



Freshwater Monitoring in Southwest Alaska Network Parks

2014 Field Season Summary

Natural Resource Data Series NPS/SWAN/NRDS—2016/1005



ON THE COVER

Evan Booher and Jeff Nelson collect water quality samples along a channel cross-section at the Lake Clark outlet on September 13, 2014

Photograph by: NPS/Dan Young

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols. This report received peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

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Abstract

The Southwest Alaska Network (SWAN) is one of four networks established within Alaska as part of the National Park Service Inventory and Monitoring Program. It consists of five park units: Alagnak Wild River, Aniakchak National Monument and Preserve, Katmai National Park and Preserve, Kenai Fjords National Park, and Lake Clark National Park and Preserve. Collectively, these units comprise 3.8 million hectares and extend over 650 km of the Alaska and Kenai Peninsulas. The freshwater resources of these park units are vast, ranging from countless small streams to large, complex lake systems. This report is intended to detail the monitoring of these resources during the 2014 field season. In general, the work is divisible into long-term monitoring of water quality and water quantity parameters, and a short-term pilot study of water temperature. Specifically, the SWAN freshwater field crew operated six vertical temperature arrays, deployed two multiparameter sondes, completed 105 vertical lake profiles, measured water level and discharge at four lake outlets, and initiated a pilot study of interstitial and surface water temperatures at ten sites. All field work was guided by the SWAN standard operating procedures or other published protocols.

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List of Acronyms

ADCP	Acoustic Doppler current profiler
ADFG	Alaska Department of Fish and Game
AMS+	Alternative Measurement Sensitivity Plus
C185	Cessna 185 airplane
CFS	cubic feet per second
DO	dissolved oxygen
GPS	Global Positioning System
EWI	equal width increments
fDOM	flourescent dissolved organic matter
I&M	Inventory and Monitoring
KATM	Katmai National Park and Preserve
KEFJ	Kenai Fjords National Park
LACL	Lake Clark National Park and Preserve
MDS	multiparameter display system
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWS	National Weather Service
RAWS	Remote Automated Weather Station
RP	reference point
S/N	serial number
SOP	standard operating procedure
SWAN	Southwest Alaska Network
VHG	vertical hydraulic gradient
WRD	Water Resources Division

Water Quality Monitoring: Vertical Temperature Arrays

The Southwest Alaska Network (SWAN) freshwater field crew maintained six year-round vertical temperature arrays in Tier 1 (high priority) lakes during 2014. Four of the temperature arrays are located in Katmai National Park and Preserve (KATM): three in different basins of Naknek Lake (NAKNL01, NAKNL02, NAKNL03) and one in Lake Brooks (LBROO01). The remaining two arrays are located in Lake Clark National Park and Preserve (LACL): one in Lake Clark (LCLAR01) and another in Kijik Lake (KIJIL01).

All temperature arrays were found and downloaded successfully at least once during the 2014 field season. Surface buoys and water temperature loggers, positioned between 0 m and 1 m depth, were installed on five arrays (all, except NAKNL03) and then retrieved at the end of the summer, before lakes started to freeze. Also, one of the three water-level loggers on the arrays was downloaded (LCLAR01). Full logger replacements were performed on two of the temperature arrays (NAKNL02 and LBROO01). The Naknek Lake Iliuk Arm array (NAKNL03) was retrieved after a splice failure in 2013 left it deployed in the lake without an anchor line or bridle line. The Iliuk Arm array was rebuilt and re-deployed on August 26, 2014.

Data logger accuracy checks have been performed inconsistently during the period of record for the SWAN temperature arrays. We recommend:

1. incorporating detailed guidelines on temperature logger accuracy checks into SOP 8 (Shearer et al. 2015), and
2. acquiring appropriate equipment to perform this activity with reasonable confidence, such as an electronic thermistor with accuracy and resolution to National Institute of Standards and Technology (NIST) specifications.

The following sections are summaries of site visits conducted in 2014. They include information on the date, time, and location of each visit, as well as who was involved, how they reached the site, and what they did while there.

KATM – Naknek Lake – North Arm

Visit 1 – June 13, 2014

Date: June 13, 2014

Time of visit: 14:25-15:40

Personnel: Evan Booher and Jeff Nelson (SWAN); Troy Hamon, Nicole Kleponis, and Katie Nicolato (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Locate array; download loggers; attach surface buoy and logger

Coordinates:

- Instrument line: 58.63676 N; 155.63763 W (06/13/2014 15:39)
- Anchor line: 58.63843 N; 155.63657 W (07/11/2010 13:39)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10339622) at 0-1 m
- Lotek MCFT2-3L radio transmitter (S/N: not recorded; frequency: 162.494 MHz; BI: 5.0 s)

Narrative:

The Naknek Lake North Arm temperature array (NAKNL01) was located with waypoints from previous site visits and the Lowrance Lakeview depth finder on the Palayaq. All loggers (5 m-70 m) were downloaded using a HOBO Waterproof Shuttle, and all logged air temperature at 11:00 on this date (Figure 1). A surface buoy was attached to the instrument line, along with a HOBO logger programmed for hourly readings (delayed launch date/time: 06/14/2014 00:00). A radio tag, to aid in array relocation, was inserted into the instrument line beneath the submersible buoy, and a new waypoint was taken above the instrument line.

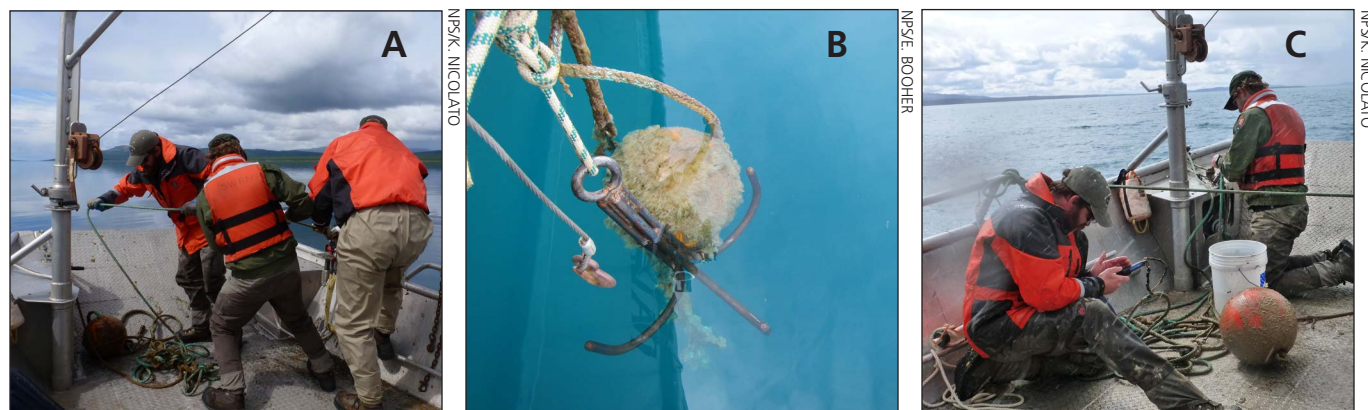


Figure 1. Evan Booher, Jeff Nelson, and Troy Hamon haul up the instrument line of the Naknek Lake North Arm (NAKNL01) temperature array on June 13, 2014 (A). The submersible buoy on the instrument line contained substantial algal growth (B). Evan Booher and Jeff Nelson download Onset HOBO Water Temp Pro v2 loggers deployed on the instrument line (C).

Visit 2 – September 23, 2014

Date: September 23, 2014

Time of visit: 10:30-11:45

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Download loggers; remove surface buoy and logger

Coordinates:

- Instrument line: 58.63673 N; 155.63829 W (09/23/2014 11:41)
- Anchor line: 58.63843 N; 155.63657 W (07/11/2010 13:39)

Narrative:

The NAKNL01 temperature array was located visually due to the surface buoy. All loggers (5 m-70 m) were downloaded with the Onset Optical Base Station and field computer. The 60 m logger (S/N: 9951833) failed to read out. It was removed and replaced with another HOBO Water Temp Pro v2 logger (S/N: 10584821; Tables 1 and 2). The 0, 5, 10, and 60 m HOBOS logged air temperature at 11:00 on this date. Later in the office, the retrieved 60 m logger downloaded successfully.

KATM – Naknek Lake – West Arm**Visit 1 – June 13, 2014**

Date: June 13, 2014

Time of visit: 16:30-17:45

Personnel: Evan Booher and Jeff Nelson (SWAN); Troy Hamon, Nicole Kleponis, and Katie Nicolato (KATM)

Mode of transport: Landing craft “Palayaq,” 27ft (KATM)

Purpose of trip: Locate array; download loggers; attach surface buoy and logger

Coordinates:

- Instrument line: 58.61648 N; 156.03680 W (06/13/2014 17:05)
- Anchor line: 58.616588032 N; 156.037234012 W (2009)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10339613 launch 06/14/2014 00:00) at 0-1 m
- Lotek MCFT2-3L radio transmitter (S/N: MC002508; frequency: 162.494 MHz; BI: 5.0 s)

Narrative:

The vertical and horizontal lines of the Naknek Lake West Arm temperature array (NAKNL02) were located successfully, with assistance from the Lowrance Lakeview depth finder and Troy Hamon as boat operator. All loggers (5 m-25 m) were downloaded and re-launched. All loggers recorded air temperature at 17:00 on this date. A surface buoy was attached to the instrument line with a HOBO logger programmed for hourly readings (delayed launch date/time: 06/14/2014 00:00). A radio tag was inserted below the submersible buoy on the instrument line.

Visit 2 – August 21, 2014

Date: August 21, 2014

Time of visit: 10:00-11:00

Personnel: Evan Booher, Jeff Nelson, and Michael Shephard (SWAN); Mark Kaufman (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Replace loggers

Coordinates:

- Instrument line: 58.61649 N; 156.03722 W (08/21/2014 11:16)
- Anchor line: 58.61659 N; 156.03723 W (2009)

Narrative:

The NAKNL02 temperature array was visited in order to replace HOBO Pro v2 temperature loggers from 5 m-25 m depths. First, these loggers were downloaded and removed from the instrument line (Table 1); then, new loggers programmed for hourly readings were installed (Table 2). In order to extend the loggers’ lifespans, they were programmed to log water temperature only (not battery voltage). The surface (0-1 m) logger status was checked—the battery reading was “good” with logging active on an hourly interval. Post-processing in Aquarius indicated that the surface logger did not measure air temperature during this visit.

Table 1. Old water temperature loggers removed from SWAN temperature arrays in 2014.

Station Name	Logger Model	Logger Depth	Serial Number	Stop Date/Time	Storage Location
NAKNL01	HOBO Pro v2	60 m	9951833	09/23/2014 10:50	Anchorage
NAKNL02	HOBO Pro v2	5 m	1021206	08/21/2014 10:27	Anchorage
NAKNL02	HOBO Pro v2	10 m	1038141	08/21/2014 10:31	Anchorage
NAKNL02	HOBO Pro v2	15 m	1044774	08/21/2014 10:31	Anchorage
NAKNL02	HOBO Pro v2	20 m	1037939	08/21/2014 10:29	Anchorage
NAKNL02	HOBO Pro v2	25 m	1038142	08/21/2014 10:25	Anchorage
LBROO01	HOBO Pro v2	5 m	9683524	09/23/2014 14:19	Anchorage
LBROO01	HOBO Pro v2	10 m	9683525	09/23/2014 14:08	Anchorage
LBROO01	HOBO Pro v2	20 m	9683526	09/23/2014 14:08	Anchorage
LBROO01	HOBO Pro v2	30 m	9683529	09/23/2014 14:06	Anchorage
LBROO01	HOBO Pro v2	40 m	9683530	09/23/2014 14:01	Anchorage
LBROO01	HOBO Pro v2	50 m	9683531	09/23/2014 13:55	Anchorage
LCLAR01	HOBO Pro v2	10 m	10339620	06/04/2014 12:21	Anchorage
LCLAR01	HOBO Pro v2	20 m	2430145	09/15/2014 13:10	Anchorage

Table 2. New water temperature loggers installed on SWAN temperature arrays in 2014.

Station Name	Logger Model	Logger Depth	Serial Number	Launch Date/Time
NAKNL01	HOBO Pro v2	60 m	10584821	09/23/2014 12:00
NAKNL02	HOBO Pro v2	5 m	1020449	08/21/2014 12:00
NAKNL02	HOBO Pro v2	10 m	10204451	08/21/2014 12:00
NAKNL02	HOBO Pro v2	15 m	10010747	08/21/2014 12:00
NAKNL02	HOBO Pro v2	20 m	10010741	08/21/2014 12:00
NAKNL02	HOBO Pro v2	25 m	10010757	08/21/2014 12:00
LBROO01	HOBO Pro v2	5 m	10584816	09/23/2014 15:00
LBROO01	HOBO Pro v2	10 m	10584782	09/23/2014 15:00
LBROO01	HOBO Pro v2	20 m	10211806	09/23/2014 15:00
LBROO01	HOBO Pro v2	30 m	10584783	09/23/2014 15:00
LBROO01	HOBO Pro v2	40 m	10339619	09/23/2014 15:00
LBROO01	HOBO Pro v2	50 m	10584776	09/23/2014 15:00
LCLAR01	HOBO Pro v2	10 m	2430136	06/04/2014 13:00
LCLAR01	HOBO Pro v2	20 m	10584777	09/15/2014 14:00

Visit 3 – September 23, 2014

Date: September 23, 2014

Time of visit: 18:30-18:45

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Remove surface buoy; download and remove surface logger

Coordinates:

- Instrument line: 58.61647 N; 156.03624 W (09/23/2014 18:43)
- Anchor line: 58.61659 N; 156.03723 W (2009)

Narrative:

The NAKNL02 temperature array was accessed with the KATM Palayaq landing craft with Jeff Nelson as operator. The surface buoy was removed, and the 0 m HOBO logger was removed and downloaded (S/N: 10339613). A full download was not performed since all loggers (5 m-25 m) were replaced the previous month on 08/21/2014. A new waypoint was taken above the instrument line prior to deployment and departure from the site.

KATM – Naknek Lake – Iliuk Arm

Visit 1 – August 19, 2014

Date: August 19, 2014

Time of visit: 19:30-22:00

Personnel: Evan Booher, Jeff Nelson, Michael Shephard, and Lisa Shoemaker (SWAN); Troy Hamon (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Locate and retrieve instrument line

Coordinates:

- Instrument line: 58.52172 N; 155.60376 W (07/29/2013 14:21)
- Anchor line: 58.52160 N; 155.60425 W (06/11/2012 17:09)

Narrative:

Loggers on the Naknek Lake Iliuk Arm (NAKNL03) temperature array were not downloaded in 2013. A splice failure between the instrument line and the bridle line during a site visit in July 2013 left the instrument line deployed vertically in the water column without easy means of retrieval. Therefore to retrieve the instrument line, the grappling hook was attached to approximately 225 m of line and lowered from the Palayaq to the lake bottom in close proximity to the location of the vertical instrument line. The location was known because of a GPS waypoint taken during the July 2013 site visit and confirmed using the Lowrance Lakeview depth finder. Once the grappling hook reached the lake bottom, Troy Hamon navigated the Palayaq in a circle around the instrument line, and then the crew attempted to pull the instrument line in. The first attempt failed to bring the array to the surface. On the second attempt, the same general strategy was used, except three full circles around the instrument line were made. Upon completion of the circles, the Palayaq was driven in a straight line away from the array. Once tension was felt on the line, it was continuously hauled in by hand until the submersible buoy surfaced. After the submersible buoy was brought to the surface, the line was transferred to the capstan winch with a davit and prussik sling as backup. The entire instrument line was removed from the lake between 9:00 and 10:00 pm and transported to King Salmon. All of the loggers (5 m-100 m) were downloaded the following day on 08/20/2014 at 16:00.

Visit 2 – August 26, 2014

Date: August 26, 2014

Time of visit: 15:00-16:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Troy Hamon (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Deploy rebuilt temperature array

Coordinates:

- Instrument line: 58.52197 N; 155.60271 W (08/26/2014 15:51)
- Anchor line: 58.52182 N; 155.60361 W (08/26/2014 15:14)

Narrative:

The NAKNL03 temperature array was rebuilt on 08/25/2014. The vertical instrument and anchor lines were not spliced to the bridle line as described in SOP 8. Instead, eye splices at the top of the instrument and anchor lines were connected to the horizontal bridle line using spring-loaded carabiners. The deployment location was determined based on waypoints taken during previous site visits. The anchor system for both the instrument and anchor lines weighed approximately 20 kg including chain and was constructed using two lead pyramid anchors. The deployment site depth was approximately 165 m. The HOBO Water Temp Pro v2 loggers were left in place on the line and were not replaced while the array was out of the lake. Each logger was attached to the instrument line with Gagnon cord that secured the mounting hole of the sensor through the instrument line at the correct depth. Each security cord was tied with bowline knots and finished with electrician's tape. The launch date/time for all loggers was 08/26/2014 16:00 with an hourly logging interval. New waypoints were taken above the instrument and anchor lines. Floating line was used for the horizontal bridle line. To keep

it submerged several carabiners were attached mid-way between the instrument and anchor lines. No surface buoy was attached to instrument line to monitor 0 m temperature, as the peak summer temperature had likely already occurred by this date.

KATM – Lake Brooks

Visit 1 – May 12, 2014

Date: May 12, 2014

Time of visit: 11:00-12:00

Personnel: Evan Booher (SWAN); Michael Saxton (KATM)

Mode of transport: Lund “Rec” boat, 16 ft (KATM)

Purpose of trip: Locate array

Coordinates:

- Instrument line: 58.53024 N; 155.85461 W (05/26/2013 12:40)
- Anchor line: 58.53020 N; 155.85052 W (09/20/2012 12:00)

Narrative:

The first attempt to locate the Lake Brooks temperature array (LBROO01) was unsuccessful. A search was conducted for approximately one hour along transects between previously recorded waypoints, by dragging a grappling hook behind the “Rec” boat. This visit was part of a day trip from King Salmon which limited the time available to search for the array.

Visit 2 – June 10, 2014

Date: June 10, 2014

Time of visit: 12:10-14:00

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Lund “Rec” boat, 16 ft (KATM)

Purpose of trip: Locate array

Coordinates:

- Instrument line: 58.53024 N; 155.85461 W (05/26/2013 12:40)
- Anchor line: 58.53020 N; 155.85052 W (09/20/2012 12:00)

Narrative:

The second attempt to locate the LBROO01 temperature array was unsuccessful. A search was conducted for approximately two hours along transects between previously recorded waypoints. Methods were similar to those used for Trip 1. The site visit was part of a day trip from King Salmon which limited the time available to search for the array. Windy conditions hindered efforts to visually locate the array.

Visit 3 – June 24, 2014

Date: June 24, 2014

Time of visit: 10:00-12:00

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN)

Mode of transport: Lund “Rec” boat, 16 ft (KATM)

Purpose of trip: Locate array; download loggers; attach surface buoy and logger

Coordinates:

- Instrument line: 58.52976 N; 155.85410 W (06/24/2014 12:13)
- Anchor line: 58.52999 N; 155.85422 W (06/24/2014 12:17)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10339618) at 0-1 m

Narrative:

The LBROO01 temperature array was located successfully in close proximity to the 05/23/2013 instrument line waypoint. All loggers (5 m-50 m) were downloaded between 11:00 and 11:30. The time stamp on the acquired data was “_:48” seconds. All loggers were re-launched for hourly logging with a time stamp of _:00 seconds using the field computer and an Optical Base Station. The surface buoy and HOBO logger programmed for hourly readings (delayed launch date/time: 06/25/2014 00:00) were deployed. Data logged by all HOBOS at 12:00 on this date are air temperatures. Moderate winds caused the boat to drift offsite during download such that the first attempt to re-deploy the temperature array occurred at a site that was too shallow. The array was moved slightly south to a deeper location. New instrument and anchor line waypoints were taken prior to departure. Note: the bridle line on LBROO01 is floating line with a piece of metal pipe secured midway between the anchor and instrument lines. This causes the bridle line to sit lower in the water column at its midpoint. It is recommended that attempts to retrieve the bridle line take place in close proximity to the instrument line where the horizontal line will be higher in the water column and potentially visible from the surface.

Visit 4 – September 23, 2014

Date: September 23, 2014

Time of visit: 14:00-14:40

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Lund “Rec” boat, 16 ft (KATM)

Purpose of trip: Download and replace loggers; remove surface buoy and logger

Coordinates:

- Instrument line: 58.53014 N; 155.85408 W (09/23/2014 14:36)
- Anchor line: 58.52999 N; 155.85422 W (06/24/2014 12:17)

Narrative:

The LBROO01 temperature array was located visually from the “Rec” boat due to the surface buoy attached to the instrument line. All loggers (0 m-50 m) were removed and downloaded. The 5 m-50 m loggers were replaced due to logger age (Tables 1 and 2). New loggers were launched (09/23/2014 15:00 hourly logging interval) and labeled by depth with a paint pen. Moderate winds caused the boat to drift offsite during download, so the array was moved slightly south before re-deployment to ensure that it was at an appropriate depth. A new instrument line waypoint was taken prior to departure from the field site. At 14:00 during this visit, HOBOS from 5 m-40 m logged either air temperatures or water temperatures displaced from intended depths.

LACL – Lake Clark

Visit 1 – June 2, 2014

Date: June 2, 2014

Time of visit: 10:45-11:15

Personnel: Evan Booher and Jeff Nelson (SWAN); Michael McNulty, Olivia Olin, and Tim Rovinelli (LACL)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Locate array; attach surface buoy and logger

Coordinates:

- Instrument line: 60.26305 N; 154.23788 W (06/2/2014 11:28)
- Anchor line: 60.26223 N; 154.23877 W (05/15/2013)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 2430138) at 0-1 m

Narrative:

Continuous water temperature monitoring was initiated at the lake surface on the Lake Clark temperature array (LCLAR01). A surface buoy was attached to the instrument line with a HOBO logger programmed for hourly readings (delayed launch date/time: 06/03/2014 00:00). Note: field crews were unable to locate the array during two previous site visits in May 2014. During one of these visits, a radio telemetry receiver was used to pinpoint the location of the array via a radio tag installed in the array line. GPS waypoints of probable locations were taken during this attempt. These waypoints were used during this site visit (06/02/2014) but were no more helpful than waypoints taken during the last visit when the logger was retrieved (10/21/2013). The grappling hook stored in Port Alsworth is significantly lighter than that stored in King Salmon. Therefore, a heavier boat anchor was used instead of the small grappling hook during retrieval attempts on this trip. The heavier anchor rode lower in the water column during “trawling” and was significantly more effective.

Visit 2 – June 4, 2014

Date: June 4, 2014

Time of visit: 10:45-11:15

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft (LACL)

Purpose of trip: Download loggers

Coordinates:

- Instrument line: 60.263048792 N; 154.237884991 W (06/04/2014 13:30)
- Anchor line: 60.262226779 N; 154.238768276 W (06/04/2014 13:30)

Narrative:

The LCLAR01 temperature array was located visually using the attached surface buoy. The array was retrieved with the newly installed capstan winch on the LACL “Chinook” landing craft. This hauling method, not used since 2009, presents a significant advantage in terms of crew safety and required effort. Due to outdated HOBOWare software on the field computer, all downloaded files indicated “bad header” upon logger read-out. All loggers were checked and re-launched (launch date/time 06/04/2014 16:00) with the field computer and Optical Base Station to ensure that the “bad header” messages were not an indication of logger failure. Later, after opening the files in the office, it was determined that they were okay. The 10 m logger (S/N: 10339620) read “fail” on the Shuttle and was replaced with a HOBO Water Temp Pro v2 logger (S/N: 2430136; Tables 1 and 2). A status check was also performed on the 0 m logger to confirm function. The Solinst M5 level logger was not downloaded because the connection cable was not on board. Waypoints were taken upon re-deployment of the instrument line and near the anchor line prior to departure from the field site. Note: the 0 m

HOBO logged air temperature at 12:00 and 13:00 during this site visit. HOBOS from 5 m-70 m logged air temperature at 12:00 on this date. The 30 m HOBO record at 13:00 also should be flagged.

Visit 3 – September 15, 2014

Date: September 15, 2014

Time of visit: 12:15-14:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft (LACL)

Purpose of trip: Download loggers; remove surface buoy and logger

Coordinates:

- Instrument line: 60.26130 N; 154.24118 W (09/15/2014 13:58)
- Anchor line: 60.262226779 N; 154.238768276 W (06/04/2014 13:30)

Narrative:

The LCLAR01 temperature array (LCLAR01) was located visually using the attached surface buoy. All loggers were downloaded and status checks were conducted to ensure function. The surface buoy and 0 m logger were removed. The ageing 20 m logger (S/N: 2430145) was replaced with a new one (S/N: 10584777; Tables 1 and 2). HOBOS at depths of 20 m-70 m logged air temperature at 13:00 on this date (09/15/2014). The 5 m Solinst M5 Level Logger (S/N: 1018539) was downloaded and re-launched (9/15/2014 14:00). Note: a splice created several years ago to repair the instrument line at 10 m depth was backed up with loops of Gagnon cord threaded through the line above and below the splice. A new piece of line was attached to each of these loops with double-backed “figure 8” knots. Two new 900-ft sections of line should be ordered so that a replacement array can be built and installed during the 2015 field season.

LACL – Kijik Lake

Visit 1 – May 29, 2014

Date: May 29, 2014

Time of visit: 11:00-13:00

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Flat-bottomed skiff “Sea King,” 14 ft (LACL)

Purpose of trip: Locate array; attach surface buoy and logger

Coordinates:

- Instrument Line: 60.29727 N; 154.32961 W (05/29/2014 11:47)
- Anchor Line: 60.29756 N; 154.32961 W (06/25/2013 18:23)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10339614) at 0-1 m
- Lotek MCFT2-3L radio transmitter (S/N: MC002506; frequency: 162.494 MHz; BI: 5.0 s)

Narrative:

Continuous water temperature monitoring was initiated at the lake surface on the Kijik Lake temperature array (KIJIL01). The array was located using GPS waypoints from the June 2013 field visit. The bridle line was detected visually near the anchor waypoint and retrieved with a grappling hook and line. The instrument line was hand-hauled to just below the submersible buoy and a surface buoy was attached to the instrument line with a HOBO logger programmed for hourly readings (delayed launch date/time: 05/30/2014 00:00). A radio tag also was installed 1 m below the submersible buoy to assist future location efforts. The 2013 anchor line waypoint was valid, so only a new instrument line waypoint was taken

prior to departure. Note: the temperature array was not fully downloaded on this date because the boat stored on-site (“Sea King”) is a narrow beam, flat bottom skiff and does not provide a stable platform for temperature array retrieval.

Visit 2 – July 2, 2014

Date: July 2, 2014

Time of visit: 12:30-14:30

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Lowe flat-bottomed jet boat, 14 ft (LACL)

Purpose of trip: Download loggers

Coordinates:

- Instrument line: 60.29726984 N; 154.32960799 W (07/02/2014 14:30)
- Anchor line: 60.29756 N; 154.32961 W (06/25/2013 18:23)

Narrative:

The KIJIL01 temperature array was accessed via the Kijik River and Little Kijik River by jet boat with Dan Young as boat operator. The temperature array was located visually using the attached surface buoy. The instrument line of the temperature array was hand-hauled by Evan Booher and Jeff Nelson. Dan Young created secure tie-off points at 10 m intervals for safety during retrieval. Loggers from 5 m-90 m depth were downloaded with a HOBO Waterproof Shuttle. Loggers were re-launched with an Optical Base Station to ensure the logging interval ended with a “_:00” time stamp. A review of data after this trip showed that this was not a necessary step towards maintaining a clean _:00 seconds time stamp. Attachment material for all loggers was replaced with Gagnon cord due to the failure of steel split rings, several of which disintegrated upon retrieval. A new instrument line waypoint was taken prior to departure from the field site. The 0 m HOBO logged air temperature at 13:00 during this visit.

Visit 3 – September 16, 2014

Date: September 16, 2014

Time of visit: 14:15-14:45

Personnel: Evan Booher and Jeff Nelson (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Purpose of trip: Remove surface buoy; download and remove surface logger

Coordinates:

- Instrument Line: 60.29722 N; 154.32983 W (09/16/2014 14:45)
- Anchor Line: 60.29756 N; 154.32961 W (06/25/2013 18:23)

Narrative:

Due to uncertainty about whether Kijik River water levels would allow boat entry, the KIJIL01 temperature array was accessed via the LACL Cessna 185 on floats, piloted by Rich Richotte. Upon completion of work on the Little Kijik River (outlet stream), the plane taxied over to the surface buoy of the temperature array. The surface buoy was removed and the 0 m HOBO was retrieved and downloaded with a Waterproof Shuttle. A full download of the array and replacement of the loggers was not possible due to access by airplane instead of jet boat. A new waypoint was taken prior to departure. Note: all temperature loggers (5 m-90 m) should be replaced during the first site visit of the 2015 field season.

Water Quality Monitoring: Continuous Sonde Deployments

The SWAN freshwater field crew deployed YSI 6600 multiparameter sondes for continuous sampling of “core parameters” in the outlets of Naknek Lake (KATM) and Lake Clark (LACL) during the open-water season in 2014. Core parameters, as defined by the NPS Water Resources Division (WRD), include temperature, specific conductance, pH, and dissolved oxygen (DO). Sondes were programmed for unattended logging on hourly sampling intervals. The Naknek Lake sonde was deployed from May 16 through October 2, with a one-week gap during the month of June (Table 3). The Lake Clark sonde was deployed from June 6 through September 13. Due to port leakage during the initial deployment, this sonde was replaced with a LACL-owned YSI 6920 sonde on July 3.

Cross-sectional water quality samples were taken upon initial deployment and final removal of sondes at each site following “equal width increments” (EWI) methods to determine channel mixing conditions for core parameters. For EWI sampling the stream cross section is broken into at least 10 increments of equal width, and core parameters are recorded in the center of each increment half way between the water surface and stream bottom on the vertical axis (Wilde 2008). In practice, we have not attained discrete EWI samples at 50% stream depth in the deeper sections of either outlet site due to a lack of appropriate equipment for maintaining sonde position at the desired depth in strong, deep currents.

Site visits occurred at monitoring locations at as close to a monthly interval as possible. Quality assurance and control procedures for continuous data were followed during site visits to quantify sensor fouling and drift. Fouling checks were made with Alternative Measurement Sensitivity Plus or “AMS+” sampling (seven rapid in-situ field samples) with the continuous sonde and an independent field meter before and after sensor cleaning occurred (Thoma et al. 2012, Irwin 2008). Post-deployment checks were conducted with calibration standards. When possible we recalibrated sensors following post-deployment checks.

Several recommendations for future efforts stem from this year’s continuous water quality monitoring work. Close visual inspection of all parts of the sonde and professional maintenance annually during the off-season would help prevent equipment failure, and subsequent loss of data, in the field. Should equipment failure occur, the ability to replace it with a back-up option is important for maintaining in-season continuity in data collection. Both the acquisition of a “back-up” sonde and provisions for professional maintenance of park-owned equipment could be options for increasing SWAN’s ability to handle unexpected and frustrating situations related to equipment failure.

Procedures for performing post-deployment field-based sensor drift checks are not outlined in SOP 3 (Shearer et al. 2015). Guidelines for this should be made explicit because the SOP assumes checks occur in a lab, which implies that the sonde is removed from and returned to the site for an activity that can easily occur on-site.

Additionally, EWI sampling at the Naknek Lake outlet has been challenging when a rangefinder is used to determine channel wetted width and horizontal distance between the boat and shoreline. The site is not well-suited to shooting estimated distances with a range finder due its wide channel and lack of structures. The Sontek M9 ADCP could be tested as an alternative tool to measure channel wetted width and the boat’s distance from shore during a EWI sampling event. The M9 unit logs both of these pieces of data during a channel transect and is usually on board during continuous water quality site visits.

We also recommend that users create all site files in the 650 MDS handheld computer well ahead of any field visit to prevent users from improvising site file names on-site. Guidance on YSI file naming should be added to the standard file naming conventions delineated in Table 10.2 of SOP 10 (Shearer et al. 2015).

Lastly, because multiparameter sonde deployment extends only through the open-water season, year-round temperature monitoring was initiated in 2014 at the outlets of Lake Clark and Kijik Lake via Onset HOB0 Water Temp Pro v2 data loggers (S/N 9683511 and 10339617, respectively). We recommend that loggers be deployed year-round at the outlets of Naknek Lake and Lake Brooks as well.

Table 3. Deployment information for the sondes used to monitor water quality at the outlets of Naknek Lake and Lake Clark.

Station Name	Deployment	Sonde Model	Sonde S/N	Start Date/Time	Stop Date/Time
Naknek Lake outlet	1	YSI 6600	03J1041	05/16/2014 16:00	06/19/2014 13:00
	2	YSI 6600	03J1041	06/26/2014 17:00	08/1/2014 16:00
	3	YSI 6600	03J1041	08/01/2014 16:00	09/4/2014 15:00
	4	YSI 6600	03J1041	09/04/2014 15:00	10/2/2014 11:00
Lake Clark outlet	1	YSI 6600	03D0618	06/03/2014 13:00	07/3/2014 15:00
	2	YSI 6920	02J0999AA	07/03/2014 17:00	07/17/2014 16:00
	3	YSI 6920	02J0999AA	07/17/2014 16:00	09/13/2014 14:00

KATM – Naknek Lake Outlet

Visit 1 – May 16, 2014

Date: May 16, 2014

Time of visit: 13:00-16:30

Personnel: Krista Bartz, Evan Booher, and Jeff Nelson (SWAN)

Mode of transport: Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Initiate continuous water quality monitoring; conduct EWI cross-section

Equipment installed:

- YSI 6600 multiparameter sonde (S/N: 03J1041)
- PVC housing
- Nylon line
- Pyramid anchors (2)

Narrative:

Continuous monitoring of core parameters was initiated at the outlet of Naknek Lake in the same location as the previous two years (2012, 2013). This location is an area of flowing water, outside of common navigation routes, with bank vegetation appropriate for anchoring equipment. Alternative sites, both upstream and downstream, were considered prior to deployment. Downstream sites on river left were characterized by a lack of vegetation or bank features needed to anchor the sonde. Other sites had higher exposure to the public and potential for vandalism (e.g., Lake Camp or the bank downstream of Trefon's Cabin). Mid-channel sites (e.g., Grandma Rock) were considered, but dismissed due to anticipated difficulties with retrieval. The broad width and low flow of the current site make it undesirable for water quality and quantity monitoring.

Sensor calibration was performed the previous day (05/15/2014) at KATM headquarters. The jet boat was trailered from King Salmon to Lake Camp and used for site access. Upon arrival at the site, an EWI cross-section of core parameters was completed nearby from 15:35 to 16:01 with the 6600 sonde, prior to deployment.

The sonde was secured to a tree using approximately 60 m of line. A small trench was dug into the river bank perpendicular to water's edge from the anchor tree. The anchor line was placed in this trench and buried to make the installation less visible. Lead pyramid anchors were attached to the sonde housing and at the approximate mid-point of the line to prevent movement of the sonde during deployment. Note: although floating line was used for this installation, it is recommended that sinking line or steel cable be used in subsequent years to decrease visibility. The sonde was programmed for unattended sampling of core parameters on an hourly interval (launch date/time: 05/16/2014 16:00; Table 4) and then deployed in the channel at maximum wadeable depth. Site waypoints were logged on a Trimble Nomad GPS (58.6817072 N; 156.4348905 W).

Table 4. Initial measurements of core parameters at the start of each sonde deployment in the outlets of Naknek Lake and Lake Clark.

Location	Sonde	Date	Time	Temperature (°C)	Sp. Cond. (µS/cm)	pH (unitless)	DO (mg/L)	DO (% sat.)
Naknek Lake	6600	05/16/2014	16:00	17.84	133	7.82	11.88	125.1
	6600	06/19/2014	13:00	10.74	133	6.71	11.74	106.82
	6600	06/26/2014	17:00	17.103	128	8.16	11.85	122.86
	6600	08/01/2014	17:30	18.75	146	7.91	11.49	123.4
	6600	09/04/2014	15:30	13.98	138	7.48	9.97	96.8
	6600	10/02/2014	11:30	7.32	136	-9.99 ^a	11.3	93.8
Lake Clark	6600	06/03/2014	13:00	6.195	65	6.88	12.72	102.72
	6600	07/01/2014	08:00	4.844	65	4.53 ^a	12.96	101.04
	6920	07/03/2014	17:00	7.911	66	7.697	10.15	101.04
	6920	07/17/2014	17:00	12.181	65	7.85	9.75	90.71
	6920	07/25/2014	16:00	10.37	65	7.824	9.62	86
	6920	09/13/2014	14:00	11.2	65	7.8	10.5	95.65

^a Data flagged as being outside the expected range of values.

Visit 2 – June, 19 2014

Date: June 19, 2014

Time of visit: 13:00-14:00

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Perform sonde maintenance

Narrative:

Maintenance on the 6600 sonde was performed approximately one month after initial deployment. The sonde was retrieved from the river and downloaded at 13:13. Checks for sensor fouling were conducted on site with the 6600 sonde and a calibrated EXO2 sonde. Checks for sensor drift, followed by recalibration, were conducted later at KATM headquarters, where supplies were available. This required removing the sonde from the monitoring site.

Visit 3 – June 26, 2014

Date: June 26, 2014

Time of visit: 11:30-14:00

Personnel: Evan Booher (SWAN), Katie Nicolato (KATM)

Mode of transport: Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Re-deploy sonde

Narrative:

The 6600 sonde was transported back to Naknek Lake outlet for re-deployment. A week lapsed between retrieval and redeployment due to logistical and personnel constraints. In the interim, water levels rose, becoming too high to wade into the channel to deploy the sonde. The jet boat therefore was used to move and drop the sonde into deeper water in the channel. The same anchor and line system was used.

Visit 4 – August 1, 2014

Date: August 1, 2014

Time of visit: 15:45-17:00

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Perform sonde maintenance

Narrative:

Maintenance on the 6600 sonde was performed approximately one month after re-deployment during the previous site visit. The sonde was retrieved from the river and downloaded at 16:15. Checks for sensor fouling were conducted on-site using the 6600 sonde and a calibrated EXO2 sonde. Checks for sensor drift also were performed on-site, and all sensors checked out. Sensors were recalibrated from 16:32-17:00. DO was calibrated and checked using the calibration cup and water-saturated air. Logging remained active during maintenance and the jet boat was used to move and drop the sonde into deeper water in the channel. The same anchor and line system was used.

Visit 5 – September 4, 2014

Date: September 4, 2014

Time of visit: 15:45-17:00

Personnel: Jeff Nelson (SWAN); Michael Nelson (Volunteer)

Mode of transport: Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Perform sonde maintenance

Narrative:

Maintenance on the 6600 sonde was performed approximately one month after the previous site visit. The sonde was retrieved from the river and downloaded at 15:15. Checks for sensor fouling were conducted on site using the 6600 sonde and a calibrated EXO2 sonde. Checks for sensor drift also were performed on-site, and all sensors checked out. The specific conductivity and pH sensors were not recalibrated. DO was recalibrated using a wet towel and water-saturated air. Logging remained active during maintenance and the sonde was placed back in the river by wading into the channel. The same anchor and line system was used.

Visit 6 – October 2, 2014

Date: October 2, 2014

Time of visit: 11:00-14:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Katie Nicolato (KATM)

Mode of transport: Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Perform sonde maintenance; remove sonde

Narrative:

Maintenance on the 6600 sonde was performed approximately one month after the previous site visit. Fouling checks were conducted using the 6600 and EXO2 sondes, before and after cleaning the 6600 (Figure 2). Because the sonde was removed for the season, drift checks were performed later at KATM headquarters, rather than conducting them in the field. Observed pH readings of -9.99 indicated failure of that sensor (Table 4). An in-field review of logged data indicated that the pH sensor failed instantaneously on 09/21/2014 at 09:00, since samples just prior to failure were within the expected range of values for the site, as determined by data collected in previous years. EWI samples of core parameters were taken at ten locations along a channel cross-section near the deployment location using the EXO2 sonde.

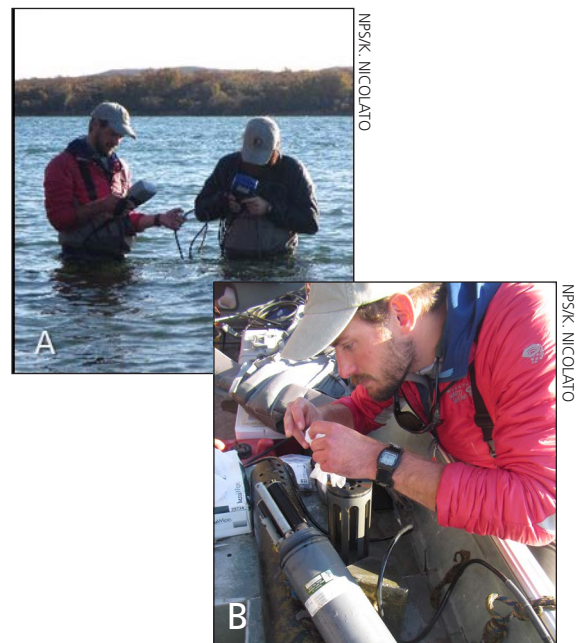


Figure 2. Evan Booher (left) and Jeff Nelson (right) collect samples (A) and clean sensors (B) to quantify the potential effects of sensor fouling on continuous water quality data at the Naknek Lake outlet on October 2, 2014.

LACL – Lake Clark Outlet

Visit 1 – June 3, 2014

Date: June 3, 2014

Time of visit: 8:30-11:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Initiate continuous water quality monitoring; conduct EWI cross-section sampling

Equipment installed:

- YSI 6600 multiparameter sonde (S/N: 03D0618)
- PVC housing
- Nylon line and dog leash
- Anchor (heavy scrap metal)
- Onset HOBO Pro v2 water temperature logger (S/N: 9683511)

Narrative:

Continuous monitoring of core parameters was initiated at the outlet of Lake Clark on 06/03/2014 in the same location as in 2012 and 2013 (Figure 3A). Sensor calibration was performed the previous day (06/02/2014) at LACL headquarters. The threads on the sonde’s pH sensor port were stripped out, so Teflon tape was used to help secure the sensor in place. On the day of deployment, EWI discrete samples of core water quality parameters were taken using the YSI 6600 sonde from 12:12-12:26 at 10 locations along a channel cross-section near the deployment location. The sonde was then programmed for unattended sampling of core parameters on an hourly interval (launch date/time: 06/03/2014 13:00). A piece of heavy scrap metal was attached to the sonde housing to anchor it to the river bottom (Figure 3B). A small trench was dug into the river bank in line with the anchor tree down to water’s edge. The line was placed in this trench and buried to make the installation less visible to the public. A HOBO water temperature logger was secured to the sonde housing to log hourly water temperature (Figure 3C). The HOBO was co-located with the sonde with the intention of moving it later in the season to a location within the outlet channel where it could log water temperature year-round without becoming de-watered.



Figure 3. Installation site of the multiparameter sonde for continuous water quality monitoring at the Lake Clark outlet on June 3, 2014 (A). The sonde was cased in in PVC housing and anchored to the substrate (B). Attached to the PVC housing was a HOBO data logger, to initiate continuous year-round water temperature monitoring at the Lake Clark outlet (C).

Visit 2 – July 1, 2014

Date: July 1, 2014

Time of visit: 9:30-11:00

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Perform sonde maintenance

Narrative:

The Lake Clark outlet was accessed by boat in order to download and maintain the 6600 sonde. The unattended logger data file was downloaded from the sonde to the YSI 650 multiparameter display system (MDS). The 6600 was found to be recording pH values well outside the previously observed range for the site (Table 4). The pH sensor was removed and it was determined that the Teflon tape seal created prior to the initial deployment had failed to keep water out of the port. A visual inspection of the logged data indicated that the pH sensor may have begun logging faulty data on 06/05/2014 at 03:00, since there were abrupt changes in the pH and pH mV values on this date from 02:00 (6.86 and 4.03 mV) to 03:00 (6.309 and 31.74 mV). Sensor fouling and drift checks were conducted in the field. The DO sensor was recalibrated using air-saturated water in a water bath with an air pump powered from the boat battery. The specific conductivity sensor was not recalibrated because post-deployment check results met data quality objectives. The pH sensor was removed and replaced with a port plug, and the sonde was placed back in the river.

Visit 3 – July 3, 2014

Date: July 3, 2014

Time of visit: 14:30-16:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Perform sonde maintenance

Narrative:

The Lake Clark outlet was accessed by boat in order to exchange the faulty YSI 6600 sonde (owned by SWAN) for a functioning YSI 6920 sonde (owned by LACL). The 6920 (S/N: 02J0999AA) was calibrated in the morning prior to departure for the field site, using the pH sensor from the 6600 and the specific conductivity sensor from the 6920. Upon arrival, the specific conductivity readings on the 6920 appeared unstable and out of range. Therefore, the specific conductivity sensor from the 6600 was swapped onto the 6920. Also, the DO sensor from the 6600 was swapped onto the 6920 and calibrated in the field in a water bath with an air pump (air-saturated water) from 15:50-16:00. The 6920 was programmed for unattended sampling with a start date/time of 07/03/2014 17:00 and placed back in the river by wading into the channel. The same anchor and line system was used. Since the specific conductivity sensor transferred from the 6600 to the 6920 was not calibrated on the new sonde, it was initially thought that a return trip to recalibrate this sensor was necessary (see below), although it was discovered later that YSI 6 series sensors retain their calibration from one sonde to another.

Visit 4 – July 17, 2014

Date: July 17, 2014

Time of visit: 15:30-16:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Perform sonde maintenance

Narrative:

The Lake Clark outlet was accessed by boat in order to calibrate the specific conductivity sensor on 6920 sonde. This sensor was checked with the 100 $\mu\text{S}/\text{cm}$ standard and then recalibrated with the 1413 $\mu\text{S}/\text{cm}$ standard. The data file was downloaded on 07/17/2014 at 16:00. This data point logged air and should be removed from the record during data processing. It was confirmed that logging was active with the next sample programmed to occur on 07/17/2014 at 17:00.

It was also noted that the DO readings were low relative to previously recorded data at the site, as well as readings on the EXO2 sonde (Table 5). The 6920 sonde was placed back in the river by wading into the channel. The same anchor and line system was used.

Table 5. Comparison of core water quality parameters as measured by the continuous monitoring sonde (YSI 6920) and the field sonde (YSI EXO2) at the Lake Clark Outlet on 07/17/2014.

Date	Time	Sonde Model	Temperature (°C)	Sp. Cond. (μS/cm)	pH (unitless)	DO (mg/L)	DO (%sat.)
07/17/2014	16:38	6920	12.30	65	7.76	9.81	91.7
07/17/2014	16:35	EXO2	12.559	64.5	8.1	11.46	107.8

Visit 5 – July 25, 2014

Date: July 25, 2014

Time of visit: 16:00-18:00

Personnel: Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Perform sonde maintenance

Narrative:

The Lake Clark outlet was accessed by boat in order to follow up on the low DO readings recorded on 07/17/2014 with the 6920 sonde. The DO sensor was calibrated twice because the initial calibration results were unsatisfactory. Post calibration readings following the second calibration were in better agreement with readings taken with the EXO2 sonde. The sonde was re-deployed by wading into the channel. The same anchor and line system was used.

Visit 6 – September 13, 2014

Date: September 13, 2014

Time of visit: 14:00-16:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Perform sonde maintenance; remove sonde

Equipment removed:

- YSI 6920 multiparameter sonde (S/N: 02J0999AA)
- PVC housing

Narrative:

This trip to the Lake Clark outlet followed sockeye salmon otolith sampling on the Tazimina River to assist the LACL fisheries program. Fouling checks were conducted using the 6920 and EXO2 sondes, before and after cleaning the 6920. Drift checks were performed later at LACL headquarters, rather than conducting them in the field. EWI discrete samples of core water quality parameters were taken at 10 locations along a channel cross-section near the location of the sonde from 15:41-15:47 with the 6920. The 6920 and newly repaired 6600 sondes were winterized and placed in storage in the gym in Port Alsworth at the end of this field trip. The EXO2 was returned to KATM for further use.

Water Quality Monitoring: Vertical Lake Profiles

The SWAN freshwater field crew measured “core parameters,” as defined by the NPS WRD, on all Tier 1 (high priority) and Tier 2 (medium priority) lakes within LACL and KATM during an index season from late-July to late-August 2014. Due to weather and logistical delays, Tier 2 sampling in Kenai Fjords National Park (KEFJ) took place in early September 2014.

All profiles were sampled according to the relevant SWAN standard operating procedures (SOPs 3 and 4; Shearer et al. 2015). Profiles were collected with a YSI EXO2 multiparameter sonde (S/N: 14D100505). The EXO2, purchased in the spring of 2014, had the capacity to sample seven parameters simultaneously. Therefore, turbidity, total algae, and fluorescent dissolved organic matter (fDOM) were measured, in addition to the core parameters (temperature, pH, dissolved oxygen, and specific conductivity). The EXO2 was set to run mode for the duration of the sampling and sensors were immersed in water in the calibration cup with while in transit between sites. Data were collected on descent through the water column after equilibration at near surface depth. Graphically displayed values of temperature vs. pH were used by sample collectors to gauge equilibration.

KATM – Tier 1 Lakes

Tier 1 lakes in KATM include Naknek Lake and Lake Brooks. Vertical profile sampling of these lakes occurred 08/04/2014-08/10/2014 (Table 6). All sampling was done by boat based out of KATM headquarters in King Salmon and Brooks Camp. Jeff Nelson, Evan Booher, and Nicole Collier performed Secchi disc measurements and recorded weather and lake surface conditions. Vertical profile measurements were performed with the EXO2 multiparameter sonde operated by Jeff Nelson and Evan Booher on alternating days.

Table 6. Sampling dates and times by lake and basin for 2014 vertical profile sampling in KATM and LACL Tier 1 lakes.

Park	Lake and Basin	Date	Start Time	Stop Time	Total Time
LACL	Lake Clark - Upper	07/15/2014	08:10	14:58	6:48
	Lake Clark - Upper, Middle	07/16/2014	09:06	15:52	6:46
	Lake Clark - Lower	07/17/2014	10:06	16:16	6:10
	Kijik Lake	07/24/2014	11:22	11:51	0:29
LACL Subtotal					20:13
KATM	Naknek Lake - Iliuk, East	08/04/2014	09:59	18:54	8:55
	Naknek Lake - East, North	08/05/2014	08:14	17:30	9:16
	Naknek Lake - West	08/06/2014	10:18	11:24	1:06
	Naknek Lake - West; Lake Brooks	08/10/2014	09:16	18:11	8:55
KATM Subtotal					28:12

Naknek Lake – Iliuk Arm and East Basin – August 4, 2014

Date: August 4, 2014

Time of visit: 09:55-18:54

Personnel: Evan Booher and Jeff Nelson (SWAN); Nicole Collier (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Narrative:

Vertical profiles were completed at the following points: I-001, I-002, I-003, I-004, I-005, I-007, I-008, I-009, I-010, I-011, E-001, E-004, and E-007.

Naknek Lake – East Basin and North Arm – August 5, 2014

Date: August 5, 2014

Time of visit: 08:14-17:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Narrative:

Vertical profiles were completed at the following points: E-002, E-003, E-005, E-006, E-008, E-009, E-010, N-001, N-002, N-003, N-004, N-006, N-007, N-008, N-009, N-010, and N-011. Distinct stratification was observed in the West end of the North Arm. Temperature gradients of approximately 7°C were observed from 15 m-20 m sampling depths.

Naknek Lake – West Basin – August 6, 2014

Date: August 6, 2014

Time of visit: 10:18-11:24

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Narrative:

Vertical profiles were completed at the following points: W-001, W-010, W-011, and W-013. The remainder of the day was spent transporting KATM personnel from Lake Camp to Brooks Camp and preparing for the dragonfly collection event with “citizen scientists” on August 9, 2014.

Naknek Lake – West Basin – August 10, 2014

Date: August 10, 2014

Time of visit: 16:26-18:11

Personnel: Evan Booher and Jeff Nelson (SWAN); Katie Nicolato and Nicole Collier (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Narrative:

Vertical profiles were completed at the following points: W-004, W-005, W-006, W-007, W-008, and W-009. The profile at Lake Brooks (LBROO05) was also completed, as described below.

Lake Brooks – August 10, 2014

Date: August 10, 2014

Time of visit: 09:16-09:55

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Lund V-hull skiff, unnamed, 18 ft (KATM)

Narrative:

Vertical profile sampling of a single point on Lake Brooks, LBROO05, occurred on August 10, 2014 along with six points in the West Basin of Naknek Lake.

KATM – Tier 2 Lakes

Vertical profile sampling of 16 Tier 2 lakes in KATM occurred 07/29/2014-07/31/2014 (Table 7; Figure 4). All travel was done in a de Havilland Beaver on floats, based out of the KATM headquarters in King Salmon and piloted by Allen Gilliland. Evan Booher performed Secchi disc measurements. Allen Gilliland, Henrik Westerkam, and Sara Wolman recorded weather and lake surface conditions. Jeff Nelson performed lake profile measurements with the YSI EXO2 multiparameter sonde.

Table 7. Tally of Tier 2 lakes and times by date for 2014 vertical profile sampling in KATM, LACL, and KEFJ.

Park	Date	Number of Tier 2 Lakes	Start Time	Stop Time	Total Time
KATM	07/29/2014	4	14:00	16:45	2:45
	07/30/2014	9	09:47	16:02	6:15
	07/31/2014	3	09:40	12:15	2:35
	KATM Subtotal	16			11:35
LACL	07/22/2014	2	11:57	13:38	1:41
	07/23/2014	7	14:37	19:20	4:43
	07/24/2014	4	11:22 ^a	16:09 ^a	4:47 ^a
	07/25/2014	2	11:10	12:26	1:16
	LACL Subtotal	15			12:27
KEFJ	09/08/2014	2	11:25	12:49	1:24

^a Information in this row includes one Tier 1 lake (Kijik Lake).

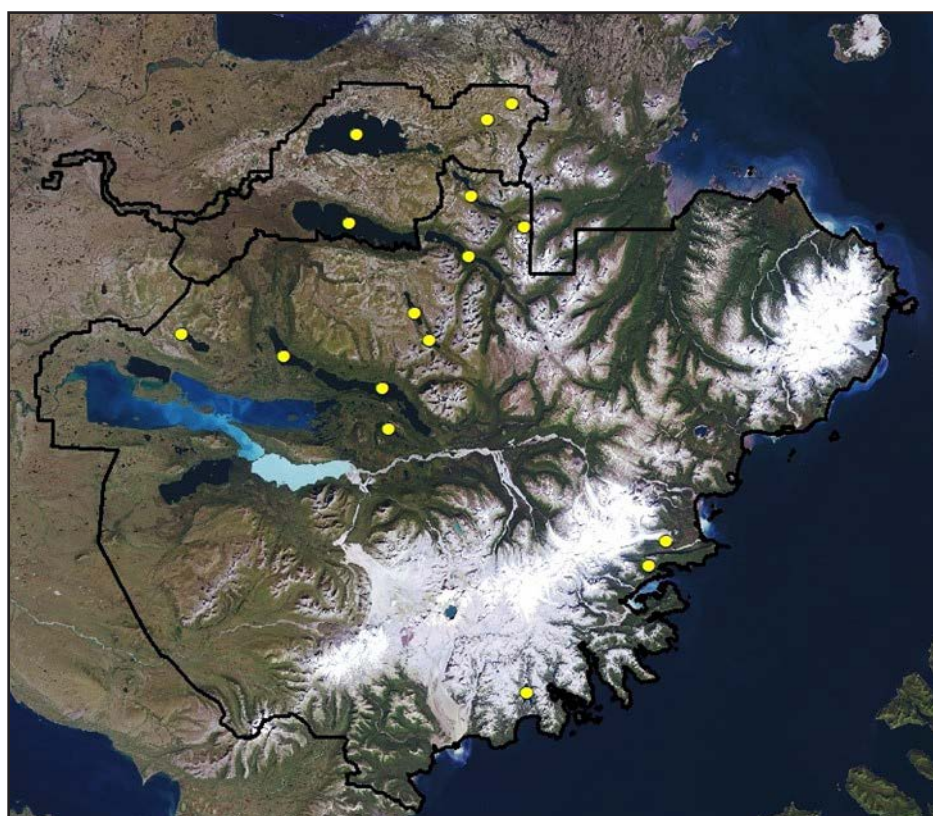


Figure 4. Tier 2 sampling locations in KATM, accessed by floatplane July 29-31, 2014. Yellow points indicate sampling locations; black lines represent park boundaries.

Interior Lakes – July 29, 2014

Date: July 29, 2014

Time of visit: 14:00-16:45

Personnel: Evan Booher and Jeff Nelson (SWAN); Allen Gilliland and Henrik Westerkam (KATM)

Mode of transport: de Havilland Beaver on floats “5143G” (KATM)

Narrative:

Vertical profiles were completed on Jo Jo Lake, Lake Grosvenor, Lake Coville, and Idavain Lake.

Interior Lakes – July 30, 2014

Date: July 30, 2014

Time of visit: 09:47-16:02

Personnel: Evan Booher and Jeff Nelson (SWAN); Allen Gilliland (KATM)

Mode of transport: de Havilland Beaver on floats “5143G” (KATM)

Narrative:

Vertical profiles were completed on the following lakes: Pirate Lake, Kulik Lake, Murray Lake, Hammersly Lake, Spectacle Lake, Mirror Lake, Battle Lake, Nonvianuk Lake, and Kukaklek Lake. This flight was diverted twice to provide an aerial observation platform during the attempted capture of Bear 854 near the mouth of Dumpling Creek.

Coastal Lakes – July 31, 2014

Date: July 31, 2014

Time of visit: 09:40-12:15

Personnel: Evan Booher and Jeff Nelson (SWAN); Allen Gilliland and Sara Wolman (KATM)

Mode of transport: de Havilland Beaver on floats “5143G” (KATM)

Narrative:

Vertical profiles were completed on Dakavak Lake, Hallo Glacier Lake, and Devil’s Cove Lake (Figure 5).



Figure 5. Jeff Nelson measures core parameters with a YSI EXO2 multiparameter sonde in Hallo Glacier Lake on July 31, 2014.

LACL – Tier 1 Lakes

Tier 1 lakes in LACL include Lake Clark and Kijik Lake. Vertical profile sampling of Lake Clark occurred 07/15/2014–07/17/2014. During this time, all sampling was done by boat based out of LACL field headquarters in Port Alsworth. Sampling the three basins of Lake Clark (upper, middle, and lower) required three days (Table 7). Jeff Nelson, Evan Booher, Jeremy Wirtz, Malia Vansant, and Jessica Winn performed Secchi disc measurements and recorded weather and lake surface conditions. Vertical profile measurements were performed with the EXO2 sonde operated by Jeff Nelson and Evan Booher on alternating days. Vertical profile sampling of Kijik Lake occurred via float plane on July 24, 2014, along with four Tier 2 lakes.

Lake Clark – Upper Basin – July 15, 2014

Date: July 15, 2014

Time of visit: 08:10-14:58

Personnel: Evan Booher, Jeff Nelson, and Michael Shephard (SWAN); Jessica Winn (LACL)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Narrative:

Vertical profiles were completed for the following points: U-001, U-002, U-003, U-005, U-006, U-007, U-008, U-009, and U-010 (Figure 6).



Figure 6. Evan Booher samples core parameters with the EXO2 multiparameter sonde in Lake Clark on July 15, 2014.

Lake Clark – Upper and Middle Basin – July 16, 2013

Date: July 16, 2014

Time of visit: 09:06-15:52

Personnel: Jeff Nelson and Evan Booher (SWAN)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Narrative:

Vertical profiles were completed for the following points: U-004, M-001, M-002, M-003, M-004, M-005, M-006, M-007, M-008, M-009, and M-010.

Lake Clark – Lower Basin – July 17, 2013

Date: July 17, 2014

Time of visit: 10:06-16:16

Personnel: Evan Booher and Jeff Nelson (SWAN); Malia Vansant and Jeremy Wirtz (LACL)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Narrative:

Vertical profiles were completed for the following points: L-001, L-002, L-003, L-004, L-005, L-006, L-007, L-008, L-009, and L-010 (Figure 7). In addition to completing the Lower Basin profiles, discharge was measured at the Lake Clark outlet and the conductivity sensor on the YSI 6920 multiparameter sonde was calibrated.

Lake Clark – Kijik Lake

Date: July 24, 2014

Time of visit: 11:22-11:51

Personnel: Krista Bartz and Jeff Nelson (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Narrative:

Vertical profile sampling of a single point on Kijik Lake, KIJIL01, occurred on July 24, 2014 along with four Tier 2 lakes. The EXO2 depth sensor was recalibrated at this site, and the depth finder did not function properly.

LACL – Tier 2 Lakes

Vertical profile sampling of 15 LACL Tier 2 lakes (plus Kijik Lake) occurred July 22-25, 2014 (Table 7). All

transportation was by a Cessna 185 on floats, based out of the LACL field headquarters in Port Alsworth. Rich Richotte piloted the plane, and recorded weather and lake surface conditions. Jeff Nelson and Krista Bartz performed Secchi disc measurements. They also performed lake profile measurements with the EXO2 multiparameter sonde. Waypoints were taken to gather location data for each sampling site (Figure 8).

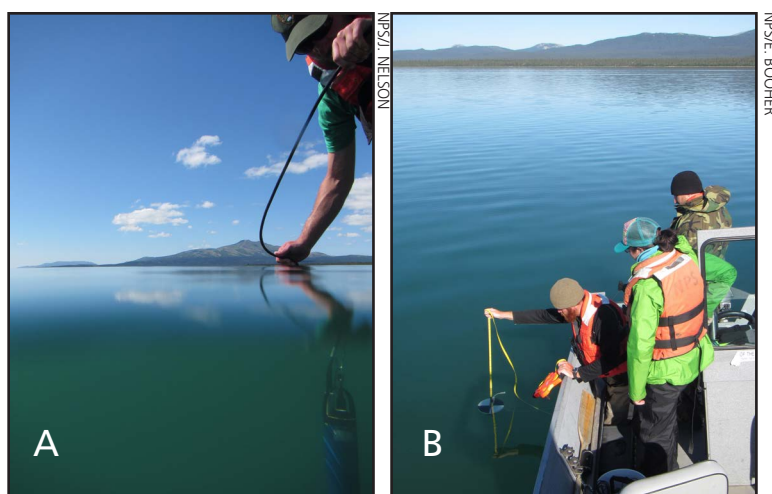


Figure 7. Evan Booher samples core parameters with the EXO2 multiparameter sonde (A) and Jeff Nelson takes Secchi disk readings to measure water clarity (B) in Lake Clark on July 17, 2014.

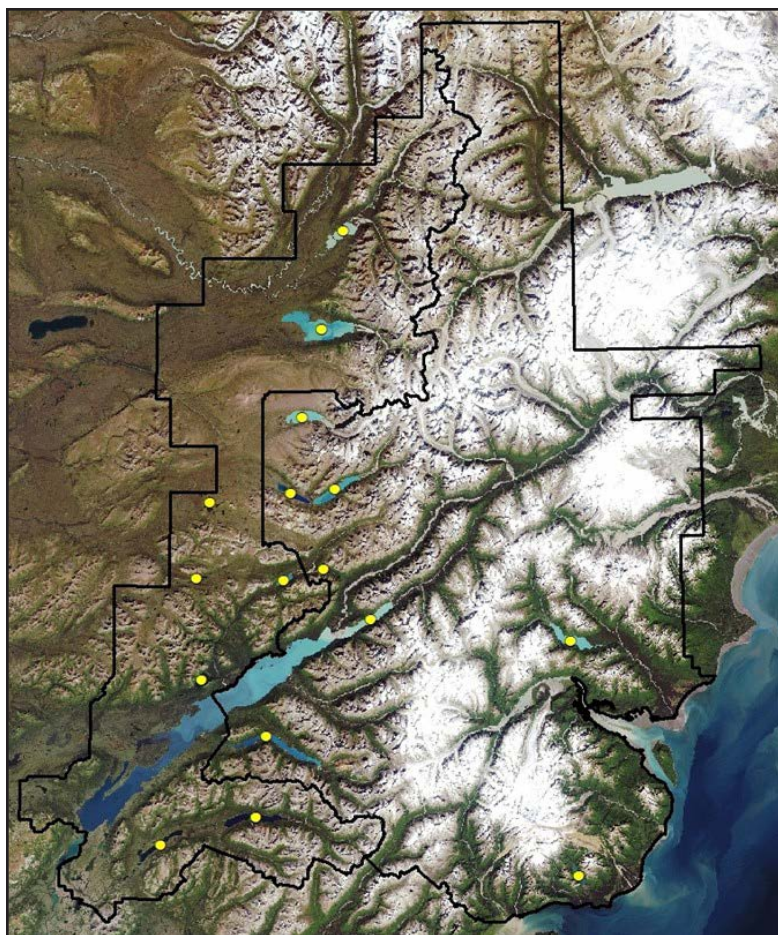


Figure 8. Tier 2 and Kijik Lake sampling locations in LACL, accessed by floatplane July 22-25, 2014. Yellow points indicate sampling locations; black lines represent park boundaries.

Interior Lakes – July 24, 2014

Date: July 24, 2014

Time of visit: 11:22-16:09

Personnel: Krista Bartz and Jeff Nelson (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Narrative:

Vertical profiles were completed at the following lakes: Little Lake Clark, Lower Tazimina Lake, Upper Tazimina Lake, Kontrashibuna Lake, and Kijik Lake (Figure 9).

Coastal Lakes – July 22, 2014

Date: July 22, 2014

Time of visit: 11:57-13:38

Personnel: Krista Bartz and Jeff Nelson (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Narrative:

Vertical profiles were completed on Hickerson Lake and Crescent Lake. This sampling occurred in conjunction with a flight to Crescent Lake for the LACL superintendent to tour the Crescent Lake Ranger Station and to see typical day use on Crescent Lake and Crescent River firsthand.

Interior Lakes – July 23, 2014

Date: July 23, 2014

Time of visit: 14:37-19:20

Personnel: Krista Bartz and Jeff Nelson (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Narrative:

Vertical profiles were completed at the following lakes: Upper Twin Lake, Lower Twin Lake, Turquoise Lake, Two Lakes, Telaquana Lake, Snipe Lake, and Fishtrap Lake .

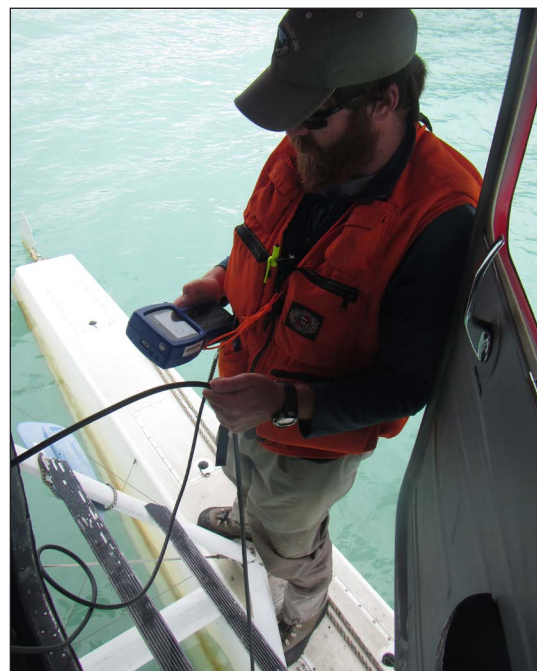


Figure 9. Jeff Nelson samples core parameters with the EXO2 multiparameter sonde in Lower Tazimina Lake on July 23, 2014.

Interior Lakes – July 25, 2014

Date: July 25, 2014

Time of visit: 11:10-12:26

Personnel: Krista Bartz and Jeff Nelson (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Narrative:

Vertical profiles were completed at Lachbuna Lake and Portage Lake. This trip occurred in conjunction with an overflight of the Newhalen River to look for migrating salmon at the request of Dan Young (LACL). At the conclusion of the overflight, Jeff Nelson was dropped off at the RM 22 counting tower to travel back to Port Alsworth by boat with Dan Young, stopping along the way at the Lake Clark outlet to recalibrate a malfunctioning DO sensor on the YSI 6920 multiparameter sonde.

KEFJ – Tier 2 Lakes

This was SWAN’s first year performing vertical profile sampling of lakes in KEFJ. Ideally, this trip would have taken place immediately following the conclusion of KATM Tier 1 sampling, but weather and logistics delayed the flight until September 8, 2014. All travel was done by a Cessna 185 on floats, based out of the Lake Hood Seaplane Base in Anchorage. Rich Richotte piloted the plane and recorded weather and lake surface conditions. Krista Bartz performed Secchi disc measurements, and Evan Booher collected lake profile measurements with the EXO2 sonde.

Coastal Lakes – September 8, 2014

Date: September 8, 2014

Time of visit: 11:25-12:49

Personnel: Krista Bartz and Evan Booher (SWAN); Rich Richotte (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Narrative:

Vertical profiles were completed on Delight Lake and Desire Lake. A gradient in specific conductivity was observed through the water column in Delight Lake (approximately 18 $\mu\text{S}/\text{cm}$ at 0 m depth to 32 $\mu\text{S}/\text{cm}$ at 35 m depth). Live salmon were observed in the outlet streams of both lakes, and also in the middle of Desire Lake. Spawned out/dead salmon were observed in Desire Lake.

Water Quality Monitoring: Lake Level and Discharge

The SWAN freshwater field crew monitored two water quantity parameters during the 2014 field season: water level and discharge. Water level was measured hourly at the outlets of all four Tier 1 lakes (i.e., Naknek Lake and Lake Brooks in KATM; Lake Clark and Kijik Lake in LACL). Discharge was measured periodically at the same locations (i.e., four times at each lake except Kijik, where it was measured three times). This was the first year that the Kijik Lake outlet was included in SWAN water quantity monitoring. As such, a survey was conducted to establish the elevation of the level logger relative to a benchmark and two reference points. Similar surveys were conducted at the outlets of Lake Clark and Naknek Lake, because the level logger elevations at these sites changed between 2013 and 2014. Ultimately, water level and discharge data will be used to create or refine rating curves for estimating daily lake discharge, as described in SOP10 (Shearer et al. 2015).

KATM – Naknek Lake Outlet

Visit 1 – April 11, 2014

Date: April 11, 2014

Time of visit: Unknown

Personnel: Carissa Turner, Wendy Artz, and Whitney Rapp (KATM)

Mode of transport: Unknown

Purpose of trip: Locate level logger

Narrative:

During the last site visit of 2013, on September 22, high water had prevented removal of the level logger deployed on “To Go Rock” at Lake Camp (In-Situ Level TROLL 500; S/N: 128552). Therefore, the level logger had been operating since May 25, 2013 when KATM staff made an early attempt to locate and retrieve the logger. They found the staff gage lying next to the rock, heavily damaged presumably by ice during winter (Figure 10). The pre-fabricated fitting for the level logger was sheared off, and the logger was nowhere to be found.



Figure 10. Past (A) and present (B) photos of the staff gage and level logger (white arrow in A) on “To Go Rock,” located upstream of the boat dock at Lake Camp on the Naknek River.

Visit 2 – May 6, 2014

Date: May 6, 2014

Time of visit: Unknown

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Ford Explorer “Sportrac” (KATM)

Purpose of trip: Locate level logger

Narrative:

A second attempt was made to locate the level logger last seen fixed to “To Go Rock.” The level logger was found via metal detector, buried in the sediment directly below the remains of the staff. The staff was assessed for structural stability and a new fitting and mounting location were planned. A tape-down reading from National Oceanic and Atmospheric Administration National Weather Service (NOAA NWS) marker was 71.45 ft (Table 8).

Table 8. Summary of discharge measurements made via ADCP during the 2014 field season.

Park	Outlet	Date	Time ^a	Discharge ^b (cfs)	Stage (ft)
KATM	Naknek Lake	05/09/2014	12:01-12:17	4,319	68.33 ^c
	Naknek Lake	08/01/2014	17:21-17:42	10,146	^c
	Naknek Lake	09/04/2014	17:39-18:01	10,432	^c
	Naknek Lake	10/02/2014	13:02-13:16	9,702	18.50 ^c
	Lake Brooks	05/12/2014	12:43-12:53	243	2.78 ^d
	Lake Brooks	06/24/2014	14:50-16:03	650	3.41 ^d
	Lake Brooks	80/07/2014	11:01-11:33	332	2.84 ^d
	Lake Brooks	09/23/2014	16:15-16:26	483	3.17 ^d
LACL	Lake Clark	06/03/2014	15:57-16:14	7,707	40.50 ^e
	Lake Clark	07/01/2014	10:49-11:00	14,019	19.85 ^e
	Lake Clark	07/25/2014	17:21-17:34	16,740	^e
	Lake Clark	09/13/2014	14:41-14:52	15,680	19.30 ^f
	Kijik Lake	05/28/2014	15:25-15:38	116	0.656 ^f
	Kijik Lake	07/02/2014	15:11-15:22	187	0.88 ^f
	Kijik Lake	09/16/2014	12:10-12:20	145	0.82 ^f

^a Start times of the first and last transects used to calculate mean discharge.

^b Discharge values have not yet undergone thorough quality control checks.

^c Tape-down reading from the NOAA – NWS marker. If blank, no tape-down reading was made.

^d Measured distance from the bottom of the USGS staff to the water surface.

^e Tape-down reading from the Lake Clark outlet marker. If blank, no tape-down reading was made.

^f Measured distance from the top of the level logger housing to the water surface.

Visit 3 – May 9, 2014

Date: May 9, 2014

Time of visit: 11:30-13:00

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Ford Explorer “Sportrac,” Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Measure stream discharge

Narrative:

This trip involved an early-season discharge measurement at the Naknek Lake outlet site. Four transects were performed with the SonTek M9 ADCP between 12:01 and 12:17. Mean total discharge was 4,319 cfs (Table 8). A tape-down reading from the NOAA-NWS marker was 68.33 ft (Figure 11, Table 8).



Figure 11. The NOAA-NWS marker used for tape-down measurements of stage at the Naknek Lake outlet. Measurements were made from the base of the rebar. Photo taken June, 2014.

Visit 4 – May 23, 2014

Date: May 23, 2014

Time of visit: Unknown

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Ford Explorer “Sportrac” (KATM)

Purpose of trip: Initiate continuous water level monitoring

Narrative:

This trip was to Lake Camp was made in order to initiate hourly water level monitoring for the open water season of 2014. The level logger (In-Situ Level TROLL 500; S/N: 128541; Table 9) was mounted to the remains of the staff (i.e., the metal mounting brackets) at a slightly lower elevation than the former mounting location (Figure 12). Due to time constraints, no survey was performed on this date to relate the new logger location to previously established benchmarks. A barometric pressure logger (In-Situ Baro TROLL; S/N: 129457) was deployed underneath the front awning on the Lake Camp pit toilet. A tape-down reading from the NOAA-NWS marker was 58.83 ft.

Table 9. Summary of level and baro loggers deployed at various “Tier 1” lake outlets in 2014. Make, model, serial number (S/N), and coordinate (NAD83) information is provided.

Park	Outlet Name	Item	Make and Model	S/N	Latitude	Longitude
KATM	Naknek Lake	Level logger	In-Situ Level TROLL 500	128541	58.67289 N	156.4572 W
	Naknek Lake	Baro logger	In-Situ Baro TROLL	129457	58.67300 N	156.45876 W
	Lake Brooks	Level logger	In-Situ Level TROLL 200	101962	58.54780 N	155.79532 W
	Lake Brooks	Baro logger	In-Situ Baro TROLL 500	128786	58.54627 N	155.79355 W
LACL	Lake Clark	Level logger	Solinst Levellogger 3001	1018127	60.01704 N	154.75512 W
	Lake Clark	Baro logger	Solinst Baro Logger	1017792	60.19715 N	154.32250 W
	Kijik Lake	Level logger	In-Situ Aqua TROLL 200	160225	60.30716 N	154.29060 W
	Kijik Lake	Baro logger	In-Situ Baro TROLL 500	129459	60.30695 N	154.29070 W



Figure 12. Installation of the In-Situ level logger on the remains of the USGS staff at the Naknek Lake outlet on May 23, 2014. The staff was damaged by ice during the 2013-2014 winter.

Visit 5 – August 1, 2014

Date: August 1, 2014

Time of visit: 17:00-18:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Ford Explorer “Sportrac,” Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Measure stream discharge

Narrative:

Four discharge transects were performed on the Naknek River near Lake Camp with the SonTek M9 ADCP between 17:21 and 17:42, producing a mean total discharge of 10,146 cfs (Table 8). No tape-down reading was taken on this date.

Visit 6 – September 4, 2014

Date: September 4, 2014

Time of visit: 17:15-18:45

Personnel: Jeff Nelson (SWAN); Michael Nelson (Volunteer)

Mode of transport: Ford Explorer “Sportrac,” Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Measure stream discharge

Narrative:

Four discharge transects were performed on the Naknek River near Lake Camp with the SonTek M9 ADCP between 17:39 and 18:01, producing a mean total discharge of 10,432 cfs (Table 8). No tape-down reading was taken on this date.

Visit 7 – October 2, 2014

Date: October 2, 2014

Time of visit: 12:30-14:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Katie Nicolato (KATM)

Mode of transport: Ford Explorer “Sportrac,” Alweld flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Measure stream discharge

Narrative:

Four discharge transects were performed on the Naknek River near Lake Camp with the SonTek M9 ADCP between 13:02 and 13:16. Mean total discharge was 9,702 cfs (Table 8). A tape-down reading from the NOAA-NWS marker was 18.50 ft. The level logger was not retrieved during this visit due to high water levels.

Visit 8 – October 31, 2014

Date: October 31, 2014

Time of visit: 14:30-15:30

Personnel: Jeff Nelson and Evan Booher (SWAN)

Mode of transport: Ford Explorer “Sportrac” (KATM)

Purpose of trip: Survey level logger

Narrative:

A survey was performed to relate the current level logger location to previously established benchmarks. The survey was necessary because the level logger was deployed in a different location than in previous years. Jeff Nelson ran the transit and Evan Booher held the stadia rod during the survey.

Visit 9 – November 24, 2014

Date: November 24, 2014

Time of visit: 12:30-13:30

Personnel: Carissa Turner and Katie Nicolato (KATM)

Mode of transport: Unknown

Purpose of trip: Retrieve and download level logger

Narrative:

The level logger was retrieved from “To Go Rock” at approximately 13:00 by KATM Natural Resources staff. The rock was still mostly underwater on this date, so a dry suit was required. Because the level logger continued recording data until November 26, the tail end of the time series will need to be omitted. Note: the baro logger was downloaded in the field on November 17, but left in place until December 1 when it was retrieved and re-downloaded.

KATM – Lake Brooks Outlet

Visit 1 – May 12, 2014

Date: May 12, 2014

Time of visit: 12:30-13:30

Personnel: Evan Booher (SWAN); Michael Saxton (KATM)

Mode of transport: de Havilland Beaver on floats “5143G” (KATM)

Purpose of trip: Initiate continuous water level monitoring; measure stream discharge

Narrative:

The outlet of Lake Brooks was accessed by the Beaver on floats, piloted by Allen Gilliland, in order to initiate continuous water level monitoring and measure stream discharge. The water level was very low, likely because the Brooks basin was mostly snow-free by mid-April 2014 according to maintenance staff.

The level logger was installed in the pre-fabricated fitting on the USGS staff, and the baro logger was installed on the Lake Brooks picnic area shed (Table 9). Both the level and baro loggers were programmed for hourly readings (launch date/time: 05/12/2014 14:00). The level logger was programmed to log water depth, pressure, and temperature. The baro logger was programmed to log pressure and temperature. Note: a “user calibration” was performed on the level logger using Win_Situ software prior to deployment—this should not be done for future deployments as it zeroes the normal pressure offset of the logger. If pressure readings seem out of range, then reset factory settings instead of performing a user calibration. The length of the logger housing deployed was 9.5 in. The logger housing was installed on the staff’s prefabricated fitting used in previous years. The top of the logger housing is located at an elevation near the 3.6 ft tick mark on the USGS staff. The observed stage (2.78 ft) was the measured distance from the bottom of the USGS staff (3.34 ft) to the water surface (Table 8). The sensor end of the logger was barely submerged at time of deployment.

Nine transects were measured with the SonTek M9 ADCP. Mean total discharge was 243 cfs (Table 8). The high number of transects was required due to communication problems between the computer and ADCP, as well as transects that contained missing samples and measured values that did not agree within 5% over four consecutive measurements. Two transects containing missing samples and the first transect from river-right to river-left were excluded from the final calculation of mean discharge. Michael performed transects by wading with the unit while Evan operated the computer. GPS was functional at time of the discharge measurement.

Visit 2 – June 24, 2014

Date: June 24, 2014

Time of visit: 14:45-16:15

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN)

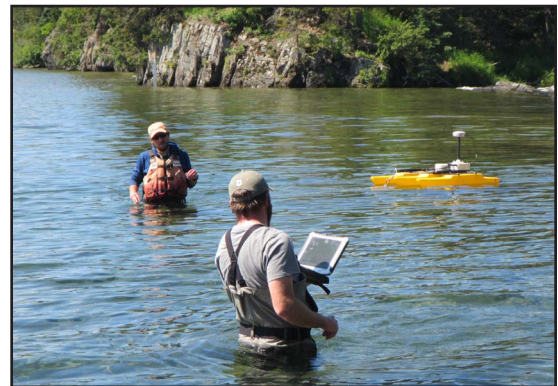
Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Measure stream discharge

Narrative:

The water level was up considerably since the first site visit. The Three Forks RAWs reported 2.3 inches of rainfall for the month of June, including a large rainfall event on June 17, 2014.

Stream discharge was measured with the SonTek M9 ADCP via nine channel transects. Mean total discharge was 650 cfs (Table 8). Two transects containing missing samples were excluded from this calculation, as well as one transect that was omitted during post-processing. Thus, mean total discharge represented an average of six transects (in equal amounts from river right-left and left-right). Evan performed transects by wading with the unit while Jeff operated the computer. GPS was functional at time of the discharge measurement. Note: failure of the Bluetooth communication between the ADCP and the field computer during the fourth transect necessitated a complete reboot of the computer and ADCP systems, causing a roughly half-hour delay in sampling (Figure 13). The battery for the Power and Communications Module (PCM) of the ADCP was not fully charged and may have contributed to the difficulties experienced during sampling.



NPS/K. BARTZ

Figure 13. Evan Booher (left) and Jeff Nelson (right) troubleshoot a stream discharge measurement at the Lake Brooks outlet on June 24, 2014.

Visit 3 – August 7, 2014

Date: August 7, 2014

Time of visit: 10:45-11:45

Personnel: Evan Booher, Jeff Nelson, and Tim Shepherd (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Measure stream discharge

Narrative:

This trip involved a mid-season discharge measurement at the Lake Brooks outlet site. Observed stage (2.84 ft) was the measured distance from the bottom of the USGS staff (3.34 ft) to the water surface (Table 8). The sensor end of the logger was barely submerged during the site visit.

Six discharge measurements were made with the SonTek M9 ADCP; mean total discharge was 332 cfs (Table 8). Evan performed transects by wading with the unit and Jeff operated the computer. GPS was functional at time of the discharge measurement. Large schools of sockeye salmon were present in the transect area.

Visit 4 – September 23, 2014

Date: September 23, 2014

Time of visit: 16:00-16:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of Transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Measure stream discharge; remove level and baro loggers

Narrative:

This was the final visit to the Lake Brooks outlet site. Observed stage (3.17 ft) was the measured distance from the bottom of the USGS staff (3.34 ft) to the water surface (Table 8). The level logger was removed from the USGS staff at approximately 16:30. The baro logger was removed from the Lake Brooks picnic area shed at 16:45. Loggers were downloaded off site, after returning to the King Salmon. There, the battery on the level logger was determined to be dead. External power enabled data extraction from the logger, which apparently logged only 40 points of data before it stopped functioning.

Four discharge transects were performed with the SonTek M9 ADCP. Mean total discharge was 483 cfs (Table 8). Evan performed transects by wading with the unit and Jeff operated the computer. GPS was functional at time of the discharge measurement. Large schools of sockeye salmon were present in transect area.

LACL – Lake Clark Outlet

Visit 1 – June 3, 2014

Date: June 3, 2014

Time of visit: 15:30-16:45

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Alumaweld skiff “Nerka,” 19 ft (LACL)

Purpose of trip: Initiate continuous water level monitoring; measure stream discharge

Narrative:

The Lake Clark outlet (Figure 14) was accessed by boat from Port Alsworth in order to initiate hourly water level monitoring for the open water season of 2014. The level logger (Solinst Levellogger Model 3001, S/N: 1018127) was installed by driving rebar into the substrate and attaching the logger housing to the rebar with hose clamps (Figure 15A). The barometric pressure logger (Solinst Baro Logger S/N: 1017792) was attached to a white spruce tree adjacent to the river (Figure 15B). A survey was completed to establish the relative elevation of the level logger from existing reference points and to create a tape-down station (Figures 15C and 15D). Four discharge measurements were completed with the SonTek M9 ADCP between 15:57 and 16:14. Mean total discharge was 7,707 cfs, and the tape-down distance at the outlet was 40.5 feet (Table 8).



Figure 14. Panoramic view of the Lake Clark outlet site on June 3, 2014.



Figure 15. The Solinst level logger (A) and baro logger (B), as installed at the Lake Clark outlet on June 3, 2014. A survey was completed on that date to establish the elevation of the level logger relative to existing reference points, RP1 (C) and RP2 (D). Note that the benchmark monument is located near the base of the tree holding the RP1 nail (C).

Visit 2 – July 1, 2014

Date: July 1, 2014

Time of visit: 10:15-11:30

Personnel: Jeff Nelson and Evan Booher (SWAN)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Measure stream discharge

Narrative:

This trip involved a mid-season discharge measurement at the Lake Clark outlet site. Four transects were taken with the SonTek M9 ADCP between 10:49 and 11:00. Mean total discharge was 14,019 cfs, and the tape-down distance was 19.85 feet.

Visit 3 – July 25, 2014

Date: July 25, 2014

Time of visit: 17:00-18:00

Personnel: Jeff Nelson (SWAN); Dan Young (LACL)

Mode of Transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Measure stream discharge

Narrative:

The Lake Clark outlet was accessed from the River Mile 22 fish counting tower after completing Tier 2 Vertical Profiles at Lachbuna and Portage Lakes. Four discharge measurements were taken with the SonTek M9 ADCP between 17:21 and 17:34. Mean total discharge was 16,740 cfs. The tape-down distance was not measured.

Visit 4 – September 13, 2014

Date: September 13, 2014

Time of visit: 14:15-15:15

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft (LACL)

Purpose of trip: Measure stream discharge

Narrative:

This trip to the Lake Clark outlet followed sockeye salmon otolith sampling on the Tazimina River. Four discharge measurements were taken with the SonTek M9 ADCP between 14:41 and 14:52. The mean total discharge was 15,680 cfs and the tape-down distance was 19.30 ft. Due to high water levels, the level logger could not be removed on this date.

Visit 5 – September 30, 2014

Date: September 30, 2014

Time of visit: 14:00-15:15

Personnel: Krista Bartz (SWAN); Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft (LACL)

Purpose of trip: Remove level and baro loggers

Narrative:

The Lake Clark outlet was accessed using the “Chinook” landing craft, operated by Dan Young. Dan retrieved the level logger from the rebar at approximately 14:15. Tools and a dry suit were needed. Krista retrieved the baro logger. Neither logger stopped recording data until about a month after retrieval.

LACL – Kijik Lake Outlet

Visit 1 – May 28, 2014

Date: May 28, 2014

Time of visit: 12:00-16:30

Personnel: Krista Bartz, Evan Booher, Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Purpose of trip: Initiate continuous water level monitoring; measure stream discharge

Narrative:

The outlet of Kijik Lake was accessed by the C185, piloted by Rich Richotte, in order to establish a water level monitoring site. A site was selected on river right of the Little Kijik River, just upstream from where USGS monitored water temperature 10 years earlier (Brabets and Ourso 2006), and just downstream from where the interstitial and surface water temperature loggers were deployed on May 29, 2014. The level logger was installed using rebar and hose clamps in a pool that appeared unlikely to become de-watered during low flows (Figure 16). The baro logger was fixed to a white spruce with a nail and p-cord. Both loggers were programmed for hourly readings (delayed launch date/time: 05/29/2014 00:00). The level logger was programmed to log water depth, pressure, and temperature. The baro logger was programmed to log pressure and temperature.

The relative elevation of the level logger was calculated using differential leveling. A cross-sectional survey was performed at this location to establish a relationship between the elevation of the level logger and channel features including water's edge, potential bankfull width indicators, and stream depth along the cross-sectional profile. A benchmark was established on a streamside boulder (Figure 17A), and two additional reference points were established on nearby white spruce trees (Figure 17B and 17C). During the survey, Evan Booher positioned the stadia rod while Jeff Nelson operated the transit and recorded data (Figure 17D).



Figure 16. Housing for the In-Situ level logger, attached to rebar and installed in the Little Kijik River on May 28, 2014. The Onset HOBO Water Temp Pro v2 (intended for continuous, year-round water temperature monitoring) is visible in the background.



Figure 17. A survey was conducted on May 28, 2014 in the Little Kijik River to establish the elevation of the level logger relative to a benchmark (A) and two reference points, RP1 (B) and RP2 (C), that were nails fixed to white spruce trees. Jeff Nelson and Evan Booher conducted the survey (D).

Four discharge measurements were made with the SonTek M9 RiverSurveyor ADCP, producing a mean total discharge of 116 cfs (Table 8). Jeff performed transects by wading with the unit and Evan operated the computer. The ADCP GPS was not functional at time of discharge measurement. Observed stage (0.656 ft) was the measured distance from the top of the level logger housing to the water surface.

Visit 2 – July 2, 2014

Date: July 2, 2014

Time of visit: 14:45-16:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Purpose of trip: Measure stream discharge

Narrative:

This trip involved a mid-season discharge measurement at the newly established Kijik Lake outlet water level site. Four transects were made with the SonTek M9 ADCP. The mean total discharge was 187 cfs, and the observed stage was 0.88 ft (Table 8). Jeff performed transects by wading with the unit; Evan operated the computer (Figure 18). GPS was functional at time of discharge measurement. Dan Young took site photos. Schools of large humpback whitefish (*Coregonus pidschian*) were observed feeding in the area.

Visit 3 – September 16, 2014

Date: September 16, 2014

Time of visit: 11:00-12:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Purpose of trip: Measure stream discharge; download level/baro loggers

Narrative:

This was the final site visit of the 2014 season. The level logger was downloaded at 11:00. During the removal of the level logger from the rebar, the entire installation came out of the substrate. The level logger was re-launched (09/16/2014; 12:00; hourly depth, pressure, temperature) and re-installed with the rebar and hose clamps in the same pool. The distance from the top of the logger housing to the water surface was re-measured after installation (0.83 ft). Note: the elevation of the logger should be re-surveyed prior to removal and download during the first site visit of 2015. The baro logger was downloaded at 11:17 and re-launched (09/16/2014; 12:00; hourly pressure and temperature). It was re-installed in the same location on the spruce tree. The decision to leave the level and baro loggers deployed during winter reflects our understanding that the Little Kijik River remains ice-free year-round.

Four discharge measurements were made with the SonTek M9 ADCP, resulting in a mean total discharge of 145 cfs (Table 8). An alternate cross-section was selected for discharge measurements due to presence of sockeye salmon and their redds in the cross-section measured during the previous two visits. Evan performed transects by wading with the unit while Jeff operated the computer (Figure 19). GPS was functional at time of discharge measurement.



Figure 18. Evan Booher (left) and Jeff Nelson (right) prepare to measure stream discharge on the Little Kijik River on July 2, 2014.



Figure 19. Evan Booher assembles the SonTek M9 RiverSurveyor ADCP in preparation for a stream discharge measurement on Little Kijik River on September 16, 2014. Spawning salmon were present during this site visit.

Pilot Study: Surface and Interstitial Water Temperatures

During the 2014 field season, the SWAN freshwater field crew implemented a pilot study of year-round water temperatures at sites with known or suspected salmon spawning. Temperature loggers were co-located above and below the substrate in stream channel and lake beach sites. Loggers were installed at four sites in KATM and six sites in LACL (Table 10). LACL sites were selected on the basis of a telemetry survey of spawning distribution (Young and Woody 2007). KATM sites were selected following meetings with NPS and Alaska Department of Fish and Game biologists. Sites in both parks also were chosen for overall accessibility.

Temperature loggers were installed according to protocols outlined by Mauger (2008), Zimmerman and Finn (2012), and Baxter and others (2003). At each site, a surface-water temperature logger (i.e., above-substrate logger) was anchored by driving rebar into the stream bed. An interstitial water temperature logger (i.e., below-substrate logger) was anchored using a large plastic zip-tie, marked with a survey flag that was visible above the stream bed. A mini-piezometer also was installed adjacent to the interstitial logger to estimate vertical hydraulic gradient (VHG), a unitless number which indicates the strength of upwelling (if negative) or downwelling (if positive).

Loggers were programmed to start recording prior to submersion. Once the loggers were submerged, water temperature was recorded adjacent to the loggers as close to the top of the hour as possible using a NIST-certified thermistor, in order to have an independent temperature reading for comparison. The independent reading of interstitial temperature was recorded inside the mini-piezometer. Finally, two reference points were selected and marked, and the distances between these points and the loggers were recorded to aid in relocating the loggers at a future date.

Table 10. Installation dates, serial numbers (S/N), and coordinates for data loggers at 10 temperature monitoring sites initiated in 2014.

Park	Site Type	Site Name	Installation Date	HOBO Pro v2		TidbiT v2	
				S/N ^a	Coordinates	S/N ^b	Coordinates
KATM	Stream	Up-A-Tree Creek	06/24/2014	9951824	58.51134 N 155.80389 W ^c	10206472	58.51134 N 155.80389 W ^c
KATM	Stream	Margot Creek	06/25/2014	10339624	58.48593 N 155.57772 W ^c	2251261	58.48593 N 155.57772 W ^c
KATM	Beach	Naknek Lake-Margot	06/25/2014	10339623	58.49053 N 155.57254 W ^c	2251251	58.49053 N 155.57254 W ^c
KATM	Stream	Savonoski River	10/01/2014	9981832	58.52946 N 155.30376 W	^d	^d
LACL	Stream	Little Kijik River	05/29/2014	9683503	60.30727 N 154.29102 W ^c	10339617	60.30727 N 154.29102 W ^c
LACL	Stream	Tazimina River	06/19/2014	2337919	59.93125 N 154.81355 W	10206464	59.93148 N 154.81355 W
LACL	Stream	Tlikakila River	10/01/2014	10584779	60.49937 N 153.68665 W	2251274	60.49936 N 153.68678 W
LACL	Beach	Kijik Lake	05/29/2014	9683504	60.28634 N 154.34644 W	10206471	60.28634 N 154.34642 W
LACL	Beach	Lake Clark–Chulitna	06/17/2014	10339615	60.28035 N 154.26651 W ^e	10206468	60.28053 N 154.26639 W
LACL	Beach	Lake Clark–Port Alsworth	09/30/2014	10584775	60.19009 N 154.35281 W ^c	10206466	60.19009 N 154.35281 W ^c

^a Onset HOBO Water Temp Pro v2 loggers are being used to monitor surface water temperature.

^b Onset TidbiT v2 loggers are being used to monitor interstitial water temperature.

^c Only one waypoint was recorded, because the loggers HOBO and Tidbit are adjacent to each other.

^d No logger was installed below the sediment surface at this site in 2014.

^e Coordinates for October 15, 2014 onward.

KATM – Up-A-Tree Creek

Visit 1 – June 24, 2014

Date: June 24, 2014

Time of visit: 19:15-20:45

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN); Landis Ehler and Mark Kaufman (KATM)

Mode of transport: Lund “Rec” boat, 16 ft (KATM)

Purpose of trip: Install loggers

Narrative:

The mouth of Up-A-Tree Creek was accessed from Brooks Camp using the Lake Brooks recreational boat. Surface and interstitial water temperature loggers were co-located approximately 1.2 m apart in a straight run near the mouth of the creek (Figure 20A). VHG measurement indicated slight upwelling (-0.106). Two white spruce on the river right bank, upstream and downstream of the loggers, were selected as reference points (Table 11; Figure 20B and 20C). **Note:** a paired beach site at the mouth of Up-A-Tree Creek was scoped but deemed unsuitable for salmon spawning due to large substrate size. However, in late August of 2015, sockeye salmon were seen holding off the mouth of the creek, so this decision could be reconsidered in the future.

Table 11. Reference points selected for use in locating water temperature loggers.

Park	Location	Reference Point	Species ^a	Latitude	Longitude
KATM	Up-A-Tree Creek	1	PIGL	58.51131 N	155.80374 W
	Up-A-Tree Creek	2	PIGL	58.51131 N	155.80373 W
	Margot Creek	1	SASP	58.48601 N	155.57777 W
LACL	Tlikakila River	1	SASP	60.49942 N	153.68669 W
	Tlikakila River	2	SASP	60.49947 N	153.68709 W
	Lake Clark-Chulitna	1	PIGL	60.28093 N	154.26622 W
	Lake Clark-Chulitna	2	^b	60.28090 N	154.26677 W
	Lake Clark-Aslworth	1	PIGL	60.19017 N	154.35236 W
	Lake Clark-Aslworth	2	POBA	60.19032 N	154.35252 W

^a PIGL = *Picea glauca* (white spruce), SASP = *Salix* spp. (willow), and POBA = *Populus balsamifera* (balsam poplar).

^b Selected reference point was a building, not a tree or shrub.



Figure 20. A stream temperature monitoring site is established at Up-A-Tree Creek on June 24, 2014 (A), with reference trees #1 (B) and #2 (C) identified by Jeff Nelson.

KATM – Margot Creek

Visit 1 – June 25, 2014

Date: June 25, 2014

Time of visit: 14:15-15:15

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Install loggers

Narrative:

The mouth of Margot Creek was accessed from Brooks Camp using the “Palayaq.” Surface and interstitial water temperature loggers were co-located ~1.7 m apart in a side channel of Margot Creek. This location was selected instead of the main channel based on relative substrate size and perceived year-round flow and stability. VHG measurement indicated slight upwelling (-0.159). Reference point selection was limited by a lack of trees nearby, so a single six-foot tall willow on the river left bank was flagged (Table 11; Figure 21).



Figure 21. Jeff Nelson flags a willow on a side channel of Margot Creek on June 25, 2014.

KATM – Naknek Lake – Margot Creek Mouth

Visit 1 – June 25, 2014

Date: June 25, 2014

Time of visit: 13:00-14:15

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN)

Mode of transport: Landing craft “Palayaq,” 27 ft (KATM)

Purpose of trip: Install loggers

Narrative:

Surface and interstitial water temperature loggers were co-located on the shoreline of Naknek Lake, along the beach just north of the mouth of Margot Creek. The loggers were installed where the left-most edge of Margot Creek joins the Iliuk Arm of the lake. These loggers may be difficult to re-locate due to the dynamic nature of the shoreline substrate at this site and the lack of reference points nearby (Figure 22).



Figure 22. Jeff Nelson (left) and Evan Booher (right) install data loggers for continuous year-round water temperature monitoring where Margot Creek drains to the Iliuk Arm of Naknek Lake (A). Reference points were not available nearby (B).

KATM – Savonoski River

Visit 1 - October 1, 2014

Date: October 1, 2014

Time of visit: 15:00-16:30

Personnel: Evan Booher and Jeff Nelson (SWAN); Troy Hamon (KATM)

Mode of transport: Landing craft “Palayaq,” 27 ft; “Alweld” flat-bottom jet boat, 18 ft (KATM)

Purpose of trip: Install logger

Narrative:

The “Alweld” was driven from Lake Camp to the entrance of the Iliuk Arm. It was then towed with the “Palayaq” from the entrance of Iliuk Arm to the mouth of the Savonoski River, due to the potential impact of heavy seas on operating speed and crew safety. The “Alweld” was driven again, from the mouth of the Savonoski River to a site approximately 3.75 km upstream. There, a surface water temperature logger was installed with rebar approximately 6.7 m from the base of the steep section of the river right bank (Figure 23). No interstitial water temperature logger was deployed during this visit because the necessary equipment was being used concurrently in LACL. The SonTek M9 ADCP was used to approximate EWI water temperature samples at a cross-section near the location of the installed temperature logger.



NPSE: BOOHER

Figure 23. Jeff Nelson balances a sledgehammer on rebar anchoring a newly deployed HOBOT in the Savonoski River on October 1, 2014. The yellow line indicates the distance from the base of the vertical part of the bank to the rebar.

LACL – Little Kijik River

Visit 1 – May 29, 2014

Date: May 29, 2014

Time of visit: 11:00-14:00

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN); Dan Young (LACL)

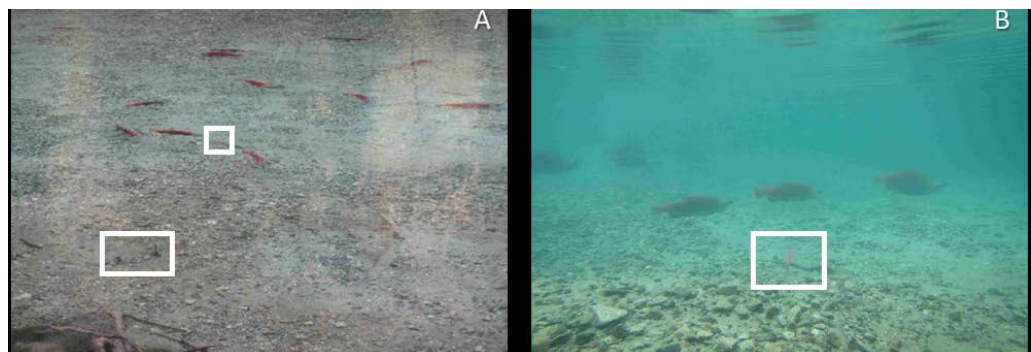
Mode of transport: Cessna 185 on floats “9987N” (LACL); flat-bottomed skiff “Sea King” (LACL)

Purpose of trip: Install loggers

Narrative:

Travel to the Little Kijik River occurred by air with Rich Richotte piloting the C185 on floats. Krista Bartz and Dan Young were dropped off at the eastern end of Kijik Lake to begin site selection for and installation of the loggers; Jeff Nelson and Evan Booher joined them partway through the site visit.

Surface and interstitial water temperature loggers were co-located approximately 0.27 km downstream from the Kijik Lake outlet, near the left bank of the Little Kijik River. This location was selected based on (a) the results of a telemetry survey of spawning distribution, (b) photographs showing sockeye salmon holding at the site, and (c) visible evidence that redds were built there previously (Figure 24). The location is upstream of the level logger and HOBOT installed on May 28, 2014. It is also downstream of a small spring-fed tributary with water $\sim 3^{\circ}\text{C}$ colder than that in the Little Kijik River. VHG measurement indicated upwelling (-0.117). Reference points were not identified during this visit.



NPSE: BOOHER

Figure 24. Sockeye salmon and redds in the Little Kijik River on September 16, 2014. The HOBOT Water Temp Pro v2 (A) and pink survey flag atop the TidbiT v2 (A and B) are highlighted with white boxes.

Visit 2 – July 2, 2014

Date: July 2, 2014

Time of visit: 14:45-16:00

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Lowe flat-bottomed jet boat, 14 ft (LACL)

Purpose of trip: Locate and inspect logger installations

Narrative:

The Little Kijik River was accessed by jet boat from Port Alsworth, via Lake Clark and Kijik River, with Dan Young as boat operator. The HOBO Pro v2 (S/N 9683503) and TidbiT v2 (S/N 10206465) on river left, and the HOBO Pro v2 (S/N 10339617) on river right, were found in place as installed during the first site visit of the year.

Visit 3 – September 16, 2014

Date: September 16, 2014

Time of visit: 11:00-12:30

Personnel: Evan Booher and Jeff Nelson (SWAN)

Mode of transport: Cessna 185 on floats “9987N” (LACL)

Purpose of trip: Download loggers

Narrative:

Travel to Little Kijik River occurred by air with Rich Richotte piloting the C185 on floats. Both HOBO Pro v2 loggers (S/N: 9683503 and 10339617) were found in place, as installed during the first site visit of the year (Figure 24). Both were downloaded with an Onset Waterproof Shuttle. Independent water temperature readings with a NIST thermometer were not taken during this site visit, nor was the TidbiT v2 logger (S/N 10206465) downloaded.

LACL – Tazimina River

Visit 1 – June 19, 2014

Date: June 19, 2014

Time of visit: 14:00-16:00

Personnel: Dan Young, Olivia Olin, Tim Rovinelli, and Katherine Sutton (LACL)

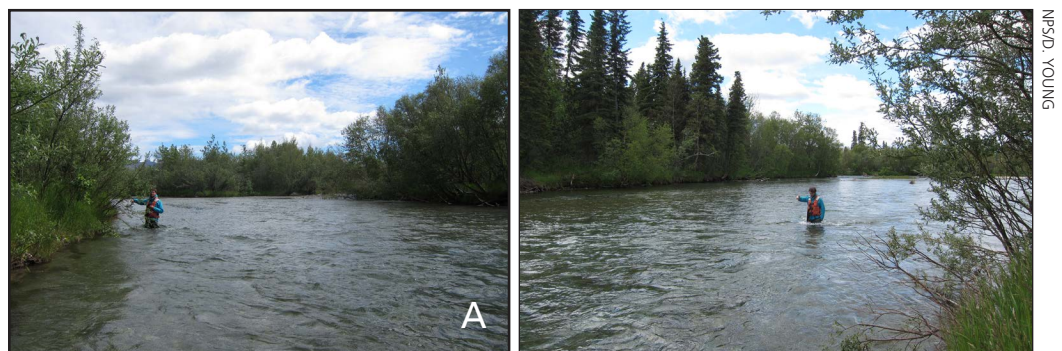
Mode of transport: Work Skiff landing craft “Chinook,” 26 ft; G3 console jet boat, 18 ft (LACL)

Purpose of trip: Install loggers

Narrative:

The mouth of the Tazimina River was accessed using the “Chinook” landing craft, with the jet boat in tow. The “Chinook” was anchored at the mouth, and the jet boat was used to travel up-river. Surface and interstitial water temperature loggers were co-located in a straight run near the river right bank, with the HOBO deployed ~80 m upstream of the TidbiT (Figure 25). VHG measurement indicated upwelling (-0.178). Reference points were not identified during this visit.

Figure 25. Locations of the surface (A) and interstitial (B) water temperature loggers installed in the Tazimina River on June 19, 2014, as indicated by SCA intern Tim Rovinelli.



Visit 2 – September 13, 2014

Date: September 13, 2014

Time of visit: 12:30-13:30

Personnel: Evan Booher and Jeff Nelson (SWAN); Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft; G3 console jet boat, 18 ft (LACL)

Purpose of trip: Locate and inspect logger installations

Narrative:

The Tazimina River was accessed by towing the G3 console jet boat to the mouth of the Tazimina River on Sixmile Lake with the “Chinook” landing craft from Port Alsworth, via Lake Clark. Dan Young operated the “Chinook” and Evan Booher and Jeff Nelson operated the jet boat during travel up and down the river. An attempt was made to locate the temperature loggers after assisting with otolith sampling. The HOBO Pro v2 was found in place, as installed in June. The TidbiT v2 was not found. Note: a higher accuracy GPS (e.g., Trimble) and shovel might aid in locating the TidbiT next spring, in case the logger was buried by spawning sockeye salmon.

LACL – Tlikikila River

Visit 1 – October 1, 2014

Date: October 1, 2014

Time of visit: 13:00 – 16:30

Personnel: Krista Bartz (SWAN); Dan Young (LACL)

Mode of transport: Piper PA-18 Super Cub “N7875D”; Cessna 206 on wheels “N6352Z” (LACL)

Purpose of trip: Install loggers

Narrative:

The Tlikikila River was accessed via two wheel planes: one carrying Krista Bartz and Rich Richotte (pilot), and the other carrying Dan Young and Lynn Ellis (pilot). This site was selected after flying over the lower ~5 km of a 16 km stretch of river (from Otter Lake to Moose Pasture Pass) where sockeye spawning was observed in past years. It was chosen because of its relatively high concentration of spawners and ease of wading. Note: because the river is braided at this site, and the loggers are installed in the smaller of two braids (Figure 27A), the loggers might be dewatered at lower flows.

Surface and interstitial water temperature loggers were co-located 9.05 m apart, with the HOBO Pro v2 upstream of the TidbiT v2, near the right bank of the river right braid. VHG measurement indicated slight upwelling (-0.023). Two willows on the right bank were selected as reference points and marked with blue pieces of p-cord (Table 11; Figure 26B).

Before returning to Port Alsworth, an overflight was made from the site where the loggers were deployed to the end of the 16 km stretch identified as having higher densities of spawning. Few spawners were observed during the flight, and none were as abundant as those at the selected site.

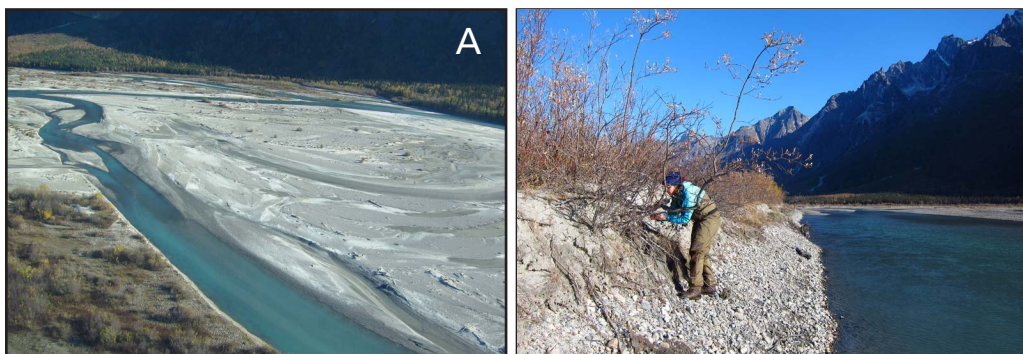


Figure 26. View of the Tlikakila River reach where water temperatures loggers were deployed on October 1, 2014 (A). Krista Bartz marks a willow (reference point #1) to help find the loggers during future visits (B).

LACL – Kijik Lake

Visit 1 – May 29, 2014

Date: May 29, 2014

Time of visit: 14:15-14:45

Personnel: Evan Booher, Jeff Nelson, and Krista Bartz (SWAN); Dan Young (LACL)

Mode of transport: Cessna 185 on floats “9987N” (LACL); flat-bottomed skiff “Sea King” (LACL)

Purpose of trip: Install loggers

Narrative:

Surface and interstitial water temperature loggers were co-located approximately 12 m from the shoreline of a beach at the head (i.e., west end) of Kijik Lake (Figure 27A). This site was selected based on a telemetry survey of spawning distribution (Young and Woody 2007) and recent observations of spawning sockeye (Dan Young pers com). Windy conditions precluded meaningful piezometer measurements. Reference points were not identified during this visit, although a downed dead birch trunk and an outlying live birch tree were noted on the shoreline to the north and south (respectively) of the logger location (Figure 27B).

Figure 27. Underwater view of the interstitial (foreground) and surface (background) temperature logging devices installed in Kijik Lake on May 29, 2014 (A). View of the lake shore from the logger location, showing the live (left) and dead (right) birch trunks (B).



LACL – Lake Clark at “Chulitna Lodge Beach”

Visit 1 – June 17, 2014

Date: June 17, 2014

Time of visit: 15:00-16:00

Personnel: Andrew Kirby, Olivia Olin, Katherine Sutton, and Dan Young (LACL)

Mode of transport: Alumaweld V-hull skiff “Fishtrap,” 19 ft (LACL)

Purpose of trip: Install loggers

Narrative:

Surface and interstitial water temperature loggers were co-located approximately 12 m offshore from the Chulitna Lodge beach, on the north side of Lake Clark near the mouth of the Kijik River. This site was selected based on a telemetry survey of spawning distribution (Young and Woody 2007) and recent observations of spawning sockeye. Deep water and windy conditions prohibited piezometer measurements, and reference points were not identified.

Visit 2 – October 15, 2014

Date: October 15, 2014

Time of visit: Unknown

Personnel: Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft (LACL)

Purpose of trip: Locate and inspect logger installations; move logger

Narrative:

Dan Young visited the site, after deciding during an earlier visit (sampling otoliths on October 2, 2014) that the surface temperature logger needed to be moved to deeper water. The logger was re-positioned and coordinates were updated to 60.28035 N and 154.26651 W. Reference points were also identified on this date (Table 11; Figure 28).



Figure 28. Reference points selected for the “Chulitna Lodge Beach” site on October 15, 2014: a tree (tallest white spruce in the foreground in A) and a building (front left corner of the sauna in B). The view from sauna to the relocated surface temperature logger is shown in C).

LACL – Lake Clark at “Port Alsworth Beach”

Visit 1 – September 30, 2014

Date: September 30, 2014

Time of visit: 17:00-18:00

Personnel: Krista Bartz (SWAN); Dan Young (LACL)

Mode of transport: Work Skiff landing craft “Chinook,” 26 ft (LACL)

Purpose of trip: Install loggers

Narrative:

Surface and interstitial water temperature loggers were co-located 1.3 m apart on the south side of Lake Clark approximately 1 km west of the mouth of the Tanalian River. This site was selected based on a telemetry survey of spawning distribution (Young and Woody 2007) and its proximity to sockeye spawners and redds in 2014. The piezometer was installed at a shallower depth than the loggers because the depth adjacent to the loggers overtopped the piezometer. VHG measurement indicated slight upwelling (-0.011). Two trees were selected as reference points and coordinates were taken (Table 11; Figure 29).



Figure 29. Reference trees #1 (A) and #2 (B) at the “Port Alsworth Beach” site, established on September 30, 2014. The view from reference tree #2 to the temperature logger location is shown in C.

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