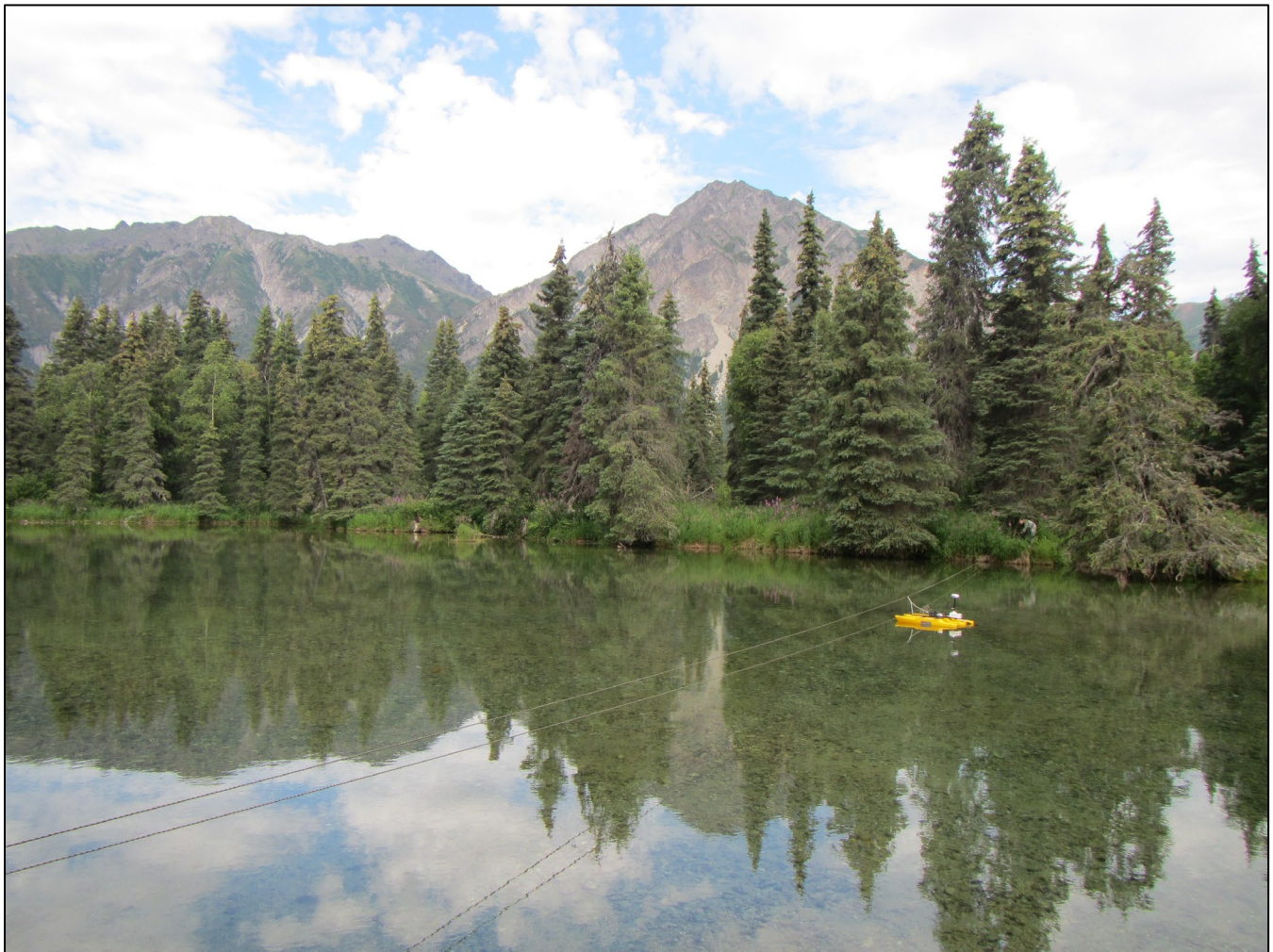




Freshwater Monitoring in Southwest Alaska Network Parks

2016 Field Season Summary

Natural Resource Data Series NPS/SWAN/NRDS—2018/1188



ON THE COVER

Collecting a discharge measurement via cableway at the outlet of Kijik Lake in Lake Clark National Park and Preserve, Alaska (NPS/EVAN BOOHER).

Freshwater Monitoring in Southwest Alaska Network Parks

2016 Field Season Summary

Natural Resource Data Series NPS/SWAN/NRDS—2018/1188

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Southwest Alaska Network
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October 2018

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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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 informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

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Executive Summary

This report details the field work completed by the Southwest Alaska Network (SWAN) freshwater monitoring program for the 2016 field season (April 21 – October 19, 2016). Recommendations to improve field methods, as well as descriptions of data processing, are also included in this document. All sampling efforts were guided by the SWAN freshwater monitoring protocol (Shearer et al. 2015a and 2015b). In 2016, the SWAN freshwater monitoring program completed 83 vertical lake profiles, operated six vertical temperature arrays, maintained two continuous water quality monitoring stations, measured stage and discharge at four lake outlets, and maintained interstitial and surface water temperature monitoring at 10 sites. Additionally, fish, water, and sediment samples were collected throughout summer months for a collaborative study examining potential sources of mercury in lake trout (*Salvelinus namaycush*).

Acknowledgments

Successful monitoring of freshwater resources would not have been possible in 2016 without the assistance, guidance, and logistical support of the following individuals: D. Young, T. Hamon, A. Kirby, B. Peterson, R. Richotte, D. Welty, C. Ricks, D. Madrid, D. Lombardi, K. Martin, E. Audette, R. Evans, D. Monhollan, M. Cohn, K. Grimm, M. Verrier, and C. Phillips. Additionally, C. Miller, T. Shepherd, and P. Gabriel helped advance this report from a draft to a final product.

List of Acronyms

ADCP – Acoustic Doppler Current Profiler

cfs – cubic feet per second

GPS – Global Positioning System

EDI – Equal Discharge Increment

EWI – Equal Width Increment

GIP – Geoscientist in the Park

KATM – Katmai National Park and Preserve

LACL – Lake Clark National Park and Preserve

MRL – Mercury Research Laboratory

NIST – National Institute of Standards and Technology

NPS – National Park Service

NWIS – National Water Information System

SCA – Student Conservation Association

S/N – Serial Number

SOP – Standard Operating Procedure

SWAN – Southwest Alaska Network

USGS – United States Geological Survey

VHG – Vertical hydraulic gradient

WRD – Water Resources Division

Water Quality Monitoring: Vertical Temperature Arrays

The Southwest Alaska Network (SWAN) freshwater field crew maintained six vertical temperature arrays in Tier 1 lakes during the summer and fall of 2016. Four of the temperature arrays were 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 were located in Lake Clark National Park and Preserve (LACL): one in Lake Clark (LCLAR01) and another in Kijik Lake (KIJIL01). The 2016 field season was successful in terms of data collection and site maintenance for all six arrays.

Each temperature array was downloaded twice during the 2016 field season, except KIJIL01, which was downloaded once in early June. Surface water temperature loggers, positioned between 0 m and 1 m depth, were installed on all six arrays, left in place for the index temperature period (time window of greatest thermal stratification and maximum near-surface temperatures) during the summer, and retrieved during the fall of 2016. Partial logger replacement was performed on two temperature arrays (NAKNL01 and LCLAR01). GPS coordinates (with dates) are listed for each site visit below, to provide updated location information of instrument and anchor lines.

One issue encountered during the winter of 2016 was the movement of KIJIL01. LACL pilots reported seeing the array at the lake surface of the west (inlet) end of the lake during an overflight in May. A subsequent field trip was made to the lake by jet boat to assess any damage to the array and move it to its original position in the lake. The entire array was found in shallow water, with no apparent damage. Data retrieved from the temperature loggers were visually reviewed following reinstallation. The 50 m – 90 m depth time series had distinct breaks at the end of January that might indicate array movement. Air temperature was also plotted vs. lake temperature at 5 and 10 m depths to assist in reconstruction of conditions over the period of interest (Figure 1).

A review of KIJIL01 data suggests that lake ice formation and break-up might have influenced movement of the array. Wind-driven movement of one or both of the vertical lines could have allowed a portion of the bridle line to float to (or near) the surface. If that piece of line then became entrained in ice, a subsequent wind-driven break-up event could have pushed ice that dragged the entire array in the direction of wave travel on the lake. Storms that bring significant magnitude winds to the region generally travel in from the east, and the source direction of significant wind events beginning on January 24th and 30th were indeed east. Thus, we posit that lake conditions influenced by episodic weather events played a role in repositioning the array. To remedy this issue in the future, it is recommended that bridle lines be made of polyester (which is negatively buoyant) rather than polypropylene (which is positively buoyant). Alternatively, they could be outfitted with weights along their entire length to prevent flotation and exposure at the lake surface.

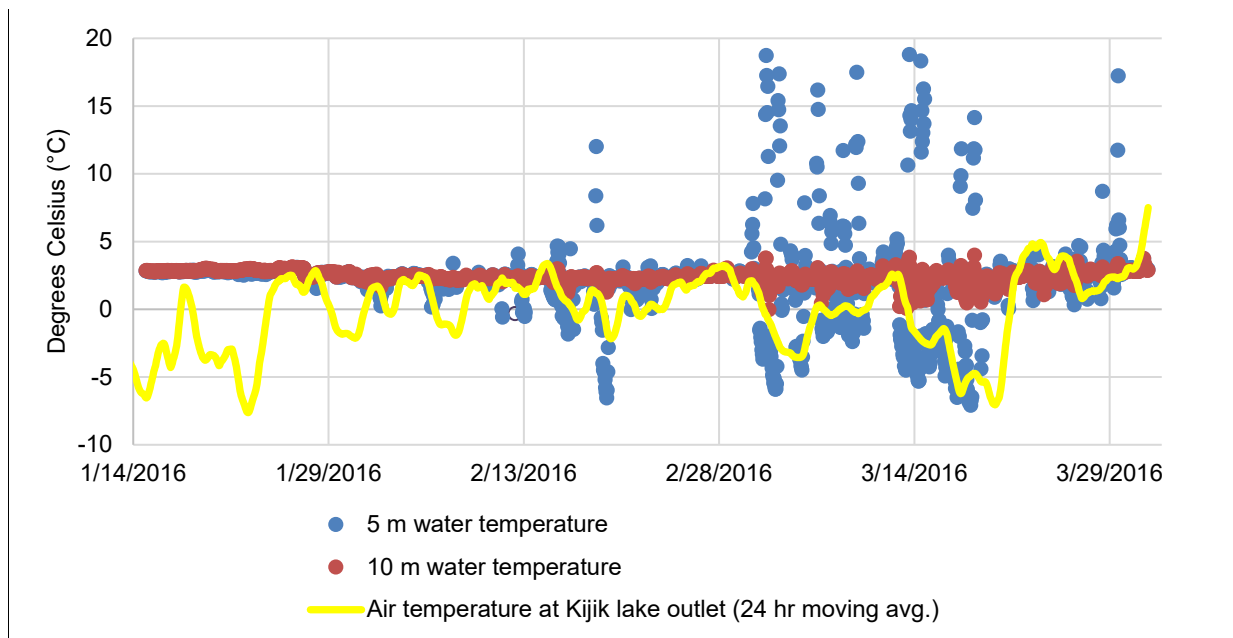


Figure 1. Comparison of hourly air and water temperatures at Kijik Lake. Periods of time when air and water temperatures align may indicate when the KIJIL01 temperature data loggers became de-watered. Air temperatures were recorded at the Kijik Lake outlet. Water temperatures were recorded at 5 m and 10 m depths on the KIJIL01 temperature array.

KATM – Naknek Lake – North Arm

Visit 1 – June 8, 2016

Date: June 8, 2016

Time of Visit: 10:45 – 11:55

Personnel: Evan Booher, Krista Bartz, Mark Melham (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: 58.63691, -155.63792 (06/08/2016)
- Anchor line: 58.52967, -155.8549 (06/08/2016)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10584828) at 0-1 m

Narrative:

All HOBOS (5 m to 70 m) were stopped, downloaded, and relaunched (delayed launch date/time: 06/08/2016 12:00) using the Onset Optical Base Station and field computer. A surface buoy was attached to the instrument line, along with a HOBO programmed for hourly readings (delayed launch date/time: 06/08/2016 12:00). All HOBOS probably logged air temperature at 11:00 on this date and

may not have fully equilibrated to water temperature at 12:00. This site is missing a level logger; an old one should be added.

Visit 2 – September 8, 2016

Date: September 8, 2016

Time of Visit: 10:00 – 12:00

Personnel: Evan Booher, Katie Junghans, Mike Verrier (SWAN GIP Intern)

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

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

Coordinates:

- Instrument line: 58.63725, -155.63873 (09/08/2016)
- Anchor line: 58.52967, -155.8549 (06/08/2016)

Equipment installed:

- Onset HOBO Water Temp Pro v2 at depths 5 m through 70 m (S/N: 10584792, 10584800, 10584799, 10862452, 10584822, 10862451, 10584813, and 10584789)

Narrative:

The NAKNL01 temperature array was located visually due to the surface buoy. The 0 m HOBO was stopped and downloaded, as were HOBOS from 5 m to 70 m. All HOBOS between 5 m and 70 m were replaced and relaunched (delayed launch date/time: 09/08/2016 12:00). The surface buoy and 0 m HOBO were removed. A new instrument line waypoint was taken prior to departure from the field site. Temperatures recorded by HOBOS at 10:00, 11:00, and 12:00 are suspect. The junction between the instrument line and the anchor chain is rusted and should be replaced.

KATM – Naknek Lake – West Arm

Visit 1 – June 9, 2016

Date: June 9, 2016

Time of Visit: 11:00 – 13:00

Personnel: Evan Booher, Katie Junghans, Krista Bartz, Kassie Grimm (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: 58.61665, -156.03737 (10/14/2015)
- Anchor line: 58.61659, -156.03723 (2009; exact date unknown)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10339613) at 0-1 m

Narrative:

The Naknek Lake West Arm temperature array (NAKNL02) was located successfully. When intending to pull up the instrument line, the anchor line was mistakenly pulled up to its submersible

buoy. All loggers (5 m to 25 m) were stopped, downloaded, and relaunched (delayed launch date/time: 06/09/2016 12:00). A surface buoy was attached to the instrument line with a HOBO logger programmed for hourly readings. The Solinst level logger was logging every 4 hours. This interval was retained upon relaunch of the logger after retrieving the data. During this time, the boat drifted away from the waypoint and the anchor line was redeployed at a depth that was too shallow (23 m vs. 28 m), causing the submersible buoy of the instrument line to float on the surface. Before the lines could be repositioned, the wind increased to unsafe levels and the operation had to be aborted until the next day.

Visit 2 – June 10, 2016

Date: June 10, 2016

Time of Visit: 08:00 – 09:30

Personnel: Evan Booher, Katie Junghans, Krista Bartz

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

Purpose of Trip: Reposition anchor and instrument line to correct location

Coordinates:

- Instrument line: 58.61674, -156.03706 (06/10/2016)
- Anchor line: 58.61671, -156.03732 (06/10/2016)

Narrative:

In order to reposition the incorrectly deployed array, the surface logger was pulled from the water at 08:30. Both lines were lifted until the anchors were off of the bottom of the lake. The lines were then moved; the anchor line was redeployed at 09:12, and the instrument line was redeployed at 09:28. New waypoints were taken for both lines prior to departure from the field site. Data recorded at 09:00 and 10:00 should be considered suspect as the instrument line was being, or had just been, repositioned.

Visit 3 – September 8, 2016

Date: September 8, 2016

Time of Visit: 13:00 – 14:30

Personnel: Evan Booher, Katie Junghans, Mike Verrier (SWAN GIP Intern)

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

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

Coordinates:

- Instrument line: 58.61657, -156.0374 (09/08/2016)
- Anchor line: 58.61671, -156.03732 (06/10/2016)

Narrative:

The NAKNL02 temperature array was located visually using the surface buoy. The 0 m HOBO was stopped and downloaded with the Onset Optical Base Station and field computer. All other HOBOS (5 m to 25 m) were stopped, downloaded, and relaunched (delayed launch date/time: 09/08/2016 14:00). The Solinst level logger was stopped, downloaded, and relaunched (delayed launch date/time: 09/08/2016 14:00). The cords attaching several HOBOS to the instrument line were repaired. The

surface buoy and 0 m HOBO were removed. The instrument line was redeployed at 14:05, thus values recorded at 14:00 are suspect. A new instrument line waypoint was taken prior to departure from the field site.

KATM – Naknek Lake – Iliuk Arm

Visit 1 – June 8, 2016

Date: June 8, 2016

Time of Visit: 14:00 – 15:00

Personnel: Evan Booher, Krista Bartz, Mark Melham (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: 58.52161, -155.60294 (06/08/2016)
- Anchor line: 58.52183, -155.60361 (10/01/2015)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10584820) at 0-1 m

Narrative:

The Naknek Lake Iliuk Arm temperature array (NAKNL03) was successfully retrieved. All loggers (5 m to 100 m) were stopped, downloaded, and relaunched (delayed launch date/time: 06/08/2016 15:00) using the Onset Optical Base Station and field computer. A surface buoy was attached to the instrument line, along with a HOBO programmed for hourly readings. The instrument line was redeployed at 15:00, so temperatures recorded at this time should be considered suspect. A new instrument line waypoint was taken prior to departure from the field site. The bridle line is showing signs of wear.

Visit 2 – September 7, 2016

Date: September 7, 2016

Time of Visit: 14:30 – 16:00

Personnel: Evan Booher, Katie Junghans, Mike Verrier (GIP)

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

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

Coordinates:

- Instrument line: 58.5218, -155.60255 (09/07/2016)
- Anchor line: 58.52183, -155.60361 (10/01/2015)

Narrative:

The NAKNL03 temperature array was located visually via the surface buoy. The surface HOBO (0 m) was stopped and downloaded with the Onset Waterproof Shuttle. The other HOBOs (5 m to 100 m) were stopped, downloaded, and relaunched (delayed launch date/time: 09/07/2016 16:00). The

surface buoy and 0 m HOBO were removed. HOBOS recorded air temperature at 15:00 and may not have fully equilibrated at the 16:00 water temperature recording, so these temperature measurements should be regarded as suspect. A new instrument line waypoint was taken prior to departure from the site.

KATM – Lake Brooks

Visit 1 – June 7, 2016

Date: June 7, 2016

Time of Visit: 16:30 – 19:00

Personnel: Evan Booher, Krista Bartz

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

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

Coordinates:

- Instrument line: 58.52974, -155.85435 (06/07/2016)
- Anchor line: 58.53015, -155.85428 (06/07/2016)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10584784) at 0-1 m

Narrative:

The LBROO01 temperature array was located successfully. All HOBOS (5 m to 50 m) were stopped, downloaded, and relaunched (delayed launch date/time: 06/07/2016 18:00). A surface buoy was attached to the instrument line, along with a HOBO programmed for hourly readings. Temperatures recorded at 17:00 and 18:00 are suspect. There is no level logger at this site, so an old level logger should be installed. New instrument and anchor line waypoints were taken prior to departure. Note: The 5 m and 10 m HOBOS are separated by ~4 m, not 5 m as in the protocol. Also, the bridle line on LBROO01 is buoyant (polypropylene) line, with a piece of metal pipe secured midway between the anchor and instrument lines to counteract floating. 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 2 – September 8, 2016

Date: September 8, 2016

Time of Visit: 16:00 – 17:00

Personnel: Evan Booher, Katie Junghans, Mike Verrier (GIP)

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

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

Coordinates:

- Instrument line: 58.52977, -155.85396 (09/08/2016)
- Anchor line: 58.53011, -155.85428 (09/08/2016)

Narrative:

The LBROO01 temperature array was located visually from the “Rec” boat via the surface buoy. The surface HOB0 (0 m) was stopped and downloaded. Other HOB0s (5 m to 50 m) were stopped, downloaded, and relaunched (delayed launch date/time: 09/08/2016 17:00). The surface buoy and HOB0 were removed. Data logged at 17:00 may be suspect, as the HOB0s may not have fully equilibrated to the temperature of the water. New instrument and anchor line waypoints were taken prior to departure.

LACL – Lake Clark

Visit 1 – June 3, 2016

Date: June 3, 2016

Time of Visit: 11:30 – 12:30

Personnel: Evan Booher, Dan Young (LACL), Eileen Audette (LACL)

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

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

Coordinates:

- Instrument line: 60.26564, -154.23252 (06/03/2016)
- Anchor line: 60.26230, -154.23886 (07/14/2015)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOB0 Water Temp Pro v2 logger (S/N: 10339616) at 0-1 m

Narrative:

The LCLAR01 temperature array was successfully located. A surface buoy was attached to the instrument line, along with a HOB0 programmed for hourly readings at 0 m. Other HOB0s were not downloaded on this date.

Visit 2 – July 14, 2016

Date: July 14, 2016

Time of Visit: 15:00 – 16:30

Personnel: Evan Booher, Katie Junghans, Dan Young (LACL), Brian Dodd (LACL)

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

Purpose of Trip: Download loggers

Coordinates:

- Instrument line: 60.26575, -154.23187 (07/14/2016)
- Anchor line: 60.26548, -154.23294 (07/14/2016)

Equipment installed:

- Onset HOB0 Water Temp Pro v2 at 30 m depth (S/N: 10584786)

Narrative:

The LCLAR01 temperature array was located visually from the “Chinook” landing craft via the surface buoy attached to the instrument line. HOBOS (5 m to 100 m) were stopped, downloaded, and relaunched (delayed launch date/time: 07/14/2016 16:00). Data recorded at 16:00 may be suspect, as the HOBOS may not have fully equilibrated to the temperature of the water. New waypoints were taken for the instrument and anchor lines prior to departure.

Visit 3 – September 13 2016

Date: September 13, 2016

Time of Visit: 14:00 – 16:30

Personnel: Evan Booher, Katie Junghans, Krista Bartz

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

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

Coordinates:

- Instrument line: 60.26542, -154.2325 (09/13/2016)
- Anchor line: 60.26548, -154.23294 (07/14/2016)

Equipment installed:

- Onset HOBO Water Temp Pro v2 at depths 40 m through 100 m (S/N: 11001166, 11001167, 11001171, 11001175, 11001178, 11001181, and 11001163)

Narrative:

The LCLAR01 temperature array was located visually from the “Chinook” landing craft via the surface buoy. The surface HOBO (0 m) was stopped and downloaded. HOBOS from 5 m through 30 m were stopped, downloaded, and relaunched (delayed launch date/time: 09/13/2016 15:00). HOBOS from 40 m through 100 m were stopped, downloaded, and replaced with new loggers (delayed launch date/time of 09/13/2016 at 16:00). The Solinst level logger was stopped, downloaded, and relaunched (delayed launch date/time: 09/13/2016 15:00). The surface buoy and 0 m HOBO were removed. Data logged at 14:00, 1500, and 16:00 are suspect. New instrument waypoints were taken prior to departure.

LACL – Kijik Lake

Visit 1 – June 2, 2016

Date: June 2, 2016

Time of Visit: 13:00 – 16:00

Personnel: Evan Booher, Dan Young (LACL), Kelly Martin (LACL), Eileen Audette (LACL)

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

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

Coordinates:

- Instrument line: 60.26800, -154.32959 (06/02/2016)
- Anchor line: 60.29777, -154.32933 (06/02/2016)

Equipment installed:

- Crab-pot buoy with approximately 6 m of line
- Onset HOBO Water Temp Pro v2 logger (S/N: 10010760) at 0-1 m

Narrative:

On 05/27/2016, the KIJIL01 temperature array was spotted about 200 ft from the inlet end of the lake by R. Richotte and D. Welty on 05/27/2016 during a flight. Submersible buoys on both the anchor and instrument lines were floating at the surface. On 06/02/2016, the KIJIL01 temperature array was again located visually by the submersible buoys floating on the lake surface. Both the anchor line and instrument line were repositioned to the original location at mid-lake based on GPS locations from previous site visits. All HOBOS (5 m to 90 m) were stopped, downloaded, and relaunched using the Onset Optical Base Station and field computer. A surface buoy was attached to the instrument line, along with a HOBO programmed for hourly readings. Data recorded at 15:00 may be air temperature and should be regarded as suspect.

Visit 2 – September 14, 2016

Date: September 14, 2016

Time of Visit: 10:00 – 10:15

Personnel: Evan Booher, Hannah Lee (SWAN Vegetation)

Mode of Transport: Cessna 185 on floats (LACL)

Purpose of Trip: Remove surface buoy and logger

Coordinates:

- Instrument line: 60.29775, -154.32957 (09/14/2016)
- Anchor line: 60.29777, -154.32933 (06/02/2016)

Narrative:

The surface buoy and 0 m HOBO were removed. The HOBO was then stopped and downloaded. Data recorded at 11:00 should be regarded as suspect.

Water Quality Monitoring: Continuous Sonde Deployments

The SWAN Freshwater Monitoring crew deployed YSI 6600 multiparameter sondes for continuous sampling of NPS WRD (Water Resources Division) “core parameters” at the outlets of Naknek Lake (KATM) and Lake Clark (LACL) during the open-water season of 2016. Core parameters, as defined by the NPS WRD, include temperature, specific conductance, pH, dissolved oxygen, and turbidity. Sondes were programmed for unattended logging on hourly sampling intervals. The Naknek Lake sonde was deployed from May 15 through October 4. The Lake Clark sonde was deployed from April 21 through September 15.

Cross-sectional water quality samples were taken upon initial deployment and final removal of sondes at each site following the “equal width increment” (EWI) method. Channel mixing conditions were determined for core parameters to provide an indication of “representativeness” of the monitor location towards describing overall stream conditions. For EWI sampling, the stream cross section is broken into at least 10 increments of equal width, and core parameters are recorded at the center of each increment halfway between the water surface and stream bottom on the vertical axis (Wilde 2008), as well as the monitor location at the beginning and end of a sample period. Samples were taken near the surface of the water column instead of at 50% of the channel depth value. It is recommended that we explore the “equal discharge increment” (EDI) method in the future. For EDI sampling, the appropriate number of increments and the depth of each sample can be calculated based on an ADCP measurement, through the use of a software application available from the U.S. Geological Survey Hydroacoustics group. This could save time and effort during future site visits.

Site visits occurred at monitoring locations at approximately one-month intervals. Quality assurance and quality control procedures were followed during site visits to quantify sensor fouling and drift. Specifically, fouling checks were based on rapid discrete measurements ($N = 7$) recorded by the deployed sonde (YSI 6600) and an independent sonde (YSI EXO2) before and after sensor cleaning. Drift checks were conducted with calibration standards, and recalibration occurred when a check fell outside acceptable error limits, as outlined in the SWAN freshwater monitoring protocol (SOP 3; Shearer et al. 2015b). Note that one-point calibrations were performed for turbidity in deionized water following the standard two-point calibrations, to eliminate negative readings per guidance from the manufacturer (see p. 12 at <https://www.ysi.com/File%20Library/Documents/Tips/YSI-Calibration-Maintenance-Troubleshooting-Tips-6-Series-Sondes-2-8-10.pdf>). Minimal fouling was visible on the sensors during each site visit.

KATM – Naknek Lake Outlet

Visit 1 – May 15, 2016

Date: May 15, 2016

Time of visit: 17:00 – 19:00

Personnel: Evan Boohar, Katie Junghans

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 braided anchor line
- Pyramid anchors (2)

Narrative:

Continuous water quality monitoring was initiated at the outlet of Naknek Lake in the same location used during the 2015 field season. Sensor calibration was performed in the morning on the day of deployment at KATM headquarters in King Salmon. A one-point calibration (i.e., a “single-point offset at 0.5 NTU) was performed for turbidity following the standard two-point calibration to prevent negative readings in the field, a known issue during data collection in 2015. Once on site but prior to deployment, an EWI cross-section of core parameters was completed with the 6600 sonde from 12:51 to 13:11. Results indicated well-mixed channel conditions for specific conductivity and pH, but not for temperature, dissolved oxygen (DO), or turbidity. The sonde was programmed for unattended sampling on an hourly interval (launch date/time: 05/15/2016 14:00) and then deployed in the channel. A line was secured from the bottom of the hazard buoy to the housing of the sonde, and lead pyramid weights were used to anchor the sonde to the stream bed.

Visit 2 – June 29, 2016

Date: June 29, 2016

Time of visit: 14:00 – 16:00

Personnel: Evan Booher, Katie Junghans

Mode of transport: Palayaq landing craft, 27 ft (KATM)

Purpose of trip: Perform sonde maintenance; download data

Narrative:

Maintenance and data retrieval on the 6600 sonde was performed approximately 1.5 months after initial deployment. The sonde was retrieved from the river after 14:00 and returned before 16:00. Logging was disabled during the site visit, so a data gap will exist at 15:00 on 06/29/2016. 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 reported readings within the acceptable error limits.

Visit 3 – August 15, 2016

Date: August 15, 2016

Time of visit: 13:30 – 15:30

Personnel: Evan Booher, Katie Junghans

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

Purpose of trip: Perform sonde maintenance; download data

Narrative:

The sonde was retrieved from the river at 13:30 and downloaded at 14:00. 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 reported readings within the acceptable error limits.

Visit 4 – October 4, 2016

Date: October 4, 2016

Time of visit: 12:00 – 15:00

Personnel: Evan Booher, Katie Junghans

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

Purpose of trip: Perform sonde maintenance; download data; remove sonde for season

Narrative:

The sonde was pulled from the river after 14:00 and downloaded. Checks for sensor fouling were conducted on site using the 6600 sonde and a calibrated EXO2 sonde. Checks for sensor drift were performed off site on 10/05/2016. All sensors reported readings within the acceptable error limits.

LACL – Lake Clark Outlet

Visit 1 – April 21, 2016

Date: April 21, 2016

Time of visit: 17:00 – 20:00

Personnel: Evan Booher, Dan Young (LACL)

Mode of transport: Fishtrap Alumaweld Skiff, 16 ft (LACL)

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

Equipment installed:

- YSI 6600 multiparameter sonde (S/N: 03D0618)
- PVC housing
- Stainless steel cable (~30 ft) with fastening hardware
- HOBO Pro v2 temperature logger (S/N: 10584809)

Narrative:

The first site visit to the Lake Clark outlet was scheduled to coincide with the low-flow portion of the hydrograph, emphasized by ice-free conditions lake-wide during the winter of 2015-2016. Sensor calibration was performed in the morning on the day of deployment. Once on site but prior to deployment, an EWI cross-section of core parameters was completed with the 6600 sonde from 17:39 to 17:51. Results indicated well-mixed channel conditions for parameters except pH at the monitor location. The trend in pH values across the channel suggested that this result likely reflected sensor equilibration more than actual channel conditions. The sonde was programmed for unattended sampling on an hourly interval (launch date/time: 04/21/2016 19:00) and then deployed from the river-left bank anchored to a spruce tree, at the same location used since 2012 (60.01607;

-154.75426). A HOBO with the same launch date/time was attached to the sonde housing. Note that a turbidity sensor was not available at the start of the field season, so no turbidity data were collected during the first deployment of 2015 in LACL.

Visit 2 – May 27, 2016

Date: May 27, 2016

Time of visit: 14:00 – 16:00

Personnel: Evan Booher, Katie Junghans

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

Purpose of trip: Perform sonde maintenance; download data

Narrative:

The sonde was retrieved from the river at approximately 15:10, and then downloaded and redeployed before 18:00. Logging was disabled during maintenance, so a data gap will exist in the time series at 16:00 and 17:00 on 05/27/2016. 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 reported readings within the acceptable error limits.

Visit 3 – July 12, 2016

Date: July 12, 2016

Time of visit: 14:00 – 16:00

Personnel: Evan Booher, Katie Junghans, Diego Madrid (LACL)

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

Purpose of trip: Perform sonde maintenance; download data

Narrative:

The sonde was retrieved from the river at approximately 14:40. It was downloaded and redeployed by 16:40. 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 reported readings within the acceptable error limits. Data recorded at 15:00 should be flagged and removed from the time series since they occurred during maintenance. An EWI cross-section of core parameters was completed near the monitoring site from 16:45 to 16:57. Results indicated well-mixed channel conditions for pH and dissolved oxygen only, possibly due to user error as the final four data points had elevated temperature or reduced specific conductance, indicative of turbulence or partial submersion of the sensors beneath the water surface.

Visit 4 – September 15, 2016

Date: September 15, 2016

Time of visit: 11:00 – 16:00

Personnel: Evan Booher, Katie Junghans, Krista Bartz

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

Purpose of trip: Perform sonde maintenance; download data; remove sonde for the season

Narrative:

This was the final site visit of the season for continuous water quality monitoring at the Lake Clark outlet. Logging of unattended samples by the sonde was disabled following retrieval of the logger file. The pH sensor was broken during cleaning; thus no fouling or drift checks could be completed for pH. Fouling checks for other sensors were conducted on site using the 6600 sonde and a calibrated EXO2 sonde (Figure 2). Drift checks for other sensors were performed off site in Port Alsworth, where all sensors reported readings within the acceptable error limits. Prior to departure, an EWI cross-section was completed near the monitoring site. All parameters were found to be well-mixed. The HOBO at this location (S/N: 10584809) was stopped, downloaded and removed for the winter.



Figure 2. Evan Booher and Katie Junghans take side-by-side water quality measurements on September 15, 2016 to assess sensor fouling on the 6600 sonde deployed at the outlet of Lake Clark (NPS/KRISTA BARTZ).

Water Quality Monitoring: Vertical Lake Profiles

The SWAN freshwater field crew measured “core parameters,” as defined by the NPS Water Resource Division, in all Tier 1 (high priority) lakes, as well as a subset of Tier 2 (medium priority) lakes within KATM and LACL. Measurements occurred from July 19 to August 3, 2016, during the index period specified in the SWAN freshwater monitoring protocol (late July through late August; Shearer et al. 2015a).

Tier 1 lake sites in Naknek Lake and Lake Clark ($n = 70$) were profiled according to the relevant SWAN standard operating procedures (SOPs 3 and 4; Shearer et al. 2015b). Profiles were collected with a YSI EXO2 multiparameter sonde (S/N: 14D100505), which has 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 programmed for “one-sample logging” (i.e., discrete measurements at fixed depths) under the default averaging mode. Data were collected on descent through the water column after equilibration near the surface. The time required for equilibration was gauged via graphically displayed values of pH and temperature.

Tier 1 lake sites in Lake Brooks and Kijik Lake ($n = 2$), and a subset of Tier 2 lake sites in KATM and LACL ($n = 11$), were profiled using an alternate method as part of a collaborative research project documenting mercury in resident lake fish. As a result, most site coordinates differed from vertical lake profile coordinates used in past years (Figure 3). Also, the profiles were conducted with a different YSI EXO2 sonde (S/N: 14H102443), owned by the USGS Mercury Research Lab (MRL). The MRL sonde was programmed for “continuous mode logging” (i.e., once every two seconds) under the default averaging mode. The sonde time zone was set to “UTC” (Universal Time Coordinated) not “UTC -8,” so the times were adjusted during post-processing of the data.

To assess whether the discrete and continuous methods produced comparable results, one site in each basin of Naknek Lake (East, Iliuk, North, and West) in KATM was profiled using both methods, back-to-back. A continuous profile was also taken at one site in the middle basin of Lake Clark, two days after the fixed profile. Upon comparison of the data, we found that the continuous method was faster and captured subtleties missed by the discrete method (Figure 4). However, the two methods produced significantly different results for dissolved oxygen and specific conductivity, according to paired t-tests (two-tail $p < 0.001$; $df = 64$). Further testing is warranted to assess whether combining the “accelerated” or “rapid” averaging mode with the continuous method would produce comparable results to the discrete method under default averaging.

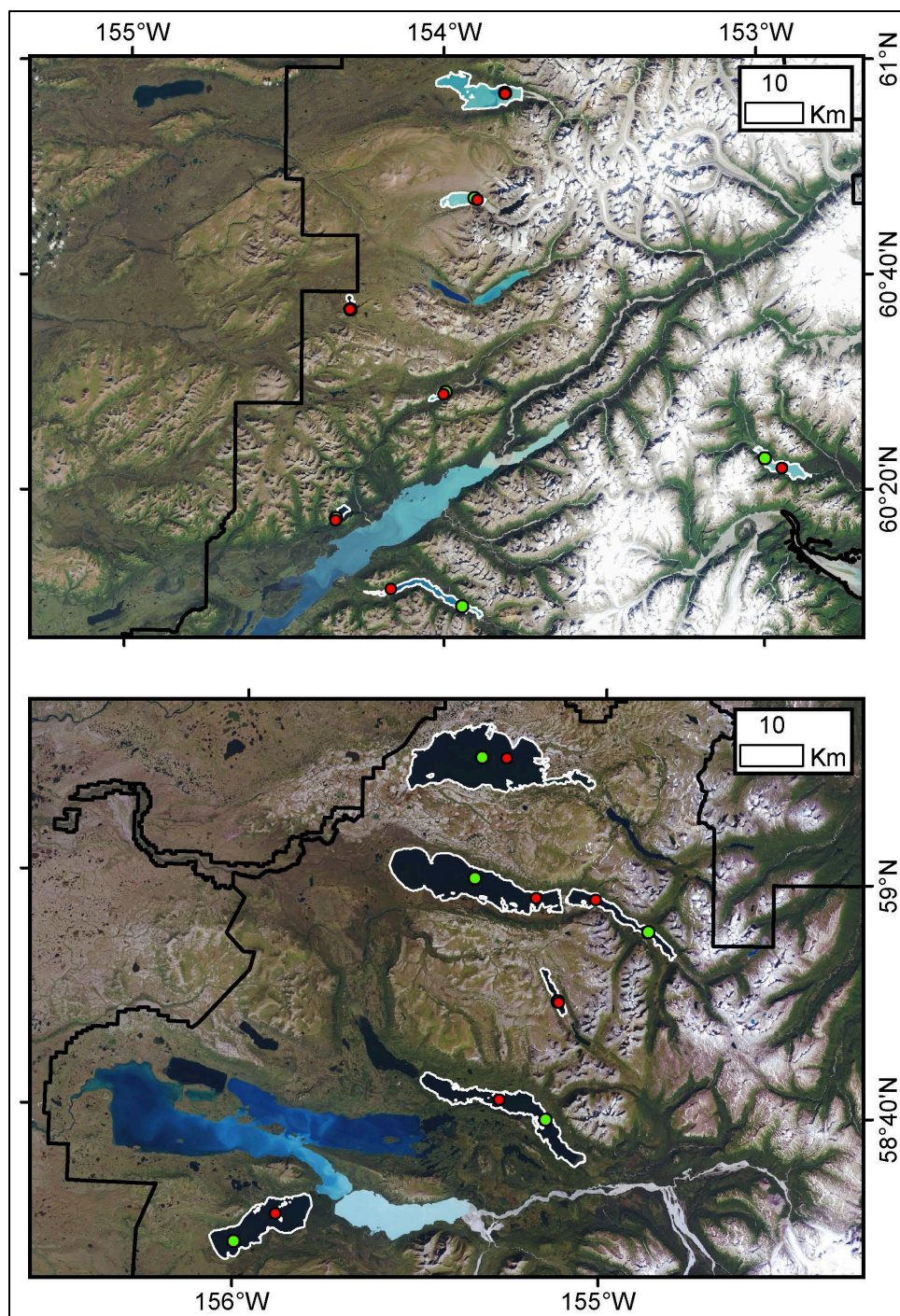


Figure 3. Vertical lake profile sites for 2016 (green points) and past years (red points) for a subset of Tier 1 and Tier 2 lakes in LACL (upper panel) and KATM (lower panel). In lakes where only one point is visible, the site for 2016 is identical to that monitored in past years. Black lines indicate park boundaries.

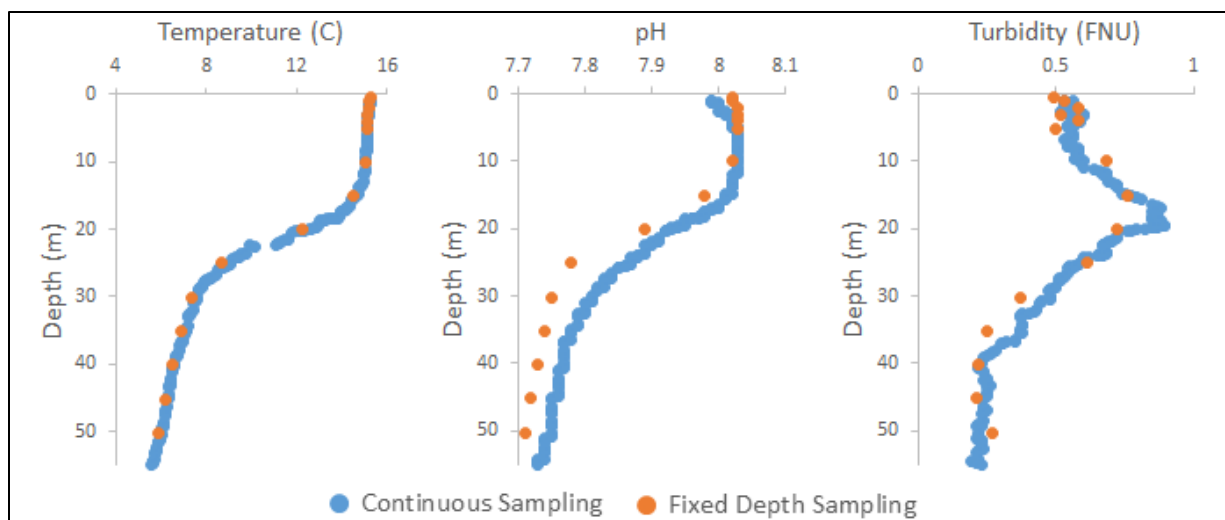


Figure 4. Data collected in the North Basin of Naknek Lake at site N-010 using two alternate profiling methods: continuous sampling every 2 seconds and discrete sampling at fixed depths.

KATM – Tier 1 Lakes

Tier 1 lakes in KATM consist of Naknek Lake and Lake Brooks. Sampling of these lakes occurred July 26 – August 3, 2016. During this time, sampling was conducted by boat (for Naknek Lake) and floatplane (for Lake Brooks) based out of Brooks Camp or KATM headquarters in King Salmon. Profiling the 40 sites within the 4 basins of Naknek Lake required 3 days. Evan Booher performed Secchi disc measurements and recorded weather and lake surface conditions. Vertical profile measurements were performed by either Evan Booher or Katie Junghans.

Naknek Lake – Lake Brooks – July 26, 2016

Date: July 26, 2016

Time of visit: 17:00 – 18:20

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM), Ryan Lepak (USGS)

Mode of transport: de Havilland Beaver on floats (KATM)

Narrative:

This profile was conducted as part of the research project on mercury in resident lake fish, so the coordinates differ from those in past years (Figure 3).

Naknek Lake – East and West Basin – August 1, 2016

Date: August 1, 2016

Time of visit: 12:08 – 17:43

Personnel: Evan Booher, Katie Junghans

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

Narrative:

Vertical lake profiles were completed at the following sites: E-002, E-003, E-008, E-009, W-001, W-004, W-005, W-006, W-007, W-008, W-009, W-010, W-011, and W-013

Naknek Lake – East and North Arm – August 2, 2016

Date: August 2, 2016

Time of visit: 9:30 – 16:50

Personnel: Evan Booher, Katie Junghans

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

Narrative:

Vertical lake profiles were completed at the following sites: E-001, E-004, E-005, E-006, E-007, E-010, N-001, N-002, N-003, N-004, N-006, N-007, N-008, N-009, N-010, and N-011.

Naknek Lake – Illiuk Arm – August 3, 2016

Date: August 3, 2016

Time of visit: 9:04 – 13:32

Personnel: Evan Booher, Katie Junghans

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

Narrative:

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

KATM – Tier 2 Lakes

Vertical profile sampling of five Tier 2 lakes in KATM occurred July 25 – 27, 2016. All travel was done in a de Havilland Beaver on floats, based out of the KATM headquarters in King Salmon and piloted by Craig Ricks. Evan Booher, Katie Junghans, Craig Ricks, and Montana Cohn performed Secchi disc measurements and recorded weather and lake surface conditions. Evan Booher, Katie Junghans, and Ryan Lepak performed lake profile measurements.

Interior Lakes – July 25, 2016

Date: July 25, 2016

Time of visit: 17:00 – 21:13

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM), Ryan Lepak (USGS)

Mode of transport: de Havilland Beaver on floats (KATM)

Narrative:

Vertical lake profiles were completed at Lake Grosvenor and Hammersly Lake.

Interior Lakes – July 26, 2016

Date: July 26, 2016

Time of visit: 11:50 – 15:35

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM), Ryan Lepak (USGS)

Mode of transport: de Havilland Beaver on floats (KATM)

Narrative:

Vertical lake profiles were completed at Kulik Lake and Nonvianuk Lake.

Interior Lakes – July 27, 2016

Date: July 27, 2016

Time of visit: 11:23 – 12:40

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM), Montana Cohn (KATM), Ryan Lepak (USGS)

Mode of transport: de Havilland Beaver on floats (KATM)

Narrative:

A vertical lake profile was completed at Kukaklek Lake.

LACL – Tier 1 Lakes

Tier 1 lakes in LACL include Lake Clark and Kijik Lake. Sampling of these lakes occurred July 19 – 22, 2016. During this time, sampling was done by boat (for Lake Clark) and floatplane (for Kijik Lake), based out of LACL field headquarters in Port Alsworth. Profiling the 30 sites within the 3 basins of Lake Clark required 4 days. Katie Junghans, Krista Bartz, and Rich Richotte performed Secchi disc measurements and recorded weather and lake surface conditions. Vertical profile measurements were performed by Katie Junghans, Krista Bartz, Evan Booher, and Jake Ogorek.

Kijik Lake – July 19, 2016

Date: July 19, 2016

Time of visit: 15:40 – 17:50

Personnel: Evan Booher, Rich Richotte (LACL), Jake Ogorek (USGS)

Mode of transport: Cessna 185 on floats (LACL)

Narrative:

This profile was conducted as part of research project on mercury in resident lake fish, so the coordinates differ from those in past years (Figure 3).

Lake Clark – Middle Basin – July 19, 2016

Date: July 19, 2016

Time of visit: 13:19 – 16:57

Personnel: Katie Junghans, Krista Bartz

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

Narrative:

Vertical lake profiles were completed at the following sites: M-001, M-004, M-007, M-008, and M-010.

Lake Clark – Middle and Upper Basin – July 20, 2016

Date: July 20, 2016

Time of visit: 10:09 – 16:00

Personnel: Katie Junghans, Krista Bartz

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

Narrative:

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

Lake Clark – Lower Basin – July 21, 2016

Date: July 21, 2016

Time of visit: 10:39 – 16:24

Personnel: Evan Booher, Katie Junghans, Krista Bartz, Dan Monhollon (SCA intern)

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

Narrative:

Vertical lake profiles were completed at the following sites: L-001, L-002, L-003, L-004, L-005, L-006, L-007, L-008, L-009, and L-010 (Figure 5).



Figure 5. Katie Junghans (right) and Dan Monhollon (left) measure water quality parameters along a vertical profile in the lower basin of Lake Clark, LACL, on July 21, 2016 (NPS/KRISTA BARTZ).

Lake Clark – Upper Basin – July 22, 2016

Date: July 22, 2016

Time of visit: 12:29 – 14:34

Personnel: Katie Junghans Krista Bartz

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

Narrative:

Vertical lake profiles were completed at the following sites: U-002, U-003, U-005, U-006, and U-009.

LACL – Tier 2 Lakes

Vertical profile sampling of six LACL Tier 2 lakes occurred July 18 – 20, 2016. All transportation utilized a Cessna 185 on floats, based out of the LACL field headquarters in Port Alsworth. Rich Richotte and Don Welty piloted the plane and recorded weather and lake surface conditions. Evan

Booher, Rich Richotte, and Don Welty performed Secchi disc measurements. Evan Booher and Jake Ogorek performed lake profile measurements.

Interior Lakes – July 18, 2016

Date: July 18, 2016

Time of visit: 11:58 – 17:15

Personnel: Evan Booher, Rich Richotte (LACL), Jake Ogorek (USGS)

Mode of transport: Cessna 185 on floats (LACL)

Narrative:

Vertical lake profiles were completed at Lachbuna Lake and Snipe Lake.

Coastal Lakes – July 19, 2016

Date: July 19, 2016

Time of visit: 11:30 – 13:30

Personnel: Evan Booher, Rich Richotte (LACL), Jake Ogorek (USGS)

Mode of transport: Cessna 185 on floats (LACL)

Narrative:

A vertical lake profile was completed at Crescent Lake.

Interior Lakes – July 20, 2016

Date: July 20, 2016

Time of visit: 10:15 – 18:50

Personnel: Evan Booher, Don Welty (LACL), Jake Ogorek (USGS)

Mode of transport: Cessna 185 on floats (LACL)

Narrative:

Vertical lake profiles were completed at Kontrashibuna Lake, Telaquana Lake, and Turquoise Lake.

Water Quantity Monitoring: Lake Level and Discharge

The SWAN freshwater field crew monitored two water quantity parameters during the 2016 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) using level loggers. Discharge was measured periodically at the same locations using an Acoustic Doppler Current Profiler (ADCP). Surveys were conducted at each outlet to establish the elevation of the level logger relative to a benchmark and two reference points, because the level logger elevations at these sites changed between 2015 and 2016. Ultimately, water level and discharge data will be used to create or refine rating curves for estimating daily lake discharge. Efforts to process data to that end and recommendations for future data collection efforts are described below.

Application of Survey Data to Water Level Data

Application of survey data to the water level time series was initiated in the spring of 2016 and is ongoing. SOPs 7 and 10 in the SWAN freshwater monitoring protocol (Shearer et al. 2015b) are currently under revision to account for and document methods used to apply surveyed level logger elevation as an offset correction to water level time series. Surveyed elevation can be used as a correction factor to account for adjustments in vertical position between deployment periods. Over time, raw water level data can be normalized to a reference elevation, making the data comparable among years. The logger elevation is a constant value that is added to each hourly record over the duration of a given deployment's time series, as outlined in Figure 6.

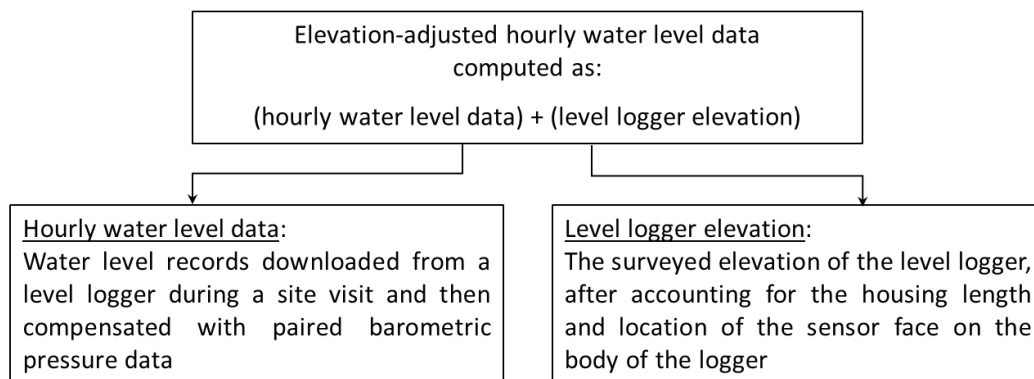


Figure 6. Flow diagram detailing how a surveyed elevation is applied as a correction factor to hourly water level data.

The elevation of the logger is a fixed value applied to every data point of the time series. During the survey, the cap on the level logger housing is used as the survey point. By subtracting the length of the housing from the cap to the sensor face on the logger, the actual “zero point” location of data collection is ascertained. To minimize future movement in elevation of level loggers, we recommend bracketing the location on the rebar where the logger/housing combination is installed. This could be achieved by placing hardware on the rebar that marks the position of the housing during a deployment period. In a subsequent deployment the instrument could then be reaffixed to the rebar in the same location as the previous deployment.

Development of Rating Curves

Rating curve development using AQUARIUS software was tested in late September using field data collected by USGS staff at the Lake Brooks outlet during 2006 and 2007. Data were downloaded from the USGS National Water Information System ([NWIS](#)), saved as a comma delimited file (*.csv), and appended to the Lake Brooks Outlet location in the “AA DEMOTEST -> SWAN Practice” area of Springboard using the Field Visit Toolbox. When parameters for stage and discharge are appended to a site, they are available for use in the Rating Development Toolbox of AQUARIUS. A basic rating was created for Lake Brooks Outlet (Figure 7), which will be refined and updated with newer field measurements as this work continues.

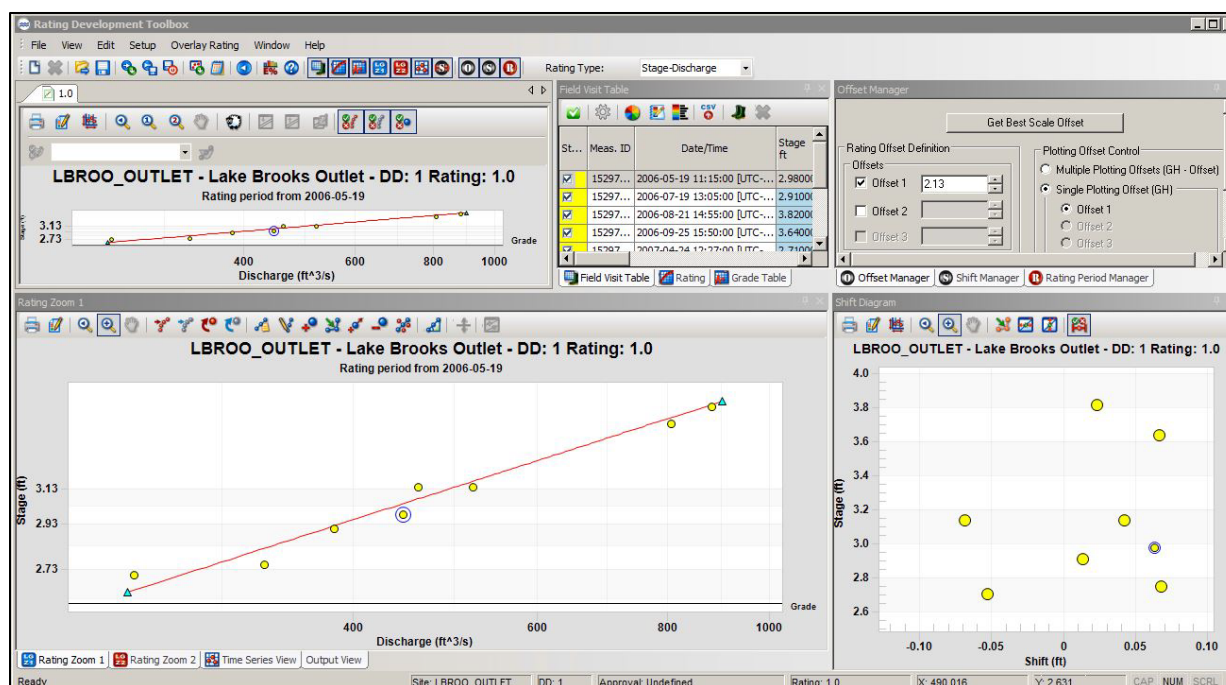


Figure 7. A screenshot of the work environment for the AQUARIUS Rating Development Toolbox. This rating was created from field data during site installation in 2006 and 2007 using basic techniques described in USGS training videos.

Guidance on the use of the AQUARIUS Rating Development Toolbox was found through instructional training videos produced by the USGS and publicly available through YouTube. The program used by the USGS, called the Graphical Rating and Shift Application Tool (GRSAT), is functionally identical to the AQUARIUS Rating Development Toolbox available to NPS users.

Recommendations for Future Monitoring

Several recommendations for water quantity monitoring stem from this year’s field season. For sites with year-round data (i.e., Kijik), we should explore the feasibility of taking winter and low-flow discharge measurements. Such data would allow us to extend future rating curves down to observed, low-flow stage values that occur in winter and early spring. At the Lake Brooks site, a bucket with holes should be used to eliminate wave action at the location of the outside staff of the crest stage

gage during every site visit (e.g., level logger data retrieval, level logger surveys, and discharge measurements).

At wadeable gaging sites (Brooks, Kijik), new surveys of channel cross-section and potential station control features should be completed to determine point of zero of flow (PZF) and thus gage height of zero flow (GZF) elevations. GZF is an important site characteristic because it helps determine the appropriate logarithmic scale used in rating analysis and can influence the shape of a low water rating curve (Kennedy 1984). At non-wadeable sites (Lake Clark, Naknek Lake), channel control is likely at virtually all stages of flow and, given the volume of water at these sites, cross-sectional data collection by levels is not possible. Options to collect cross-sectional data at these sites should be explored, and could include pairing bank cross-sectional data from levels with ADCP depth soundings. A water level elevation measurement ascertained during a survey by levels could be used to tie in depth sounding and distance measurements from an ADCP-derived channel profile, allowing us to estimate PZF at these two locations (Figure 8). Analysis of these paired data sets for site visits where concurrent surveys and ADCP discharge measurements occur could give us an indication of the relative stability of channel conditions over time.

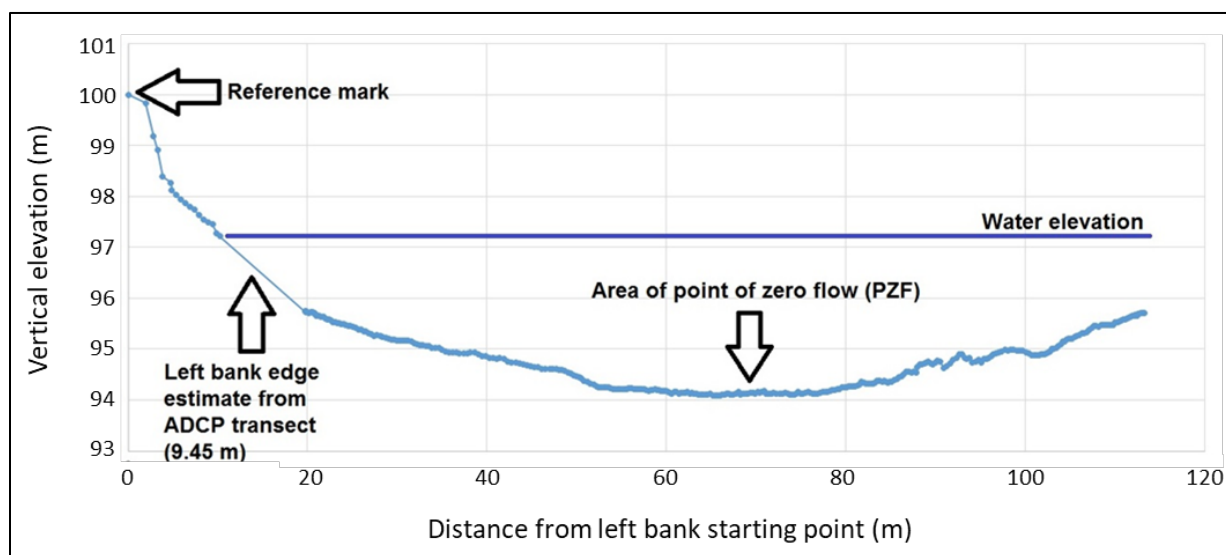


Figure 8. Cross-section data taken by levels and an acoustic Doppler current profiler (ADCP) at the Lake Clark outlet on June 3, 2014. The water surface elevation ascertained by levels was used to tie in depth sounding and distance measurements taken along a channel cross-section at the gaging site. Future survey efforts could extend measurements by levels into the channel to eliminate the data gap seen at the left bank edge.

KATM – Naknek Lake Outlet

Visit 1 – May 2, 2016

Date: May 2, 2016

Time of visit: 13:00 – 15:00

Personnel: Evan Booher, Bob Peterson (KATM)

Mode of transport: Park vehicle

Purpose of trip: Download level, baro, and HOBO loggers; survey level logger elevation

Narrative:

The level and baro loggers were downloaded and relaunched (launch date/time: 05/02/2016 16:00), but the HOBO Pro v2 water temperature logger was not recovered (S/N: 10010754). It had been installed the previous year on a dock piling accessible only in low water conditions. Consider moving it to an alternate location. A level survey was run to establish the elevation of the level logger, both before removal and after redeployment. Photos were taken of the survey benchmark and reference points. Biofouling and rust on the level logger and its housing were also documented (Figure 9).



Figure 9. Biofouling and rust found on the housing (A) and level logger (B) at the outlet of Naknek Lake on May 2, 2016 (NPS/BOB PETERSON).

Visit 2 – July 1, 2016

Date: July 1, 2016

Time of visit: 11:30 – 13:10

Personnel: Evan Booher, Katie Junghans

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

Purpose of trip: Measure stream discharge

Narrative:

Four successful discharge measurements were completed with the SonTek M9 ADCP between 12:11 and 12:53. Pre-processed mean total discharge was 12,755 cubic feet per second (cfs).

Visit 3 – August 15, 2016

Date: August 15, 2016

Time of visit: 14:50 – 16:35

Personnel: Evan Booher, Katie Junghans, Crissy Phillips (KATM)

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

Purpose of trip: Measure stream discharge

Narrative:

Two successful discharge measurements were completed with the SonTek M9 ADCP between 15:32 and 16:35. Pre-processed mean total discharge was 15,591 cfs.

KATM – Lake Brooks Outlet

Visit 1 – May 20, 2016

Date: May 20, 2016

Time of visit: 16:00 – 17:30

Personnel: Evan Booher, Katie Junghans

Mode of transport: On foot

Purpose of trip: Deploy level and baro loggers; survey level logger elevation; download HOB0

Narrative:

The level logger was installed on rebar affixed to the crest stage gage infrastructure on the river-left side of the channel and a survey was run to establish its new elevation. The baro logger was installed on the Lake Brooks picnic area shed. Both the level and baro loggers were programmed for hourly readings (launch date/time: 05/20/2016 17:00). The galvanized cable securing the HOB0 Pro v2 logger (S/N: 10010743) to the rebar was broken and the HOB0 was lost.

Visit 2 – July 7, 2016

Date: July 7, 2016

Time of visit: 14:30 – 16:00

Personnel: Evan Booher, Katie Junghans

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

Purpose of trip: Replace HOB0; measure stream discharge

Narrative:

A new HOB0 Pro v2 logger (S/N: 10584829) was deployed using Gagnon cord instead of cable. The upper hose clamp that secures the rebar with the level logger to the staff gage was broken. Several zip ties were added to fasten the rebar temporarily. The channel width was measured (260 ft) and a cableway setup was attempted. However, the setup was not well planned and the line became tangled. The cableway may be impractical for this site during mid-summer due to higher discharge, wider channel, and greater potential for bear and visitor use than earlier in the season. A power boat was used for this measurement as an alternative means of traversing the channel. Four successful discharge measurements were completed with the SonTek M9 ADCP between 15:38 and 16:00. Pre-processed mean total discharge was 554 cfs.

Visit 3 – September 9, 2016

Date: September 9, 2016

Time of visit: 10:30 – 17:40

Personnel: Evan Booher, Katie Junghans, Kassie Grimm (KATM)

Mode of transport: On foot

Purpose of trip: Download level, baro, and HOB0 loggers; replace level logger housing; survey level logger elevation

Narrative:

Many bears were fishing at the outlet, delaying work by several hours. Eventually, the level, baro, and HOBO loggers were downloaded. The old level logger housing had become rusted and was in need of replacement. A new stainless steel housing unit was constructed and installed (Figure 10). This new housing unit was longer and wider than the old one and required larger hose clamps to secure it. The logger was rigged to hang vertically from the top cap of the housing unit, rather than resting freely at an angle inside the pipe, as in past years. A survey was run to establish the elevation of the level logger, before removal and after redeployment. This was the first year that the level and baro loggers at this site were intentionally redeployed in the fall for overwinter monitoring.

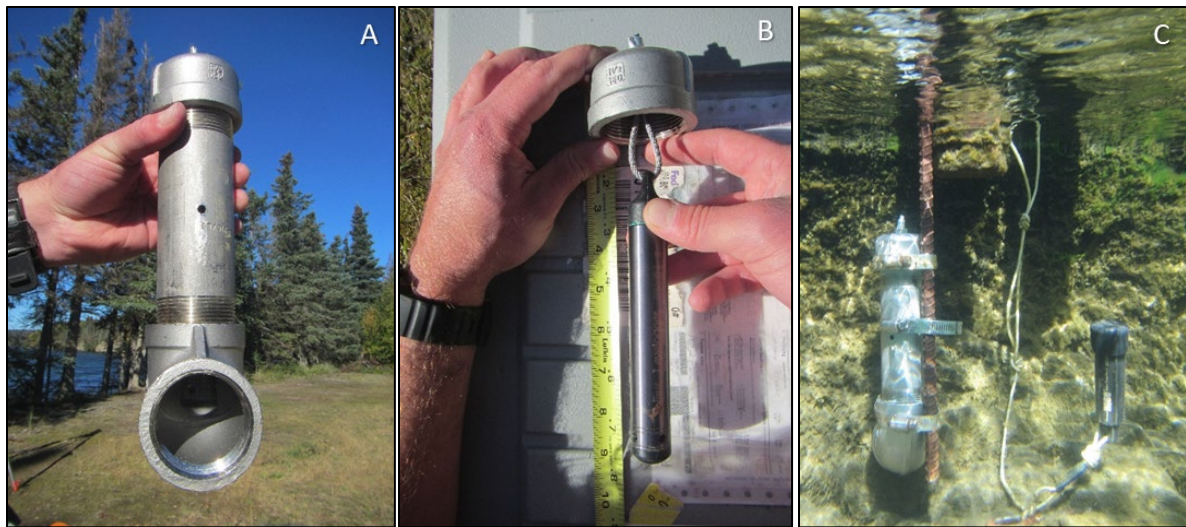


Figure 10. New housing unit at the Lake Brooks Outlet (A), with the level logger hanging freely from a cable laced through the cap (B) then anchored with a nut and swage (C) (NPS/KATIE JUNGHANS).

LACL – Lake Clark Outlet

Visit 1 – April 21, 2016

Date: April 21, 2016

Time of visit: 19:10 – 20:00

Personnel: Evan Booher, Dan Young

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

Purpose of trip: Download level and baro loggers; survey level logger elevation; deploy HOBO; measure stream discharge

Narrative:

The level and baro loggers were downloaded and redeployed (launch date/time: 04/21/2016 17:00), and a survey was run to establish the elevation of the level logger, before and after download. A HOBO Pro v2 logger (S/N: 10584788) programmed to record water temperature hourly (launch date/time: 04/22/2016 00:00) was co-located on the rebar to which the level logger was attached. Four successful discharge measurements were completed with the SonTek M9 ADCP between 19:39 and 19:53. Pre-processed mean total discharge was 5,028 cfs.

Visit 2 – July 12, 2016

Date: July 12, 2016

Time of visit: 14:00 – 14:50

Personnel: Evan Booher, Katie Junghans, Diego Madrid (LACL)

Mode of transport: Neacola V-Hull skiff (LACL)

Purpose of trip: Measure stream discharge

Narrative:

Four successful discharge measurements were completed with the SonTek M9 ADCP between 14:20 and 14:48, and pre-processed mean total discharge was 22,808 cfs. This was one of the highest discharge measurements made over the period of record for this site.

Visit 3 – September 15, 2016

Date: September 15, 2016

Time of visit: 11:00 – 14:20

Personnel: Evan Booher, Katie Junghans, Krista Bartz

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

Purpose of trip: Measure stream discharge

Narrative:

Four successful discharge measurements were completed with the SonTek M9 ADCP between 11:35 and 12:21. Pre-processed mean total discharge was 17,266 cfs.

LACL – Kijik Lake Outlet**Visit 1 – May 26, 2016**

Date: May 26, 2016

Time of visit: 13:30 – 15:00

Personnel: Evan Booher, Katie Junghans

Mode of transport: Cessna 185 on floats (LACL)

Purpose of trip: Download HOBO, level, and baro loggers; survey level logger elevation

Narrative:

The level and baro loggers were downloaded, as was the HOBO Pro v2 logger at this site (S/N: 10339617). The baro logger was found on the ground beneath the spruce tree to which it had been tied, with the line likely severed by a small animal. The baro logger was repositioned in the tree with Gagnon cord. A survey was conducted to document the elevation of the level logger, before and after download. Both the level and baro loggers were programmed for hourly readings (launch date/time: 05/26/2016 15:00).

Visit 2 – July 13, 2016

Date: July 13, 2016

Time of visit: 11:10 – 13:00

Personnel: Evan Booher, Katie Junghans

Mode of transport: Cessna 185 on floats (LACL)

Purpose of trip: Measure stream discharge

Narrative:

The channel width was measured to be 43 m. Four successful discharge measurements were completed with the SonTek M9 ADCP via cableway between 12:37 and 12:56 and pre-processed mean total discharge was 203 cfs.

Visit 3 – September 14, 2016

Date: September 14, 2016

Time of visit: 14:00 – 15:15

Personnel: Evan Booher, Katie Junghans, Krista Bartz, Hannah Lee (SWAN Vegetation)

Mode of transport: Cessna 185 on floats (LACL)

Purpose of trip: Download level and baro loggers; survey level logger elevation; measure stream discharge

Narrative:

The level and baro loggers were downloaded. For the level logger, a dry suit was required due to the water depth. The baro logger was again found on the ground beneath the spruce tree to which it had been tied. This time, it was reattached to the tree using wire. The rebar that secured the level logger was loose, so it was replaced with a longer piece in the same location. Also, the old level logger housing had become rusted and was in need of replacement. A new stainless steel housing unit was constructed and installed. As with the new housing unit at the outlet of Lake Brooks, this one was longer and wider than the former unit and required larger hose clamps to secure it. The level logger was hung inside the unit similarly to that shown in Figure 10. A survey was run to document the elevation of the level logger before and after download. Note that the logger was resubmerged around 12:10, making the data collected at 12:00 suspect. Finally, four successful discharge measurements were completed with the SonTek M9 ADCP via cableway between 14:46 and 15:04. Pre-processed mean total discharge was 569 cfs.

Pilot Study: Surface and Interstitial Water Temperatures

During the 2016 field season, the SWAN freshwater field crew continued a pilot study of year-round water temperatures at sites with known or suspected salmon spawning (Table 1). At each site, temperature loggers are co-located above and below the substrate in stream channel and lake beach sites following established methods (Zimmerman and Finn 2012). A surface water temperature logger (i.e., above-substrate logger) is anchored using a cable attached to rebar driven into the stream bed. An interstitial water temperature logger (i.e., below-substrate logger) is anchored using a large plastic zip-tie, marked with a survey flag that is visible above the stream bed. The surface temperature loggers are HOBO Pro v2s, and the interstitial temperature loggers are TidbiT v2s, both made by Onset. Additional methodological details are documented in Booher et al. 2015.

Work in 2016 involved successful and unsuccessful attempts at locating, downloading, and redeploying the loggers at nine existing sites (Table 1). One new site was also established (Idavain Creek). In some of the more dynamic streams, loggers had been buried by sediment or washed away and could not be located. A submersible metal detector proved useful in finding some HOBOS, because they were anchored to rebar. With this in mind, rebar was added to the anchoring system of some TidbiTs (via Gagnon cord and hose clamps) to make them more detectable in the future.

KATM – Up-A-Tree Creek

Visit 1 – August 25, 2016

Date: August 25, 2016

Time of visit: 12:00 – 15:30

Personnel: Evan Booher, Katie Junghans

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

Purpose of trip: Download and reinstall loggers

Narrative:

Both the HOBO (S/N: 9951824) and TidbiT (S/N: 10206472) loggers were easily located using the Aqua Scope. The loggers were removed, downloaded, and reinstalled. The galvanized steel cable securing the HOBO to its rebar anchor was deteriorating and was replaced with stainless steel cable. Vertical hydraulic gradient (VHG) measurement via mini-piezometer indicated slight upwelling (-0.164). Many salmon were present in the stream and redds were observed above the monitoring site (Figure 11). A brown bear sow and cubs were observed as well.

KATM – Margot Creek

Visit 1 – August 26, 2016

Date: August 26, 2016

Time of visit: 12:30 – 15:30

Personnel: Evan Booher, Katie Junghans, Daniel Lombardi (KATM)

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

Purpose of trip: Download and reinstall loggers

Table 1. Pilot study sites visited in 2016, summarized by date and whether or not the data loggers were located and reinstalled.

Park	Site Type	Site Name	Field visit Date(s)	HOB0 Pro v2 Located?	HOB0 Pro v2 Redeployed?	TidbiT v2 Located?	TidbiT v2 Redeployed?
KATM	Stream	Up-A-Tree Creek	08/25/2016	Yes	Yes	Yes	Yes
KATM	Stream	Margot Creek	08/26/2016	No	Yes	No	Yes
KATM	Beach	Naknek Lake – Margot	08/26/2016	No	No	No	No
KATM	Stream	Idavain Creek	09/28/2016	*	*	*	*
LACL	Stream	Tlikakila River	04/22/2016; 10/24/2016	Yes	Yes	No	No
LACL	Beach	Lake Clark – Alsworth	05/10/2016; 05/13/2016	Yes	Yes	Yes	Yes
LACL	Beach	Lake Clark – Chulitna	05/13/2016; 05/17/2016	No	Yes	Yes	Yes
LACL	Stream	Little Kijik River	07/13/2016	Yes	Yes	Yes	Yes
LACL	Stream	Tazimina River	07/19/2016	Yes	Yes	No	Yes
LACL	Beach	Kijik Lake	06/02/2016; 10/19/2016	No	Yes	Yes	Yes

* This was a new site in 2016.



Figure 11. Katie Junghans measures interstitial water temperature at Up-A-Tree Creek on August 25, 2016. Spawning salmon were present in the reach during the site visit (NPS/EVAN BOOHER).

Narrative:

Margot Creek is a very dynamic stream and, in 2016, it experienced high water levels. Although the loggers were located in a seemingly stable side channel, the morphology of the monitoring site experienced significant change since 2015. With the use of a metal detector, the rebar that anchored the HOBO was located. However, the galvanized cable that secured the HOBO to the rebar had failed and the logger (S/N: 10339624) was lost. The TidbiT (S/N: 2251299) was lost as well, likely due to scour or burial. New HOBO and TidbiT loggers were installed (S/N: 10584803 and 10980766, respectively), and the TidbiT zip tie was anchored to rebar. Metadata (e.g., logger coordinates, distances of reference points) and photos were taken to assist in future relocation. VHG measurement indicated slight downwelling (0.619). Many salmon and anglers were present and redds were observed in the stream below the monitoring site.

KATM – Naknek Lake - Margot Beach

Visit 1 – August 26, 2016

Date: August 26, 2016

Time of visit: 12:30

Personnel: Evan Booher, Katie Junghans, Daniel Lombardi (KATM)

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

Purpose of trip: Download and reinstall loggers

Narrative:

In 2016, many waterbodies in KATM, including Naknek Lake, experienced high water levels during the summer season. Upon arrival to the mouth of Margot Creek, it was apparent that the beach monitoring site was significantly altered by inundation. Lake water was well above the sandy beach and had cut into the terrace approximately a meter. The HOBO and TidbiT loggers (S/N 10339623 and 2251251, respectively) were assumed to be lost.

KATM – Idavain Creek

Visit 1 – September 28, 2016

Date: September 28, 2016

Time of visit: 11:00 – 14:00

Personnel: Evan Booher, Katie Junghans, Montana Cohn (KATM), Steve Powell (KATM)

Mode of transport: Workskiff V-Hull Boat (KATM)

Purpose of trip: Establish new monitoring site; install loggers

Narrative:

A new monitoring site was established at Idavain Creek. The field crew followed a trail on the river-right bank for about 1.2 km (0.75 mi) until a relatively stable reach was encountered. The HOBO (S/N: 11001179) and TidbiT (S/N: 10980764) were installed river-right, on the inside of one of the first significant meanders upstream of the creek mouth (Figure 12). Rebar was not used to anchor the TidbiT. Photos of logger locations, distances of reference points, and coordinates were taken to assist in future relocation (58.66621, -155.67084). VHG measurement indicated slight upwelling (-0.076).



Figure 12. Location of the new pilot study site established at Idavain Creek on September 28, 2016.

LACL – Tlikakila River

Visit 1 – April 22, 2016

Date: April 22, 2016

Time of visit: 12:00 – 15:00

Personnel: Evan Booher, Dan Young (LACL)

Mode of transport: Cessna 206 (LACL)

Purpose of trip: Download and reinstall loggers

Narrative:

The TidbiT (S/N: 2251274) was not located and a new one was not installed (Figure 13). The HOBO (S/N: 10584779) was located and downloaded. The rebar that anchored the HOBO was buried leaving only ~1 m of the cable secured to the HOBO above the sediment.

Visit 2 – October 24, 2016

Date: October 24, 2016

Time of visit: 13:00 – 14:30

Personnel: Andrew Kirby (LACL)

Mode of transport: Cessna 206 (LACL)

Purpose of trip: Download and reinstall loggers

Narrative:

The channel at the existing site was almost completely frozen, making the HOBO and TidbiT inaccessible due to thick ice. Therefore, a second set of loggers was deployed at a new site ~30 m upstream of Reference Shrub # 1, where a hole in the ice enabled installation. A new Reference Shrub (# 3) was identified on the river-right bank, 4.7 m from the new loggers at a bearing of 212°. This shrub, a small willow (60.49940, -153.68597), was marked with a piece of red p-cord. The rebar anchoring the new HOBO (S/N: 11001159) was located 0.3 m from the new TidbiT (S/N: 10980765) and was driven in flush with the substrate. The TidbiT was not anchored to rebar as planned because it seemed likely to become entrained in ice. A single waypoint was taken for both loggers due to their proximity (60.49940, -153.68604). VHG measurement indicated slight upwelling (-0.027).

LACL – Lake Clark – Chulitna Lodge Beach

Visit 1 – May 13, 2016

Date: May 13, 2016

Time of visit: Unknown

Personnel: Dan Young (LACL), Andrew Kirby (LACL)

Mode of transport: Unknown

Purpose of trip: Download and reinstall loggers



Figure 13. Dan Young searches for signs of the TidbiT logger using an Aqua Scope in the Tlikakila River on April 22, 2016 (NPS/EVAN BOOHER).

Narrative:

The rebar anchoring the HOBO was visually located by flagging that had been attached to it. However, the galvanized cable anchoring the HOBO (S/N: 10339615) to the rebar had rusted and failed. The HOBO was lost and not replaced on this date. The surveyor's brush above the TidbiT was visually located, despite an abundance of algae growth. When the surveyor's brush was pulled up, the TidbiT (S/N: 1026468) was no longer attached to the zip tie. The TidbiT was located after several hours of digging in the sediment. It was downloaded onsite but not reinstalled.

Visit 2 – May 17, 2016

Date: May 17, 2016

Time of visit: Unknown

Personnel: Dan Young (LACL), Andrew Kirby (LACL)

Mode of transport: Chinook Landing Craft, G3 console jetboat

Purpose of trip: Reinstall loggers

Narrative:

The TidbiT (S/N: 1026468) was reattached to a zip tie and surveyor's brush and reinstalled. The TidbiT was moved ~2 m from its former location, which had become disturbed by the digging done during the last trip. Coordinates of this new location were recorded (60.28065, -154.26601). A new HOBO (S/N: 10584827) was attached to the rebar using rope (as opposed to cable). The water was deep enough that this step required the use of a dry suit (Figure 14). VHG measurement indicated slight upwelling (-0.063).



Figure 14. Dan Young redeploys a HOBO logger on May 17, 2016 at a beach near Chulitna Lodge, on Lake Clark (NPS/ANDREW KIRBY).

LACL – Lake Clark – Port Alsworth Beach

Visit 1 – May 10, 2016

Date: May 10, 2016

Time of visit: Unknown

Personnel: Dan Young (LACL), Andrew Kirby (LACL)

Mode of transport: Unknown

Purpose of trip: Download and reinstall loggers

Narrative:

Relocation of the HOBO (S/N: 10584775) and TidbiT (S/N: 10206466) required a GPS due to the amount of algal growth visually obscuring the loggers. The HOBO did not download properly on this date, making a second trip necessary. The water level was high, preventing the use of the piezometer.

Visit 2 – May 13, 2016

Date: May 13, 2016

Time of visit: 10:00 – 12:00

Personnel: Dan Young (LACL), Andrew Kirby (LACL)

Mode of transport: Unknown

Purpose of trip: Download and reinstall HOBO

Narrative:

The HOBO which did not download properly on May 10, 2016 was downloaded using an Optic Shuttle. In the process of downloading the HOBO, the TidbiT was mistakenly dislodged. It was reinstalled in the same location at 11:40.

LACL – Little Kijik River

Visit 1 – July 13, 2016

Date: July 13, 2016

Time of visit: 13:30 – 16:00

Personnel: Evan Booher, Katie Junghans

Mode of transport: Cessna 185 on floats

Purpose of trip: Download and reinstall loggers

Narrative:

The HOBO (S/N: 9683503) and TidbiT (S/N: 10206465) were relocated using the Aqua Scope. Both were downloaded and reinstalled. The galvanized cable securing the HOBO to the rebar was worn so it was replaced with stainless steel cable. The wire securing the TidbiT to the zip tie was rusted so an additional zip tie was added for security. The TidbiT was installed ~0.6 m upstream and ~0.6 m closer to the bank than its last deployment. VHG measurement was neutral, indicating no upwelling or downwelling (0.000).

LACL – Tazimina River

Visit 1 – July 19, 2016

Date: July 19, 2016

Time of visit: 12:00 – 13:00

Personnel: Dan Young (LACL), Kelly Martin (LACL), Eileen Audette (LACL)

Mode of transport: G3 console jet boat

Purpose of trip: Download and reinstall loggers

Narrative:

The HOBO (S/N: 2337919) was located and downloaded. The TidbiT (S/N: 10206464) was not found. Woody debris had been deposited upstream of the loggers, causing a significant change in channel morphology, likely burying the TidbiT. A new TidbiT (S/N: 10206470) was installed and anchored to rebar using p-cord. The TidbiT's location was moved about 0.5 m closer to the bank than its original deployment. VHG measurement indicated slight downwelling (0.037). Note that the raw *.hobo file downloaded on this date contained an error in which every data point had the same time stamp as the original launch date/time (06/19/14 10:00:00 AM). This error was corrected during post-processing by extrapolating the date and time of each hourly measurement between the known start and stop time of the HOBO's deployment.

LACL – Kijik Lake Beach

Visit 1 – June 2, 2016

Date: June 2, 2016

Time of visit: Unknown

Personnel: Evan Booher, Dan Young (LACL), Kelly Martin (LACL)

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

Purpose of trip: Download and reinstall loggers

Narrative:

The TidbiT (S/N: 10206471) was located and downloaded. The HOBO (S/N: 10206471) was not found, possibly having been moved by lake ice during the winter. VHG measurement indicated no upwelling or downwelling (0.000).

Visit 2 – October 19, 2016

Date: October 19, 2016

Time of visit: 11:00 – 12:30

Personnel: Dan Young (LACL), Kerry Muldoon (LACL)

Mode of transport: Cessna 185 on floats

Purpose of trip: Reinstall HOBO

Narrative:

A new HOBO (S/N: 10584801) was installed so that the rebar was almost flush with the lake sediment. The TidbiT was not disturbed. Several spawning sockeye were observed in the area.

Resident Lake Fish Contaminants Study

Lake trout (*Salvelinus namaycush*) and sockeye salmon (*Oncorhynchus nerka*) were collected from KATM for a resident lake fish contamination study conducted in collaboration with the [USGS Mercury Research Laboratory](#) (MRL). Lake trout sampling was successful, taking a fraction of the time originally set aside for fish collection. This efficiency was attributable to several factors. First, sampling occurred in early summer (June), at a time when lake trout are feeding at shallower depths, potentially on concentrated prey resources such as outmigrating schools of juvenile salmon. Second, KATM's pilot remained on site during several trips, which negated the need to stay overnight. Third, park staff assisted in fishing efforts, decreasing the time required to achieve target sample sizes at select locations.

Other “lessons learned” included the following: pinching the fishing lure's barbs reduced the harm to by-catch, often rainbow trout (*O. mykiss*) or arctic char (*S. alpinus*). Also, collecting sockeye salmon after the run, when fish are dead and/or decaying, might elevate total mercury concentrations above those in fish collected while still alive. Finally, measuring fish lengths during post-trip processing should be standardized by species. Specifically, lake trout should be measured two ways: from the tip of the snout to the fork in the tail, and from the tip of the snout to the end of the tail. Sockeye salmon should be measured from mid-eye to the caudal peduncle.

Water, sediment, and plankton samples were collected in LACL July 18, 2016 to July 22, 2016 and in KATM July 25, 2016 to July 27, 2016. The USGS MRL sonde was programmed for continuous logging and lowered through the water column at the deepest known portion of the lake to characterize basic water quality parameters, determine the depth of the thermocline, and estimate mid-epilimnion (stratified layer above the thermocline) and mid-hypolimnion (layer beneath the thermocline) depths. The resulting water quality data were used as SWAN's vertical profiles for the 13 lakes involved in this study (detailed earlier in this report).

KATM – Tier 2 Lakes

Kuakaklek Lake – June 14, 2016

Date: June 14, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Robert Evans (KATM), Montana Cohn (KATM), Craig Ricks (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Ten lake trout were collected at the mouth of Moraine Creek using hook and line equipment in less than two hours. Yellow and pink pixie spoons were successful. It was necessary to pinch the barbs on the spoons to reduce harm done to by-catch of rainbow trout. The sampling was highly efficient and allowed us to forgo camping and use of the Zodiac inflatable boat. Fish were processed in King Salmon on June 15, 2016.

Lake Grosvenor – June 19, 2016

Date: June 19, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM), Kelsey Griffin (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Six lake trout were collected in under 30 minutes from the stream connecting Lake Coville and Lake Grosvenor, near Grosvenor Lodge. Staff of the lodge were very willing to aid these activities. Lake trout, rainbow trout, and various bird species were observed feeding at this inlet location – perhaps on outmigrating salmon. The connecting section between Lakes Coville and Grosvenor is probably a “pinch point” of fish migration within the watershed. Fish collection at several other locations on Lake Grosvenor were unsuccessful. Fish were processed in King Salmon on June 20, 2016.

Kulik Lake – June 21-22, 2016

Dates: June 21 and June 22, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Seven lake trout were collected from three locations on Kulik Lake over the span of two days using hook and line equipment. Pink pixie spoons and yellow needlefish spoons were successful. One lake trout was caught at the inlet stream at the east end of the lake. Its morphology differed from other lake trout collected at Kulik Lake, being thinner and lighter in color. Two fish were caught from the bank of the lake outlet. Four fish were caught from the inflatable Zodiac at an inlet stream along the north bank of the lake, approximately one mile west of the outlet. There were many rainbow trout present at this inlet. Fish were processed in King Salmon on June 24, 2016.

Nonvianuk Lake – June 23, 2016

Date: June 23, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Four lake trout were collected while fishing from the floats of the Beaver at the mouth of the Kulik River by Kulik Lodge using hook and line equipment. Pink pixie spoons and yellow needlefish spoons were successful. This short sampling endeavor was done during the return flight from Kulik Lake on June 23, 2016 (described above). Fish were processed in King Salmon on June 24, 2016.

Nonvianuk Lake – June 28, 2016

Date: June 28, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Craig Ricks (KATM), Diane Chung (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Six lake trout were collected while fishing from the floats of the Beaver at the mouth of the Kulik River by Kulik Lodge using hook and line equipment. Pink and green pixie spoons were successful. Fish were processed in King Salmon on June 28, 2016.

Hammersly Lake – August 23, 2016

Date: August 23, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Alyssa Reischauer (KATM), Craig Ricks (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Three sockeye salmon carcasses were collected from the outlet at the northwest end of Hammersly Lake. Live sockeye salmon were present, but were too few in abundance to warrant hook and line sampling. The condition of the carcasses was less than ideal, as the fish length measurements and the tissue sample quality were compromised by decay. Additionally, processing of these fish (on August 24, 2016 in King Salmon) was a challenge of willpower.

Nonvianuk Lake – August 23, 2016

Date: August 23, 2016

Time of visit: Unknown

Personnel: Evan Booher, Katie Junghans, Alyssa Reischauer (KATM), Craig Ricks (KATM)

Mode of transport: De Havilland Beaver on floats (KATM)

Purpose of trip: Fish collection

Narrative:

Sampling at Hammersly Lake went more quickly than expected, enabling a visit to Nonvianuk Lake the same day. Three sockeye salmon were collected from the river-left bank of the mouth of the Kulik River near Kulik Lodge using hook and line gear. Pink and green pixie spoons were successful. Great numbers of salmon were noted in the river and in the lake at the river mouth. Fish were processed in King Salmon on August 24, 2016.

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The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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Natural Resource Stewardship and Science

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