Aquatic Site Sampling Design – NEON Domain 18

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
Historic Changes			Added rapid habitat assessment; Added discharge to TOOK; CM updated with new template and changes based on riparian habitat assessment timing; Updated wording on reaeration timing; Update TOOK bio bout dates, update inlet sensor location and in-lake inlet/outlet bio sampling locations; Updated surface microbe sampling at OKSR to couple with flow-weighted SWC during ice-free months; Updated groundwater sampling locations and map; Updated bio contingencies; Updated groundwater sampling timing and locations
A	05/23/2019	ECO-06095	Initial Release

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1 DESCRIPTION

1.1 Purpose

The goal of the National Ecological Observatory Network (NEON) is to enable understanding and forecasting of the impacts of climate change, land use change, and invasive species on continental-scale ecology.

A disparity exists in the scale of organisms and their effects on the global environment (Hargrove & Pickering, 1992). While environmental impacts often occur at the largest scales, small scale biological and physical processes need to be understood in order to document responses of organisms, communities, populations and other small scale phenomena (Keller et al., 2008). Data will be gathered from the level of gene to ecosystem at a local to continental scale using standardized field procedures and sample processing. In order to address this disparity, NEON will approach the Grand Challenge questions through an analysis of processes, interactions and responses occurring across spatial and temporal scales.

The local data collected at NEON sites within the 20 Domains will be integrated with the targeted regional data from NEON airborne instrumentation. This will provide a direct linkage in spatial and temporal scaling from NEON's distributed sensor network and in-situ field measurements, coupled with individual plant or canopy measurements to plot or stand level observations, and ultimately to the continental scale.

1.2 Scope

This document outlines the site-specific sampling strategy proposed for NEON Aquatic field sampling activities and other directly associated activities that will be used to address key data products related to the overarching Grand Challenge questions. It provides the sampling rationale for given parameters.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD[01]	NEON.DOC.000001	NEON Observatory Design
AD[02]	NEON.DOC.002652	NEON Level 1, Level 2, Level 3 Data Products Catalog
AD[03]	NEON.DOC.005011	NEON Coordinate Systems Specification

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.001152	NEON Aquatic Sample Strategy Document
RD [04]	NEON.DOC.001085	AOS Protocol and Procedure: Stream Discharge
RD [05]	NEON.DOC.001197	AOS Protocol and Procedure: Bathymetry and Morphology of Lakes and Non-Wadeable Streams
RD [06]	NEON.DOC.002905	AOS Protocol and Procedure: Water Chemistry Sampling in Surface Waters and Groundwater
RD [07]	NEON.DOC.001886	AOS Protocol and Procedure: Stable Isotope Sampling in Surface and Ground Waters
RD [08]	NEON.DOC.001199	AOS Protocol and Procedure: Surface Water Dissolved Gas Sampling
RD [09]	NEON.DOC.001191	AOS Protocol and Procedure: Sediment Chemistry Sampling in Lakes and Non-Wadeable Streams
RD [10]	NEON.DOC.003044	AOS Protocol and Procedure: Aquatic Microbe Sampling
RD [11]	NEON.DOC.003045	AOS Protocol and Procedure: Periphyton, Seston, and Phytoplankton Sampling
RD [12]	NEON.DOC.003039	AOS Protocol and Procedure: Aquatic Plant, Bryophyte, Lichen, and Macroalgae Sampling
RD [13]	NEON.DOC.003046	AOS Protocol and Procedure: Aquatic Macroinvertebrate Sampling
RD [14]	NEON.DOC.001194	AOS Protocol and Procedure: Zooplankton Sampling in Lakes
RD [15]	NEON.DOC.003826	AOS Protocol and Procedure: Riparian Habitat Assessment
RD [16]	NEON.DOC.001296	AOS Protocol and Procedure: Fish Sampling in Lakes
RD [17]	NEON.DOC.004613	NEON Preventative Maintenance Procedure: AIS Buoy
RD [18]	NEON.DOC.001193	AOS Protocol and Procedure: Sediment Chemistry Sampling in Wadeable Streams
RD [19]	NEON.DOC.001295	AOS Protocol and Procedure: Fish Sampling in Wadeable Streams
RD [20]	NEON.DOC.003162	AOS Protocol and Procedure: Wadeable Stream Morphology
RD [20]	NEON.DOC.000693	AOS Protocol and Procedure: Reaeration in Streams

2.3 Acronyms

AQU	Aquatic or reference reach
GDD	Growing degree days
MGC	Multivariate geographic clustering
MODIS	Moderate Resolution Imaging Spectroradiometer
NOAA	National Oceanic and Atmospheric Administration
NCDC (NCEI)	National Centers for Environmental Information
SDRC	Stage discharge rating curve
S1	Aquatic reach sensor set 1
S2	Aquatic reach sensor set 2
IN	Lake Inlet
OT	Lake Outlet

3 TEMPORAL SAMPLING STRATEGY

3.1 Rationale

NEON designed a set of domains based on a statistically rigorous analysis using national data sets for eco-climatic variables, based upon algorithms for multivariate geographic clustering (MGC) (Hargrove & Hoffman, 1999, 2004). The MGC approach identified nine primary climate state variables that could define the domains, allowing for regionalization of primary features within each domain. In order to replicate the strategy used for the large scale spatial design of NEON, Aquatics has adapted this approach and modified the list of the nine variables by identifying variables that were equally pertinent to the large scale temporal design, and by adding critical variables that affect physical, biological and chemical parameters in aquatic environments.

Aquatic ecosystems exhibit physical, chemical and biological variability over a wide range of spatial and temporal scales (Steele, 1978). This has resulted in a movement towards research approaches that utilize concurrent field based, buoy, aircraft, and satellite sampling strategies in order to measure physical, chemical and biological distributions over large areas synoptically and over long time periods. The integration of such sampling strategies across scales is an integral part of NEON's approach to the addressing the Grand Challenge questions (Keller et al., 2008).

NEON must be able to extrapolate relationships between drivers (climate change, land use change, and biological invasions) and ecological consequences to areas that are not sampled by NEON facilities but where partial, extensively sampled, or gridded information is available. In order to obtain this NEON's temporal sampling strategy must be equally designed to detect and quantify trends over time, as well as characterizing the spatial pattern of those trends. The sampling approach at the field scale, hence, must address the temporal.

3.2 Approach

Sampling strategies must cover a range of temporal scales and must address issues of duration and frequency of sampling activities. The design of the temporal strategy for NEON Aquatics addresses both the duration and frequency of the field activities as well as the small scale but long-term continuous monitoring data collection. In addition, prioritization of the physical, biological and chemical parameters needs to be identified. The general layouts of NEON wadeable stream and lake sites are presented in Section 6.

NEON Aquatics has proposed the following approach in order to determine the sampling duration and frequency that will yield the best estimate of composition and/or concentration of the physical, biological and chemical parameters (Table 1, Table 2).

Physical/Chemical: Flow regime has been identified as the main variable defining the timing and frequency of sampling for the physical and chemical parameters in streams. Air temperature (ice off) has been identified for northern lakes. Air temperature controls the dynamics of ice-on and ice-off events as well as stratification and turnover events.

Biological: Degree-days, water temperature, and riparian greenness are the primary variables identified for defining the timing and frequency of sampling of most biological parameters.

A large number of the sampling protocols are, in addition, constrained by other given variables. The overwhelming constraint for Aquatics is discharge related.

Flow Regime: The characteristic annual flow curves for a given stream.

Discharge: The volume of water flow through a given cross-sectional area per given unit of time.

Sampling modules may also have specific rule sets that dictate the order and timing of collection, as well as time constraints on laboratory work to maintain viable samples. The rule sets below (Table 3, Table 4) have been identified for specific sampling modules.

Table 1. Duration, frequency and prioritization of field activities and long term monitoring for NEON wadeable streams as a function of targeted constraints and driving variables. For associated lab hours, see Appendix A. (*May be scheduled more frequently if a stochastic event significantly alters channel morphology.)

Sampling Module	Sampling Duration (hrs)	Sampling Frequency (x per year)	Constraints on Sampling	Driving Metrics for Sampling	Priority
Sensor Maintenance					
Surface water	1-2	26	Water Temperature Discharge	None	High
Meteorological	1-2	26	Weather	None	High
Groundwater (light)	1-2	26	Weather	None	High
Groundwater (full)	2-4	4	Weather	None	High
Well redevelopment	4	1	Weather	None	High
Physical					
Discharge	1-2	24	Flow	Flow Regime Precipitation	High
Reaeration	4-8	6	Flow	Flow Regime	High
Stream morphology	10-120	1 per 5 yrs*	Discharge Temperature	Flow Regime	Low to Medium
Rapid habitat assessment	4-8	1	Flow	Flow Regime	Medium
Biological					
Surface microbes	2-4	12	Discharge	Flow Regime Water Temperature	High
Aquatic Plants, Bryophytes, Lichens, and Macroalgae	3-8	3	Discharge	Flow Regime Light (PAR)	High
Macroinvertebrates	4	3	Discharge	Flow Regime Water Temperature	High
Periphyton and seston	3	3	Discharge	Flow Regime Light (PAR)	High
Benthic microbes	3	3	Discharge	Flow Regime Riparian greenness	High
Fish	8-40	2	Discharge	Flow Regime Water Temperature	Medium
Riparian habitat assessment	4-8	1	Discharge	Riparian greenness	Low
Chemical					
Surface water chemistry	1-3	26	Discharge	Flow Regime Water Temperature	High
Dissolved gas	1	26	Discharge	Flow Regime Water Temperature	Medium
Isotopes	2	26	Precipitation	Flow Regime Water Temperature	High
Sediment chemistry	4-8	2	Discharge	Flow Regime Water Temperature	Low to medium
Groundwater chemistry	6-20	2	Sufficient Water in Well	Flow Regime	Medium to High

Table 2. Duration, frequency and prioritization of field activities and long term monitoring for NEON lake sites as a function of targeted constraints and driving variables. For associated lab hours, see Appendix A. (*May be scheduled more frequently if a stochastic event significantly alters the lake basin.)

Sampling Module	Sampling Duration (hrs)	Sampling Frequency (x per year)	Constraints on Sampling	Driving Metrics for Sampling	Priority
Sensor Maintenance					
Surface water	1-2	26	Water Temperature Discharge	None	High
Meteorological	1-2	26	Weather	None	High
Groundwater (light)	1-2	26	Weather	None	High
Groundwater (full)	2-4	4	Weather	None	High
Well redevelopment	4	1	Weather	None	High
Physical					
Bathymetry	8-40	1 per 5 yrs*	Wind Ice-off	Riparian greenness	Low to Medium
Biological					
Surface Microbes	2-4	6	Ice-off Wind	Precipitation Water Temperature	High
Aquatic plants and Macroalgae	3-8	3	Ice-off Wind	Precipitation Light (PAR)	High
Macroinvertebrates	3	3	Ice-off Wind	Precipitation Water Temperature	High
Zooplankton	3	3	Ice-off Wind	Precipitation Water Temperature	High
Periphyton and phytoplankton	3	3	Ice-off Wind	Precipitation Light (PAR)	High
~~Fish~~	~~8-40~~	~~2~~	~~Ice-off~~ ~~Wind~~	~~Precipitation~~ ~~Water Temperature~~	~~Medium~~
Riparian habitat assessment	2-4	1	Wind	Riparian greenness	Low
Chemical					
Surface water chemistry	1-3	12	Ice-off Wind	Precipitation Water Temperature	High
Dissolved gas	1	12	Ice-off Wind	Precipitation Water Temperature	Medium
Isotopes	2	12	Ice-off Precipitation	Precipitation Water Temperature	High
Sediment chemistry	4-8	2	Ice-off Wind	Flow Regime Water Temperature	Low to medium
Groundwater chemistry	8-20	2	Sufficient Water in Well	Groundwater Elevation, Seasonal (spring, fall)	Medium to High

Table 3. Rule sets for sampling modules in wadeable streams. Deviations may be allowed with science approval.

Protocol	Rule set
Water chemistry, dissolved gas, and isotopes	Should be completed first to reduce the risk of contamination. However, if completing multiple protocols that could take more than a few hours, collect chemistry samples last to reduce the time between collection and processing/shipping.
	Collect recurrent samples on Tuesdays, when possible.
	Alkalinity/ANC lab processing must begin within 24 hours of collection, or the sample must be flagged.
	If the sensor location cannot be sampled due to drying, ice, etc., collect samples from an alternative location within the permitted reach and report the GPS coordinates and coordinate uncertainty in the field data.
Surface water microbes	Sample in conjunction with recurrent (usually Tuesday) water chemistry.
	Filters must be flash-frozen in the field, and kept frozen until storage in -80 ^{o}C freezer. If processing in the domain lab, freeze at -80 ^{o}C within 4 hours of collection.
	Cell counts must be preserved in the field. Maximum time to preservation if bad weather = 4 hours.
Reaeration	Sediments must not be majorly disturbed 1 hour prior to sampling within the sensor reach. Must complete discharge on days when reaeration is measured.
Aquatic plants, bryophytes, lichens, and macroalgae	Lab processing must begin within 48 hours of collection, or the sample will be flagged. AFDM samples may be dried and placed in desiccators until enough room is available in the muffle furnace.
	If a flood occurs or water returns to a dry channel, wait a minimum of 5 days after water level drops below 3x median discharge to allow for macroalgal recolonization.
	Biomass collection (clip harvest) only occurs during Bout 2.
	Minimize biomass collection within sensor reach.
Macroinvertebrates	If a flood occurs or water returns to a dry channel, wait a minimum of 5 days after water level drops below 3x median discharge to allow for recolonization.
	Must be preserved within 1 hour of collection.
	Preservative change must occur within 12-72 hours of collection.
	Minimize sampling within sensor reach.
Periphyton, seston	If a flood occurs or water returns to a dry channel, wait a minimum of 14 days after the water level drops below 3x median discharge to allow the periphyton community to recolonize.
	Sample in conjunction with benthic microbes.
	Lab processing must begin within 24 hours of collection. AFDM samples may be dried and placed in desiccators until enough room is available in the muffle furnace. Minimum lab processing time spans 2 days.
	Sample must be kept cool (~4 ^{o}C) and dark until processing at the domain lab.
	Chlorophyll filters must be shipped to the external facility within 7 days of collection.
Benthic microbes	If a flood occurs or water returns to a dry channel, wait a minimum of 14 days after the water level drops below 3x median discharge to allow the benthic microbe community to recolonize.
	Sample in conjunction with periphyton.
	Samples must be flash-frozen in the field, and kept frozen until storage in -80 ^{o}C freezer. If processing in the domain lab, freeze at -80 ^{o}C within 4 hours of collection.
Sediment chemistry	If a flood occurs or water returns to a dry channel, wait 5 days before sampling to allow sediments to settle. If water clarity improves and the presence of depositional zones occur in less than 5 days, sediment sampling may resume.
	Start field collection after biology sampling (but before fish) to minimize disturbance.
Fish	Schedule within 2 weeks of macroinvertebrate collection (biology bouts 1 and 3). Contingency situations may cause this time to be greater than 2 weeks.
	In a contingency situation, fish sampling may occur before other biological sampling. A two week recolonization period must be observed after fish and before other biological sampling.
	If a flood occurs, wait a minimum of 3 days after the water level drops below 3x median discharge to allow the fish assemblage to redistribute. If conditions do not allow for fish

	sampling during bout 1, then sample when safe conditions allow up to 2 weeks before the start of bout 2. If conditions do not allow for fish sampling to occur during bout 3, then sample when safe conditions allow up to 30 days beyond the end of bout 3.
	Should be sampled after other biology modules because disturbance to stream bottom is high.
Stream morphology	Stream morphology should occur near baseflow conditions and when the riparian canopy is senesced.
Riparian habitat assessment	Riparian habitat assessment must occur during peak greenness.
Groundwater chemistry	Completed within ± 1 day of water chemistry (contingency situations may necessitate 2 days).
Well redevelopment	Must not occur in the 2 weeks prior to groundwater chemistry sampling.
Discharge	Ensure that wading or other activities in the stream do not interfere with flow or bias discharge measurements during collection.
	A wide range of flow conditions should be targeted for measurement throughout the water year given safety considerations.
Rapid habitat assessment	Occurs between Biology/Sediment Chemistry Bouts 1 and 2, when conditions are safely wadeable and after riparian vegetation has leafed-out.

Table 4. Rule sets for sampling modules in lakes. Deviations may be allowed with science approval.

Protocol	Rule set
Water chemistry, dissolved gas, and isotopes	Should be completed first to reduce the risk of contamination. However, if completing multiple protocols that could take more than a few hours, collect chemistry samples last to reduce the time between collection and processing/shipping.
	Collect recurrent samples on Tuesdays, when possible.
	Alkalinity/ANC lab processing must begin within 24 hours of collection, or the sample must be flagged.
Surface water microbes	Sample in conjunction with recurrent (usually Tuesday) water chemistry.
	Filters must be flash-frozen in the field, and kept frozen until storage in -80 ^{o}C freezer. If processing in the domain lab, freeze at -80 ^{o}C within 4 hours of collection.
	Cell counts must be preserved in the field. Maximum time to preservation if bad weather = 4 hours.
Aquatic plants	Lab processing must begin within 48 hours of collection, or the sample must be flagged. AFDM samples may be dried and placed in desiccators until enough room is available in the muffle furnace.
	Biomass collection (clip harvest) only occurs during Bout 2.
Macroinvertebrates	Must be preserved within 1 hour of collection.
	Preservative change must occur within 12-72 hours of collection.
Zooplankton	Must be preserved with 30 minutes of collection.
Periphyton/Phytoplankton	Lab processing must begin within 24 hours of collection. AFDM samples may be dried and placed in desiccators until enough room is available in the muffle furnace. Minimum lab processing time spans 2 days.
	Sample must be kept cool (~4 ^{o}C) and dark until processing at the domain lab.
	Chlorophyll filters must be shipped to the external facility within 7 days of collection.
Fish	Schedule within 2 weeks of macroinvertebrate collection (biology bouts 1 and 3). Contingency situations may cause this time to be greater than 2 weeks.
	If conditions do not allow for fish sampling during bout 1, then sample when safe conditions allow up to 2 weeks before the start of bout 2. If conditions do not allow for fish sampling to occur during bout 3, then sample when safe conditions allow up to 30 days beyond the end of bout 3.
Sediment chemistry	Start field collection after non-fish biological sampling to minimize disturbance.
Bathymetry	Bathymetry occurs every 5 years unless extreme events warrant more frequent surveys.
	Bathymetric mapping occurs at peak greenness, during Bio Bout 2 or within ± 2 weeks of aquatic plant sampling.
Riparian habitat assessment	Riparian habitat assessment must occur during peak greenness.
Groundwater Chemistry	Completed within ±1 day of water chemistry (contingency situations may necessitate 2 days).
Well redevelopment	Must not occur in the 2 weeks prior to groundwater chemistry sampling.

4 SAMPLING DATES

The surface water sampling strategy for D18 Oksrukuyik Creek is based on hydrological data collected from the USGS hydrological monitoring location 2.7 km downstream of the NEON site. However, the sampling strategy may not accurately represent the hydrologic condition each year at the NEON site, and will need to be updated following annual data collections. Domain 18 staff needs to have the leeway to adjust sampling dates based on actual site conditions (e.g., ice on/ice off conditions).

The surface water sampling strategy for D18 Toolik Lake is based on annual air temperature data collected from NOAA National Climatic Data Center (NCDC) and from the near-real time NEON data collected at the meteorological stations. Because Toolik Lake is ice-covered throughout part of the year, surface water samples can be taken on a semi-monthly basis combined with more intensive sampling around ice-on and ice-off, while organismal sampling is based on accumulation of growing degree days throughout the season.

The following Tables and Figures indicate proposed sampling dates for all sample protocols to be undertaken at Domain 18 over the course of a year.

4.1 Sensor Maintenance

Sensor preventative maintenance for in-lake/river sensors and the meteorological station is scheduled every other week. Groundwater well maintenance includes light sensor maintenance every other week (confirm that the cables have not slipped, check for ice accumulation on the solar panel, remotely monitor the data stream), full maintenance quarterly (visually inspect the sensor, check the desiccant, check water clarity with bailers, check for roots in wells known to have that issue), and well redevelopment once per year. Additional details may be found in the preventative maintenance documents for each sensor and the lake buoys (RD[17]).

4.2 Surface and Groundwater Chemistry Sampling Dates

Water chemistry includes sampling for water chemistry, aquatic stable isotopes, and dissolved gas in surface waters. At Toolik Lake, these three protocols should be completed on the same day as each other.

4.2.1 Surface Water Chemistry Sampling Dates –OKSR

Standard recurrent sampling should take place one Tuesday per month, 12 times per year, in coordination with atmospheric chemistry sampling. At OKSR, samples are not collected during the winter months when the stream is frozen to the substrate, dates may be made up during the unfrozen portion of the year. The remaining 14 samples should be taken based on the cumulative discharge of the stream representing the increasing and decreasing periods of annual peak flow (Table 5, Figure 1). The 14 samples should be collected within 2-3 days of all proposed sampling dates, when possible. If circumstances dictate that you have to miss one of your flow-weighted sampling events and cannot reschedule within the 2-3 day window, you may re-schedule another sampling event up to 14 days from the proposed date. If one of the 14 flow-weighted samples falls on the same day (± 2 days) as a monthly Tuesday sample, adjust the flow-weighted sample by ± 7 days.

Account for missed sampling events during zero-flow (frozen) periods by adding weekly water sample collections to the schedule once the flow has returned. Continue with weekly water samples until the number of samples missed is equal to the number of weekly samples collected. Total sample numbers should not exceed 26 times per year.

Given the short sampling window in the arctic, NEON Science suggests that Oksrukuyik Creek stream water chemistry samples should be collected weekly (i.e., every Tuesday).

Table 5. Proposed stream water chemistry sampling dates for D18 Oksrukuyik Creek for the 14 samples collected to reflect the discharge related strategy. Due to short sampling season and shipping constraints, OKSR water chemistry may occur once per week.

OKSR Proposed sampling date
May 22
May 27
June 3
June 8
June 13
June 26
July 8
July 19
July 30
August 8
August 15
August 22
September 1
September 11

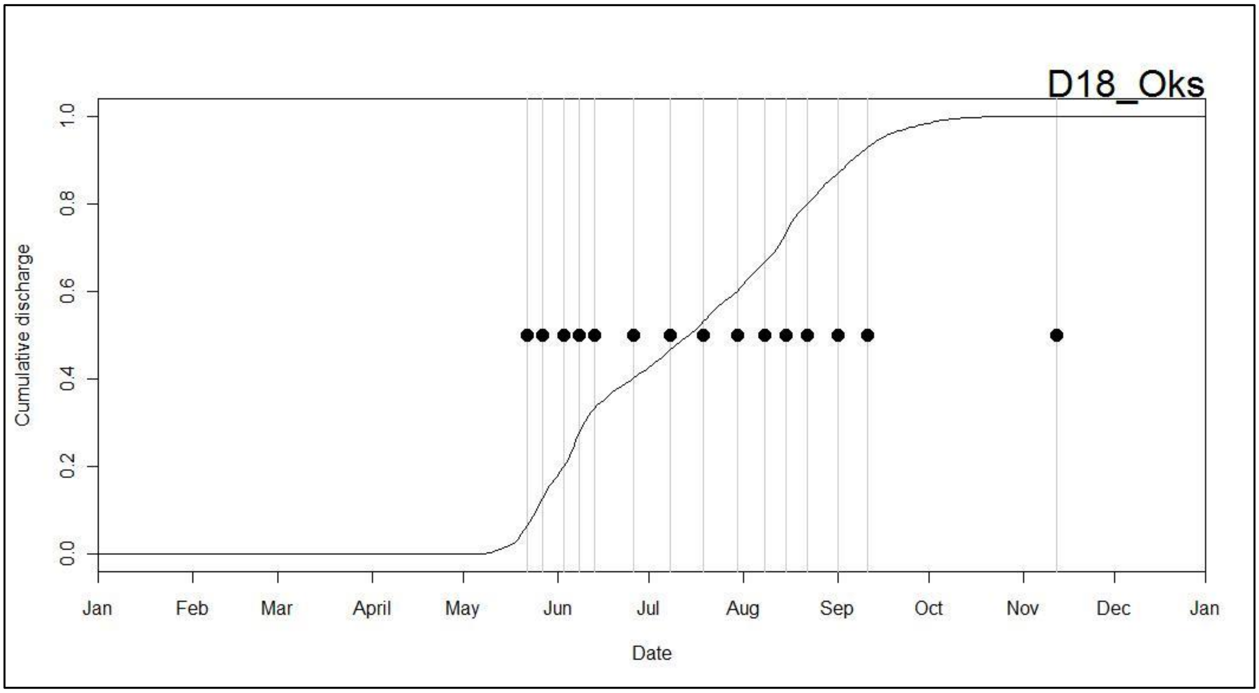

Figure 1. Timing of sample collection for 14 water chemistry samples reflecting the discharge related strategy for Oksrukuyik Creek.

4.2.2 Surface Water Chemistry Sampling Dates – TOOK

Alkalinity and ANC titrations: Following a minimum of a year of alkalinity and ANC titrations at lake inflow, center (buoy), and outflow, it was determined that no significant difference existed between the three lake locations. Thus, we will only complete alkalinity and ANC titrations from the buoy location.

Standard recurrent sampling should take place 12 times per year, generally on the first Tuesday of the month starting on the first Tuesday of February, in coordination with TIS chemistry sampling and other national programs to enable standardization. If you cannot sample all sites on the same day, prioritize the core site for Tuesday sampling and sample the other site the following day or, if necessary, the following Tuesday.

Because these sites experience sustained winter temperatures below 0 °C, sampling will be less frequent than once monthly during the winter months and more frequent than once monthly around the shoulder periods (spring, fall) when turnover occurs in the lake, coinciding with ice-on and ice-off dates (Table 6). Ice-off can be evaluated remotely by monitoring the staff gauge camera feed at the domain support facility. Ice-off in lakes is defined by the first loss of ice from the center of the lake in the spring. Ice-on in lakes is defined by the first ice coverage of the central part of the lake in the fall.

Ice-off sampling strategy: One sample bout should occur one month prior to the long-term average of ice off conditions. The following sampling should occur within 1 week (maximum 2) of ice-off conditions assuming safe conditions allow access to the water body.

Ice-on sampling strategy: One sample should occur 2 weeks prior to the long-term ice-on averages for the region. Safe conditions for access to the lake must be met. The following sampling bout should occur 2 months after long-term ice-on averages for the region. Safe conditions require a minimum of 6" of ice to be able to safely access the lake for sampling.

Table 6. Proposed stream water chemistry sampling dates for D18 Toolik Lake. Dates are estimated based on available local data and may shift based on actual site conditions.

TOOK Bout	Date
1	First Tuesday of February
2	First Tuesday of March
3	First Tuesday of April
4	First Tuesday of May
5	First day of ice off (estimated between June 1 and July 1, assuming safe conditions)
6	1 week following ice off sampling, between June 1 and July 15
7	First Tuesday of July
8	First Tuesday of August
9	First Tuesday of September
10	First Tuesday of October (assuming safe conditions)
11	First Tuesday of November (assuming safe conditions)
12	First Tuesday of December (assuming safe conditions)

4.3 Groundwater Chemistry Sampling Dates – OKSR, TOOK

Groundwater chemistry includes sampling for water chemistry and aquatic stable isotopes (2H and 18O-H2O only). These protocols should be completed on the same day as each other.

Groundwater samples will be collected twice per year from a subset of 4 wells per (Table 7). The wells will be specified prior to sampling and will remain the same between bouts. At OKSR, the four sampling wells are selected in attempt to cover all of the following categories: upstream, downstream, right bank, and left bank. Preference is also given to wells that are closer to the surface water chemistry sampling locations. This strategy enables the study of surface-groundwater interaction in the hyporheic zone and allows for more direct comparison to surface water chemistry data. At TOOK, two wells are sampled on the inlet side, and two on the outlet side of the lake. This will allow for chemical comparisons at opposite ends of the regional flow paths in addition to lake surface water samples.

Sampling will occur during four week windows representing early and late season active layer thaw. The thaw season is bounded by historical dates of initial and maximum active layer thaw. Dates are summarized in Table 8 below. Groundwater sampling should be timed to occur on the same day (preferred) or within 1-2 days (preferably 1 day) of the surface water collection. Dates will be refined after the first few years of site-specific water table data are available for analysis.

Table 7. Groundwater Observation Wells at D18 Oksrukuyik Creek and Toolik Lake. **Wells for groundwater chemistry sampling are denoted in bold text.**

OKSR Well ID	Latitude	Longitude
D18-OKSR-OW-01	68.669007	-149.146389
D18-OKSR-OW-02	68.668872	-149.147801
D18-OKSR-OW-03	**68.668764**	**-149.143506**
D18-OKSR-OW-04	68.668642	-149.146458
D18-OKSR-OW-05	**68.668708**	**-149.150487**
D18-OKSR-OW-06	68.670418	-149.144896
D18-OKSR-OW-07	**68.669267**	**-149.150933**
D18-OKSR-OW-08	**68.669952**	**-149.143670**
TOOK Well ID	**Latitude**	**Longitude**
D18-TOOK-OW-01	**68.624835**	**-149.594024**
D18-TOOK-OW-02	**68.625116**	**-149.596071**
D18-TOOK-OW-03	68.631685	-149.623795
D18-TOOK-OW-04	68.633546	-149.631605
D18-TOOK-OW-05	68.632421	-149.590086
D18-TOOK-OW-06	68.637091	-149.592222
D18-TOOK-OW-07	**68.640447**	**-149.595136**
D18-TOOK-OW-08	**68.640713**	**-149.597051**

Table 8. Proposed groundwater chemistry sampling dates for D18 Oksrukuyik Creek and Toolik Lake.

OKSR Well Bout	Start Date	End Date
1	July 1	July 28
2	August 5	September 1
TOOK Well Bout	**Start Date**	**End Date**
1	July 1	July 28
2	August 5	September 1

4.4 Discharge and Reaeration Sampling Dates – OKSR and TOOK inlet/outlet

Discharge should be collected at both OKSR and TOOK inlet and outlet. Stream discharge must be measured at aquatic sites with wadeable streams a minimum of twenty-four (24) times in order to establish a stage-discharge rating curve (SDRC) followed by twelve (12) times per year to validate and refine the rating. Due to freezing of the inlet/out at TOOK, the 24 discharge measurements will have to be distributed throughout the period of running water. After the first year of sampling, the SDRC will be reviewed and approved by NEON Science. If the SDRC is not approved by Science, then Science will request that field operations staff schedule additional sampling bouts to fill in data gaps needed to improve the SDRC.

Discharge should be conducted when it is safe to wade in the stream. Once a discharge-rating curve is established, discharge conditions will be targeted to fill in underrepresented points along the rating curve. Discharge sampling requirements will represent annual flow conditions and be constrained by zero-flow days.

Reaeration measurements should initially be completed 10x/year and then 6x/year thereafter, in conjunction with discharge measurements. Sites that are high risk sites for flooding resulting in changes in stream morphology may be requested to continue to collect reaeration 10x/year. Sampling events should be spread out throughout the year so as to collect a range of flows. Reaeration measurements may be completed more frequently (up to 10x/year) if major changes in stream flow alter reaeration parameters and a new curve must be established. Discharge must be completed on the same day that reaeration is conducted.

Do not schedule discharge or reaeration during time periods when the stream is known to freeze over or freeze solid. If reaeration and discharge are scheduled and the stream is frozen, the sampling event(s) will need to be moved in the schedule.

4.5 Biology Bout, Sediment Chemistry Sampling, and Riparian Assessment Dates

The biology bout windows for wadeable streams and lakes are based on a combination of parameters at each site. Using USGS streamflow data from nearby "proxy" sites (OKSR only), mean daily air temperature (NOAA NCDC [NCEI] datasets) to calculate growing degree days (centering around 10%, 50%, and 90% gdd) and the MODIS dataset to estimate riparian greenness (green-up and brown-down; Figure 2, Figure 3), 1 month sampling windows were pre-determined for all sites. Sampling windows may be adjusted for stream flow (OKSR) and ice on/ice off dates as all biological sampling (except for surface water microbes) is based on actual conditions at the site. Biology Bout 1 is especially susceptible to changes at sites dominated by snowmelt in the spring. Bout dates may be adjusted after consultation with NEON science at sites affected by snowmelt. The riparian assessment will be conducted during the site-specific peak greenness window defined by the MODIS dataset which may or may not coincide with the biological and sediment sampling bout dates (Table 9).

4.5.1 Oksrukuyik Creek

- Surface water microbes in wadeable streams should be sampled in conjunction with the standard recurrent water chemistry sampling, once per month, 12 times per year.
    - NOTE: At OKSR, surface water microbe samples may be combined with flow-weighted surface water chemistry as well as monthly recurrent water chemistry in order to fit 12 samples into the ice-free period.
    - Surface water DNA microbe samples collected during July should be marked for metagenomics analysis.
- Sampling for all other biological modules (aquatic plants/macroalgae, macroinvertebrates, seston/periphyton) follow pre-determined sampling windows presented in Table 9. Sediment chemistry and Fish are sampled twice per year during Bouts 1 and 3.
    - The biology/sediment chemistry bout windows may be adjusted to start 3 days earlier or and/or end 3 days later than the dates listed in Table 9 to allow for more flexibility in

scheduling. Any sampling outside of the bout window plus the 3-day buffer will require an entry in NEON's problem-tracking system.
  - Sampling for each module at a site must occur within one day, with the exception of fish which may take up to 5 days at a site.
  - Benthic microbe samples collected during Bout 2 should be marked for metagenomics analysis.
  - If weather or flooding dictates changes to the sampling schedule, the following contingencies may be applied:
    - Periphyton/phytoplankton, benthic microbes, aquatic plants, macroinvertebrates, and sediment chemistry sampling may be pushed later following flooding criteria Table 3.
    - Sediment chemistry may be moved ahead of periphyton sampling as long as a 14 day re-colonization period is allowed prior to periphyton collection.
    - All biology/sediment chemistry and Bout 1 fish sampling may occur up to 2 weeks prior to the start date of the next sampling bout.
  - Bout 3 fish sampling may occur up to 30 days past the end of the Bout 3 window, if conditions allow (i.e., flowing water is present and it is safe to sample). Fish sampling should be scheduled within the bout windows, however sampling may be pushed later using this contingency as weather dictates.
- The riparian habitat assessment will occur within the dates provided in Table 9.
- The rapid habitat assessment (an SOP in the Wadeable Stream Morphology protocol) should take place between Bouts 1 and 2 to allow for water to resume to near-baseflow conditions and allow riparian areas to green-up.
  - If a stream morphology survey has recently occurred (within the same year), contact science to confirm that the rapid habitat survey is necessary.

Table 9. Proposed Biological sampling windows for D18 Oksrukuyik Creek. Fish sampling and Sediment Chemistry will take place during Bouts 1 and 3. The riparian habitat assessment peak greenness window may not coincide with the bout windows.

OKSR Bio Bout	Start Date	End Date
1	May 21	June 18
2	June 29	July 27
3	August 7	September 4
Riparian	June 12	August 7

4.5.2 Suggested Biology and Sediment Chemistry Bout – OKSR

1. Aquatic plants, macroinvertebrates, periphyton/benthic microbes (in any order)
2. Sediment chemistry (Bouts 1 and 3 only)
3. Fish (Bouts 1 and 3 only)

a. Fish sampling may be adjusted to occur prior to other biological sampling due to grayling migration during Bout 3.

4.5.3 Other Biology Sampling – OKSR

- Surface water microbes – with Tuesday water chemistry bouts, distribute 12 sampling days throughout the ice-free part of the year
- The riparian habitat assessment can be scheduled anytime within the peak greenness window
- Rapid habitat assessment should be completed between Bouts 1 and 2 if flow conditions allow

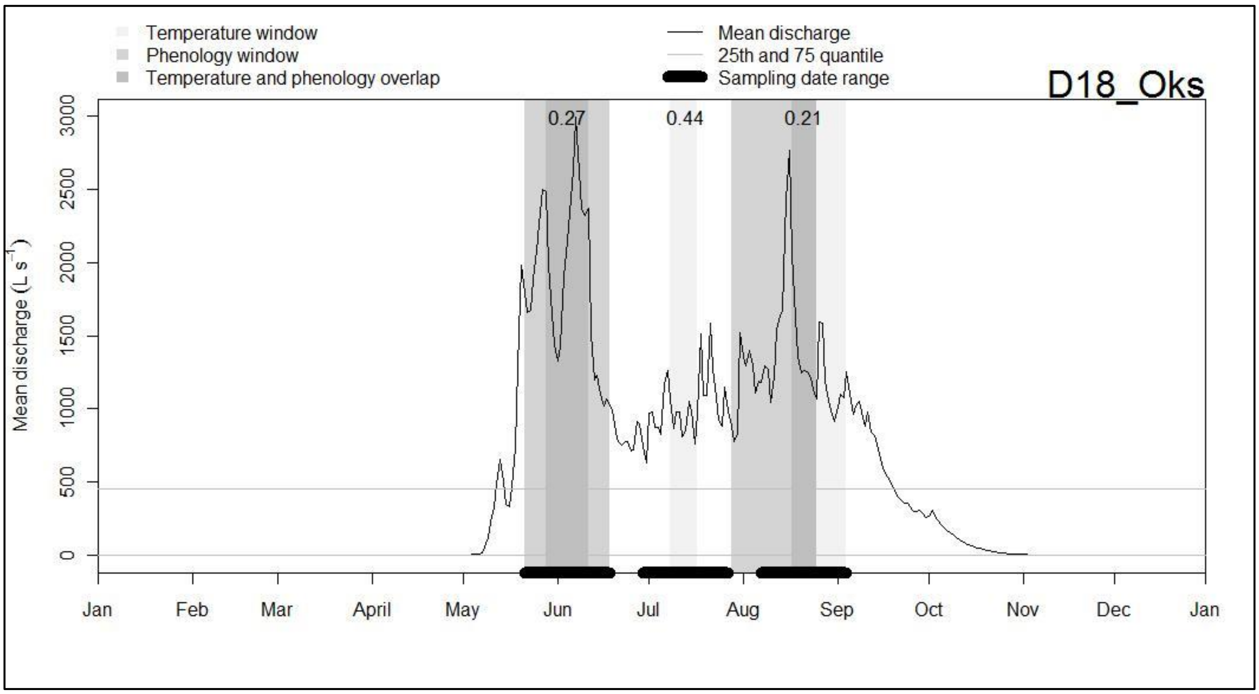

Figure 2. Proposed bouts for biological sampling at Oksrukuyik Creek. Sediment chemistry and fish sampling occur during Bouts 1 and 3.

4.5.4 Toolik Lake

- Surface water microbes in lakes should be sampled in conjunction with the standard recurrent water chemistry sampling, every other month, 6 times per year. If water chemistry sample timing fluctuates due to ice on/ice off dates, sample on every other water chemistry sampling date.
    - Surface water DNA microbe samples collected during July or August should be marked for metagenomics analysis.
- Sampling for all other biological modules (aquatic plants/macroalgae, macroinvertebrates, zooplankton, phytoplankton/periphyton) as well as sediment chemistry, follow pre-determined

sampling windows presented in Table 9. Sediment chemistry and Fish are sampled twice per year during Bouts 1 and 3.

- The biology/sediment chemistry bout windows may be adjusted to start 3 days earlier or and/or end 3 days later than the dates listed in Table 10 to allow for more flexibility in scheduling. Any sampling outside of the bout window plus the 3-day buffer will require an entry in NEON's problem-tracking system.
- Sampling for each module at a site must occur within one day, with the exception of bathymetry and fish which may take up to 5 days at a site.
- Bout 3 fish sampling may occur up to 30 days past the end of the Bout 3 window, if conditions allow (i.e., flowing water is present and it is safe to sample). Fish sampling should be scheduled within the bout windows, however sampling may be pushed later using this contingency as weather dictates.

- The riparian habitat assessment will occur within the dates provided in Table 10.

The Toolik Lake biology/sediment chemistry dates have been adjusted from the standard sample strategy rules, based on ice-off and ice-on dates recorded since 2000 at the Toolik Field Station (Toolik Field Station Environmental Data 2017). Bout 1 starts at the average ice off date recorded between 2000-2016, each bout contains 28 days, and there are 10 off days between bouts. Bout 3 has been adjusted taking into account the >0% ice cover and 100% ice cover data provided by the Toolik Field Station environmental staff (Table 10). Depending on the year, sampling during bout 3 may be cut short by an early ice-on date. At northern lakes where ice on/ice off dates are a consideration, consider the suggested sampling bouts a guideline. Sample within the windows provided below if possible. On years where the ice off date is later than the start of Bout 1, adjust the window to 1 month after the date of actual ice off for sampling. At D18 TOOK, because bout windows are close together, all bouts may be adjusted with the guidance of science.

Table 10. Proposed Biological sampling windows for D18 Toolik Lake. Sediment chemistry and fish sampling will take place during Bouts 1 and 3. The riparian habitat assessment peak greenness window may not coincide with the bout windows.

TOOK Bio Bout	Start Date	End Date
1	June 19	July 17
2	July 27	August 24
3	September 3	October 1
Riparian	June 13	August 8

4.5.5 Suggested Biology and Sediment Chemistry Bout – TOOK

1. Aquatic plants, macroinvertebrates, periphyton/phytoplankton, zooplankton (in any order)
    a. Secchi/Depth profile data collection must also occur on days when phytoplankton and zooplankton are sampled.
2. Sediment chemistry (Bouts 1 and 3 only)

3. Fish (Bouts 1 and 3 only)
    a. Fish sampling may be adjusted to occur prior to other biological sampling due to grayling migration during Bout 3.

4.5.6 Other Biology Sampling

- Surface water microbes – 1st water chemistry bout of every-other month (likely Tuesday)
    - If sampling does not occur monthly due to frozen conditions, distribute 6 sample dates across the year.
- Bathymetry – schedule within ± 2 weeks of Bout 2 aquatic plant sampling
    - Occurs every 5 years unless morphology changes significantly due to an extreme event
- The riparian habitat assessment can be scheduled anytime within the peak greenness window

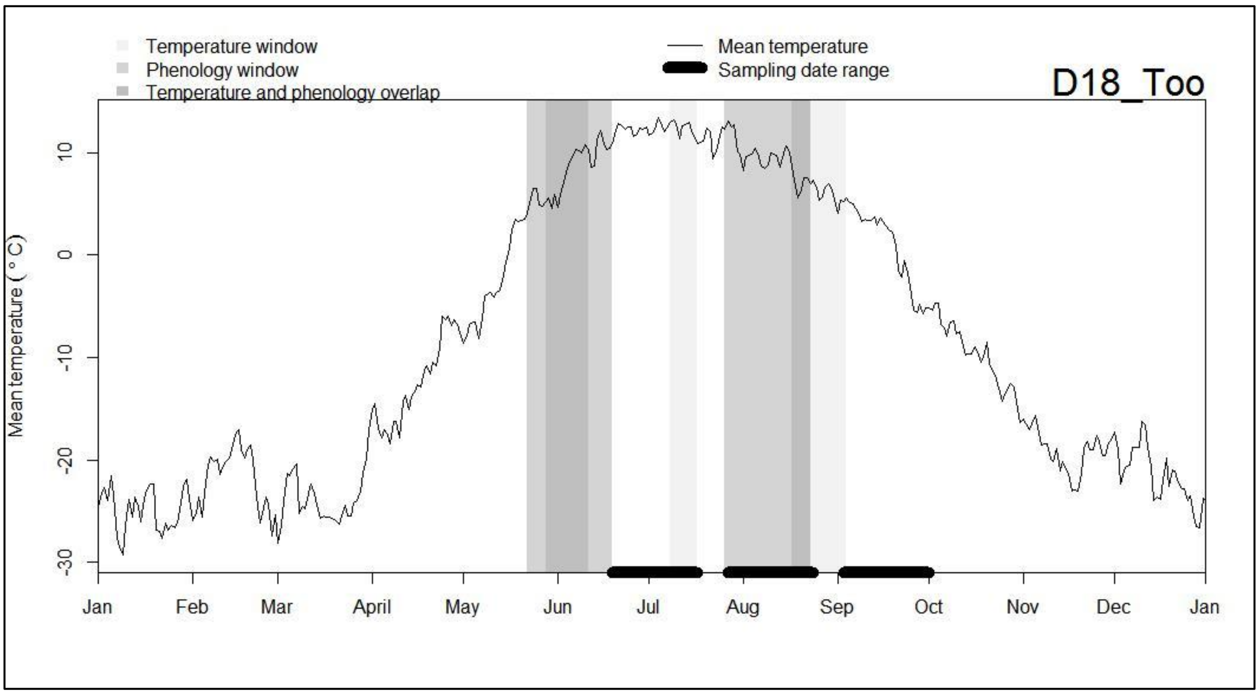

Figure 3. Proposed bouts for biological sampling in D18 Toolik Lake. Sediment chemistry and fish sampling occurs during Bouts 1 and 3. Bouts lag behind warming air temperature because ice on the lake takes longer to melt at this latitude.

5 PROTOCOL DISTURBANCE AND PRIORITIZATION

5.1 Disturbance Criteria

Each aquatic protocol has its own unique sensitivity to disturbance and perturbations (Table 11, Table 12). These sensitivities should dictate the order in which protocols are completed.

Table 11. Disturbance criteria for streams. Impact level: high (4), medium/high (3), medium/low (2), low (1), none (0). The morphology reach is the entire permitted reach (usually 1 km long). The sensor reach is the length of stream between S1 and S2.

Sample	Requirements	Impact Level	Disturbance
Sensor maintenance	None	0	Wading near sensor sets
Discharge	None	1	Wading only at *established cross-sections*
Reaeration	2 days - no major substrate disturbance, 1 hour with no disturbance to stream	0	Salt/SF6 addition to *sensor reach*
Stream morphology	None	4	Wading through and displacing rocks in *morphology reach* (H)
Aquatic plants	5 days- no scouring or trampling of substrate; low turbidity during sampling	3	Wading and collection at established cross-section transects
Invertebrates	5 days- no scouring or trampling of substrate	3	Wading and disturbance of substrate in *morphology reach*
Periphyton, seston, and benthic microbes	2 weeks- no scouring or trampling of substrate	2	Wading and substrate disturbance in *morphology reach*
Sediment chemistry	1 week- no physical disturbance to depositional zones	2	Wading and substrate disturbance in *morphology reach*
Fish	6 hours- no disturbance that causes turbid conditions	4	Wading extensively throughout *morphology reach*
Surface water chemistry, dissolved gas, isotopes, and surface microbes	Allow stream to clear before sampling minutes, no wading upstream	1	Wading *above S2*
Groundwater chemistry	None	0	Groundwater Removal
Riparian habitat assessment	None	2	Wading and substrate disturbance in *morphology reach*
Rapid habitat assessment	None	2	Wading and substrate disturbance in *morphology reach*

Table 12. Disturbance Criteria for lake sampling. Impact level: high (4), medium/high (3), medium/low (2), low (1), none (0). Bathymetry/morphology spans the entire permitted area. Sensors are located at the deepest point in the lake, and near the lake inlet and outlet.

Sample	Requirements	Impact Level	Disturbance
Sensor maintenance	None	1	Boat activity near sensor locations
Bathymetry	None	1	Boat activity throughout lake
Aquatic plants	None	3	Benthic collection at randomized points throughout the lake
Invertebrates	None	3	Benthic collection near water chemistry sampling sites and wading and substrate disturbance near shore
Zooplankton	6 hours- no disturbance that causes turbid conditions	2	Boat activity near sensor locations
Periphyton and phytoplankton	6 hours- no disturbance that causes turbid conditions	2	Wading and substrate disturbance near shore, boat activity near sensor locations
Sediment chemistry	None	4	Boat activity and benthic disturbance near sensor locations
Fish	6 hours- no disturbance that causes turbid conditions	4	Boat activity and wading nearshore.
Surface water chemistry, dissolved gas, isotopes, and surface microbes	None	1	Boat activity near sensor locations
Groundwater chemistry	None	0	Groundwater Removal
Riparian habitat assessment	None	2	Boat activity and substrate disturbance nearshore

6 SPATIAL SAMPLING STRATEGY

6.1 General Site Sampling Locations

The stream sampling reach is ideally 1000 (± 50) m long. Locations provided in the "proposed" columns in Table 13 and Table 14 are estimates. Field personnel should measure the 1000 m reach, taking care to stay within the permitted boundaries of the site and record coordinates. Specific coordinates at each site will be used for the life of the site.

Stream sampling protocols reference several locations within the site, including the sensor locations for the aquatic site (S1, S2). Other locations provided to the field ecologists include the location of the streamside meteorological station and riparian transects. Benthic biological samples may be taken throughout the entire sampling reach, with locations chosen by the field ecologists at the time of sampling (). Minimize benthic sampling in the sensor reach if possible (i.e., no more than 3 replicates for any benthic sampling module).

Lake sampling protocols reference several locations within the lake, including the buoy (or center) location, the inlet sensor, and the outlet sensor (i.e., water chemistry, isotopes, dissolved gas, surface water microbes, phytoplankton, zooplankton protocols). Lake sites are also divided into 10 sections divided by the riparian bank locations (Figure 5), which are used when sampling macroinvertebrates, periphyton, and the riparian habitat assessment. Locations provided in the "proposed" columns in Table 15 and Table 16, are estimates. Specific coordinates at each site will be used for the life of the site.

See Table 13 and Table 14 for module-specific sampling locations and rules sets, and Figure 4 and Figure 5 for the generic site layouts.

Table 13. Module-specific sampling locations, wadeable streams. *May occur at an alternate location if necessary

Sampling module	Location
Surface water chemistry*	S2 and groundwater wells
Dissolved gas*	S2
Isotopes*	S2 and groundwater wells
Surface water microbes*	S2
Seston*	S2
Discharge	Location chosen by field ecologists/HQ, return to transect unless morphology or flow changes significantly
Reaeration	Injection site upstream of S1, 4 sampling stations spread evenly between S1 and S2
Riparian habitat assessment	Transects determined by HQ and provided to domain staff
Benthic microbes	Same location as periphyton samples
Periphyton	Locations determined by field ecologists within habitat types determined by morphology map; locations may vary from bout to bout
Aquatic plants, bryophytes, lichens, and macroalgae	Transects determined on first sampling bout by field ecologists; return to transects on subsequent bouts
Macroinvertebrates	Locations determined by field ecologists within habitat types determined by morphology map; locations may vary from bout to bout
Fish	Full 1 km permitted reach. Reaches determined on first sampling bout by field ecologists; return to reaches on subsequent bouts

Sampling module	Location
Sediment chemistry	Two 250 m stations are established with in the 500 m sediment sampling reach. Sediment is collected from depositional zones within each station which may change bout to bout
Groundwater wells	Locations determined by HQ
Rapid habitat assessment and Stream morphology	From BOT to TOP marker (1 km sampling reach)

Table 14. Module-specific sampling locations, lakes.

Sampling module	Location
Surface water chemistry	Buoy and groundwater wells
Dissolved gas	Buoy
Isotopes	Buoy and groundwater wells
Surface water microbes	Buoy
Phytoplankton	Buoy, lake inlet sensor (adjusted in-lake location for bio sampling), lake outlet sensor (adjusted in-lake location for bio sampling)
Riparian habitat assessment	Sections determined by HQ and provided to domain staff
Periphyton	In riparian sections, exact location determined by field ecologists
Aquatic plants, bryophytes, and macroalgae	10 randomized points
Macroinvertebrates (ponar)	Buoy, lake inlet sensor (adjusted in-lake location for bio sampling), lake outlet sensor (adjusted in-lake location for bio sampling)
Macroinvertebrates (sweep)	In riparian sections, exact location determined by field ecologists
Zooplankton	Buoy, lake inlet sensor (adjusted in-lake location for bio sampling), lake outlet sensor (adjusted in-lake location for bio sampling)
Sediment chemistry	Buoy, lake inlet sensor (adjusted in-lake location for bio sampling)
Groundwater wells	Locations determined by HQ
Bathymetry	Whole lake

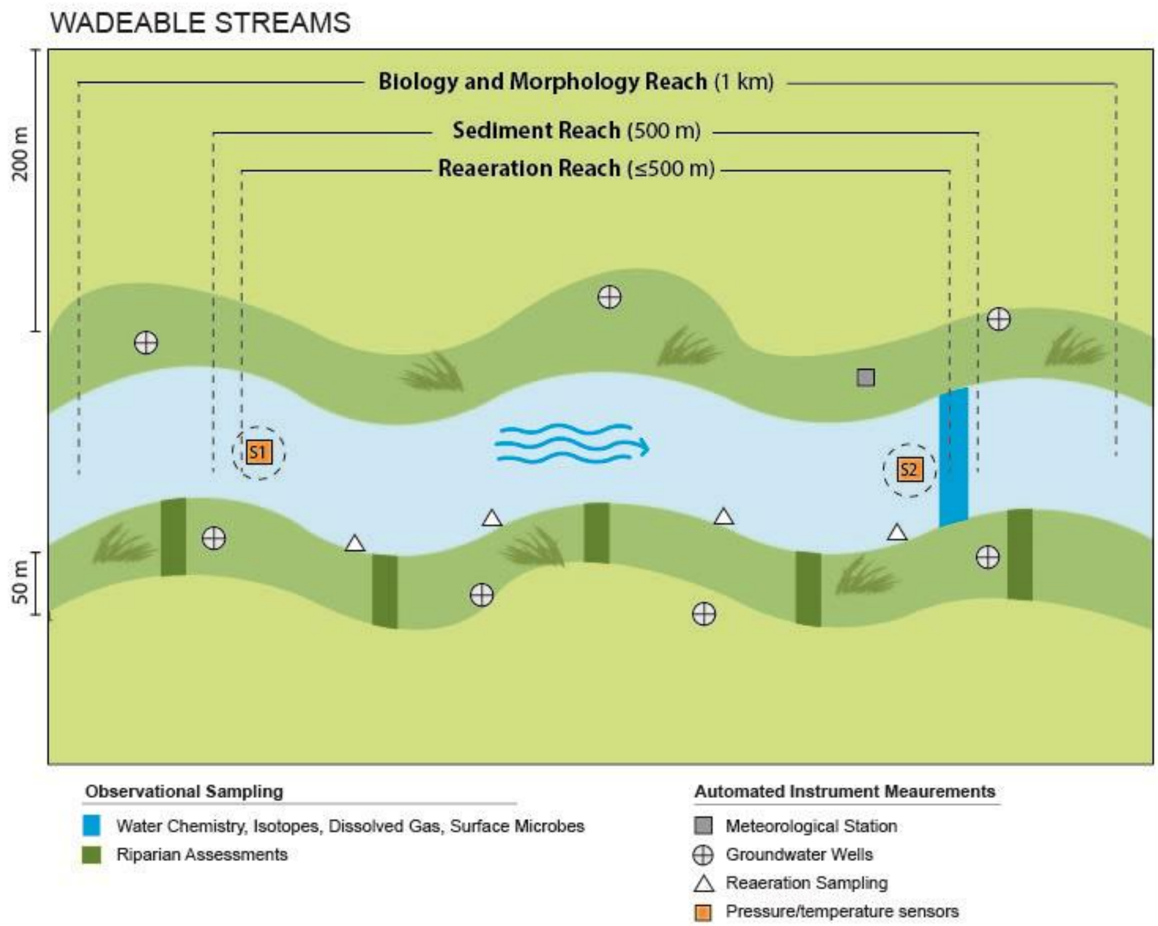

Figure 4. Generic diagram for an AQU site showing sampling locations in a wadeable stream system. Note: the sensor locations are not typically installed as depicted; sediment stations 1 and 2 are divided by the biological reach center not the midpoint between sensors.

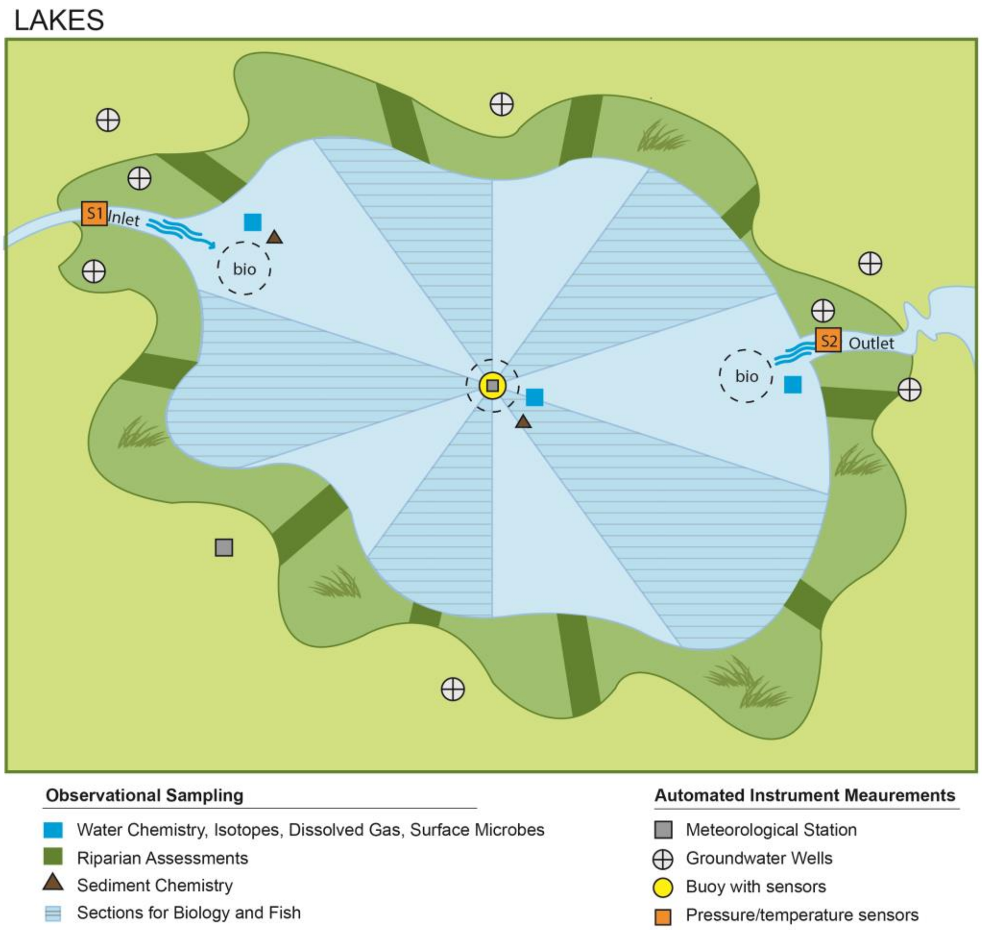

Figure 5. General diagram for an AQU site showing sampling locations in a lake system. TOOK has a true inlet and outlet stream where discharge measurements are collected, while littoral biology samples associated with the inlet and outlet are collected in the lake itself.

Table 15. OKSR Sampling Locations. Proposed coordinates are determined prior to sampling at HQ. Coordinates are groundtruthed by Field Science in the field and reported to Science. If available in the table, Field Science coordinates should be used for sampling.

Location ID	***Description***	***Proposed Latitude***	***Proposed Longitude***	***Field Sci Latitude***	***Field Sci longitude***
01 - Riparian	Riparian coordinates*	68.671425	-149.137113	68.671425	-149.137113
02 - Riparian	Riparian coordinates*	68.670861	-149.138871	68.670861	-149.138871
03 - Riparian	Riparian coordinates*	68.670380	-149.140773	68.670380	-149.140773
04 - Riparian	Riparian coordinates*	68.669582	-149.141506	68.669582	-149.141506
05 - Riparian	Riparian coordinates*	68.669741	-149.143447	68.669741	-149.143447
06 - Riparian	Riparian coordinates*	68.669082	-149.144650	68.669082	-149.144650
07 - Riparian	Riparian coordinates*	68.669268	-149.146910	68.669268	-149.146910
08 - Riparian	Riparian coordinates*	68.668995	-149.149249	68.668995	-149.149249
09 - Riparian	Riparian coordinates*	68.668819	-149.151113	68.668819	-149.151113
10 - Riparian	Riparian coordinates*	68.668606	-149.153108	68.668606	-149.153108
permitted top	Top of permitted reach**	68.668465	-149.154285		
permitted bottom	Bottom of permitted reach**	68.672284	-149.134532		
TOP	Top of sampling reach***	68.668465	-149.154285	68.668465	-149.154285
BOT	Bottom of sampling reach***	68.671735	-149.136263	68.672284	-149.134532
S1	S1 sensor location from SCR	68.669017	-149.149939		
S2	S2 sensor location from SCR	68.669669	-149.143497		
Discharge	Discharge location, decided by Field Science			68.669669	-149.143497

*Riparian coordinates should be approximately evenly spaced throughout the sampling reach, approximately every 100 m starting 50 m from the top and bottom of the sampling reach.
**Do not sample outside of this boundary
***Should be 1000 m unless permitting restricted

Table 16. TOOK Sampling Locations. Proposed coordinates are determined prior to sampling at HQ. Coordinates are groundtruthed by Field Science in the field and reported to Science. If available in the table, Field Science coordinates should be used for sampling.

Location ID	*Description*	*Proposed Latitude*	*Proposed Longitude*	*Field Sci Latitude*	*Field Sci longitude*
01 - Riparian	Riparian coordinates*	68.625308	-149.599532	68.625308	-149.599532
02 - Riparian	Riparian coordinates*	68.627900	-149.612434	68.627900	-149.612434
03 - Riparian	Riparian coordinates*	68.631912	-149.622009	68.631912	-149.622009
04 - Riparian	Riparian coordinates*	68.633800	-149.630790	68.633800	-149.630790
05 - Riparian	Riparian coordinates*	68.635193	-149.614877	68.635193	-149.614877
06 - Riparian	Riparian coordinates*	68.637359	-149.606125	68.637359	-149.606125
07 - Riparian	Riparian coordinates*	68.640035	-149.597700	68.640035	-149.597700
08 - Riparian	Riparian coordinates*	68.636834	-149.591490	68.636834	-149.591490
09 - Riparian	Riparian coordinates*	68.633014	-149.589370	68.633014	-149.589370
10 - Riparian	Riparian coordinates*	68.629038	-149.591704	68.629038	-149.591704
Inlet – bio/sed chem	Inlet bio/sed chem sampling location from FOPS			68.62546	-149.5986
Outlet – bio/sed chem	Outlet bio/sed chem sampling location from Field Science			68.640417	-149.595717
Inlet	Inlet sensor location from SCR	68.625739	-149.597241	65.625565	-149.595237
Outlet	Outlet sensor location from SCR	68.640690	-149.594909	68.640667	-149.59373
S1	S1 sensor location from TT Visit	68.630699	-149.611405		

*Riparian coordinates should be approximately evenly spaced throughout the sampling area

6.2 Site-Access and Instrument Locations

NEON sites will be visited by field ecologists on a regular basis. To protect the environment near sites, several access points have been established to minimize local disturbance over the life of the project for locations that are accessed frequently (e.g., sensors; Figure 6, Figure 7). Field ecologists must use established paths and access points when possible to avoid causing disturbance to the site.

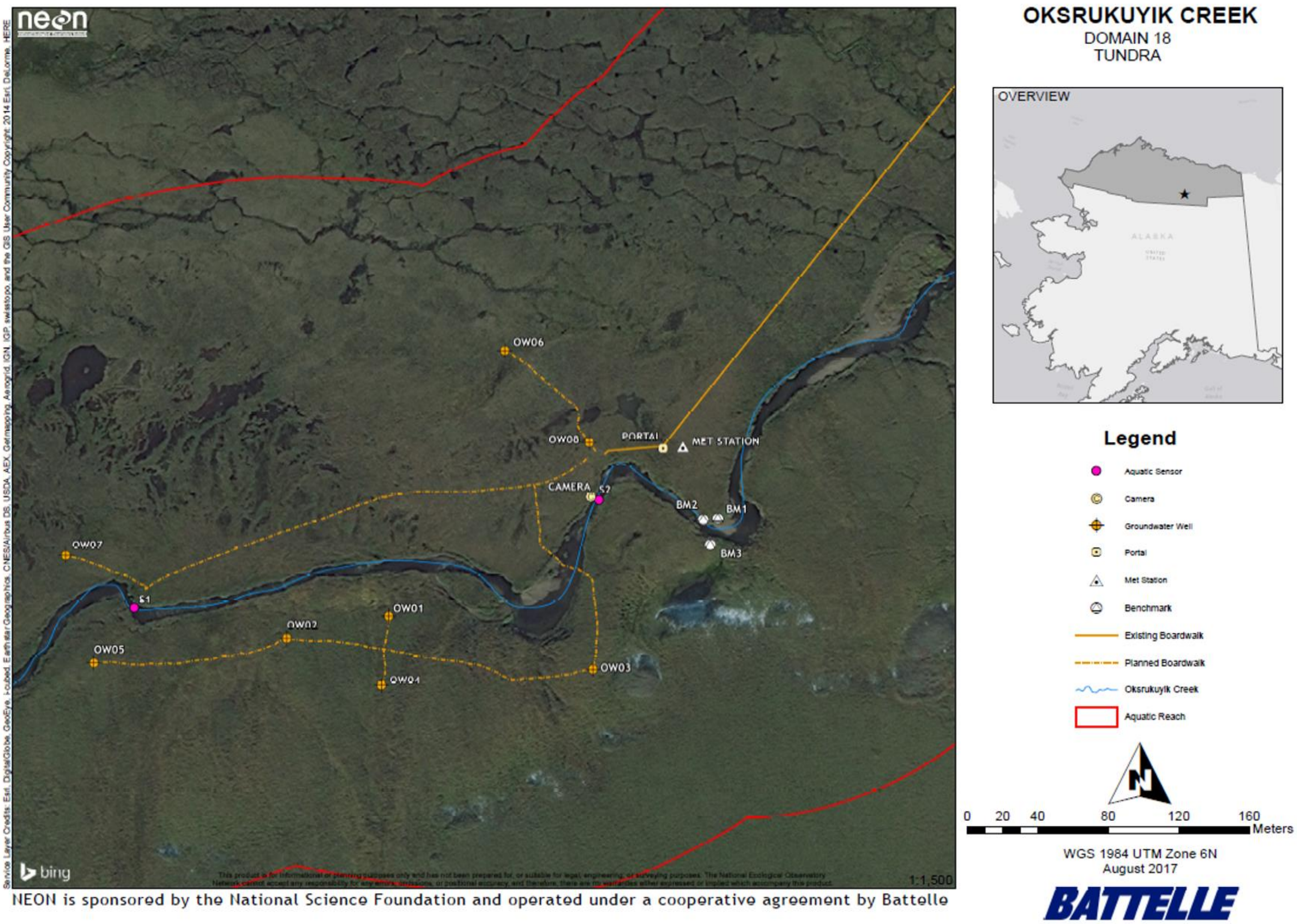

Figure 6. Site access and instrument locations at D18 Oksrukuyik Creek.

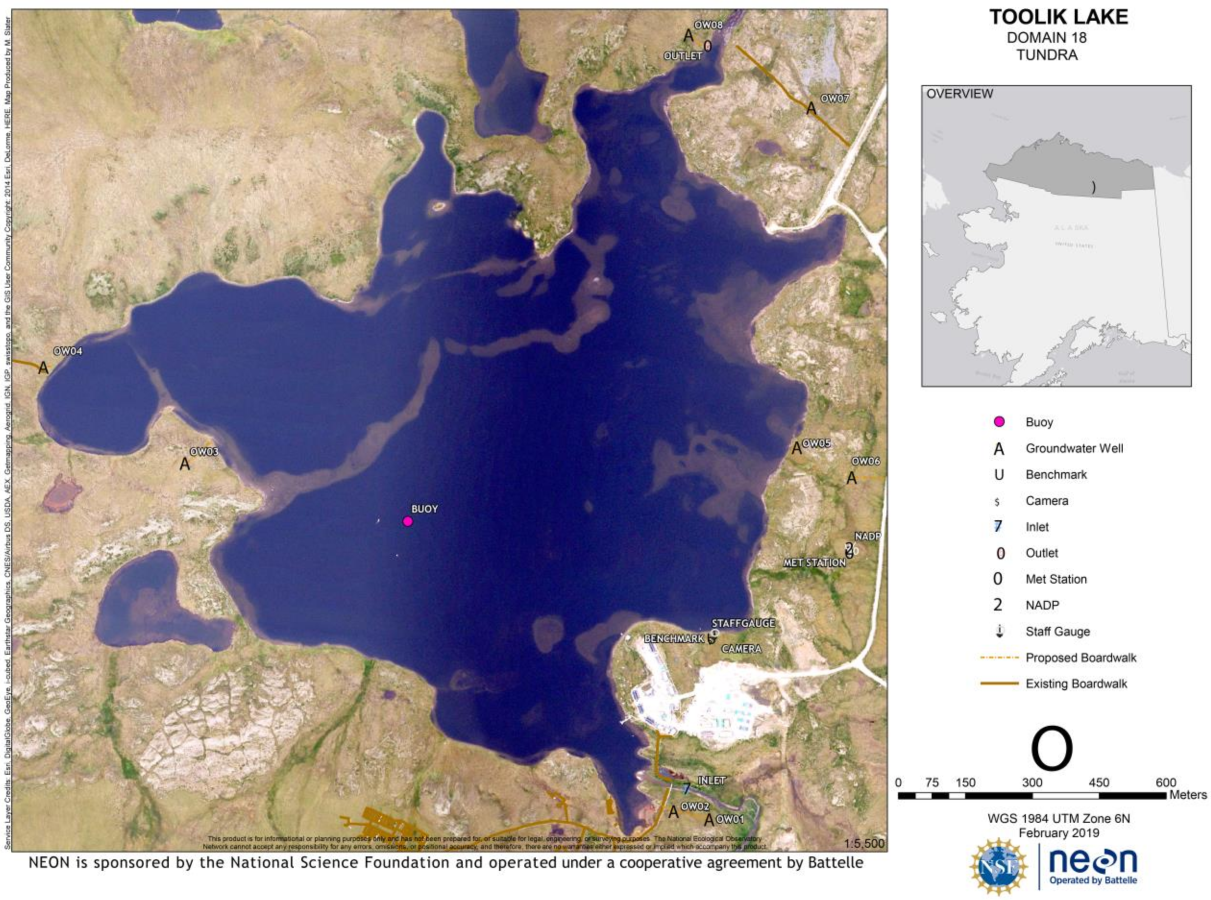

Figure 7. Site access and instrument locations at D18 Toolik Lake.

6.3 Riparian Sampling Locations

Riparian coordinates are determined prior to sampling at HQ. Coordinates are groundtruthed by Field Science in and reported back to Science to update Table 15 and Table 16. If available in the table, Field Science coordinates should be used for riparian sampling. Stream riparian transects are numbered from 1-10 starting at the downstream end of the sampling reach (Figure 8). Lake riparian transects are numbered from 1-10 clockwise around the lake (Figure 9).

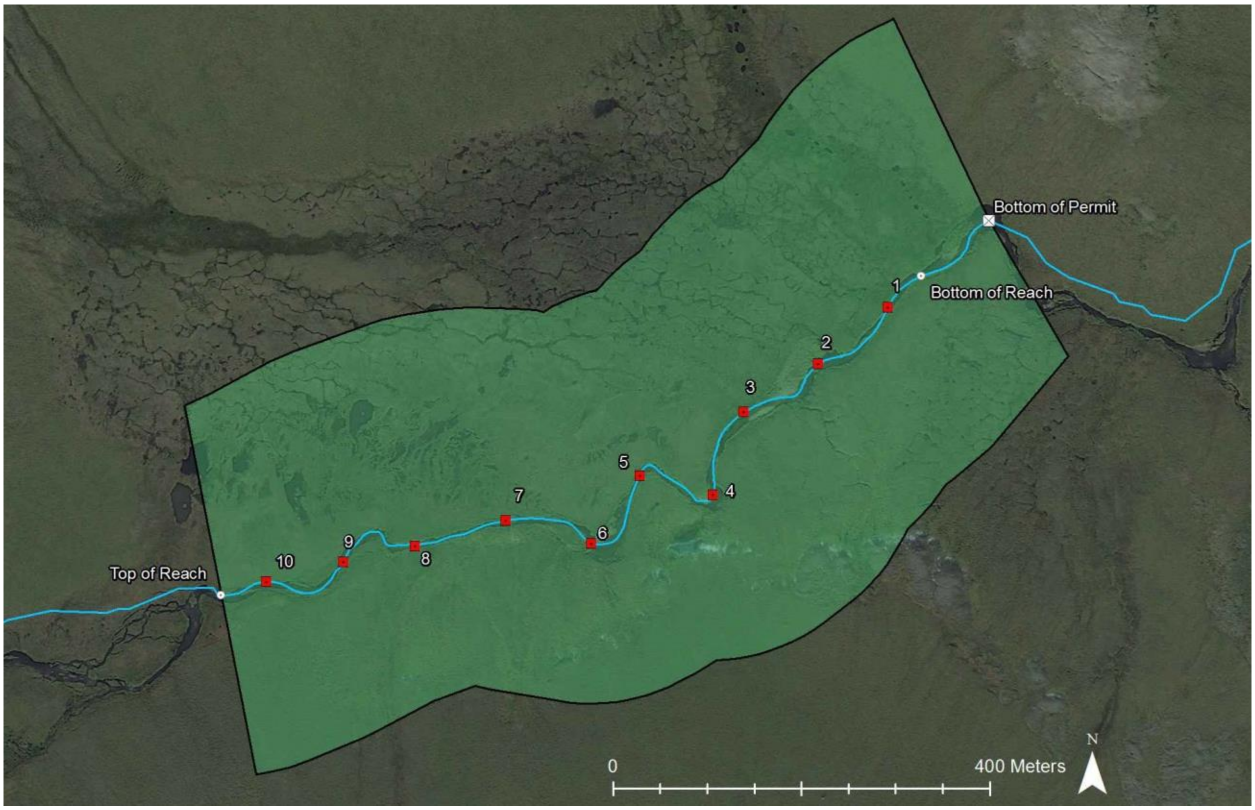

Figure 8. OKSR ideal riparian sampling design

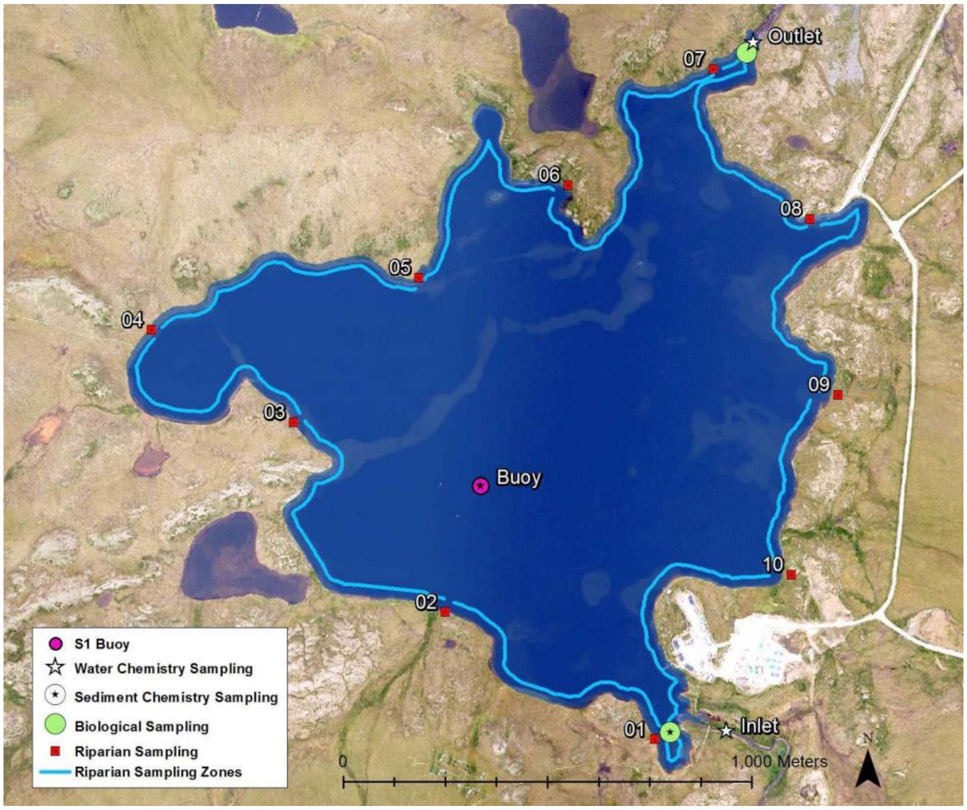

Figure 9. TOOK ideal riparian sampling design

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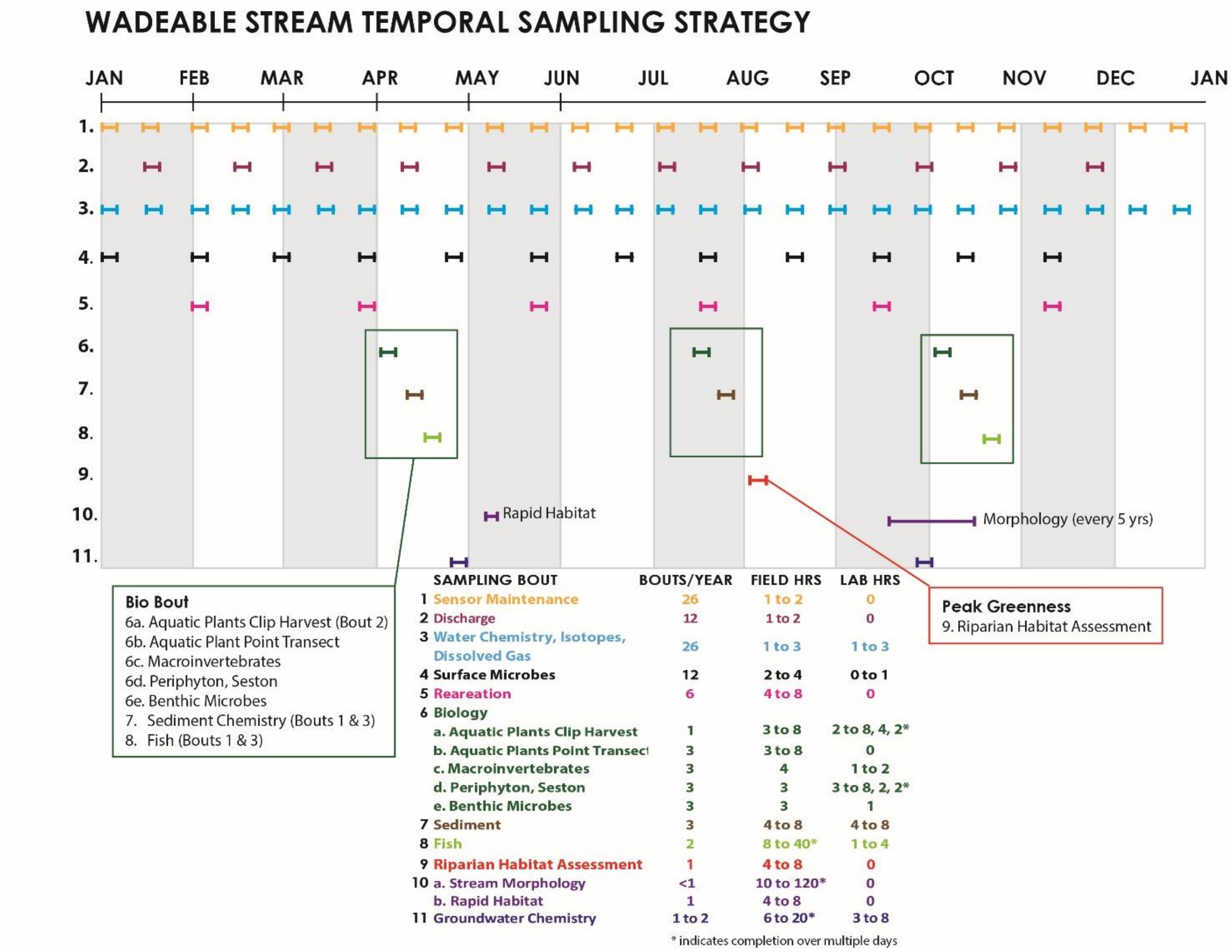
APPENDIX A WADEABLE STREAMS

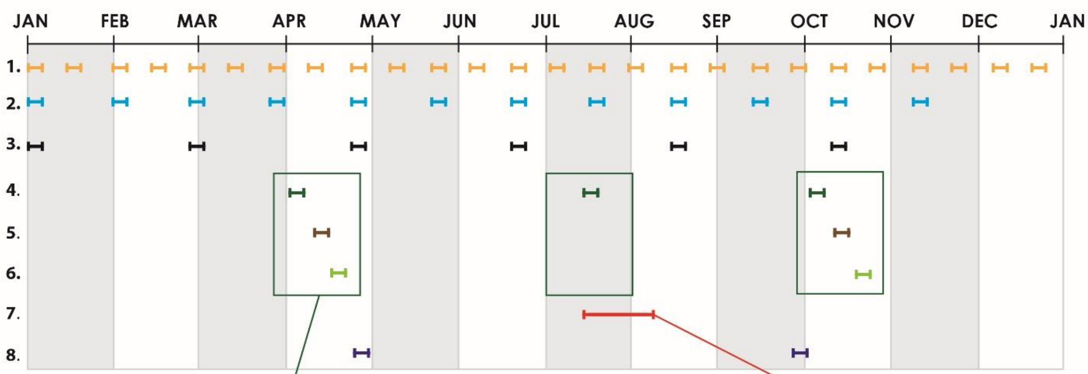


SAMPLING BOUT	BOUTS/YEAR	FIELD HRS	LAB HRS
1 Sensor Maintenance	26	1 to 2	0
2 Discharge	12	1 to 2	0
3 Water Chemistry, Isotopes, Dissolved Gas	26	1 to 3	1 to 3
4 Surface Microbes	12	2 to 4	0 to 1
5 Reareation	6	4 to 8	0
6 Biology			
a. Aquatic Plants Clip Harvest	1	3 to 8	2 to 8, 4, 2*
b. Aquatic Plants Point Transect	3	3 to 8	0
c. Macroinvertebrates	3	4	1 to 2
d. Periphyton, Seston	3	3	3 to 8, 2, 2*
e. Benthic Microbes	3	3	1
7 Sediment	3	4 to 8	4 to 8
8 Fish	2	8 to 40*	1 to 4
9 Riparian Habitat Assessment	1	4 to 8	0
10 a. Stream Morphology	<1	10 to 120*	0
b. Rapid Habitat	1	4 to 8	0
11 Groundwater Chemistry	1 to 2	6 to 20*	3 to 8

* indicates completion over multiple days

APPENDIX B LAKES

LAKE TEMPORAL SAMPLING STRATEGY



Bio Bout
4a. Aquatic Plant Clip Harvest (Bout 2)
4b. Aquatic Plant Point Pres/Abs (Bouts 1 & 3)
4c. Macroinvertebrates
4d. Periphyton, Phytoplankton
4e. Zooplankton
5. Sediment Chemistry (Bouts 1 & 3)
6. Fish (Bouts 1 & 3)

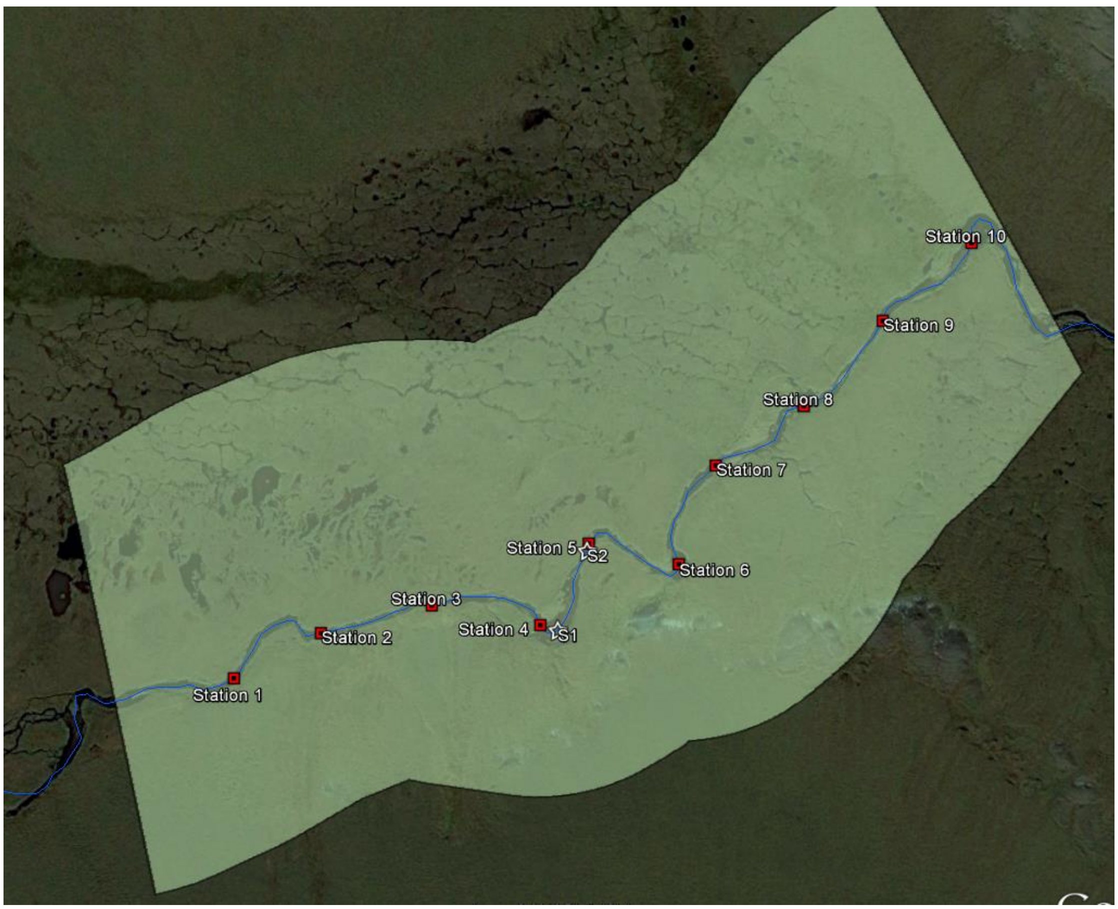
Peak Greeness
7a. Riparian Habitat Assessment
7b. Bathymetry (every 5 yrs)

	SAMPLING BOUT	BOUTS/YEAR	FIELD HRS	LAB HRS
1	Sensor Maintenance	26	1 to 2	0
2	Water Chemistry, Isotopes, Dissolved Gas	12	1 to 3	1 to 3
3	Surface Microbes	12	2 to 4	0 to 1
4	Biology			
	a. Aquatic Plant Clip Harvest	1	3 to 8	4 to 8, 4, 2*
	b. Aquatic Plant Point Pres/Abs	2	3 to 8	0
	c. Macroinvertebrates	3	4	1 to 2
	d. Periphyton, Phytoplankton	3	3	4 to 8, 2, 2*
	e. Zooplankton	3	4	1 to 2
5	Sediment Chemistry	2	4 to 8	1 to 4
6	Fish	2	8 to 40*	1 to 4
7	Peak Greenness			
	a. Riparian Habitat Assessment	1	4 to 8	0
	b. Bathymetry	<1	8 to 40*	0
8	Groundwater Chemistry	2	6 to 20*	3 to 8

* indicates completion over multiple days

APPENDIX C OBSOLETE LOCATIONS, OKSR

OKSR Obsolete Locations		
Station	Latitude	Longitude
1	68.668629°	-149.151470°
2	68.668997°	-149.149514°
3	68.669225°	-149.147003°
4	68.669065°	-149.144542°
5	68.669734°	-149.143445°
6	68.669565°	-149.141407°
7	68.670378°	-149.140564°
8	68.670868°	-149.138570°
9	68.671567°	-149.136798°
10	68.672202°	-149.134818°
S1	68.669017	-149.149939
S2	68.669669	-149.143497
Discharge		
TOP of Reach	68.668614	-149.154249
BOT of Reach	68.672678	-149.134813



APPENDIX D OBSOLETE LOCATIONS, TOOK

TOOK Obsolete Locations		
Station	Latitude	Longitude
1	68.629038°	-149.591704°
2	68.625308°	-149.599532°
3	68.627900°	-149.612434°
4	68.631912°	-149.622009°
5	68.633800°	-149.630790°
6	68.635193°	-149.614877°
7	68.637359°	-149.606125°
8	68.640035°	-149.597700°
9	68.636834°	-149.591490°
10	68.633014°	-149.589370°
S1	68.630692	-149.610636