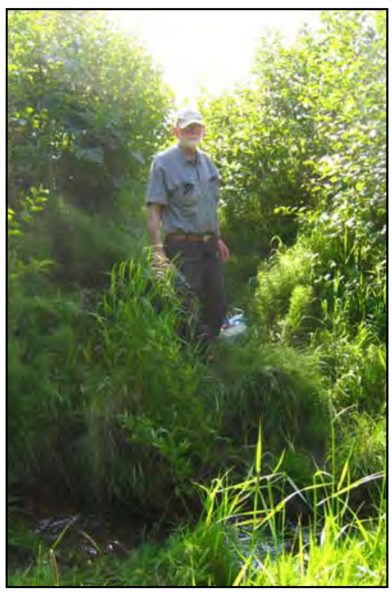
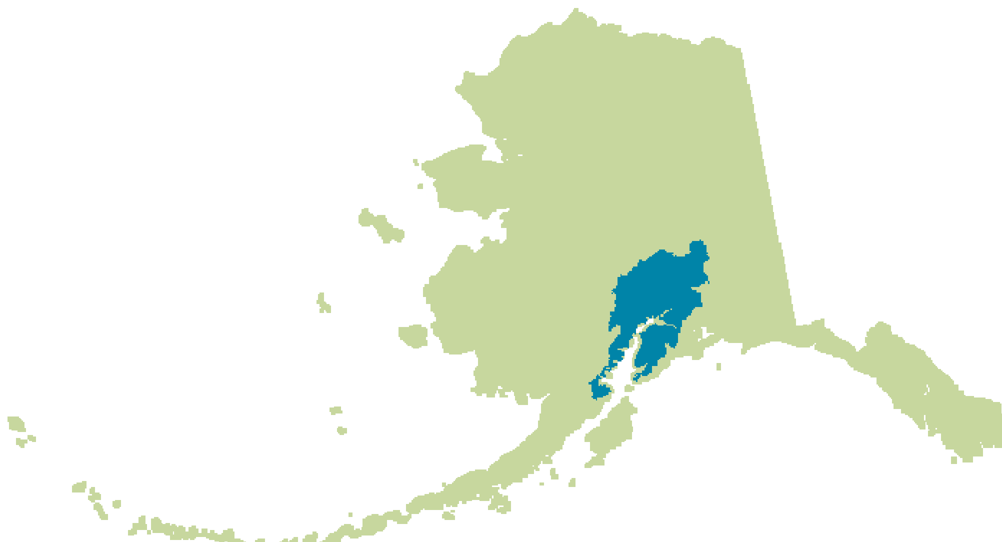
Citizens' Environmental Monitoring Program

Baseline Water Quality Report



Bidarka Creek

1996—2010



Cook Inletkeeper is a community-based nonprofit organization that combines advocacy, outreach, and science toward its mission to protect Alaska's Cook Inlet watershed and the life it sustains.

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INTRODUCTION

Citizens' Environmental Monitoring Program

With nearly a million miles of streams and rivers in Alaska, the lack of baseline water quality information—especially in populated regions such as Southcentral Alaska, home to the vast majority of Alaskans—may result in an inability to provide adequate 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'

Frank Vondersaar sampled water quality at Bidarka Creek from 2005 to 2010. He is one of over 300 volunteers that have collected baseline water quality data through Inletkeeper's CEMP.

Environmental Monitoring Program, known to many by its acronym—CEMP. The Citizens' Environmental Monitoring Program, the first of its kind in Alaska, is designed to meet the need for baseline water quality data for local watersheds around Southcentral Alaska. Baseline data collection is the primary aim of the CEMP model.

Many waterbodies in Alaska have not been polluted, and we rely on these systems to support our fish, wildlife, and human communities. Inletkeeper created the CEMP to provide Alaskans with the tools needed to be active stewards of our water and watersheds for future generations. By training citizen volunteers to monitor water quality we are empowering the community to keep its eyes and ears tuned to changes that may impact and threaten Alaska's water resources.

Baseline Reports

As we complete baseline data collection for a given waterbody, we create a baseline water quality report to compile watershed-specific information. Within these pages you will find background on the CEMP methods and quality assurance measures, GIS analyses of the individual watershed, and the water quality data we've collected through the years. Finally, each report provides suggestions for future monitoring efforts. It is our intention that these reports will become a comprehensive baseline water quality library which will provide landowners, city councils, developers, and communities with valuable information for responsible decision-making.

What are Baseline Data?

A baseline is defined as historical or reference information from which new data can be measured or compared. The Citizens' Environmental Monitoring Program collects baseline water quality data to better understand our current environment in a changing world. Population growth, increased development, and climate change are some of the catalysts for change which can alter the quality of our waterbodies. By collecting baseline data, we can track those changes and make better decisions to protect water quality for future generations. We use the following as guidelines for defining a baseline dataset:

- 5+ years of data with at least 80 site visits
- At least 40 site visits during summer months
- At least 5 site visits during every month of the year that the site was monitored
- 3 years of continuous temperature monitoring (at select sites)
- 6 bioassessment sampling events over at least 3 years (at select sites)

For more information about these guidelines, see the CEMP Effectiveness Report (2003) available online at http://www.inletkeeper.org/CEMP/effectiveness.htm.

Kachemak Bay and Anchor River Watersheds

Inletkeeper's volunteer monitoring program in Cook Inlet has focused on surface water quality 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 that shaped its monitoring program. Cook Inletkeeper's CEMP has trained over 300 volunteer water quality monitors since 1996. As of January 2011, over 2,000 observations have been made in the Kachemak Bay and Anchor River watersheds.

To meet its primary goal of baseline data collection in these watersheds, CEMP monitoring is focused on obtaining 5 or more 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 annual sampling schedule includes 16 site visits; a "complete dataset" has 75%, 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 a baseline dataset if other criteria are met. The map above shows the location of the sites that will have completed baseline datasets by 2014. Baseline reports for these sites will make up the baseline water quality library.

All of the CEMP sites that will have baseline water quality datasets completed by 2014. Baseline reports will be developed as datasets are completed. A full baseline water quality library from the efforts of the Kachemak Bay and Anchor River CEMP is anticipated by 2015.

INTRODUCTION

CEMP Partnership of Southcentral Alaska

The Citizens' Environmental Monitoring Program (CEMP) was created by Cook Inletkeeper to actively engage citizen volunteers in the collection and distribution of important habitat and water quality data. By 1997, other organizations were interested in developing similar programs and the CEMP Partnership of Southcentral Alaska was formed. The Partnership developed guiding documents that are used by all Partner monitoring programs in the region. These documents include a Quality Assurance Project Plan, Standard Operating Procedures, and data quality objectives for all parameters. Since 2000 the Partnership has held an annual meeting in Anchorage in February. All CEMP Coordinators are recertified in testing methods, and a business meeting is held to discuss any proposed changes, challenges, or ideas for the Partnership in the coming year.

While each partner organization has a unique program, the CEMP Partnership has three priority objectives :

1. Inventory baseline water quality data in the waterways of Southcentral Alaska;

2. Detect and report significant changes and track water quality trends; and,

3. Raise public awareness of the importance of water quality through hands-on involvement.

As of 2010, the Partnership had trained over 700 citizens in water quality monitoring procedures described in the CEMP Quality Assurance Project Plan. Nearly 5,000 observations have been made at over 250 stream, wetland, lake, and estuarine sites in South central Alaska. Volunteers have contributed well over $550,000 of in-kind donations in helping the CEMP Partnership meet its objectives. In the coming years the Partnership will build its Baseline Water Quality Library with reports from around Southcentral Alaska. A contact list for current Partners can be found on the Inletkeeper website (http://www.inletkeeper.org)

Top: Jukes Lake, monitored through the Mat-Su Lake Monitoring Program. Bottom: CEMP monitoring with the Wasilla Soil and Water Conservation District.

CEMP Partnership Partners are (on the right from north to south):

Upper Susitna Soil and Water Conservation District (Talkeetna)

Wasilla Soil and Water Conservation District (Wasilla)

Mat-Su Borough Lake Monitoring Program (Palmer)

Anchorage Waterways Council (Anchorage)

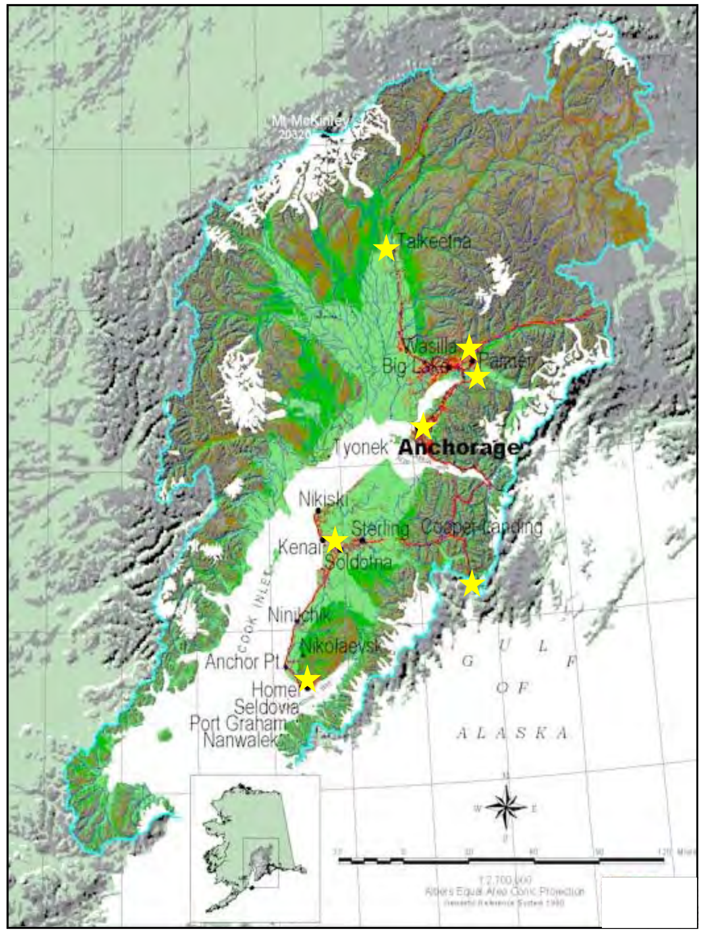
University of Alaska Anchorage Environment and Natural Resources Institute (Anchorage)

Kenai Watershed Forum (Soldotna)

Resurrection Bay Conservation Society (Seward)

Homer Soil and Water Conservation District (Homer)

Cook Inletkeeper (Homer)



Top: The Cook Inlet watershed with CEMP Partners represented with yellow stars. Bottom: Water quality monitoring and environmental education with the Anchorage Waterways Council.

METHODS

To ensure adequate quality assurance oversight and consistency of volunteer-collected data, Cook Inletkeeper staff follow the Quality Assurance Project Plan for Inletkeeper's CEMP. The Quality Assurance Project Plan (version 2002, updated in 2010) has been reviewed and approved by the Alaska Department of Environmental Conservation, the Environmental Protection Agency, and the project's Technical Advisory Committee. A Field Procedure booklet and Standard Operating Procedures outline detailed methods for sampling and data management. In accordance with the Quality Assurance Project Plan, many quality assurance and quality control measures are taken to validate the volunteer collected data, including training, Partnership-wide data quality objectives, and data management.

Volunteers learn how to follow protocols for collecting water quality data in the Inletkeeper lab during Phase II of CEMP training.

Training

Volunteers are required to complete Phase I through III of training to be eligible to collect data for CEMP. Phase I is an introduction to the watershed concept and monitoring procedures. Phase II is designed to teach the volunteers to use the monitoring kits and equipment. This phase involves both laboratory and field training. Phase III is an on-site training. Volunteers may begin monitoring on their own after successful completion of Phases I-III. Volunteer monitors must also attend an annual re-certification (Phase IV) training where they analyze blind performance evaluation standards and review monitoring procedures. Volunteers must complete a separate training in order to participate in biological monitoring. Trainings are offered once a year by University of Alaska Anchorage Environment and Natural Resources Institute certified trainers.

Data Quality Objectives

Volunteer monitors perform analysis on duplicate samples during each site visit. Replicate measurements are also taken for samples analyzed in the lab. Measurements must meet predetermined data quality objectives for sensitivity, precision, and accuracy. Data Quality Objectives for CEMP parameters used by Inletkeeper are included on the following page.

Data Management

The CEMP Coordinator reviews all data sheets for completeness. Volunteers are contacted if there are questions regarding the data sheet and monitoring event. The CEMP Coordinator enters all of the data into an MS Access database. This database was developed in 2000 in coordination with the Anchorage Waterways Council. It provides quality assurance checks on data entry and is used to review and summarize data for annual and baseline reports. As we complete baseline datasets, we are working with the Alaska Department of Environmental Conservation to migrate data into STORET—the Environmental Protection Agency's online repository for water quality monitoring data.

Parameter	Method/Range	Units	Sensitivity (a)	Precision	Accuracy	Calibration Method
Air Temperature	Thermometer -40 to 120°F	Degree Farenheit (°F)	1.0°F	±1.0°F	±1.0°F	NIST Certified Thermometer
Water Temperature	Thermometer -5.0 to +50.0°C	Degrees Celsius (°C)	0.5°C	±0.5°C	±0.5°C	NIST Certified Thermometer
	Hanna Meter HI 98129 0.0 to 60.0 °C; 32.0 to 140.0°F	(°C) (°F)	0.1 °C 0.1°F	±0.5 °C ±1.0 °F	±0.5 °C ±1.0 °F	NIST Certified Thermometer
	Stowaway Tidbit (Onset Computer Corp.)	(°C) (°F)	0.16°C	5%	0.2 @ 20°C	NIST Certified Thermometer
pH	pH Octet Comparator (Wide-Range) Lamotte 5858 3.0 to 10.0 units	Standard pH units	0.25 units	±0.6 units	±0.4 units	Checked against Hanna Meter HI 98129
	Hanna pH Tester Combo HI98129 0.0 to 14.0	Standard pH units	0.01	±0.02 units	±0.01 units	Standard Solutions Method
Dissolved Oxygen	Micro Winkler Titration Lamotte 5856 0 to 20 mg/l	Milligrams per liter (mg/l)	0.1 mg/l	±0.6 mg/l	±0.3 mg/l	Checked against DO Meter
Turbidity	LaMotte Model 2020 Turbidity Meter 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% or 0.05 for readings below 100 NTUs (whichever is greater) +3% above 100 NTUs	Standard Solutions Method
Specific Conductance	Hanna TDS Meter 0 to 3999 microS/cm	Micro-Siemens/cm (µS/cm) (converted to 25 °C)	1.0 µS	±2 units	±2% of the standard	Standard Solutions Method
E. Coli	EasyGel Coliscan 0 to 60 CFU	Number of colony forming units (CFU) per 100 ml	1 CFU/100 ml	Control checks of sterility, temperature	Control checks of sterility, temperature	Send water sample split to EPA/ADEC Certified Lab

WATER QUALITY PARAMETERS

Primary parameters (water temperature, dissolved oxygen, pH, specific conductance, turbidity, and bacteria) were measured using standard Environmental Protection Agency approved procedures and/or methods which are used by established citizens' volunteer monitoring programs (e.g., Friends of Casco Bay's Citizens' 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 (EPA 1997). All methods used are consistent with those recommended by the test kit manufactures (LaMotte, Hanna, Hach and Micrology Laboratories).

CEMP monitors measures pH and specific conductance using waterproof Hanna combo meters. Monitors calibrate their meters before every sampling event. In addition, Inletkeeper's CEMP Coordinator collects all meters quarterly to clean and calibrate them in the laboratory. The meters automatically correct pH and conductivity values for the stream temperature.

Site photos from Bidarka Creek Top: looking upstream, fall of 2006, Middle: looking upstream, winter of 2007, Bottom: looking upstream, summer 2007.

WATER QUALITY STANDARDS

Results from sampling are referenced against state (Alaska Department of Environmental Conservation) and federal (Environmental Protection Agency) water quality standards. These standards are listed in the table below. Beaver Creek is held to standards for Water supply: Growth and Propagation of fish, shellfish, aquatic life, and wildlife.

Right: CEMP monitors go through a 3-day training to become certified for water quality sampling at Cook Inletkeeper's laboratory in Homer.

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 < 6.5 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 < 6.5 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

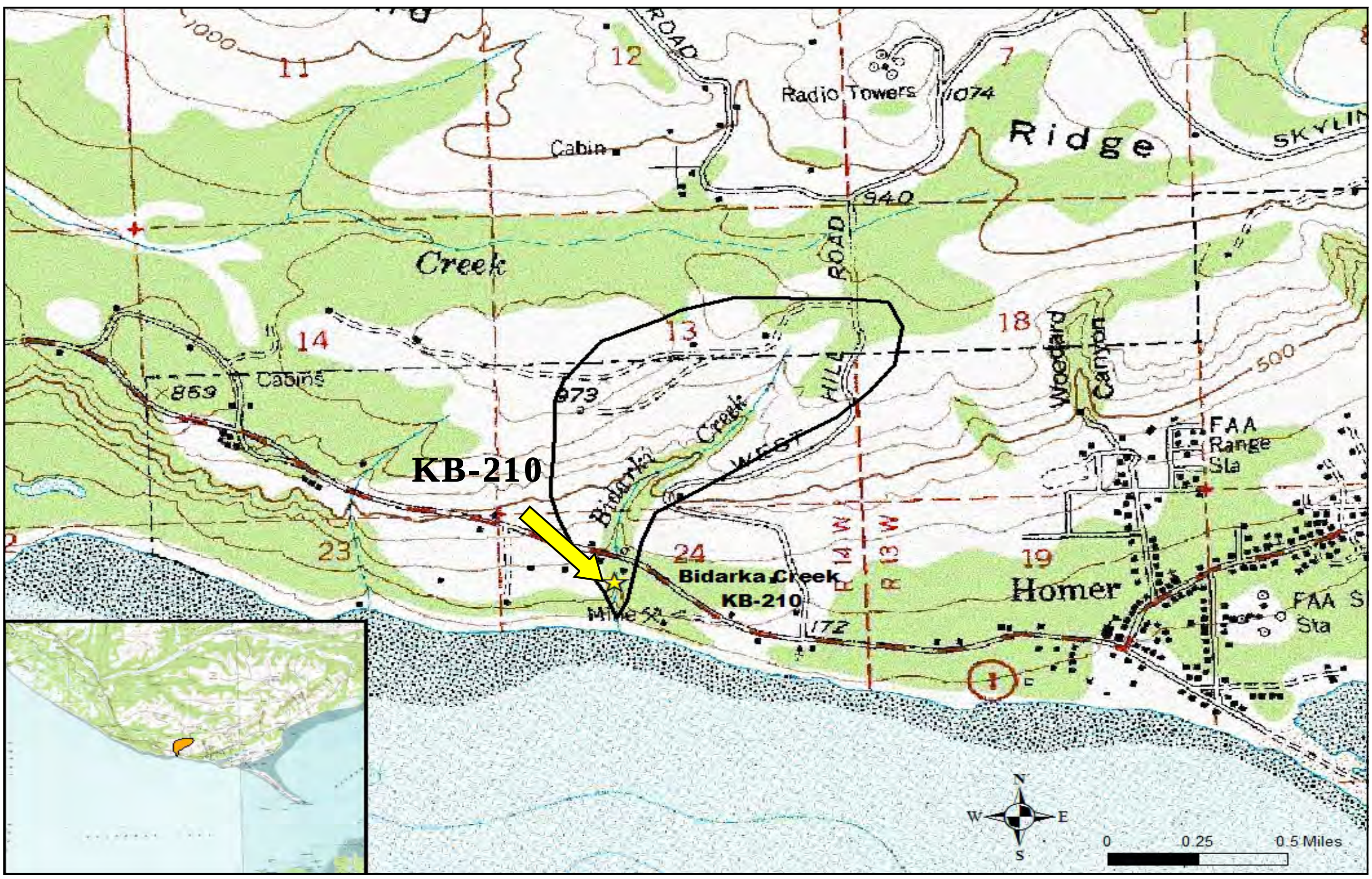
BIDARKA CREEK: OVERVIEW

Bidarka Creek runs approximately 1.5 miles through the City of Homer, just to the west of West Hill Road. The creek flows into Kachemak Bay after passing under the Sterling Highway a quarter mile past milepost 172 heading north. The Bidarka Creek watershed drains approximately 405 acres. The CEMP sampling site for Bidarka Creek, KB-210, is located 0.2 miles down Saltwater Drive, off of the Sterling Highway (GPS Coordinates: 59° 38.733', 151° 35.318', GCS NAD 83) and just upstream of the Saltwater Drive culvert.

From the Kenai Peninsula Borough Parcel Viewer (accessed 09/21/2011). Dead standing spruce, common in the treed areas of the watershed, can be seen in the red circle.

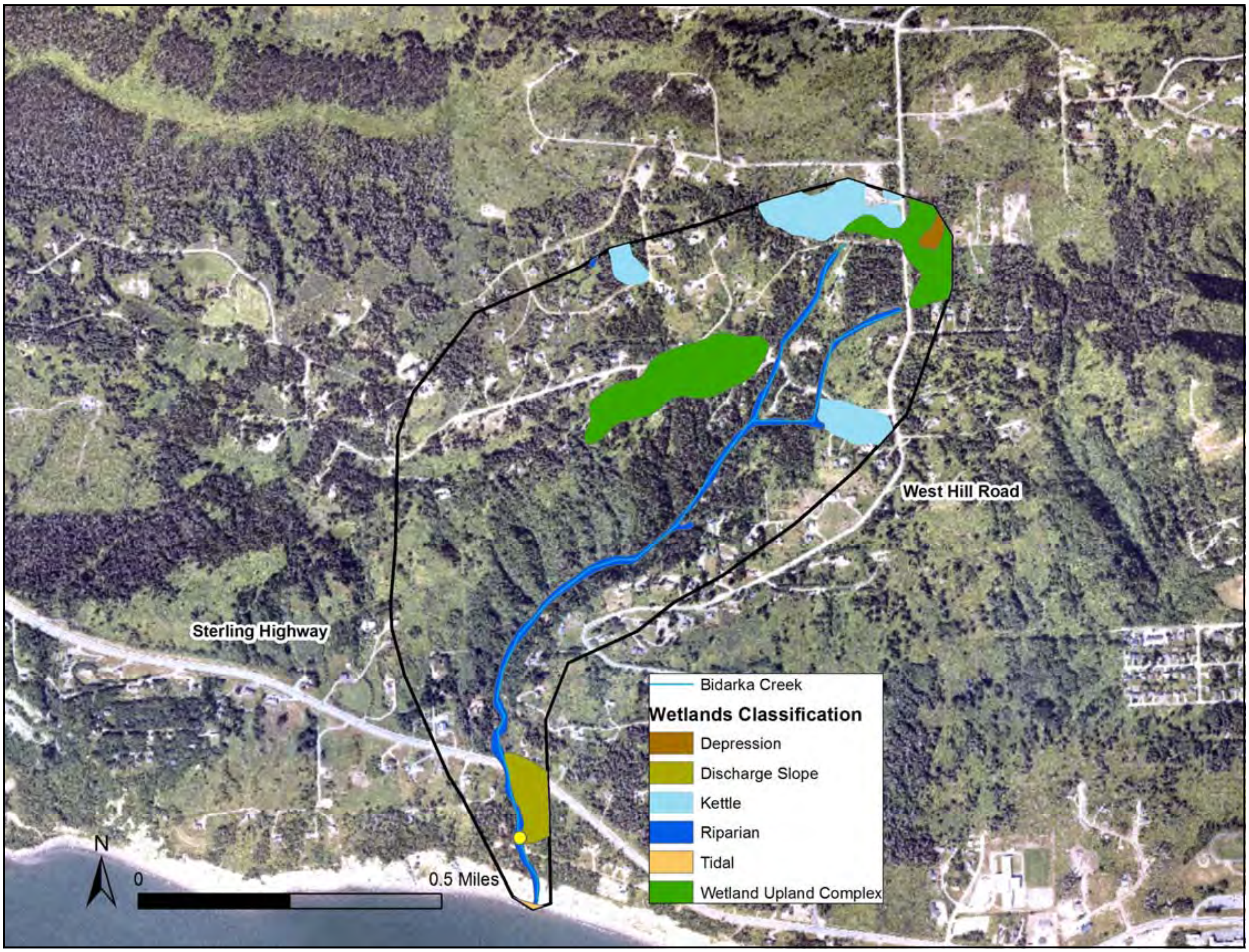
Vegetation Types

The Bidarka Creek watershed is composed of primarily alder, spruce, and mixed forest. There are



Bidarka Creek watershed is located within the City of Homer, just west of West Hill Road. Topographic maps from the United States Geologic Survey.

areas in the lower portion of the watershed that are classified as herbaceous, with grasses and sedges dominating the landscape. Much of the spruce forest throughout the watershed was affected by the spruce bark beetle outbreak in the late-1990s, resulting in large areas of standing dead trees. A snapshot from the Kenai Peninsula Borough's parcel viewer shows stands of dead spruce visible in satellite imagery. Wetland ecosystems are present primarily in the upper third of the watershed (see the map below). The kettle areas (shown in light blue below) are places where glacial deposits of ice left depressions that are now dominated by peatlands and a perched water table. (To learn more about the wetland mapping project on the Kenai Peninsula, visit: http://www.kenaiwetlands.net/index.htm).

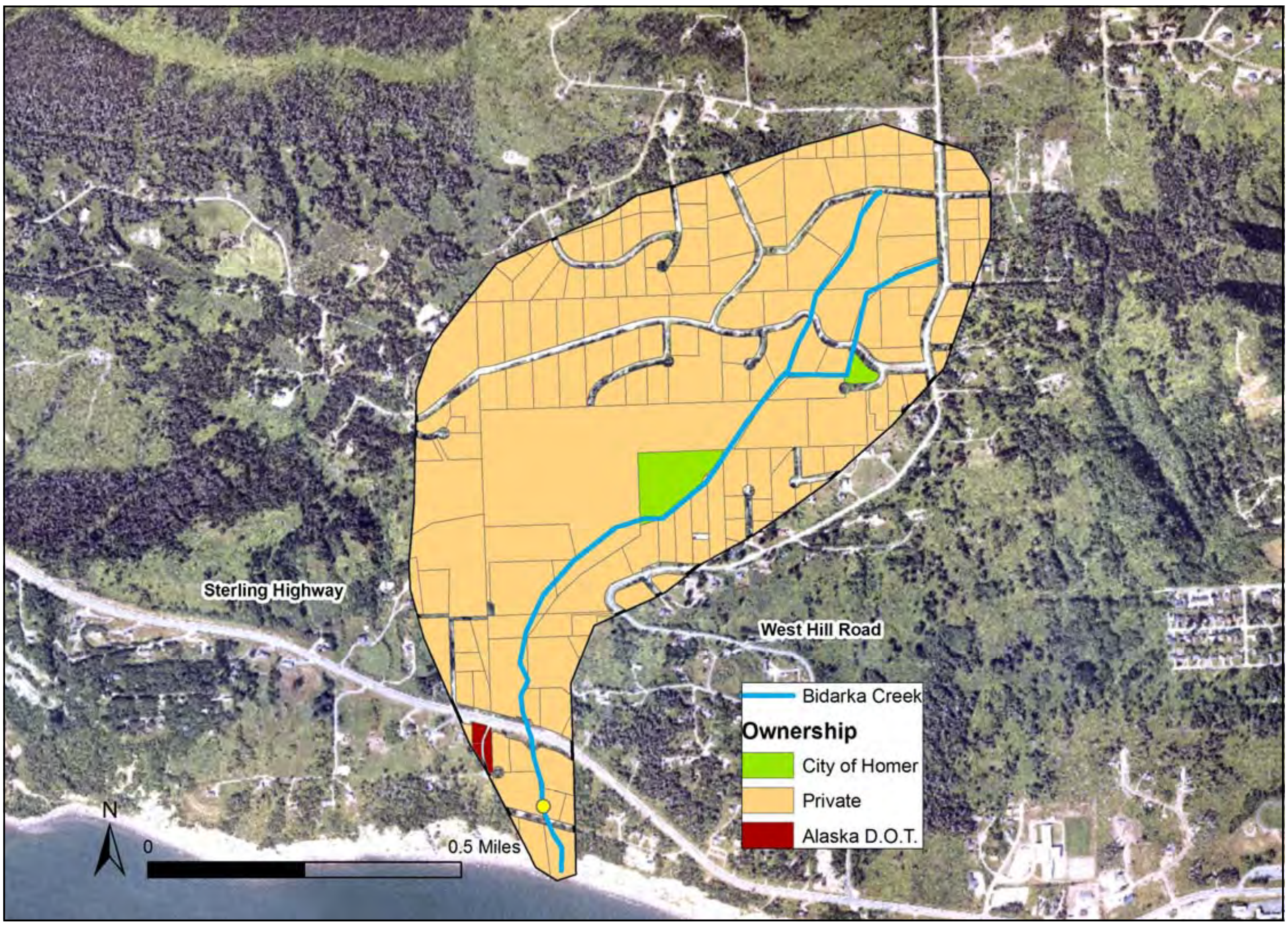


Wetland map: Wetland Mapping & Classification of Kenai Lowlands, Alaska, published May 3, 2007. Basemap: Kenai Peninsula Borough fixed wing aerial imagery, 2003.

BIDARKA CREEK: OVERVIEW

Land Ownership

The majority of the land within the Bidarka Creek watershed is privately owned. Two parcels are owned by the City of Homer (shown in green) that total 7.61 acres. The larger of the two parcels (just over 6.5 acres) is designated as 'Bidarka Creek Greenbelt' by the City. Acquired in 2001 from the Kenai Peninsula Borough (KBP Ordinance 83-01), the 2011 Land Allocation Plan for the City of Homer states that this parcel's designated use is "Public Purpose. Retain as undeveloped Greenbelt and to protect drainage". The other City-owned parcel, 1.04 acres just south of Highland Drive and adjacent to Upland Court, was deeded to the City in 1989 by the original subdivider. The designated use states that the land is for Public Use/Emerald Highland Estates Park. A plat note restricts use of the potential park to residents of the surrounding subdivision. The City does not intend to provide services to a park that isn't open to the public, and at this point no park has been developed on this property. The Department of Transportation owns three small parcels in the bottom-half of the watershed, totaling 1.36 acres. There is a general office building on the property, south of the Sterling Highway.



Basemap: Kenai Peninsula Borough fixed wing aerial imagery, 2003. Ownership map from the Kenai Peninsula Borough GIS Division, 2010.

Wildlife

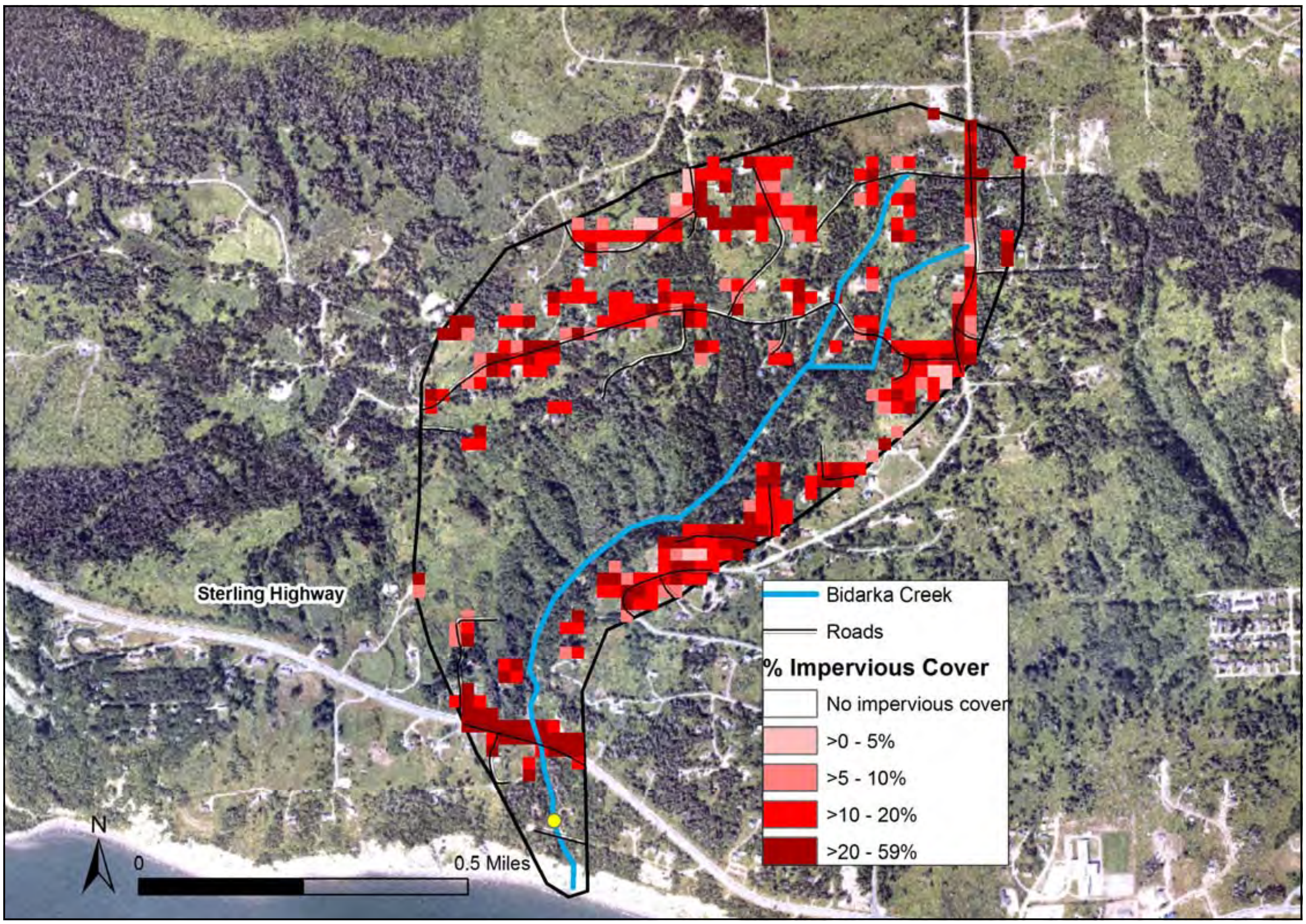
Bidarka Creek is located on the Homer bench, which provides moose calving habitat on the lower Kenai Peninsula. Black bear are fairly common within the Homer City limits, and other mammals such as coyotes, porcupines, red squirrels, and snowshoe hares are present. Snowshoe hare populations were anecdotally very high during 2010-2011. Birds documented at the site throughout the years include bald eagles, magpies, ducks, and finches. For more information on local birds in the Homer area, view http://kachemakbaybirders.org/.

Bidarka Creek does not support salmon populations. This may be due in part to the steep and cascading nature of the stream in the lower reaches, as well as its overall shallow depth. It is possible there are stickleback and/or sculpin in the system, however volunteer monitors did not record seeing fish during their monitoring at KB-210.

Above: A site photo taken at Bidarka Creek in the fall of 2006 shows a mallard duck in the stream. Bottom left: As a small system, Bidarka Creek would often freeze solid during the winter months at the CEMP sampling site. This picture was taken in the winter of 2008, looking upstream from the sampling location.

Human Use

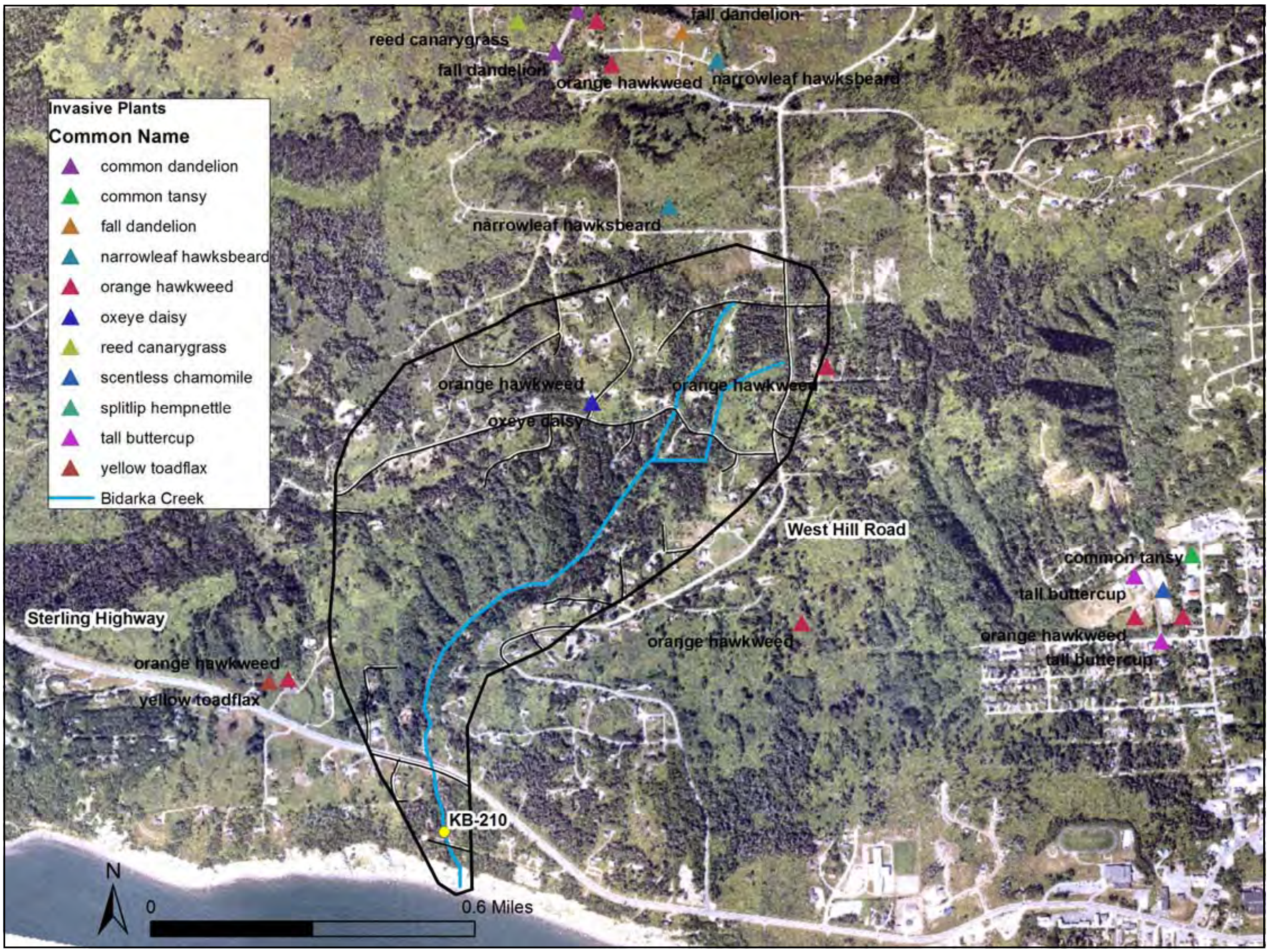
The majority of land within the Bidarka Creek watershed is privately owned. There are 5.8 miles of road within the watershed, 1.5 of which are paved. The remainder are dirt/unpaved roads. Primary roads that are within the watershed include (going north to south): Jeffrey Ave, Highland Drive, West Hill Road, the Sterling Highway, and Saltwater Drive. There are several smaller, secondary roads that come off of these primary roads that are within the watershed, as can be seen on the map below (roads are marked by a double black line). Impervious cover includes any surface that water cannot flow through. Pavement, hard-packed dirt, and building roofs are all examples of impervious cover. In 2001, the Environmental Protection Agency, in partnership with other agencies and organizations, used the National Land Cover Dataset (NLCD) to develop a map of impervious cover for the United States, including Alaska. More about this project can be viewed at http://www.epa.gov/mrlc/nlcd-2001.html. Each square in the map below measures 30 meters by 30 meters, and is classified by the percent impervious cover. Using these data, we estimate that approximately 8% of the Bidarka Creek watershed is impervious cover (as of 2001).



Basemap: Kenai Peninsula Borough fixed wing aerial imagery, 2003. Impervious cover from the National Land Cover Dataset: http://www.epa.gov/mrlc/nlcd-2001.html. Roads from the KPB GIS Department.

Invasive Species

Orange hawkweed and oxeye daisy are documented to occur within the Bidarka Creek watershed. These common invasive plants are found throughout neighborhoods in Homer, and can be seen on lands surrounding Bidarka Creek. Reed canarygrass, an aggressive invasive that can fill in stream beds and destroy habitat for fish and other aquatic organisms, has been documented north of Bidarka Creek, in the Diamond Creek watershed. No invasive species were seen during the habitat assessment at CEMP site KB-210 in August 2010, however landowners in the watershed should be educated and pro-active in stopping the spread of these plants. More information on invasive plants in the Homer area and on the Kenai Peninsula can be found at the Homer Soil and Water Conservation District's website: http://www.homerswcd.org/invasives/invasivepg.htm.



Basemap: Kenai Peninsula Borough fixed wing aerial imagery, 2003. Invasive species data from the AKEPIC Data Portal, accessed September 2011: http://aknhp.uaa.alaska.edu/maps/akepic/.

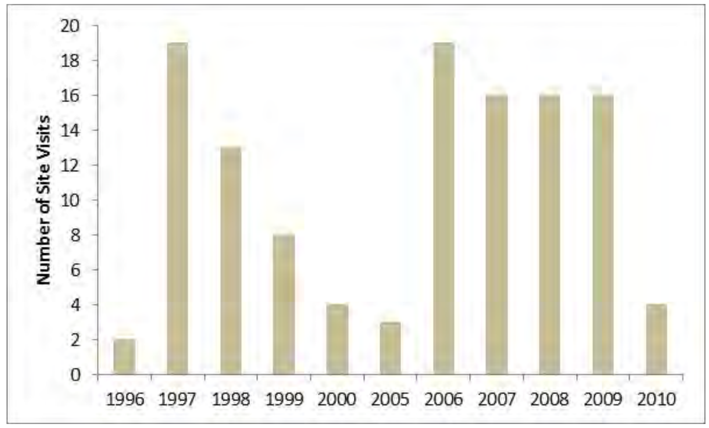
BIDARKA CREEK: VOLUNTEER MONITORS

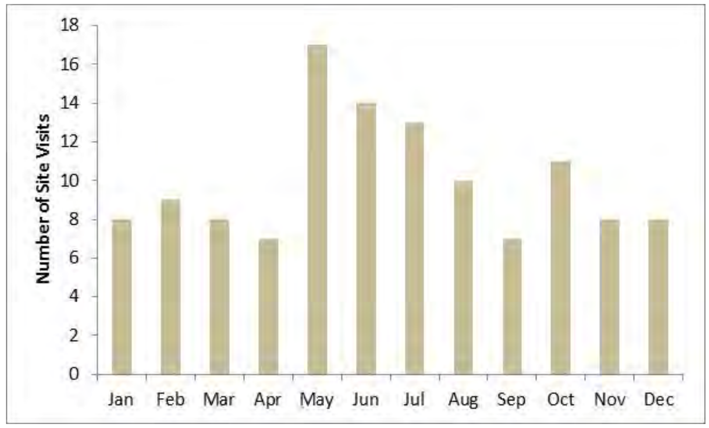
Steve Hackett first visited Bidarka Creek in November of 1996. Steve monitored Bidarka Creek, below the culverts under Saltwater Drive, until March 1997. Beginning on May 2, 1997, Joel Cooper and Marla McPherson monitored Bidarka Creek until June 18, 2000. During these years, Joel documented 29 hours spent monitoring and Marla 18 hours. Together they cataloged water quality during 44 separate sampling events. On October 3, 2005, Frank Vondersaar took over sampling at Bidarka Creek (above the culverts that run under Saltwater Drive). From late-2005 through early-2010, Frank logged nearly 100 hours of water quality monitoring, taking samples during 74 separate sampling events.

Complete datasets (more than 12 samples per year) were collected in 1997 and 1998. Beginning in 2006, complete datasets for water quality were collected each year through 2009 and into the beginning of 2010. The final water quality sampling event occurred on April 25, 2010.

All exceedences of Alaska water quality standards are noted in the respective sections. Bidarka Creek is held to the standards for water recreation: contact recreation (freshwater).

Thank you to Steve, Joel, Marla, and Frank for all of their hard work and dedication over the years!





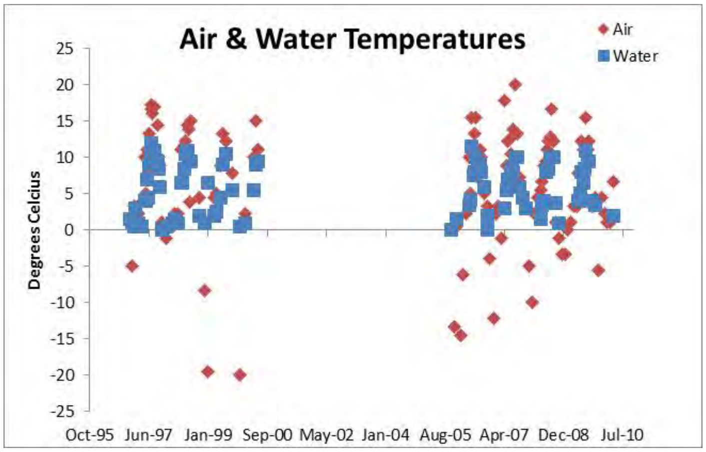
Top: Number of site visits to Bidarka Creek by year, from 1996—2010. Bottom: Number of site visits to Bidarka Creek by month from 1996 – 2010.

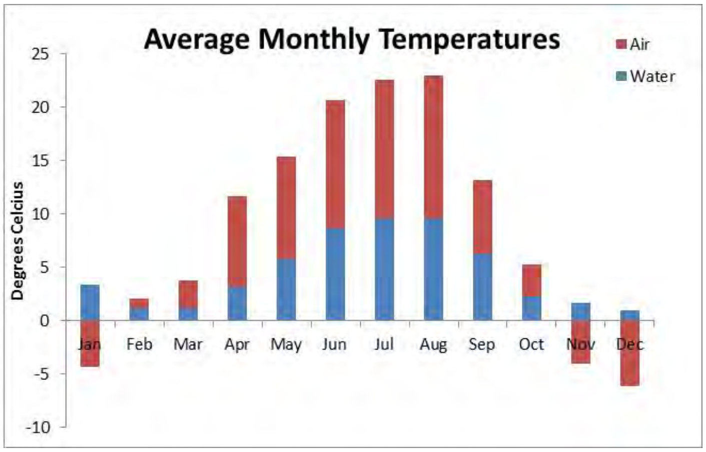
Right: Frank Vondersaar sampled Bidarka Creek from 2005 to 2010. Facing Page: Joel Cooper sampled Bidarka Creek, below the culvert, from 1997 to 2000 with the help of Marla McPherson.

During CEMP site visits, monitors record water and air temperatures using alcohol-filled thermometers. Fish and other aquatic organisms are adapted to living within a certain temperature range. Changes in riparian (or streamside) vegetation, groundwater inputs, weather, and climate patterns can all affect water temperatures.

CEMP monitors took 94 water temperature measurements at Bidarka Creek from 1996 to 2010. The average water temperature was 5.8°C, and ranged from 0°C to 12°C. Average water temperatures were lowest during December (1.0° C), February (1.1°C) and March (1.2°C). The warmest average water temperatures occurred during June (8.7°C), July (9.6°C) and August (9.6°C). CEMP sampling never documented water temperatures exceeding the state water quality standard for contact recreation, which is 30.0° C.

Air temperature was recorded at 117 site visits to Bidarka Creek. Average air temperature was 5.9° C (43°F). Air temperature ranged from -20°C (-4°F) to 20°C (68°F). Air temperature was lowest during the winter months of November (-4.0°C), December (-6.1°C) and January (-4.3°C) and warmest during June (12.0°C), July (13.1°C) and August (13.4°C).





Top: All water (blue) and air (red) temperatures taken with the alcohol-filled thermometers by CEMP monitors during site visits at Bidarka Creek from 1996 to 2010. Bottom: Average water (blue) and air (red) temperatures by month from CEMP site visits between 1996 and 2010.

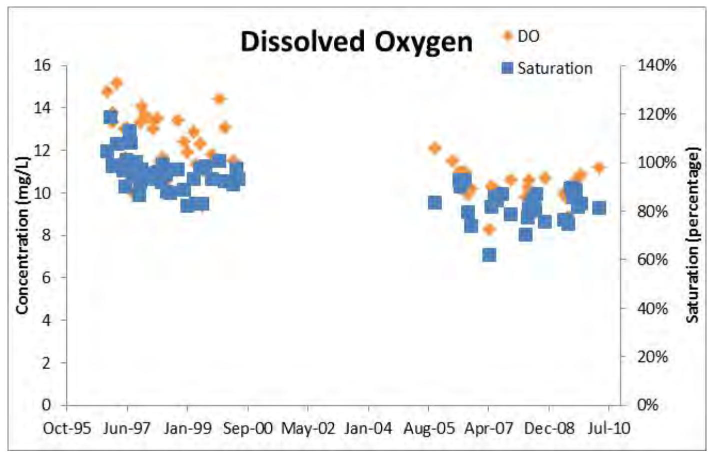
BIDARKA CREEK: DISSOLVED OXYGEN

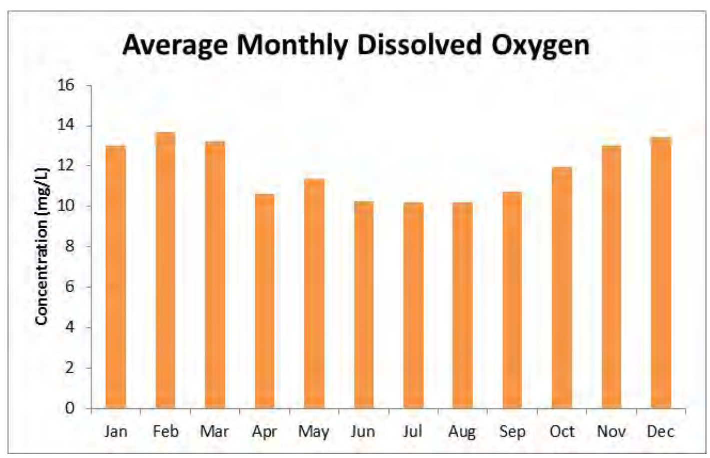
CEMP monitors the levels of dissolved oxygen (DO) in our streams. Oxygen is needed by fish and other aquatic organisms to live. We measure DO using a chemical titration, and express it as a concentration of milligrams of oxygen per liter of water. The amount of oxygen that can be dissolved in water is temperature dependent; colder water can hold more oxygen. Therefore we also look at how saturated the water is with oxygen, that is-how much oxygen does it hold compared to what it could hold at that temperature. Saturation is expressed as a percent.

CEMP monitors measure dissolved oxygen using the Winkler Titration. Most of the chemical reagents in their monitoring kits are for this test.

Changes in dissolved oxygen can be caused by turbulence and interactions with the air (like in a waterfall), decaying plant matter, sewage, and wastewater inputs. High levels of photosynthesis and increased mixing with the air through riffles and small waterfalls could increase saturation levels above 100%, creating a condition of super-saturation.

The concentration of dissolved oxygen at Bidarka Creek was higher from 1996-2000 (average DO = 12.2 mg/L) than from 2005-2010 (average DO = 10.2 mg/L) ($p<0.001$, $t = 8.49$). We suspect that this is from a change in the site location during these two periods. In the early years, sampling occurred below the culvert that runs under Saltwater Drive. Beginning in 2005, the sampling site was moved upstream to above the culvert. The drop from the culvert may have provided additional mixing in the stream, therefore increasing the concentration of dissolved oxygen downstream.





Top: All dissolved oxygen concentration levels (mg/L, orange) and saturation (%, blue) measured by CEMP monitors during site visits at Bidarka Creek from 1996 to 2010. Bottom: Average dissolved oxygen concentration levels by month from CEMP site visits between 1996 and 2010.

Dissolved oxygen was measured during 77 site visits to Bidarka Creek. The concentration of DO ranged from 8.3 mg/L to 15.2 mg/L, and was 11.3 mg/L on average across all years. The lowest DO concentrations at Bidarka Creek occur during the summer months of June, July, and August. At no time during CEMP monitoring did Bidarka Creek exceed Alaska water quality standards for dissolved oxygen in a contact recreation stream (less than 4.0 mg/L).

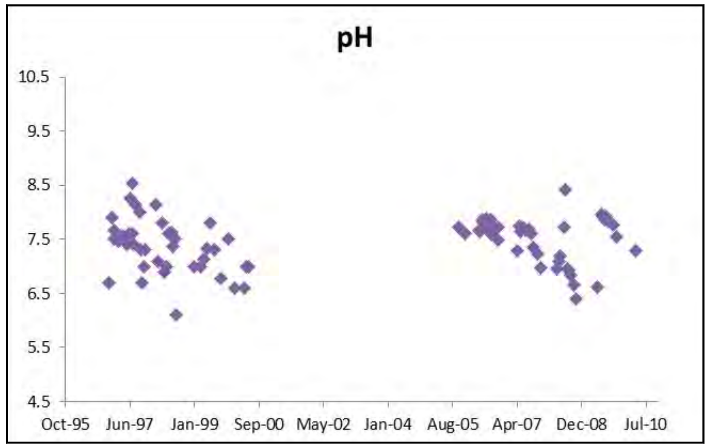
DO Saturation ranged from 62% to 119%. Supersaturation conditions (greater than 100%) were measured during 8 site visits, all occurring prior to the 2005 shift in site location from downstream to upstream of the culvert.

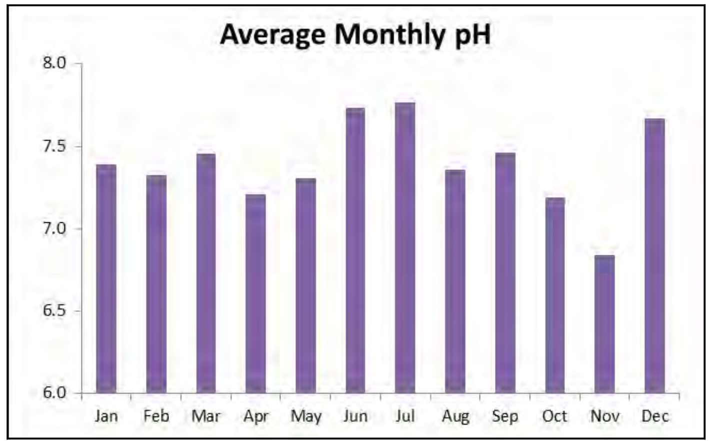
Bidarka Creek was often frozen under ice until March, with increased turbidity in April. This picture was taken at Bidarka Creek in the fall of 2007. Saltwater Drive runs above the culvert.

BIDARKA CREEK: pH

pH is a measure of the level of activity of hydrogen atoms in the water. It is expressed on a logarithmic scale and ranges from 0 (acidic) to 14 (basic). Most streams naturally range between 6.5 to 8.0 pH units. Differences in pH can result from rain and groundwater inputs, decaying plant material, and inputs from runoff. Rain water tends to have a lower pH, ranging from 5.6 to 5.8.

pH averaged 7.4 at Bidarka Creek. The range of pH values was 6.1 (in August 1998) to 8.5 (in July 1997). Monthly averages fluctuated from 6.8 in November to 7.8 in July. Lower pH averages were in November and April – both are generally rainy months. Rain inputs can lower pH in streams, as the average pH of rain is slightly acidic at 5.5. pH exceeded the lower Alaska water quality standard of 6.5 twice, once in August 1998 (6.1) and again in October 2008 (6.4). These isolated incidents over the 8+ years of sampling do not point to any persistent concerns with pH in Bidarka Creek.



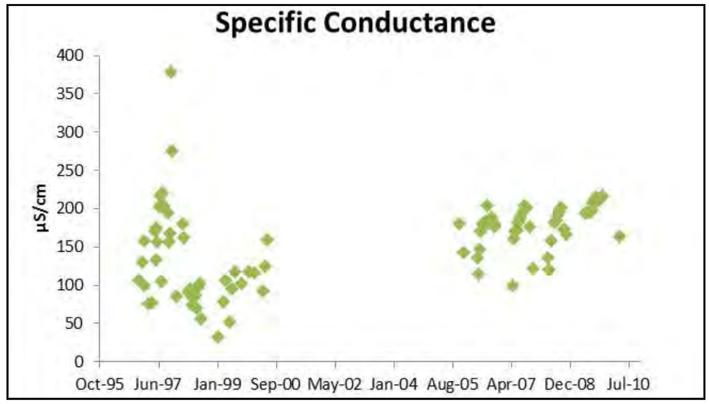


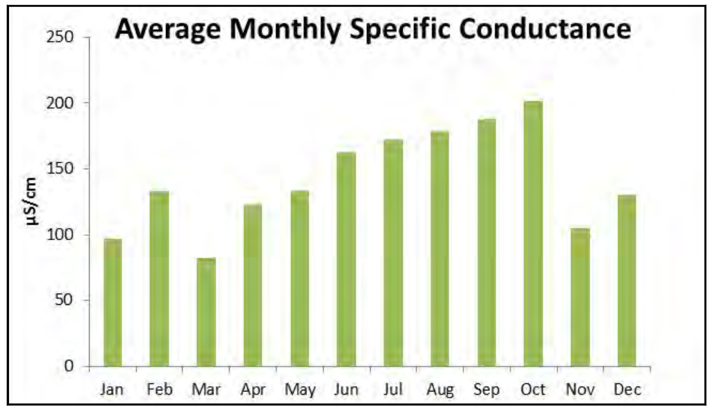
Top: All pH taken by the Hanna Meter by CEMP monitors during site visits at Bidarka Creek from 1996 to 2010. Bottom: Average pH by month from CEMP site visits between 2002 and 2010.

BIDARKA CREEK: SPECIFIC CONDUCTANCE

Specific conductance measures the ability of water to conduct an electrical current at a given temperature. It is recorded as micro Siemens per centimeter (µS/cm). The presence of ions, or salts, in water increases the ability to conduct electricity; thus, specific conductance is a way to measure the dissolved solids in a stream. Specific conductance is influenced by groundwater (increasing conductance) and rainwater inputs (decreasing conductance) as well as road and other runoff (which tends to increase conductance).

CEMP volunteers measured specific conductance during 155 site visits to Bidarka Creek. Average specific conductance was 155 µS/cm and ranged from 33 µS/cm to 378 µS/cm. The highest specific conductance levels measured at Bidarka Creek were in the fall of 1997. While we aren't sure what caused this brief spike in specific conductance, levels across all years are similar to other streams in the city of Homer and running off of the Homer bench (such as Woodard and Palmer Creeks). In contrast, CEMP sites that are in the Anchor River watershed have specific conductance levels consistently under 100 µS/cm, and often less than 50 µS/cm. On the Homer bench, it's likely that many of our streams are both heavily fed by ground and sub-surface water, which would increase the amount of dissolved ions and therefore the conductance of the surface water. Many of these streams also have some rural/urban interface, with more roads and other impervious surfaces which can affect the runoff entering the streams during rain events (which would otherwise act to depress specific conductance levels). The impervious cover analysis done by the Environmental Protection Agency (see page 16 of this report) estimates that approximately 8% of the Bidarka Creek watershed is impervious cover. A study in Anchorage creeks indicated that water quality may be affected when impervious cover is greater than 4.4—5.8%, lower than the estimated current level in the Bidarka Creek watershed (Ourso & Franzel, 2003). This potential impact of urbanization of local watersheds should be considered in future planning to protect water quality.





Top: All specific conductance data (µS/cm) were taken with a Hanna Meter (HI 98129) by CEMP monitors during site visits to Bidarka Creek from 1996 to 2010. Bottom: Average specific conductance (µS/cm) by month from CEMP site visits between 1996 and 2010.

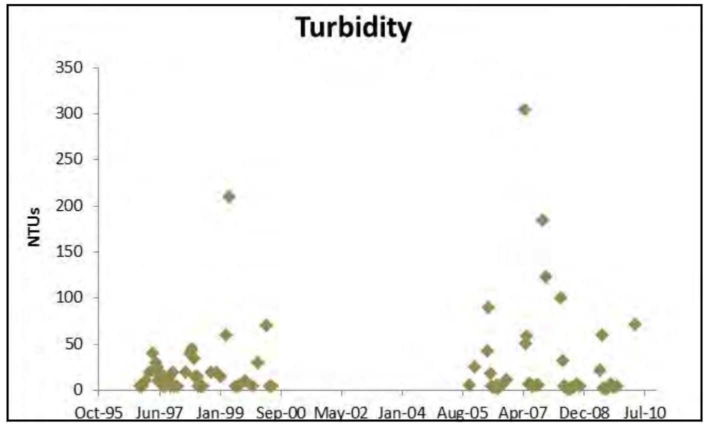
R.T. Ourso & S.A. Frenzel, 2003. Identification of linear and threshold responses in streams along a gradient of urbanization in Anchorage, Alaska. Hydrobiologia. 501: 117-131.

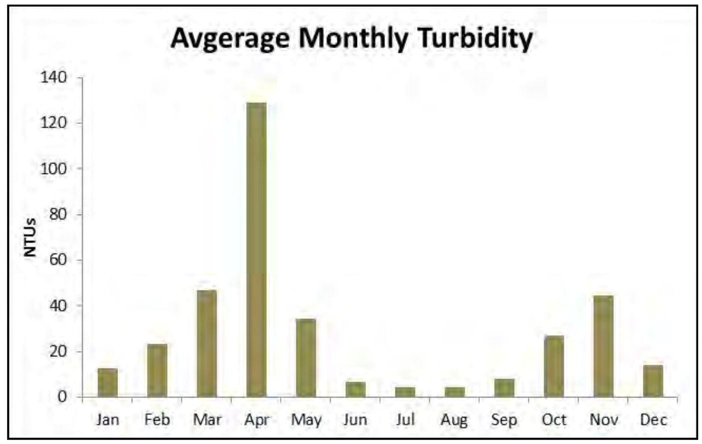
BIDARKA CREEK: TURBIDITY

Turbidity is a measure of water clarity and describes the amount of light scattered or absorbed by water. Turbidity is measured in Nephelometric Turbidity Units (NTUs). Lower NTU values correspond to clearer water. Silt, clay, organic material, and colored organic compounds can all influence turbidity. Natural and human caused erosion, as well as storm water runoff can increase turbidity. Negative impacts from increased turbidity may include increased water temperatures, decreased habitat for aquatic organisms, and more opportunities for the growth of potentially harmful bacteria.

The state water quality standard for turbidity is related to natural conditions. CEMP data provide valuable information to establish what the natural turbidity conditions are for Bidarka Creek.

CEMP monitors took turbidity samples during 90 site visits to Bidarka Creek. Turbidity was 25 NTUs on average over all years, with notably higher levels during the spring month of April, when the average turbidity was 129 NTUs. Spring break-up and runoff can dramatically increase the turbidity of streams, especially where there are roads and other disturbed habitats that may contribute to sedimentation during storm events. Minimum turbidity at Bidarka Creek from 8 years of sampling was 1.5; turbidity was under 5 NTUs during much of the summer months of June, July and August.



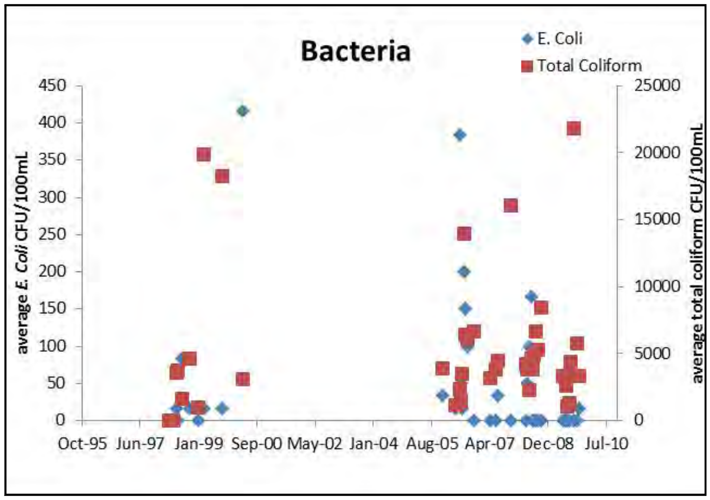


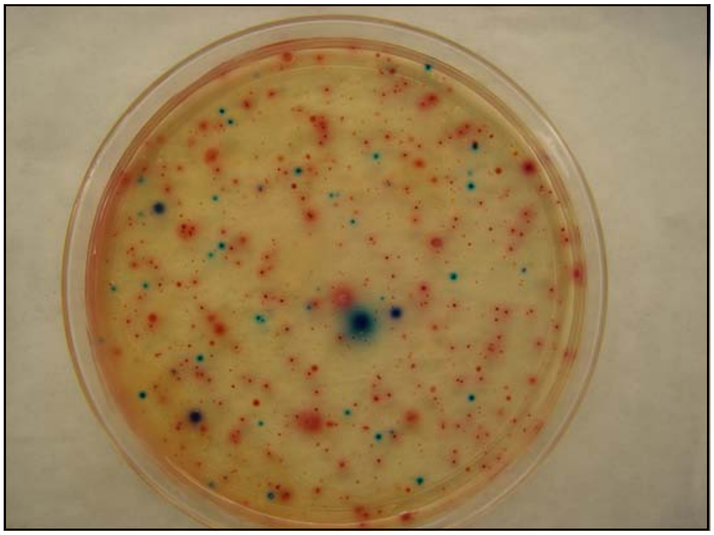
Top: All turbidity data (NTU) were collected by CEMP monitors during site visits to Bidarka Creek from 1996 to 2010. Water samples for turbidity analysis are collected in the field and analyzed in the lab using a LaMotte Turbidimeter. Bottom: Average turbidity (NTU) by month from CEMP site visits between 1996 and 2010.

BIDARKA CREEK: BACTERIA

CEMP volunteers monitor for total coliforms and *E. coli* at all sites throughout the year. Many types of coliform bacteria are normally found in soil and water. *E. coli* is an indicator of fecal bacteria that is found in the intestines of human and other warm-blooded animals. State water quality standards are for fecal coliforms. CEMP tests reveal the number of colony forming units (CFUs) of *E. coli*, which we utilize as a preliminary indicator of fecal coliforms. In the event of a persistent exceedence through both high and low stream flows, the CEMP Coordinator would send samples to a state-certified lab in Anchorage for official fecal coliform testing. Finding *E. coli* levels that are above state water quality standards may be indicative of contamination by runoff from animal waste, decaying animals, or human waste from sewage or leaking septic tanks.

CEMP monitors collected water samples for bacteria testing that were successfully plated and incubated during 42 site visits. *E. coli* colonies were detected in 20 of these samples (48%), and colony counts ranged from 17 CFUs/100mL to 417 CFUs/100mL on May 3, 2000. This and 2 additional site visits found preliminary bacteria levels at or above the Alaska water quality standard for bacteria, which states that no single sample should exceed 200 CFU/100mL of fecal coliforms. On June 11, 2006 there were 383 CFU/100mL of *E. coli*, and on July 25, 2006 there were 200 CFU/100mL of *E. coli*. Following each finding of high bacteria levels, colony counts returned to levels below the water quality standards. Bacteria counts at Bidarka Creek continued to fluctuate throughout the year, with highest counts occurring during May, June, and August.





Top: Bacteria levels at Bidarka Creek from 1996 – 2010. E. coli *colonies are in blue, and total coliform colonies in red. Both data sets show the average colony forming units (CFU) per 100mL. Bottom: Water samples are mixed with a bacteria-growing medium and incubated on a petri dish for 48 hours. Different types of bacteria show up as different colors, providing counts of total coliform and* E.coli *colonies.*

BIDARKA CREEK: HABITAT ASSESSMENT

On August 19, 2010 Inletkeeper staff performed a habitat assessment over a 50-meter reach of Bidarka Creek. The downstream boundary of the reach began at the current CEMP site, just upstream of the culvert that passes under Saltwater Drive.

Top: Looking north from Saltwater Drive up Bidarka Creek. Bottom: Looking south from Saltwater Drive, down Bidarka Creek. The culvert can be seen just to the left in the picture. Both photographs were taken on August 19, 2010.

This 'Stream Walk' assessment is performed to provide the community with a snapshot of the physical environment surrounding a CEMP sampling site. This physical assessment complements the chemical and biological monitoring done over time by volunteers. Though similar in some aspects to the habitat assessment done during bioassessment, the Stream Walk is designed to provide detailed habitat information outside of a bioassessment sampling session. In some cases, such as at Bidarka Creek, bioassessment has not been done and therefore there is no documentation of broader habitat conditions that can compliment water quality data. Stream Walks can be incorporated into future monitoring plans on a regular basis, and can provide qualitative information on the surrounding stream habitat in a cost- and time-effective manner.

Bidarka Creek falls nearly 100 feet over the course of the 50-meter reach sampled during the habitat assessment. The stream was approximately 90% full, with clear water in both clarity and color. The streambed was composed of a mixture of sand (35%), gravel (30%), and cobble (30%), with 5% of larger boulders present. The stream width ranged from a minimum of 28" to a maximum of 5.5', with an average width of 36". The depth of Bidarka Creek ranged from 2" to 10", and was approximately 4" on average. Although the stream bed rocks and stones felt slimy, there was no visible algal growth, with some periphyton growth on larger rocks.

The riparian zone surrounding the stream was composed of intact native vegetation for more than 60 feet on the right bank, and an average of 35 feet on the left bank. A private gravel driveway (approximately 10 feet wide) parallels this reach of Bidarka Creek along the left bank, about 35 feet to the east. There is another house off the right bank, greater than 60 feet away and in the

From the top of the 50-meter reach, looking downstream/south.

lower sections of the sampled reach. Stream bank stability was rated as primarily stable, with 5% of the left bank ranked as moderately stable. No erosion from human activity was noted, and no sections of man-made channels or erosion control were present. The vegetation within the 35 – 60 foot riparian zone consisted largely of small deciduous trees (less than 20 feet tall) such as alder (*Alnus tenuifolia*) and cottonwood (*Populus balsamifera*). Tall conifers (spruce, *Picea spp*.) covered approximately 15% of the left riparian area and less than 1% of the right riparian area. Tall deciduous trees (greater than 20 feet tall; cottonwood, alder, and birch *Betula kenaica*) covered 10% of the riparian zone adjacent to both banks. The riparian zone adjacent to the right bank had less than 1% of short shrubs such as willow (*Salix spp*.), and approximately 40% grasses, ferns, and other short plants such as horsetails (*Equisetum arvense*) and ferns.

Aside from the presence of 2 houses on either side of the stream, no evidence of human activity was noted. Based on our observations, within the 60 foot riparian zone, 82% of the left side was undeveloped/unprotected land with 18% unpaved road, and 100% of the right side of the stream was undeveloped/unprotected land. Both sides are privately owned. We did not see any fish, other aquatic species, or any terrestrial animals. Although we did not see any birds during the survey, this is likely songbird habitat given the vegetation present.

CEMP utilizes photographs taken throughout the years to document visual changes in the stream or surrounding environment. Site photographs can be found online, linked from Inletkeeper's website (http://www.inletkeeper.org). Photo points will be established in order to visually monitor with photographs over time.

BIDARKA CREEK: FUTURE MONITORING

Through CEMP, volunteers monitored Bidarka Creek from 1996 to 2000, and again from 2005 to 2010. This baseline report summarizes the chemical and physical data collected at Bidarka Creek over these years. Our monitoring efforts have shown overall high water quality at this stream. Levels of turbidity and specific conductance are similar to those of other streams within the City of Homer and that flow off of the Homer bench. Bacteria counts are generally low, but higher than in more remote streams. Occasional spikes in E. coli have been documented over the years. With potential increased development, streamside stakeholders should ensure that private septic systems are maintained and impervious cover is minimized in order to maintain the water quality in Bidarka Creek.

Top: Looking downstream at Bidarka Creek and the Saltwater Drive culvert in December 2006. Bottom: Looking downstream at Bidarka Creek and the Saltwater Drive culvert in June 2009.

Future monitoring recommendations

- Do a Stream Walk every 2-3 years (as close to the same date each time as possible), starting in 2012. Photographs should be taken from established photo points. Incorporate a basic invasive species assessment in partnership with the Homer Soil & Water Conservation District.

- Perform a GIS analysis on impervious cover in the watershed when new satellite imagery becomes available to Inletkeeper staff.

- If there is substantial development or increases in impervious cover in the watershed, consider landowner outreach to maintain riparian habitat and ensure continued high water quality.

ACKNOWLEDGEMENTS

We would like to dedicate this baseline report to Steve Hackett—the first monitor at Bidarka Creek and one of the founders of Cook Inletkeeper's CEMP (Steve is pictured below, conducting one of the first CEMP trainings in 1996). Many thanks go out to Frank, Joel, Marla, and Steve, as well as to the other 300+ CEMP volunteers throughout the years! Without their dedication and continued support, we would be unable to do this work. They have taken time to attend training sessions, yearly recertifications, and have gone into the field in all weather conditions to collect these water quality data.

Inletkeeper would like to especially thank Dan Bogan of the University of Alaska Anchorage's Environment and Natural Resources Institute for his ongoing 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 his time and efforts.

Funding has come from many sources through the years, including: the Bullitt Foundation, Gigi Foundation, Bannerman Foundation, City of Homer through the Homer Foundation, True North Foundation, Alaska Conservation Foundation, Mountaineers Foundation, Norcross Wildlife Foundation, Homer Soil and Water Conservation District, Giles W. and Elise G. Mead Foundation, Patagonia, The West Wind Foundation, Skaggs Foundation, Kongsgaard-Goldman Foundation, George H. and Jane A. Mifflin Memorial Fund, U.S. Fish and Wildlife Service, *Exxon Valdez* Oil Spill Trustee Council, and in the early years funding from 319 Clean Water Act grants through the Alaska Department of Environmental Conservation. Support from Inletkeeper's members and supporters has been invaluable since the beginning.

Thank You Volunteers!

Dedicated to Steve Hackett (1945-2011)

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