels or discharge in its streams; thus a thorough evaluation of turbidity data is not possible.





Photos on facing page:
Miller Creek, looking downstream towards East End Road, in 2004 (top) and in 2006 (bottom).

Figure 21. Average turbidity (gray bars) for all years of sampling by month in CEMP City streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Turbidity is measured in nephelometric turbidity units (NTUs) and are graphed here as the log of the NTU value. Error bars represent standard deviation.

City Streams

Conductivity & pH

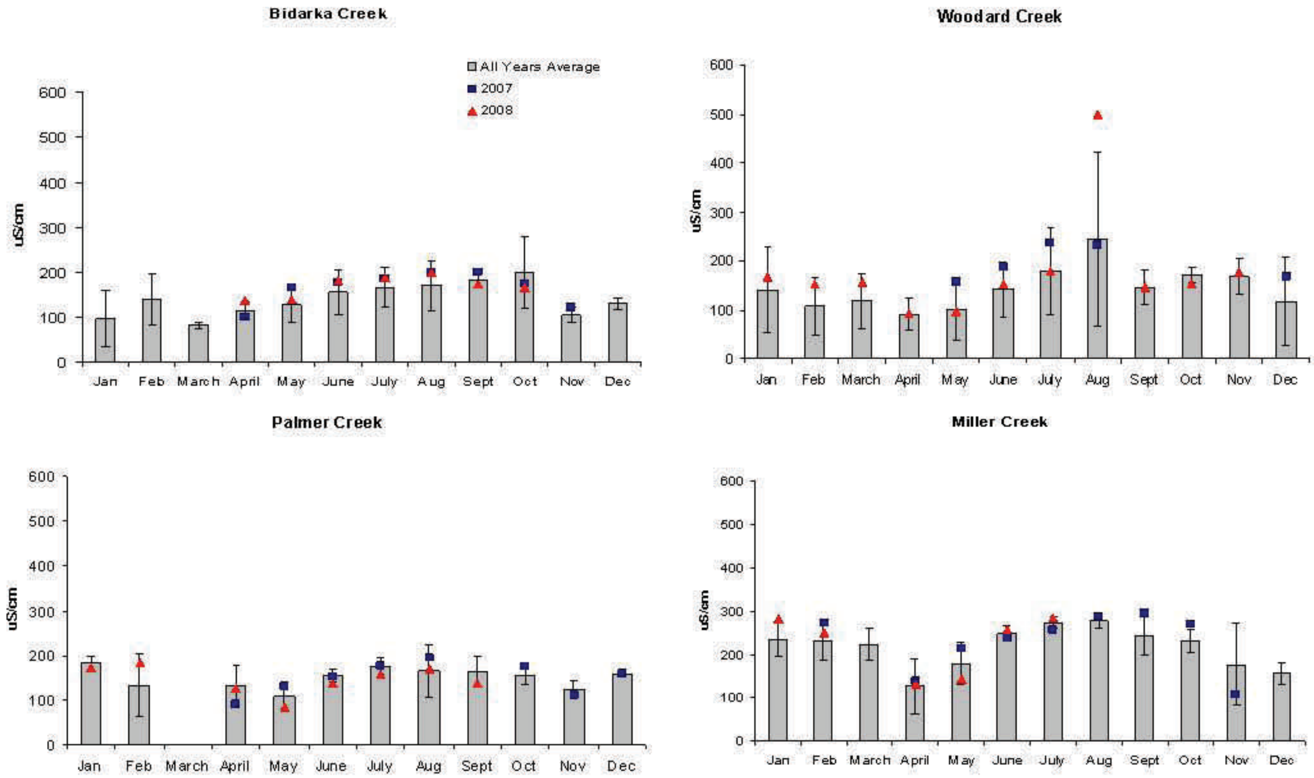


Figure 22. Average conductivity (gray bars) for all years of sampling by month in CEMP City streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Conductivity is measured as microseimens, abbreviated as µS/cm. Error bars represent standard deviation.

Conductivity at City streams ranged from 100 to 300 µS/cm. Conductivity at Woodard Creek was notably high in August 2008. The summer of 2008 was a particularly wet and rainy summer. Between June and August the Homer area received nearly 5 inches of rain which was almost twice as much as in 2007, but less than in 2006 when summer precipitation was over 6 inches. High conductivity is often correlated with areas of impervious surfaces, such as the roads and parking lots surrounding many of our city streams, that can introduce urban runoff during rain events into streams.

pH values averaged around 7.0 at all City sites in both 2007 and 2008. There were no significant differences in pH between these years at any site.

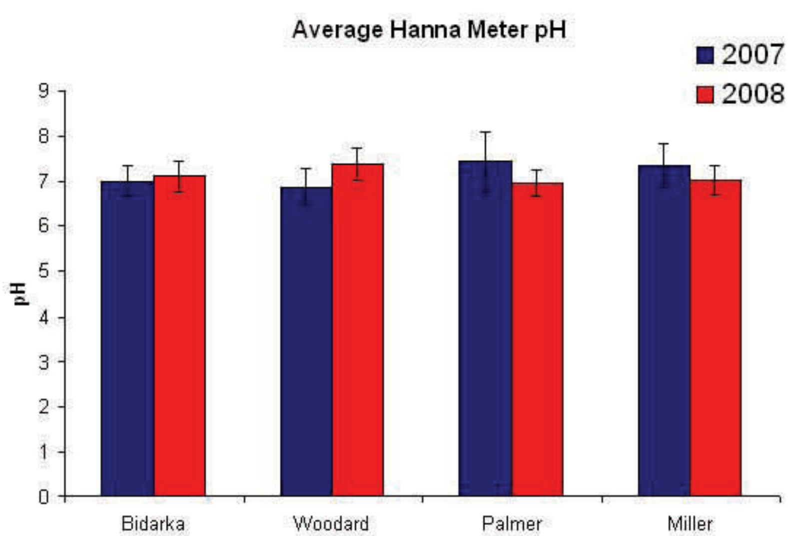


Figure 23. Average pH values for 2007 (blue) and 2008 (red) at CEMP City streams, as measured by the Hanna Combo Meter. Error bars represent standard deviation.

Dissolved Oxygen

Dissolved oxygen can be expressed as a concentration (mg/L) or as a percent saturation. There were no dissolved oxygen exceedences in 2008 in any of the four City streams monitored as part of CEMP. Both Bidarka Creek and Miller Creek had dissolved oxygen readings that were less than 6.0 mg/l in 2007. Both exceedences occurred in the summer. In August 2007, DO averaged 5.4 mg/l at Bidarka Creek. In June 2007, DO was 5.6 mg/l at Miller Creek.

Dissolved oxygen saturation levels fluctuate between 50% and 100% for most of the CEMP streams in the City. Woodard Creek had fairly low DO saturation levels through much of 2008, hovering around 60—80%.

# of visits with DO exceedences (< 7.0mg/l)	2007	2008	All Years
Bidarka Creek	1	0	1
Woodard Creek	0	1	3
Palmer Creek	1	0	2
Miller Creek	3	0	16

Figure 24. Number of site visits where the dissolved oxygen levels were low enough to exceed the state water quality standards in 2007, 2008, and in all years of sampling in the CEMP City streams.

All of the City streams dipped below 70% DO saturation in 2007 and 2008, lower than most of our other CEMP streams. Beginning on June 15, 2008, it was noted that the stream channel had moved at Palmer Creek. High levels of photosynthesis and increased mixing with the air through riffles and small waterfalls could increase dissolved saturation levels above 100%, creating a condition of supersaturation. Water quality standards for dissolved oxygen state that, “The concentration of DO may not exceed 110% of saturation in any samples collected.” Palmer Creek exceeded this standard twice in 2008, on July 27 (112%) and on August 10 (118%) before dropping again. DO saturation levels in City streams should continue to be monitored.

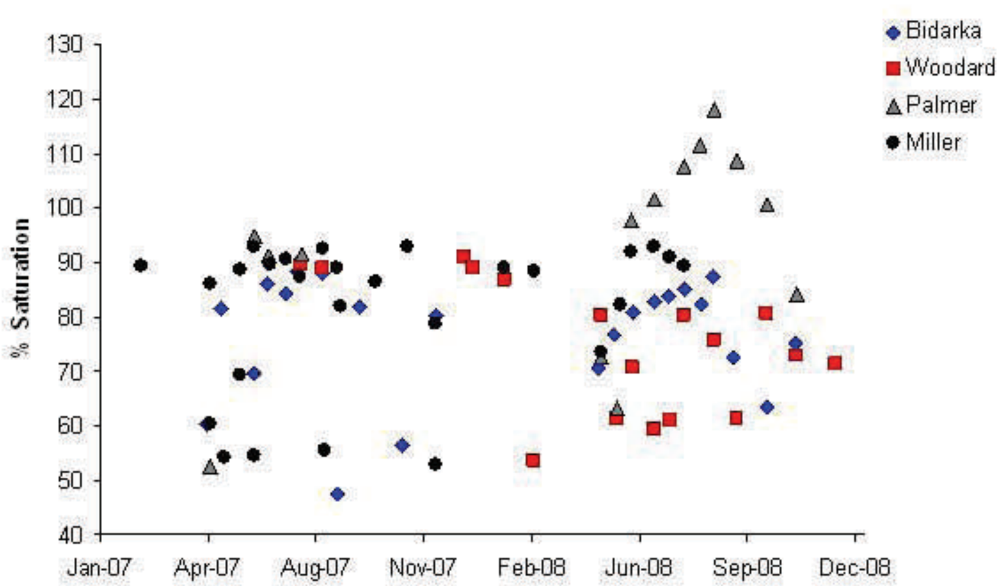


Figure 25. Dissolved oxygen saturation levels in CEMP City streams between 2007 and 2008. DO saturation indicates how much oxygen is in water relative to how much the water could hold at a given temperature.

East End Streams

In 2007-2008, three streams were monitored by CEMP Volunteers out East End Road, east of Homer. Fritz Creek is a rural stream located 7 miles east of Homer. It flows from Skyline Ridge and runs adjacent to Beaver Flats, flowing under East End Road before entering Kachemak Bay. The Fritz Creek watershed encompasses 54 square miles of land, including the Fritz Creek Critical Habitat Area—a regionally significant moose winter range. There is a resident trout population in Fritz Creek and pink salmon are listed by the Alaska Department of Fish & Game as spawning in lower Fritz Creek. Rice Creek is a small stream that flows into Kachemak Bay between Fritz Creek and McNeil Canyon, approximately 10 miles east of Homer. McNeil Creek is located 11.5 miles east of Homer and flows past the McNeil Canyon Elementary School.

Number of Observations

	2007	2008	All Years
Fritz Creek @East End	11	13	128
Rice Creek	5	12	77
McNeil Creek	11	14	78

Figure 26. Site observations in CEMP East End streams.

Fritz Creek
Diana Carbonell, Liz Diament, Mike Gracz, Derek Reynold

Rice Creek
Anne Wieland & Todd Gustafson

McNeil Creek
Scott Miller

Water Temperature

Water temperature was recorded at both Fritz Creek (below East End Road) and McNeil Creek (below the McNeil Canyon School) in 2007 and 2008. Both sites were monitored from May 21, 2007 through September 30, 2007 and from June 25, 2008 through October 17, 2008. There were no temperature exceedences in McNeil Creek either year. Average water temperatures at McNeil Creek in 2007 and 2008 were 8.4°C and 8.5°C.

There were exceedences in Fritz Creek in both 2007 and 2008, with an average temperatures each year (respectively) of 8.1°C and 7.7°C. In 2007, temperatures in Fritz Creek exceeded the state standard for migration on 3 days, July 30, August 12, and August 13. The state spawning standard was exceeded for 17 days in 2007 and 2 days in 2008 (July 10 and July 12).

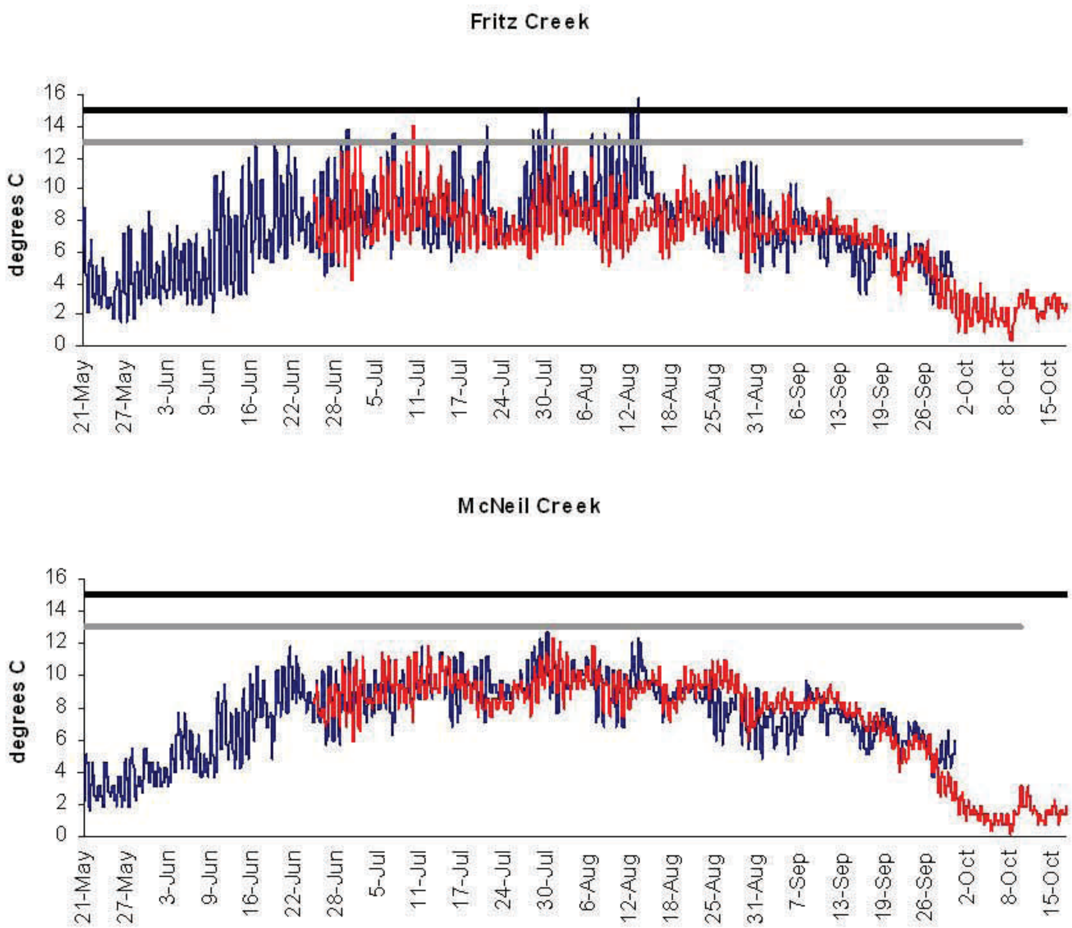
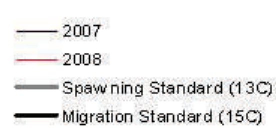


Figure 27. Water temperature recorded every 15 minutes from Fritz Creek at East End Road and from McNeil Creek (5/21/07—9/30/07 and 6/25/08—10/17/08 at both sites).



East End Streams

Bacteria & Turbidity

Rice Creek has had a higher percentage of bacteria exceedences than any other CEMP site through the years. While there were no exceedences at Rice Creek in 2007, several sampling events came close and in 2008, 2 out of 12 visits had bacteria exceedences. During all years of sampling at Fritz Creek, 5% of site visits have had bacteria exceedences. However, in 2008 over 15% of visits had bacteria exceedences. Only Rice Creek and Diamond Creek (below the landfill) had higher exceedence rates than this. Fritz Creek also had the two highest concentrations of bacteria of all CEMP sites on April 2, 2008 with 600 cfu/100mL and on June 29, 2008 with 500 cfu/100mL of *E.coli* . This exceedence event corresponds with the high turbidity levels in Fritz Creek during the same sampling periods. There were no bacteria exceedences at McNeil Creek in either year. The septic system was replaced at McNeil Canyon Elementary School in 2001—since 2002 we have seen low levels of bacteria in the CEMP site at McNeil Creek.

% of visits with bacteria exceedences

	2007	2008	All Years
Fritz Creek @EastEnd	0%	15%	6%
Rice Creek	0%	17%	17%
McNeil Creek	0%	0%	6%

Figure 28. Percentage of water samples where *E.coli* colony counts exceeded the state water quality standards in 2007 and 2008 in the CEMP East End streams.

Fritz Creek in the summer (above) and the winter (right). Mike Gracz is busy in the winter photo digging through ice for a water sample. Harlequin ducks are often seen at this Fritz Creek site, just below East End Road, during the spring and summer.

East End Streams

Fritz Creek and Rice Creek have higher levels of turbidity than McNeil Creek. Turbidity at all three East End streams has been generally higher in the spring and the fall, similar to other CEMP streams in the Kachemak Bay and Anchor River watersheds. In April 2008, Fritz Creek @ East End Road exceeded the water quality standard for turbidity. The April 2008 turbidity value was 150 NTUs, considerably higher than the long-term average of 41 NTUs during the month of April. This exceedences was one of 4 in 2008—all others occurred in CEMP streams within Homer City limits.

While regular monitoring of turbidity helps detect trends that might indicate increasing erosion, turbidity is closely related to stream volume and velocity (stream flow) and should be looked at in relation to these factors. CEMP does not currently monitor flow levels or discharge in its streams; thus a thorough evaluation of turbidity data is not possible.

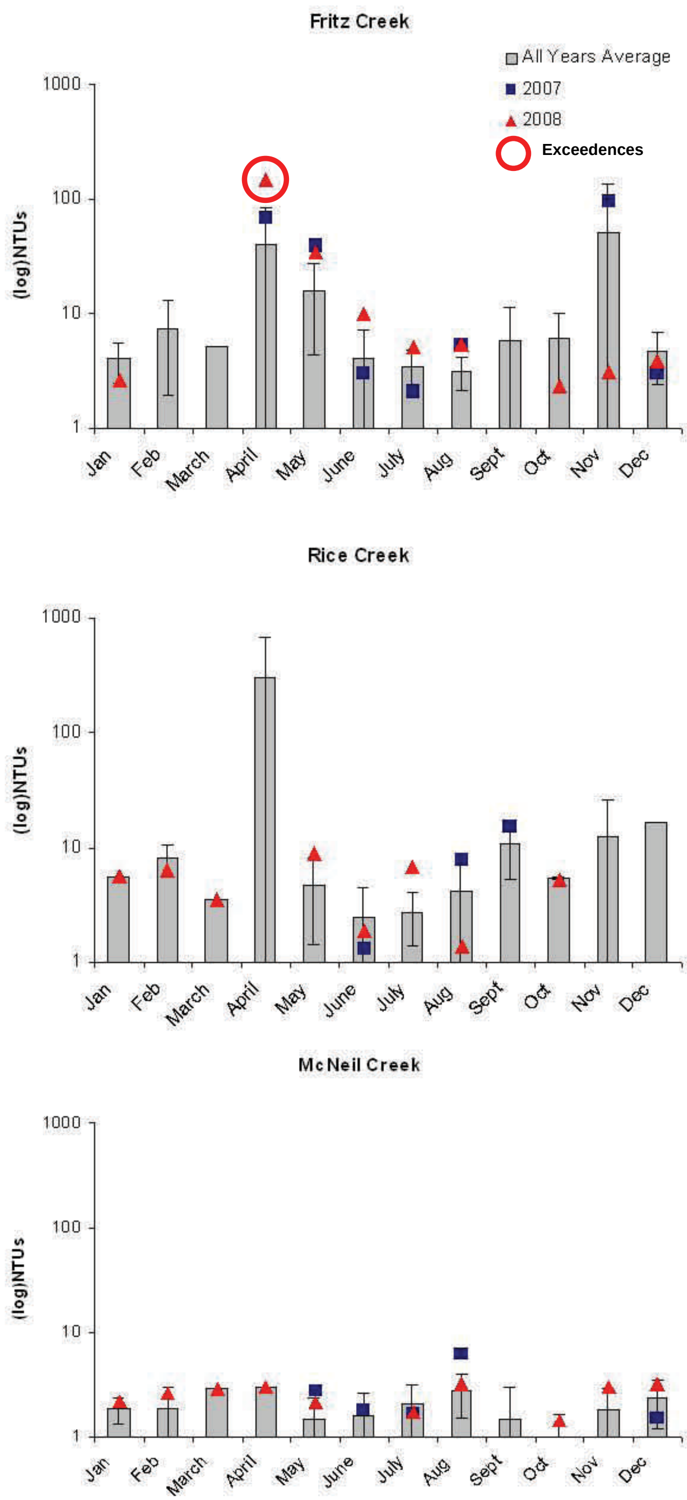
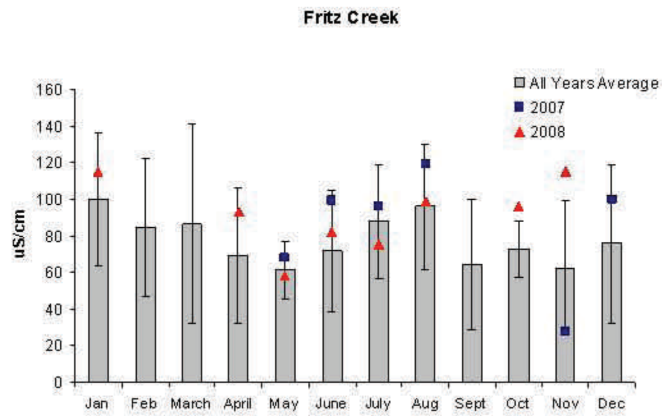
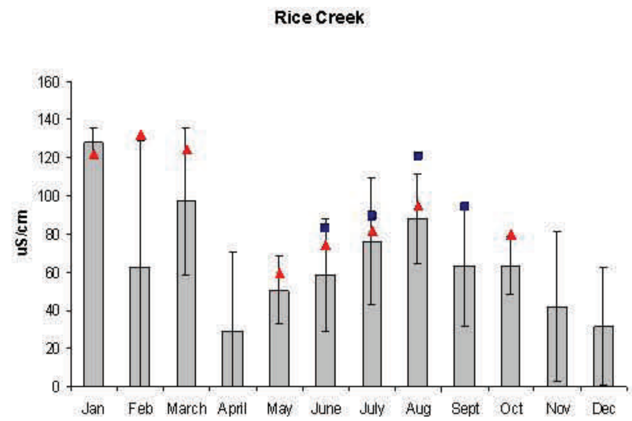


Figure 29. Average turbidity (gray bars) for all years of sampling by month in CEMP East End streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Turbidity is measured in nephelometric turbidity units (NTUs) and are graphed here as the log of the NTU value. Error bars represent standard deviation.

East End Streams

Conductivity & pH





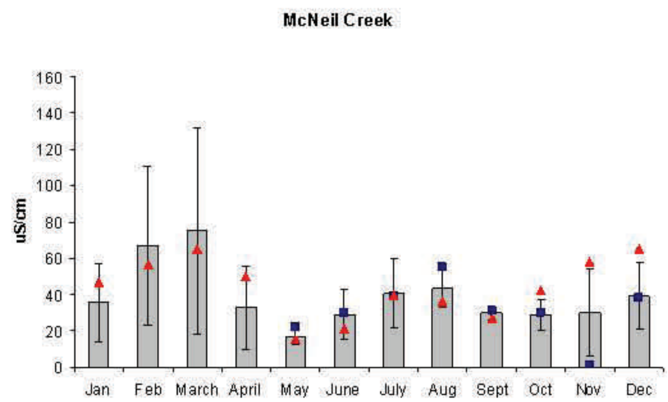


Figure 30. Average conductivity (gray bars) for all years of sampling by month in CEMP East End streams. 2007 (blue squares) and 2008 (red triangles) data are shown by month for each stream. Conductivity is measured as microseimens, abbreviated as µS/cm. Error bars represent standard deviation.

Conductivity values at all East End sites ranged generally from 20—120 µS/cm. Highest conductivity values occur in the early-Spring (February-March) and mid-Summer (July-August), periods of low rainfall when streams are dominated by groundwater which has naturally high conductivity. Conductivity values at McNeil Creek remained fairly consistent, below 50 µS/cm except in the early spring. Fritz Creek has consistently higher conductivity values, possibly due to its close proximity to East End Road and influence from the associated run-off.

pH values were between 6.5 and 7.0 at Fritz Creek and Rice Creeks in 2007 and 2008. McNeil Creek had a lower average pH, 5.6. The 2007-08 average pH at McNeil is lower than the 6.13 average pH for all years at this site (1997-2008). pH exceedences occurred 3 times at Fritz Creek, 11 times at Rice Creek, and at every visit (25 times) to McNeil Creek.

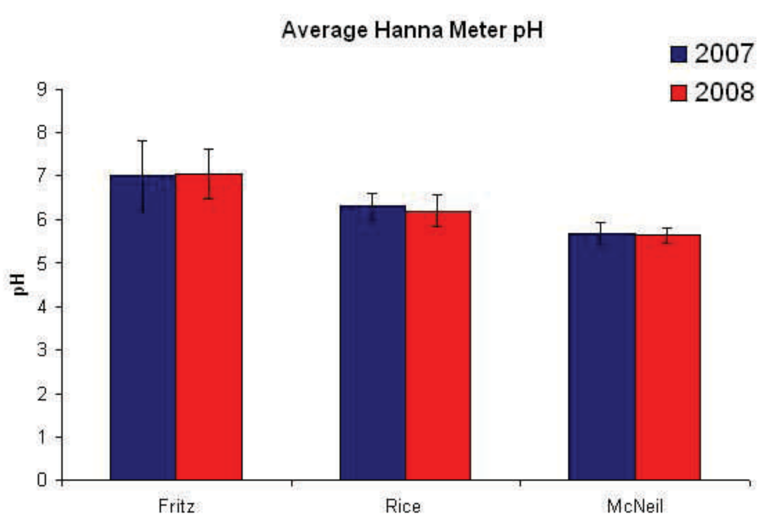


Figure 31. Average pH values for 2007 (blue) and 2008 (red) at CEMP East End streams, as measured by the Hanna Combo Meter. Error bars represent standard deviation.

Dissolved Oxygen

Throughout all years of CEMP sampling at East End streams, there have been no exceedences of dissolved oxygen levels below the state standards at Fritz Creek, 2 exceedences at Rice Creek (April 2004 and July 2006) and 1 exceedences at McNeil Creek (July 2004). In May 2008, a time with high water levels and correspondingly high turbidity values, the dissolved oxygen saturation fell to 60%.

# of visits with DO exceedences (< 7.0mg/l)	2007	2008	All Years
Fritz Creek @EastEnd	1	1	2
Rice Creek	1	0	4
McNeil Creek	0	0	2

Figure 32. Number of site visits where the dissolved oxygen levels were low enough to exceed the state water quality standards in 2007, 2008, and in all years of sampling in the CEMP East End streams.

Dissolved oxygen saturation was consistently between 80—90% at McNeil Creek. Saturation fluctuated more at Fritz and Rice Creeks, with levels the lowest at Rice Creek in 2007. During July and August of 2007, water levels were very low. Anne noted in her comments on August 12, 2007, "Stream barely flowing—mostly small puddles…". By the fall of 2007, rains had come and restored the stream flow. In September, 2007 Anne noted, "Rain poured until 4PM. This summer was one of only 4 since 1980 when Dave Stinchcomb well did not dry up."

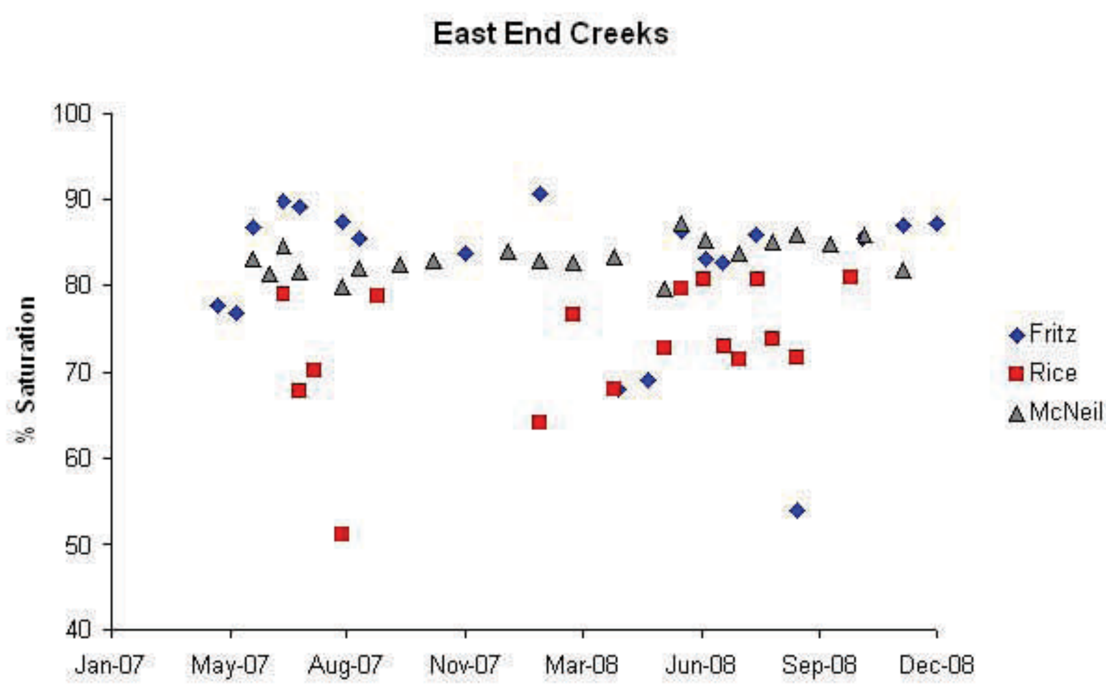


Figure 33. Dissolved oxygen saturation levels in CEMP East End streams between 2007 and 2008. DO Saturation indicates how much oxygen is in water relative to how much the water could hold at a given temperature.

Baseline Status

Anchor River Watershed

Although CEMP has been monitoring Two Moose Creek, Ruby Creek, and the Anchor Tributary for 8 to 13 years, there are few years of full datasets at any of these sites. Beaver Creek has had 7 consistent years, from 2003 –2009, of full years of data (n>12). In 2009 CEMP resumed monitoring Bridge Creek at Easy Street (above the reservoir). This site has been monitored on and off since 1997 and has 2 years of full datasets, 2004 and 2005. Future monitoring will focus efforts on these important salmon streams that flow into the Anchor River. In 2010 we will place a temperature logger back at Beaver Creek and continue bioassessments at this site. Temperature monitoring and bioassessments will continue at Two Moose Creek and Ruby Creek.

Diamond Creek Watershed

Since 1997 CEMP has monitored 8 sites at different times along Diamond Creek for a total of 407 observations. Two sites, above and below the landfill, are still being monitored. Lower Diamond Creek sites were monitored consistently from 1997 to 2000. Monitoring above and below the landfill began in 1999/2000 and has continued, somewhat sporadically, through 2009. Below the landfill we have 3 years of full datasets and above the landfill we have 5 (both counting 2009). The Diamond Creek watershed is a local watershed that CEMP has been focused on since its beginnings. We are looking ahead to writing baseline reports on this watershed and hoping to get a few more years of consistent data above and below the landfill. Temperature monitoring and bioassessments will continue at the lower Diamond Creek site in 2010.

City Streams

Monitoring at Bidarka Creek began in 1996 and has been monitored yearly since then except from 2001-2004. During the past four years (2006-2009) full datasets have been collected at Bidarka Creek. CEMP will prioritize sampling of Bidarka Creek in 2010 to have a current, full baseline dataset for this site. Four sites along Woodard Creek have been monitored since 1997. Active sites on Woodard Creek are located by the Pratt Museum and above the hospital on the upper reach of the stream. While the Pratt site has been monitored every year since 1998, there are only 2 years of full datasets—2008 and 2009. Upper Woodard Creek has a single year of full data—2002. CEMP will continue to monitor these sites to provide more years of full datasets to complete a baseline report for Woodard Creek. Temperature monitoring and bioassessments will continue at the Pratt site on Woodard Creek.
Palmer Creek has been monitored consistently since 2005. We have three years of full datasets for Palmer Creek, and will continue to focus efforts on baseline data collection at this site. Two main sites have been monitored by CEMP on Miller Creek—one above and one below East End Road. Monitoring at these sites began in 2002. We have resumed monitoring at Miller Creek above East End Road and currently have 3 full years of data for this site. Miller Creek below East End Road has 5 years of full datasets from 2003-2007. We will focus on the next two years of data collection above East End Road for a full suite of baseline data at these sites on Miller Creek. In 2010, CEMP will begin monitoring a site just above the outflow to Mud Bay below Northern Enterprise boatyard. This site was monitored from 1996-2001, though only has 1 year of full data.

East End Streams

Three sites on Fritz Creek have been monitored by CEMP: Upper Fritz Creek (2002-2007), Fritz Creek below East End Road (1997-2009), and Lower Fritz Creek (2006 & 2009). Fritz Creek at East End Road has a remarkable 9 years of full datasets! Huge kudos to Diana, Mike, Liz, and the others who have been some of our most dedicated and consistent monitors. Lower Fritz Creek and Upper Fritz Creek have been sporadically monitored, and future efforts will focus more on these sites for a robust baseline dataset on the Fritz Creek watershed. Several sites on Rice Creek have been monitored by Anne Wieland regularly since 1999, with a total of 218 site visits. Her main site, located at the Stinchcomb's well, has 3 years of full datasets since 2005, and a total of 98 site visits since 1999. We will continue to collect data on this site to complete a baseline survey of this system. McNeil Creek, just below McNeil Canyon Elementary School, has been monitored since 1997. There have been 89 site visits to McNeil Creek and we have 1 year of complete data (2008) at this site

Other Monitoring Programs at Inletkeeper

Aquatic Insect Sampling

Twice a summer, in June and again in August, Inletkeeper staff train citizen scientists to collect, identify, and record the abundance and diversity of aquatic insects in a selection of our CEMP streams. The numbers and types of aquatic insects, affectionately referred to as 'bugs', in our streams can tell us a great deal about water quality. We use these data, along with our CEMP water chemistry data, to look at changes and trends over time within the Kachemak Bay and Anchor River watersheds. Volunteers are always needed for bug sampling—please contact the Monitoring & Outreach Coordinator at Inletkeeper for more information and to sign up!

BEACH Sampling

In response to the increasing incidence of water-borne illnesses at public beaches, the U.S. Congress passed the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000. The BEACH Act provides support for state programs to reduce the risk to beach users from contact with fecal-contaminated water. Under the BEACH Act, the Alaska Department of Environmental Conservation (ADEC) has received grant funding from the U.S. Environmental Protection Agency (EPA) to create an Alaska BEACH Program. Alaskan communities such as Homer participate in the BEACH Program, taking a pro-active approach and demonstrating a commitment to ensuring public health. Cook Inletkeeper works with ADEC to monitor beaches for bacteria in the Homer area. We monitor from April through August, once per week, and volunteers are always needed!

Salmon Stream Temperature Network

For the past seven years, Cook Inletkeeper has documented warm water in local salmon streams, with summer temperatures routinely exceeding state water quality standards established to protect spawning and migrating fish. High stream temperatures make fish increasingly vulnerable to pollution, predation and disease. State and federal agencies have recognized the importance of Inletkeeper's Stream Temperature Monitoring Network and are supporting its expansion to 48 streams throughout the Cook Inlet watershed. Through this work, Cook Inletkeeper's aims to ensure the biological resilience of salmon streams to a changing climate by protecting and restoring salmon habitat; partnering with organizations to collect and distribute stream water temperature data for all of Cook Inlet; and educating Alaskans about the implications of climate change to the health of salmon and their habitat.

Stream Temperature Monitoring Network data logger locations.

Acknowledgments

None of our work would be possible without the hundreds of citizen scientists who have joined Inletkeeper's Citizens' Environmental Monitoring Program through the years. They have taken time to attend training sessions, yearly recertification, and have gone out into the field in all weather conditions to collect important water quality data from Cook Inlet's streams and estuaries.

Inletkeeper would like to thank Dan Bogan of the University of Alaska Anchorage's Environment and Natural Resources Institute for his invaluable support and training. Dan has volunteered many hours to CEMP and the CEMP Partnership—our program is stronger and the data are better because of it.

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