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The Expedition to the Peel River in 2019: Fluvial Transport Across a Permafrost Landscape

Edited by

Frederieke Miesner, P. Paul Overduin, Kirsi Keskitalo,
Niek J. Speetjens, Jorien Vonk, Sebastian Westermann

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Titel: Die Expeditionsteilnehmer paddeln im Juli 2019 in der Schlucht unterhalb des Aberdeen Canyon auf dem Peel River im Yukon Territory, Kanada (Foto: P. Overduin).
Cover: Participants paddle down the gorge below Aberdeen Canyon on the Peel River in the Yukon Territory, Canada in July 2019 (Photo: P. Overduin).

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The Expedition to the Peel River in 2019: Fluvial Transport Across a Permafrost Landscape

EU Horizon2020 project
Nunataryuk
Consisting of 7 legs
from

16 June 2019 - 11 August 2019

NUNATARYUK
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Chief Scientist
Paul Overduin

Coordinator
Frederieke Miesner

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Introduction

Frederieke Miesner[1], P. Paul Overduin[1], Kirsi Keskitalo[2], Niek J. Speetjens[2], Jorien Vonk[2], Sebastian Westermann[3]

[1] AWI
[2] VUA
[3] UIO

Scientific Background

This field project is part of the EU Horizon2020 project *Nunataryuk*, which studies the interactions between people and changes to permafrost, with a focus on the Arctic coastal region. Our work seeks to understand how organic carbon is transported from hydrological catchments affected by permafrost. The impact of changing climate on permafrost landscapes is visible as intensified erosion, thaw slumping and lateral transport of sediment and dissolved material, which affects river and coastal ecosystems. Organic carbon, in particular and dissolved forms, is an important component of the carbon cycle. Although it is one of the primary food sources for aquatic ecosystems, organic carbon, as well as other dissolved and particulate matter, can decrease light penetration and reduce photosynthetic rates. Organic carbon is transformed while transported by the river system, for example by photodegradation. As climate change warms and thaws permafrost, thermokarst activity intensifies, increasing release rates of organic carbon, sediment and other transported matter in the river systems of the north.

Data-constrained spatial modelling provides important quantification of potential permafrost thaw impacts at the local-scale. This portion of the *Nunataryuk* project seeks to gather data on lateral fluxes of organic matter across a large permafrost-affected watershed draining to the Arctic Ocean, and to model thaw vulnerability of different periglacial landforms combined with high-resolution GIS-datasets. The overarching goal is to quantify past, current and future remobilization potential of carbon, nutrients and contaminants from permafrost catchments, and to relate results to landscape changes in the catchment. Based on the results, methodologies and lessons learned from local scale analyses, a simplified scheme will be developed and applied at the pan-Arctic scale. Such data-constrained pan-Arctic scaling of potential lateral fluxes are particularly valuable as they may be both complementary and independent from Earth System Model (ESM) estimates.

Expedition Goals

Our goal is to understand the change in water chemistry within the Peel River catchment along its channel. By sampling tributaries draining the range of sub-catchment sizes and the range of their landscape covers, we aim to quantify how different landscape units contribute to the transport of organic and inorganic carbon, sediment and dissolved element fluxes northward from the land to the Arctic Ocean.

Our methods are to:

1. collect water samples for the analyses of stable isotopes of water, colored and fluorescent dissolved organic matter (CDOM and fDOM), dissolved organic and inorganic carbon (DOC and DIC), and major dissolved ions,
2. measure chlorophyll concentration, water electrical conductivity (EC), pH and temperature with handheld devices at sampling sites and continuously along the river,
3. sample bank sediments and particulate organic matter filtered from the water for total suspended sediment, organic carbon content, lipid biomarker and carbon isotope ($\delta^{13}C$, $\Delta^{14}C$) analyses.

This study will help us to understand organic carbon dynamics coupled to landscape characteristics in a permafrost underlain river system. Our high-resolution sampling of the Peel River is a challenge due to its remoteness and the difficulty of accessing smaller tributaries, but has the potential to add to our knowledge of permafrost carbon remobilization and lateral transport within an entire water catchment. We will quantify organic and inorganic carbon amounts and use carbon isotopes to constrain sources and age of organic carbon in the water column. We will also investigate carbon composition and degradation status in a molecular level using lipid biomarkers. Studying changes in permafrost landscapes will help us to comprehend possible climate impacts of thawing permafrost in the future both in a local and global scale.

We understand science to be one way of listening to the natural world. A goal of this expedition was to choose methods that reflect our respect for the land and the river and that allow for unexpected insights during fieldwork. Logistics and methods were chosen to encourage familiarity with the spatial and temporal scales of the river and its sub-catchments. By travelling with, on and in the river, we hoped to get acquainted with its changing waters and the events and places that affect it on its way from source to river mouth. By travelling slowly and at ground level, we aimed for spatial and temporal sampling frequencies that matched both the granularity of changes to the landscape and the variability of water sources to the river. This approach is embedded in a larger scale perspective gained by repeated river water sampling by partners in Fort McPherson throughout the trip and by using satellite remote sensing for planning the trip, selecting sampling sites during the trip and to interpret field data in the context of larger-scale landscape changes.

Existing Work

The Peel watershed has an area of 70,680 km^2 and drains to the Mackenzie River and then further to the Arctic Ocean. The Peel River drains regions of continuous and discontinuous permafrost in the Yukon and Northwest Territories, Canada. A broad spectrum of permafrost response to climate warming is thus combined and integrated in one river system. Global climate change is affecting hydrology in the Yukon and Northwest Territories. These effects include warmer summer and winter air temperatures, higher flows, higher summer precipitation and earlier freshets in mountainous regions. In the continuous permafrost zone, most winter stream flows have increased (Janowicz 2007). The Peel Plateau is an ice-rich morainic landscape occupying the northern portion of the Peel watershed. It has been the focus of much research, since the effects of warming create obvious and dramatic thermokarst features such as retrogressive thaw slumps (Littlefair et al. 2017, 2018; Kokelj et al. 2013, 2015, 2017a, 2017b; St. Pierre et al. 2018; Zolkos et al. 2018, 2019, in review). These changes are underway in the context of global processes generally intensifying land to ocean transfer of suspended and dissolved freights including contaminants (e.g., Drake et al. 2018; Li Yung Lung et al. 2018; Tank et al. 2016; Zolkos et al. 2020).

Results from hydrological studies and monitoring are available via the NWT Water Stewardship website, which provides outreach for the joint implementation of Northern Voices, Northern Waters: NWT Water Stewardship Strategy and from the Canadian national hydrometric program (https://wateroffice.ec.gc.ca/). Historical discharge data for the Peel River above Fort McPherson are available since September 30, 1969. Information on the Peel River in the context of circum-Arctic hydrological monitoring is available from McClelland et al. (2015). Previous studies of water quality in the Peel River watershed at the main discharge measurement point above Fort McPherson and throughout the watershed include Czarnecki and Beavers (1999). Schreier et al. (1980) present water quality for the Ogilvie monitoring station, where a major sub-catchment (7,220 km^2) of the Peel River was monitored over a multi-year period at multiple locations.

A great deal of information on the region has been created and collected through the work of the Peel Watershed Planning Commission, which was formed on October 15th, 2004. Their work resulted in the creation of a Land Use Plan, which was finalized almost 15 years later by leaders from the governments of Yukon, Tr'ondëk Hwëch'in, the First Nation of Na-Cho Nyäk Dun, Vuntut Gwich'in First Nation and the Gwich'in Tribal Council. The plan will guide future use of land and resources in the Peel Watershed Planning Region, a region of 67,431 km^2 in the northeastern Yukon Territory. Reports prepared for the Commission give an assessment of many environmental and water resources of the Peel River watershed (e.g., Kenyon and Whitley 2008). Maps and descriptions of bedrock, Quaternary and surficial geology are available from the Geological Surveys of Canada and the Yukon Territory (e.g., Norris 1997). An overview of available maps and reports from the Yukon Geological Survey is given by Abbott and staff (2003).

Permitting and Logistics

The catchment area overlaps with the traditional territories of four of the Canadian First Nations: Vuntut Gwich'in, Tetlit Gwich'in, Na-Cho Nyäk Dun and Tr'ondëk Hwëch'in. In the two years leading up to the expedition, we contacted representatives of each of the four First Nations to seek permits for scientific research. In addition, permits were obtained from the Yukon and the Northwest Territories governments, and from the Yukon Territorial Park Service (for work in Tombstone Territorial Park). A number of resources proved essential, including the searchable geodatabase on settlement lands available online from the Yukon territorial government (http://mapservices.gov.yk.ca/Lands/Load.htm).

The trip was divided into four legs to adapt to the changing logistical and access requirements:

1. As the river grew along its course, the type of boats required changed,
2. The team needed to be re-supplied with food and new sample materials periodically,
3. Team members were added to or left the group,
4. Sample material needed to be transported out for preservation and in order to minimize the weight and volume of material. This was associated with one of the challenges of the trip, keeping samples cool or frozen (Table 3). A number of methods were tested in advance and in the field. The most reliable was a small volume freezer, a 100 W solar panel and a portable ruggedized power station. Combined with very sunny weather, this allowed us to keep particulate samples at close to 0 °C.

Access to the study region was via Whitehorse for the European team members. A pickup truck transported participants and gear to exchange points along the Dempster Highway. It also allowed us to perform repeat sampling at points along the road (see page 9 for details). The exchange between Legs 2 and 3 was by float plane out of Mayo to a landing strip at Taco Bar at the confluence of the Peel and Snake Rivers, where floatplanes can reliably land and take off. Travel along the river was accomplished using combinations of inflatable pack rafts, which were hiked in for the Headwaters Leg (Fig. 1) and floated out. On Leg 1, a foldable canoe (brand "Ally") joined the team, to transport more sampling supplies, samples and food. Some boats and equipment boats were then left at the confluence of the Ogilvie and Blackstone rivers and participants hiked out to the Dempster Highway, packing samples for return to Whitehorse. A hardshell canoe was then added to the team for Legs 2 and 3. Having a number of boats of varying pack-ability and capacity meant that the team could react to unexpected water levels and conditions on the river. Having two canoes on the final flatwater portion of the river made it possible to paddle as a catamaran. The challenge in equipment choice was to keep gear light enough to make the required portaging, especially around Aberdeen Canyon, nonetheless feasible. The truck team picked up the Leg 3 team at the Dempster Highway ferry upstream from Fort McPherson.

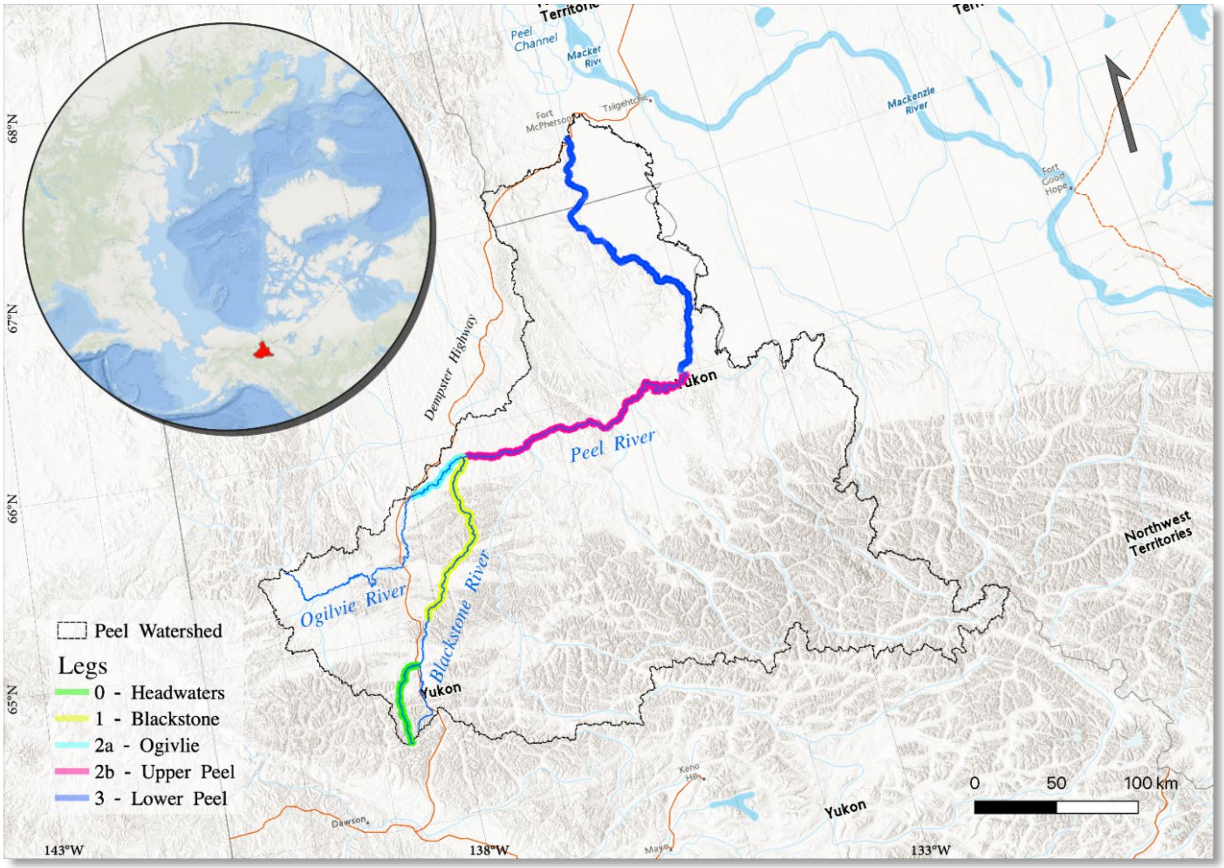

Figure 1*: Location of the Peel River catchment and paths of the four expedition legs*

Table 1: List of team members with field participation dates

Team member	Dates in the field			Organisation
Paul Overduin	Jun. 30	-	Aug. 11	**AWI** Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam Germany
Sebastian Westermann	Jun. 30	-	Aug. 11	**UIO** University of Oslo Norway
Frederieke Miesner	Jun. 30	-	Aug. 11	**AWI** Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam Germany
Torsten Sachs	Jun. 30	-	Jul. 17	**GFZ** GFZ German Research Centre for Geosciences, Potsdam Germany
Jody Overduin	Jul. 15	-	Jul. 28	**CPAWS** Canadian Parks and Wilderness Society Canada
Maria Peter	Jun. 30	-	Jul. 17	**NTNU** Norwegian University of Science and Technology, Trondheim Norway
Niek Speetjens	Jul. 04	-	Aug. 01	**VUA** Vrije Universiteit Amsterdam Netherlands
Kirsi Keskitalo	Jul. 09	-	Aug. 07	**VUA**
Wouter Berendsen	Jul. 04	-	Jul. 28	**DCMR** Dutch Environmental Protection Agency, Schiedam Netherlands
Bill Cable	Jul. 28	-	Aug. 11	**AWI** Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam Germany
Bobbi Rose Koe	Jul. 15	-	Jul. 28	**Youth of the Peel Society** Whitehorse, Yukon Canada

Table 2: Itinerary of the Peel River 2019 expedition and participants

Leg	Start	End	Boat Team	Truck Team
Groundwork in Whitehorse and the trip to Tombstone Territorial Park	2019-06-16	2019-07-01		Westermann
Headwaters, from Auston Pass	2019-07-01	2019-07-06	Peter, Sachs, Westermann	Miesner, Overduin
Blackstone River to the Ogilvie confluence and out to the Dempster Highway	2019-07-07	2019-07-14	Westermann, Peter, Sachs, Berendsen, Speetjens	Miesner, Overduin
Ogilvie and Peel rivers, from the Dempster Highway to Taco Bar	2019-07-14	2019-07-27	Keskitalo, Koe, Overduin, Overduin, Speetjens, Westermann	Berendsen, Miesner
Lower Peel River, from Taco Bar to Fort McPherson	2019-07-27	2019-08-02	Keskitalo, Miesner, Overduin, Westermann	Cable, Speetjens
Fort McPherson to Tuktoyaktuk, Inuvik-Tuktoyaktuk Highway	2019-08-03	2019-08-07		Overduin, Miesner, Keskitalo, Westermann, Cable
Dempster Highway and return to Whitehorse	2019-08-08	2019-08-11		Overduin, Miesner, Westermann, Cable

Description of sampling and sample treatment

Water samples were taken from both tributary rivers and the main stems of the Blackstone and Peel rivers. The tributaries sampled were chosen to be representative of different landscape types and catchment sizes. Samples were collected mid-stream where possible, upstream of the person taking the sample. For larger waterways, the sampler waded into the flow from the shore line to sample. For standard analysis[1] bulk water samples were collected in 1L Nalgene bottles that were pre-rinsed three times with sample water before taking the sample. As the samples for elaborate analysis[2] required larger water volumes, they were collected in 4L wine bags, also pre-rinsed three times with sample water. These samples were given identification numbers in the 1,000s and 2,000s (see Appendix 1 Table A.1).

At each sampling site, multi-parameter water quality meter (Aquaprobe 5000) measurements of pH, EC, dissolved oxygen, turbidity, CDOM, temperature, atmospheric pressure and an estimation of discharge were recorded. GPS positions were recorded and photographs of the sampling locations were taken. During the river sampling campaign, continuous measurements of the same water quality parameters were taken using a second Aquaprobe and a fluorimeter (TriOS) mounted below the water line on one of the canoes (Ally).

During the same period as and following the river trip, samples were taken at sites along the Dempster Highway and the Inuvik-Tuktoyaktuk Highway (ITH). For the Dempster sites, a set of ten sites was chosen, from the upper East Blackstone, the Ogilvie and in the Richardson mountains. These sites represented tributaries to the Peel River and were sampled up to seven times in July, August and September 2019. Additionally, some sites were sampled along the ITH, north of Inuvik, following the end of the Peel canoe trip on August 2.

For streams crossing the road, samples were usually collected on the upstream side of the road as described above. For some of these samples, water quality parameters with the Aquaprobe were not recorded in the field. These “road” sites were given identification numbers in the 7,000s (see Appendix 1 Table A.1).

At the end of each sampling day, water samples were filtered through 0.7 µm glass-fiber filters (Gf/f) and sub-sampled into suitable containers for each of the corresponding parameters and preserved accordingly (Fig. 2). The stable water isotope (non-filtered) and DIC samples were stored without headspace. Table 3 gives an overview of the sample containers and preservation methods. A list of the samples collected is given in Appendix 2 and the sampling protocol prepared for the expedition is given in Appendix 3.

[1] Standard analysis for all samples: DOC concentration, DOC-$\delta^{13}C$, dissolved nitrogen (DN), CDOM/fDOM, total suspended solids (TSS), POC load, POC-$\delta^{13}C$, total nitrogen (TN), anions, cations, stable water isotopes and dissolved inorganic carbon

[2] Additional analyses: DOC-^{14}C, POC-^{14}C, DOM and POM composition, lipid biomarkers

Table 3: Description of sample containers and preservation method

Parameter	Container	Preservation method
DOC	40ml brown glass vial	Acidified (HCl 37%, 30μl), cool, dark
CDOM/fDOM	15ml Falcon tube	Frozen, dark
TSS, POC, POM	47mm 0.7μm Gf/f filter	Frozen, dark
Anions	8ml Nalgene flask	Cool, dark,
Cations	15ml Falcon tube	Acidified (HNO_3 65%, 50μl), cool, dark
Stable water isotopes	10ml polyethylene bottle	Cool, dark, no headspace
DOC-14C	250ml polycarbonate bottle	Frozen, dark
DOM composition	250ml glass bottle	Cool, dark
POM (for biomarkers)	90mm 0.7μm Gf/f filter	Frozen, dark

Figure 2*: Subsampling at the end of the day in the field-lab (photo: Niek Speetjens)*

Metadata Results

We sampled the Peel River and its tributaries at 152 unique locations (see Table 4). Along the Dempster Highway between Tombstone Territorial Park and Fort McPherson, 10 repeat sites were sampled up to seven times between June 2 and Sept. 13. An additional 13 sites along the ITH were sampled, to extend the dataset to tundra landscapes on the coastal plain. Figure 7 shows two of the repeat sites in the Richardson Mountains, where both tributaries drain the same landscape and flow into the North Vittrekwa and ultimately into the Peel River. One of these tributaries is affected by a fresh thaw slump (Fig. 7). A total of 1,774 subsamples were taken back to be analysed in the lab (see Table 5). The spatial distribution of the sample sites along the Peel River, and the size and distribution of the sampled catchments are shown in Figures 3-6 and in Figure 8, respectively.

Table 4: List of sample location during the trip. The numbers in parentheses include samples taken at repeat sites

Expedition Leg	Number of Sample Sites	
Headwaters	20	see Figure 3
Leg1	28	see Figure 4
Leg2	48	see Figure 5
Leg3	47	see Figure 6
Truck (Jul. – Aug.)	17 (61)	
Truck North of Fort McPherson	13	
Truck (Sept.)	2 (12)	
Total	165 (229)	see Figure 7

Data Availability

The *Nunataryuk* project promotes open and free access to research data and publications. The *Nunataryuk* Data Management Plan is based on the EU's Horizon 2020 FAIR Data Management Plan (https://www.openaire.eu/open-research-data-the-new-norm-in-h2020). Data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (www.pangaea.de) subject to possible temporary access limitations to permit quality control and publication of results based on the data in the context of student degree requirements. By default the CC-BY license will be applied. Links to the data will be published in the relevant scientific publications. Both data sets and the resulting scientific publications will be linked via the *Nunataryuk* Project Database at https://zenodo.org/communities/nunataryuk/.

Outlook

The results from this expedition will represent a snapshot of water flowing through the Peel River watershed. The summer of 2019 was exceptionally warm and dry, so that our results probably reflect extreme low-water conditions. The intensification of thermokarst activity and associated increasing organic carbon and sediment release rates will thus have an effect. The nested watershed sampling approach covers five orders of magnitude of drainage area, in regions with differing glacial histories, ground ice morphology and landscape cover. We hope to link thaw vulnerability to land-to-ocean flux rates. Landscape classification based on remote sensing and numerical model linking fluxes to landscape types can then be used to create scenarios of future change in the context of further permafrost thaw.

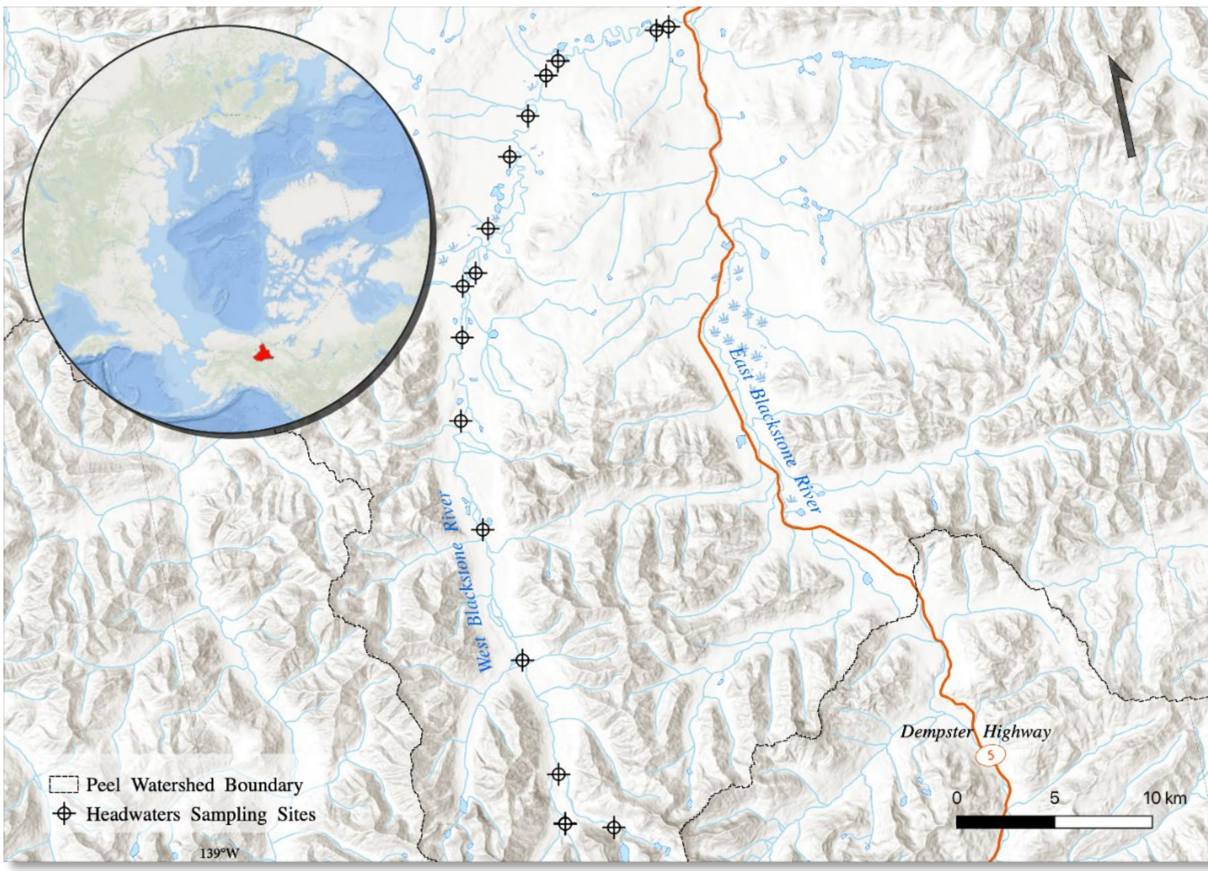

Figure 3*: Sampling sites in the headwaters of the Blackstone River, from the back country region of Tombstone Territorial Park to the Dempster Highway bridge across the West Blackstone River*

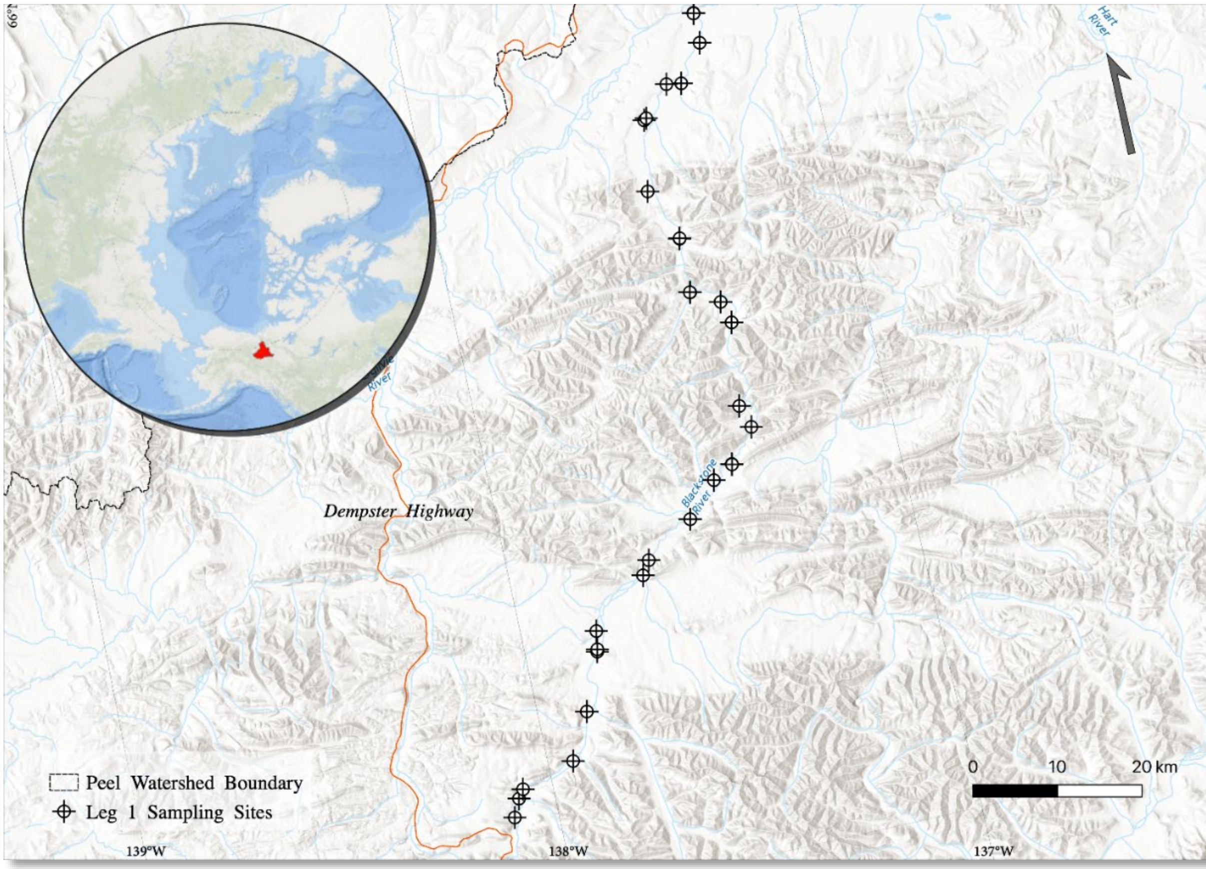

Figure 4*: Sampling sites Leg 1: the Blackstone River from point where it leaves the Dempster Highway until the confluence of the Blackstone and Ogilvie rivers (which is considered the "official" beginning of the Peel River)*

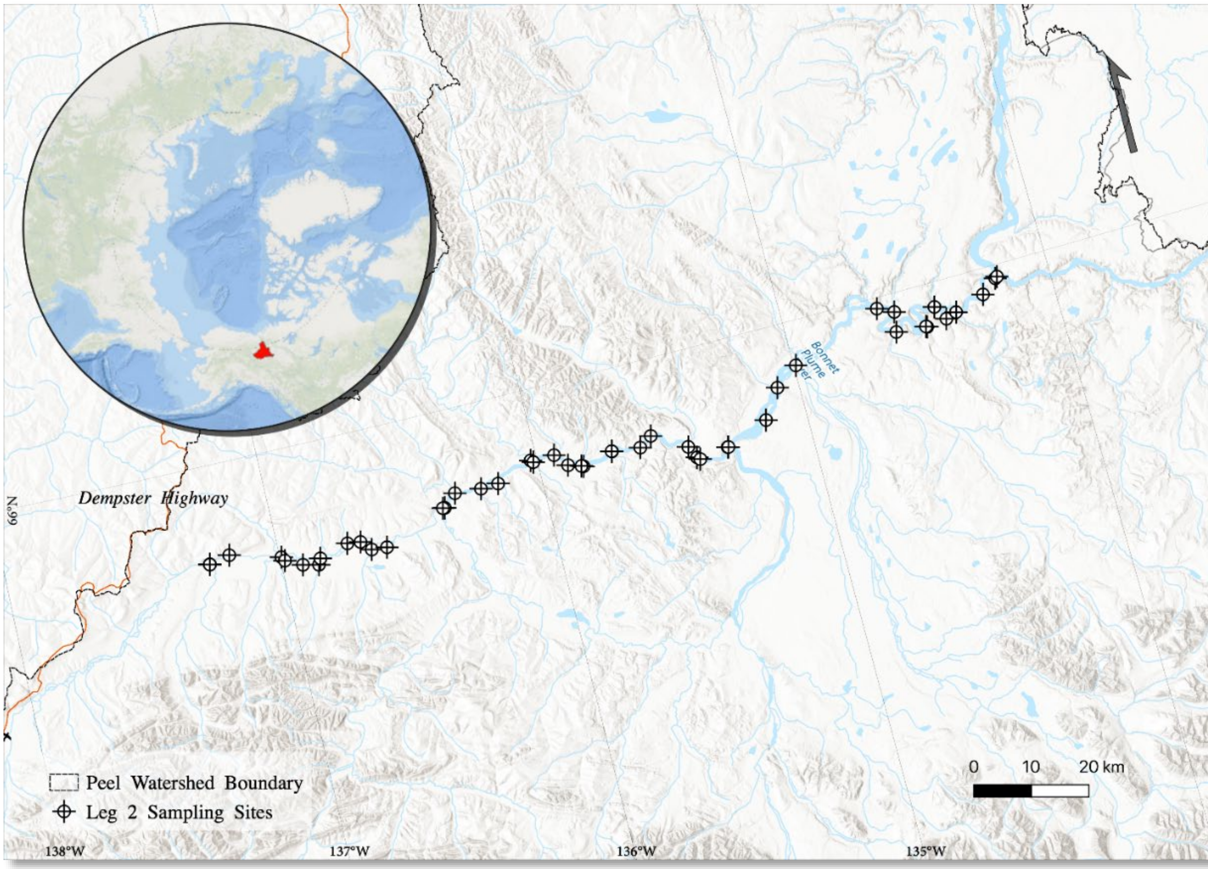

Figure 5*: Sampling sites Leg 2: Ogilvie River and Upper Peel River, from the Dempster Highway to Taco Bar*

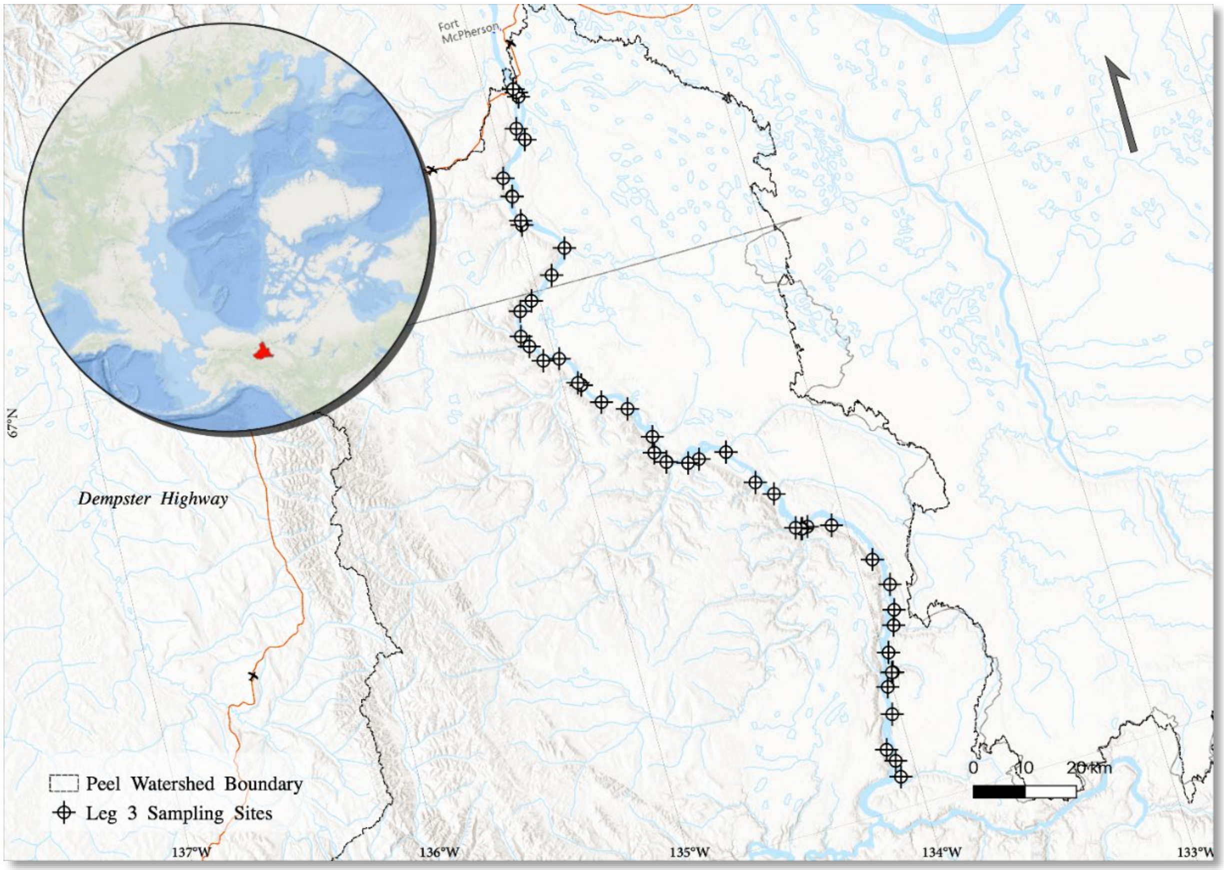

Figure 6*: Sampling sites Leg 3: Lower Peel River from Taco Bar to the Fort McPherson ferry crossing (Dempster Highway)*

Figure 7*: Two tributaries sampled as repeat sites along the Dempster Highway in the Richardson Mountains. The view is roughly towards the north. Both tributaries are similar in size, drain similar landscape and flow into the North Vittrekwa River just southward of the photo. Water in the tributary on the right carries material from the active thaw slump visible at upper right (photo: Sebastian Westermann).*

Table 5: List of total number of water and sediment samples

Anions	Cations	DOC	Δ^{14}C-DOC	Stable Isotope Water	DIC	CDOM	POC, TSS	DOM compo-sition	Sedi-ment	total
233	232	242	45	233	206	233	312	28	10	1774

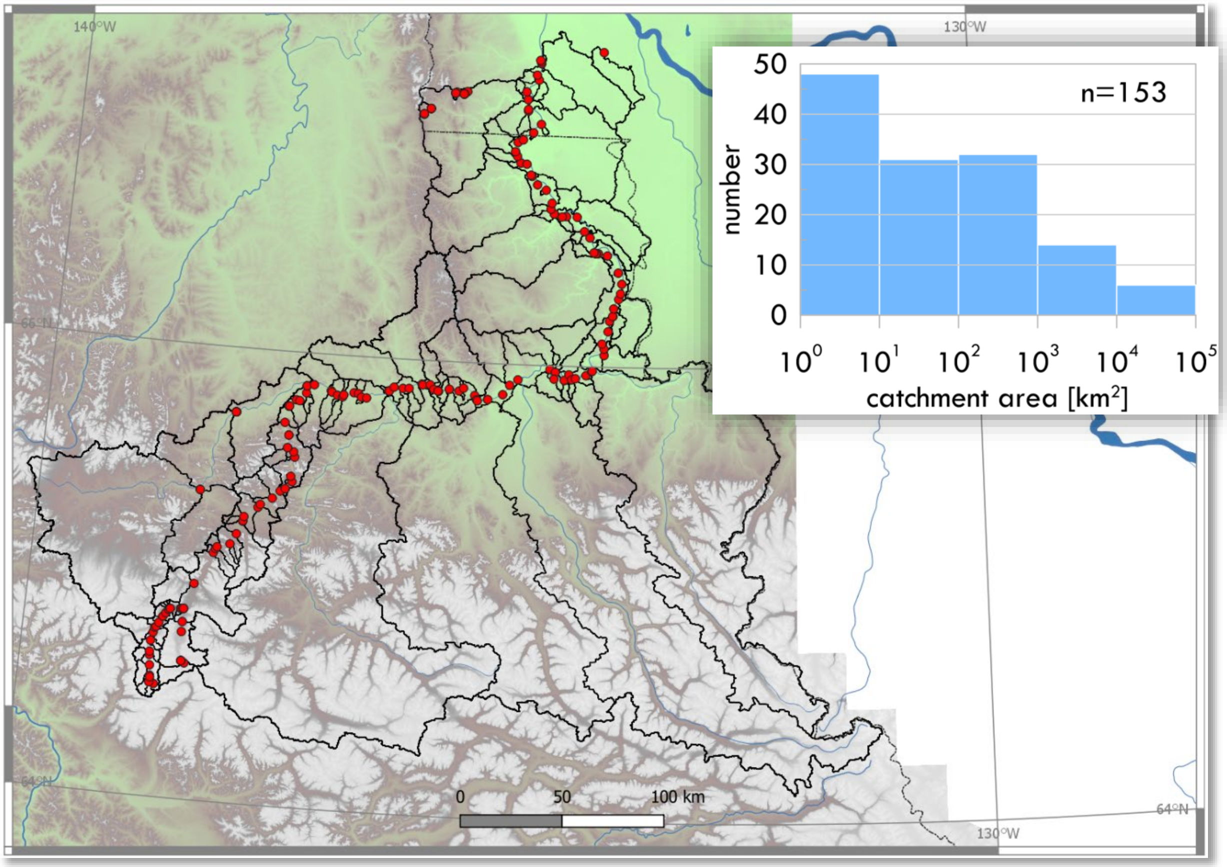

Figure 8*: Peel River watershed sub-catchment outlines corresponding to each sampling site are indicated with black outlines. Sub-catchment areas were computed in Arc GIS using the Canadian Digital Elevation Model (available at: https://open.canada.ca/data/en/dataset/7f245e4d-76c2-4caa-951a-45d1d2051333). The accompanying report (CDEM 2013) details age of data acquisition and coverage. The Arc GIS hydrology package was used to calculate 1st to 9th stream order hydrological network. Sampling points recorded in the field using GPS were corrected to lie on the corresponding river, tributary or stream. All upstream pixels are included for each sampling point, so that catchment areas indicated are nesting. The inset histogram indicates the number of catchments classified by catchment areas, which range in size from less than 1 to more than 10,000 km2.*

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A.1 Sampling sites, times and sample identification numbers

Date	Time	Sample_ID	Latitude	Longitude
2019-07-01	23:08:42	**1001**	64.505849	-138.224174
2019-07-03	16:36:29	**1002**	64.494389	-138.599022
2019-07-03	17:34:29	**1003**	64.500396	-138.647022
2019-07-03	17:37:08	**1004**	64.500203	-138.646892
2019-07-03	18:22:13	**1005**	64.522167	-138.643440
2019-07-03	20:20:28	**1006**	64.574468	-138.656770
2019-07-04	13:03:22	**1007**	64.619538	-138.668377
2019-07-04	14:29:52	**1008**	64.634181	-138.670381
2019-07-04	16:38:55	**1009**	64.683009	-138.670615
2019-07-04	18:20:28	**1010**	64.718895	-138.652295
2019-07-04	19:18:49	**1011**	64.740966	-138.641276
2019-07-05	10:47:23	**1012**	64.745582	-138.625645
2019-07-05	12:00:51	**1013**	64.763705	-138.603981
2019-07-05	14:17:00	**1014**	64.792805	-138.567515
2019-07-05	15:20:00	**1015**	64.808806	-138.540732
2019-07-05	16:55:13	**1016**	64.824658	-138.514157
2019-07-05	17:21:49	**1017**	64.829998	-138.499000
2019-07-05	17:26:16	**1018**	64.829949	-138.498812
2019-07-05	19:49:31	**1019**	64.834429	-138.392818
2019-07-05	20:11:52	**1020**	64.834894	-138.379848
2019-07-07	15:55:56	**2001**	65.091794	-138.106094
2019-07-07	16:54:43	**2002**	65.109687	-138.086745
2019-07-07	17:29:44	**2003**	65.118221	-138.072324
2019-07-08	12:59:27	**2004**	65.135750	-137.939776
2019-07-08	14:46:59	**2005**	65.182100	-137.882035
2019-07-08	17:00:32	**2006**	65.239507	-137.826756
2019-07-08	17:18:41	**2007**	65.241828	-137.825430
2019-07-08	20:10:06	**2008**	65.305600	-137.678603
2019-07-08	18:06:44	**2009**	65.260195	-137.818370
2019-07-09	13:21:32	**2010**	65.319484	-137.656976
2019-07-09	16:37:37	**2011**	65.351170	-137.536593
2019-07-09	18:26:01	**2012**	65.384764	-137.459369
2019-07-11	11:25:28	**2013**	65.396912	-137.407971
2019-07-11	12:52:44	**2014**	65.429420	-137.341408
2019-07-11	13:54:07	**2015**	65.452938	-137.359116
2019-07-11	20:41:07	**2016**	65.537858	-137.332430
2019-07-12	12:35:05	**2017**	65.560757	-137.347817
2019-07-12	13:40:43	**2018**	65.576952	-137.416177

Date	Time	Sample_ID	Latitude	Longitude
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2019-07-12	15:29:24	**2020**	65.632772	-137.412687
2019-07-12	19:07:30	**2021**	65.686952	-137.464355
2019-07-13	14:02:44	**2022**	65.758544	-137.434427
2019-07-13	14:51:05	**2023**	65.760282	-137.428393
2019-07-13	16:09:03	**2024**	65.789683	-137.361016
2019-07-13	17:06:42	**2025**	65.787194	-137.324354
2019-07-13	18:53:35	**2026**	65.823434	-137.257504
2019-07-13	20:06:40	**2027**	65.854461	-137.256173
2019-07-13	20:16:47	**2028**	65.854051	-137.256396
2019-07-17	13:43:12	**2029**	65.854544	-137.256549
2019-07-17	13:52:58	**2030**	65.854074	-137.256441
2019-07-17	14:48:50	**2031**	65.861331	-137.179816
2019-07-17	17:20:33	**2032**	65.840996	-136.994929
2019-07-17	18:15:03	**2033**	65.834768	-136.985300
2019-07-18	11:48:51	**2034**	65.822590	-136.924299
2019-07-18	12:37:53	**2035**	65.817211	-136.867164
2019-07-18	12:53:11	**2036**	65.825952	-136.856639
2019-07-18	14:05:02	**2037**	65.838641	-136.747880
2019-07-18	14:37:19	**2038**	65.836222	-136.700117
2019-07-18	15:54:16	**2039**	65.821275	-136.666271
2019-07-18	16:35:49	**2040**	65.819369	-136.609963
2019-07-19	11:28:06	**2041**	–	–
2019-07-19	10:35:02	**2041**	65.856711	-136.377904
2019-07-19	11:23:41	**2042**	65.856513	-136.370809
2019-07-19	14:27:25	**2043**	65.874397	-136.321952
2019-07-19	17:10:10	**2044**	65.871509	-136.225449
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2019-07-20	13:54:34	**2046**	65.894859	-136.023667
2019-07-20	15:11:11	**2047**	65.891504	-136.015225
2019-07-20	15:43:19	**2048**	65.894060	-135.935473
2019-07-20	16:19:34	**2049**	65.874297	-135.894103
2019-07-20	20:10:15	**2050**	65.867083	-135.840420
2019-07-21	10:10:30	**2051**	65.868252	-135.847315
2019-07-21	17:50:42	**2052**	65.878293	-135.725568
2019-07-21	18:06:40	**2053**	65.878652	-135.726828
2019-07-23	16:03:53	**2054**	65.873285	-135.621588
2019-07-23	17:04:33	**2055**	65.886405	-135.573625
2019-07-23	18:44:47	**2056**	65.856431	-135.450684
2019-07-24	10:56:03	**2057**	65.837724	-135.428924

Date	Time	Sample_ID	Latitude	Longitude
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2019-07-24	12:27:04	**2059**	65.841122	-135.310757
2019-07-24	13:06:59	**2060**	65.840977	-135.308261
2019-07-24	15:24:10	**2061**	65.865713	-135.149669
2019-07-24	16:37:54	**2062**	65.908222	-135.079180
2019-07-24	18:29:42	**2063**	65.933460	-134.992523
2019-07-24	21:14:49	**2064**	–	–
2019-07-25	14:40:38	**2065**	65.983870	-134.649921
2019-07-25	15:20:15	**2066**	65.972071	-134.591042
2019-07-25	16:28:58	**2067**	65.942140	-134.603613
2019-07-25	17:39:54	**2068**	65.937263	-134.488920
2019-07-25	21:52:45	**2069**	65.938343	-134.492595
2019-07-26	12:29:18	**2070**	65.963277	-134.443725
2019-07-26	13:33:17	**2071**	65.941423	-134.412761
2019-07-26	14:47:44	**2072**	65.947026	-134.372156
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2019-07-28	13:04:47	**2076**	66.051853	-134.068603
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2019-07-28	18:59:55	**2082**	66.224129	-133.985569
2019-07-29	10:47:50	**2083**	66.257865	-133.976129
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2019-07-29	15:43:42	**2087**	66.415292	-133.933787
2019-07-29	17:30:05	**2088**	66.489321	-134.058841
2019-07-29	20:50:33	**2089**	66.498419	-134.158491
2019-07-30	10:14:56	**2090**	66.497523	-134.181220
2019-07-30	10:40:30	**2091**	66.497888	-134.183509
2019-07-30	10:51:36	**2092**	66.497409	-134.185697
2019-07-30	11:48:56	**2093**	66.501803	-134.207780
2019-07-30	12:52:12	**2094**	66.566577	-134.256158
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Date	Time	Sample_ID	Latitude	Longitude
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2019-07-30	21:49:43	**2099**	66.666396	-134.658098
2019-07-30	22:00:57	**2100**	66.666205	-134.659307
2019-07-31	11:12:15	**2101**	66.687076	-134.698526
2019-07-31	11:57:04	**2102**	66.713782	-134.687890
2019-07-31	13:20:06	**2103**	66.769923	-134.758781
2019-07-31	14:37:02	**2104**	66.792204	-134.858016
2019-07-31	16:16:29	**2105**	66.828691	-134.922344
2019-07-31	16:39:00	**2106**	66.828867	-134.922300
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2019-08-02	11:11:20	**2116**	67.121857	-134.991083
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2019-08-02	14:33:37	**2119**	67.198646	-135.017067
2019-08-02	16:39:15	**2120**	67.251925	-134.881959
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2019-07-02	18:46:58	**7004**	64.948724	-138.277330
2019-07-02	19:31:17	**7005**	64.777372	-138.363415
2019-07-02	19:44:56	**7006**	64.733135	-138.362436
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2019-07-07	17:04:07	**7008**	64.596983	-138.306910
2019-07-07	17:22:12	**7009**	64.605934	-138.340692
2019-07-07	17:51:29	**7010**	64.777423	-138.363539
2019-07-07	19:16:42	**7011**	64.835200	-138.362000
2019-07-07	18:50:37	**7012**	64.948610	-138.277400
2019-07-07	20:44:49	**7013**	65.715200	-137.993000
2019-07-08	10:55:26	**7014**	67.079443	-136.166860

Date	Time	Sample_ID	Latitude	Longitude
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2019-07-09	17:34:57	**7017**	67.187901	-135.689099
2019-07-09	10:55:31	**7018**	67.177011	-135.727112
2019-07-09	11:40:23	**7019**	67.179177	-135.823773
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2019-07-15	17:18:07	**7021**	64.777039	-138.362693
2019-07-15	17:28:51	**7022**	64.777400	-138.363400
2019-07-22	13:04:30	**7023**	64.948700	-138.277300
2019-07-15	21:12:16	**7024**	65.715603	-137.987298
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2019-07-16	13:38:22	**7026**	67.105624	-136.091566
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2019-07-30	10:28:59	**7043**	64.835534	-138.361910
2019-07-30	10:48:04	**7044**	64.948750	-138.274910
2019-07-30	12:09:36	**7045**	65.715231	-137.992402
2019-07-30	15:53:21	**7046**	67.079423	-136.167585
2019-07-30	16:10:11	**7047**	67.105651	-136.091417
2019-07-30	16:32:50	**7048**	67.179030	-135.823545
2019-07-30	16:50:24	**7049**	67.177067	-135.726966
2019-07-30	16:55:54	**7050**	67.177019	-135.724553
2019-08-05	17:23:39	**7051**	68.439708	-133.764428
2019-08-05	17:35:50	**7052**	68.447375	-133.762904
2019-08-05	17:50:46	**7053**	68.489096	-133.764968
2019-08-05	18:16:07	**7054**	68.632457	-133.652063

Date	Time	Sample_ID	Latitude	Longitude
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2019-08-05	19:22:23	**7057**	68.941688	-133.416215
2019-08-05	19:53:51	**7058**	69.079053	-133.107558
2019-08-05	20:39:55	**7059**	69.343860	-133.038471
2019-08-08	14:28:42	**7060**	68.285812	-133.251319
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2019-08-08	16:37:57	**7063**	67.381948	-134.151969
2019-08-08	17:15:05	**7064**	67.338996	-134.874286
2019-08-08	17:57:27	**7065**	67.177094	-135.724684
2019-08-08	18:03:42	**7066**	67.177093	-135.727127
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2019-08-09	00:29:07	**7074**	64.605655	-138.340933
2019-09-13	15:47:00	**7075**	64.605860	-138.340620
2019-09-13	16:16:00	**7078**	64.777400	-138.363400
2019-09-13	16:27:00	**7086**	64.835240	-138.362150
2019-09-13	16:45:00	**7076**	64.948670	-138.275450
2019-09-13	17:15:00	**7077**	65.159340	-138.370140
2019-09-13	18:18:00	**7080**	65.715170	-137.992790
2019-09-13	21:49:00	**7082**	67.079600	-136.166900
2019-09-13	22:05:00	**7085**	67.105530	-136.091540
2019-09-13	22:20:00	**7079**	67.179100	-135.823610
2019-09-13	22:30:00	**7083**	67.177080	-135.726960
2019-09-13	22:35:00	**7084**	67.177060	-135.724590
2019-09-13	23:17:00	**7081**	67.339580	-134.874830
2019-08-01	10:37:55	**9001**	66.881234	-134.985199

A.2 Sample list

Types of samples collected at each sampling location with the measured pH and electrical conductivity values (µS cm^{-1})

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
1001	x	x		x		x		x	x			7.59	1253
1002	x	x		x		x	x	x	x			4.74	276
1003	x	x		x		x	x	x	x			5.00	122
1004	x	x		x		x		x	x			8.84	112
1005	x	x		x		x		x	x			6.77	367
1006	x	x		x		x		x	x			7.41	284
1007	x	x		x		x		x	x			7.51	399
1008	x	x		x		x		x	x			7.84	375
1009	x	x		x		x	x	x	x			7.78	393
1010	x	x		x		x	x	x	x			6.76	454
1011	x	x		x		x	x	x	x			6.67	420
1012	x	x		x	x	x	x	x	x			7.75	404
1013	x	x		x		x	x	x	x			7.45	505
1014	x	x		x		x	x	x	x			7.73	411
1015	x	x		x		x		x	x			7.92	276
1016	x	x		x		x	x	x	x			8.14	304
1017	x	x		x		x	x	x	x			7.96	320
1018	x	x		x		x	x	x	x			8.14	411
1019	x	x		x		x	x	x	x			6.72	71
1020	x	x		x		x	x	x	x			7.08	116

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
2001	x	x		x		x		x	x			8.35	454
2002	x	x		-		x	x		x			7.95	488
2003	x	x		x		x		x	x			8.09	515
2004	x	x		x		x		x	x			8.23	350
2005	x	x		x		x		x	x			8.73	474
2006	x	x		x				x	x			7.28	469
2006a						x							
2006b						x							
2007	x	x		x				x	x			8.46	462
2008	x	x		x	x	x		x	x			8.84	486
2009	x	x		x		x		x	x			8.72	411
2010	x	x		x		x		x	x			7.88	872
2011	x	-		x		x		x	x			6.23	537
2012	x	x		x		x		x	x			8.06	555
2013	x	x		x		x		x	x			8.37	469
2014	x	x		x		x		x	x			7.52	711
2015	x	x		x		x		x	x			6.04	252
2016	x	x		x	x	x	x	x	x	x		6.98	488
2017	x	x		-		x		x	x			7.60	438
2018	x	x		x		x		x	x			7.36	657
2019	x	x		x		x		x	x			7.56	655
2020	x	x		x	x	x		x	x			-	-

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
2021	x	x		x		x		x	x			6.6	446
2022	x	x		x		x		x				6.48	424
2023	x	x		x		x		x	x			6.7	488
2024	x	x		x	x	x		x	x	x		7.15	91
2025	x	x		x		x		x	x			5.02	548
2026	x	x		x		x		x	x			7.3	411
2027	x	x		x	x	x		x		x		7.59	686
2028	x	x		x		x	x	x	x			8.2	500
2029	x	x		x	x	x	x	x	x	x		7.08	604
2030	x	x		x		x	x	x	x	x		6.5	483
2031	x	x		x		x	x	x	x			6.4	133
2032	x	x		x	x	x	x	x	x			7.9	165
2033	x	x		x		x	x	x	x			7.86	619
2034	x	x		x		x	x	x	x			7.56	410
2035	x	x		x	x	x	x	x	x	x		7.2	435
2036	x	x		x		x	x	x	x			8.2	583
2037	x	x		x		x	x	x	x			8.24	407
2038	x	x		x		x	x	x	x			6	88
2039	x	x		x		x	x	x	x			7.5	492
2040	x	x		x	x	x	x	x	x	x		7	680
2041	x	x		x	x	x	x	x	x	x		7.12	508
2042	x	x		x	x	x	x	x	x			7.98	554

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
2043	x	x		x		x	x	x	x	x		7.9	494
2044	x	x		x		x	x	x	x			6.9	498
2045	x	x		x		x	x	x	x			8.16	654
2046	x	x		x	x	x	x	x	x	x		6.7	606
2047	x	x		x		x	x	x	x			8.11	747
2048	x	x		x		x	x	x	x			8.3	637
2049	x	x		x		x	x	x	x			6.8	483
2050	x	x		x	x	x	x	x	x	x		8.05	607
2051	x	x		x		x	x	x	x			8.2	572
2052	x	x		x		x	x	x	x			7.4	898
2053	x	x		x		x	x	x	x			8.61	591
2054	x	x		x		x		x	x			7.2	541
2055	x	x		x		x		x	x			8.38	1784
2056	x	x		x		x		x	x			7.6	544
2057	x	x		x		x		x	x			8	478
2058	x	x		x		x		x	x			8.35	139
2059	x	x		x	x	x		x	x	x		8.7	438
2060	x	x		x	x	x	x	x	x	x		7.5	441
2061	x	x		x		x		x	x	x		8.1	294
2062	x	x		x	x	x	x	x	x	x		8	566
2063	x	x		x	x	x	x	x	x	x		7	584
2064	x	x		x	x	x	x	x	x	x		8.21	515

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
2065	x	x		x		x		x	x			6.3	789
2066	x	x		x	x	x		x	x	x	x	4.4	680
2067	x	x		x	x	x		x	x	x		8.4	1225
2068	x	x		x		x		x	x			7.2	2906
2069	x	x		x	x	x		x	x	x		8.09	570
2070	x	x		x	x	x	x	x	x	x		4.55	840
2071	x	x		x	x	x	x	x	x			2.95	2930
2072	x	x		x	x	x	x	x	x	x		8.1	793
2073	x	x		x	x	x	x	x	x		x	8.78	2434
2074	x	x		x	x	x	x	x	x	x		7.68	573
2075	x	x		x	x	x	x	x	x	x	x	8.25	649
2076	x	x		x		x	x	x	x			6.4	558
2077	x	x		x		x	x	x	x			8.61	1579
2078	x	x		x		x	x	x	x			8.44	1860
2079	x	x		x		x	x	x	x			8.68	1418
2080	x	x		x		x	x	x	x			8.64	1848
2081	x	x		x		x	x	x	x	x		8.53	2319
2082	x	x		x	x	x	x	x	x	x		8.29	569
2083	x	x		x		x	x	x	x			8.58	3963
2084	x	x		x		x	x	x	x	x		8.17	1215
2085	x	x		x		x	x	x	x			8.19	8670
2086	x	x		x		x	x	x	x	x		8.26	1493

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
2087	x	x		x		x	x	x	x			8	6230
2088	x	x		x		x	x	x	x	x		6.99	4710
2089	x	x		x		x	x	x	x	x		8.64	606
2090	x	x		x	x	x	x	x	x	x		7.8	724
2091	-	-		-		-			x			7.53	1332
2092	x	x		x	x	x	x	x	x	x	x	8.46	702
2093	x	x		x		x	x	x	x			8.45	2031
2094	x	x		x		x	x	x	x			7.77	1064
2095	x	x		x		x	x	x	x			8.27	3881
2096	x	x		x		x	x	x	x	x		8.3	544
2097	x	x		x		x	x	x	x	x		8.22	17200
2098	x	x		x		x	x	x	x			7.2	4402
2099	x	x		x	x	x	x	x	x	x		8.53	614
2100	x	x		x	x	x	x	x	x	x		8.13	1176
2101	x	x		x		x	x	x	x			7.92	4477
2102	x	x		x		x	x	x	x			7.43	508
2103	x	x		x		x	x	x	x			3.61	4027
2104	x	x		x		x	x	x	x			7.76	1395
2105	x	x		x	x	x	x	x	x	x		8.59	615
2106	x	x		x		x	x	x	x			8	237
2107	x	x		x	x	x	x	x	x	x		8.3	1012
2108	x	x		x		x	x	x	x	x		7.92	1847

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
2109	x	x		x		x	x	x	x			8	3709
2110	x	x		x		x	x	x	x			8.2	1278
2111	x	x		x		x	x	x	x	x	x	8.4	4633
2112	x	x		x		x	x	x	x	x	x	8.44	6145
2113	x	x		x		x	x	x	x	x		8	751
2114	x	x		x		x	x	x	x	x		8.55	438
2115	x	x		x	x	x	x	x	x			8.4	1060
2116	x	x		x	x	x	x	x	x	x		6.6	183
2117	x	x		x	x	x	x	x	x	x	x	8.3	1037
2118	x	x		x	x	x	x	x	x	x		8.6	670
2119	x	x		x		x	x	x	x			8.8	1409
2120	x	x		x		x	x	x	x			8.3	315
2121	x	x		x		x	x	x	x			7.8	616
2122	x	x		x	x	x	x	x	x		x	7.55	1280
2123	x	x		x		x	x	x	x			8.3	257
7001	x	x	x	x		x	x	x	x			8.12	632
7002	x	x	x	x		x	x	x	x			8.41	570
7003	x	x	x	x		x	x	x	x			7.88	881
7004	x	x	x	x		x	x	x	x			8.12	429
7005	x	x	x	x		x	x	x	x			8.05	457
7006	x	x	x	-		x	x	x	x			7.86	94
7007	x	x	-	x	x	x	x	x	x	x		-	-

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
7008	x	x	x	x		x	x	x	x			8.4	534
7009	x	x	x	x		x	x	x	x			7.9	739
7010	x	x	x	x		x	x	x	x			7.86	456
7011	x	x	x	x		x	x	x	x			8.3	409
7012	x	x	x	x		x	x	x	x			8	450
7013	x	x	x	x		x	x	x	x			8.15	614
7014	x	x	x	x		x	x	x	x			5	247
7015	x	x	x	x		x	x	x	x			6.43	957
7016	x	x	x	x	x	x	x	x	x	x		6.6	180
7017	x	x	x	x		x	x	x	x			7.5	53
7018	x	x	x	x	x	x	x	x	x	x		7.5	170
7019	x	x	x	x		x	x	x	x			7.4	95.1
7020	x	x	-	x		x	x	x	x			7.9	703
7021	x	x	-	x		x	x	x	x			7.8	460
7022	x	x	x	x		x	x	x	x			8.2	411
7023	x	x	x	x		x	x	x	x			8	471
7024	x	x	x	x		x	x	x	x			8.3	607
7025	x	x	x	x		x		x	x			5	38.3
7026	x	x	x	x		x	x	x	x			6.3	1243
7027	x	x	x	x		x	x	x	x			7.2	67
7028	x	x	-	x		x	x	x	x			7.4	401
7029	x	x	x	x		x	x	x	x			7.6	232

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
7030	x	x		x		x	x	x	x			7.4	340
7031	x	x		x		x	x	x	x			7.3	152.6
7032	x	x		x		x	x	x	x			7.5	63.7
7033	x	x		x	x	x	x	x	x	x		6.5	162
7034	x	x		x		x	x	x	x			6.7	1185
7035	x	x		x		x	x	x	x			5.3	86
7036	x	x		x		x	x	x	x			8.2	615
7037	x	x		x		x	x	x	x			8.25	302
7038	x	x		x		x	x	x	x			8.3	384
7039	x	x		x		x	x	x	x			8	460
7040	x	x		x		x	x	x	x			7.9	678
7041	x	x		x		x	x	x	x			6.52	821
7042	x	x		x		x	x	x	x			7.9	597
7043	x	x		x		x	x	x	x	x		8.1	459
7044	x	x		x		x	x	x	x			7	305
7045	x	x		x		x	x	x	x			6.3	730
7046	x	x		x		x	x	x	x			5.3	364
7047	x	x		x		x	x	x	x	x		5.86	1732
7048	x	x		x		x	x	x	x			4.3	107
7049	x	x		x		x	x	x	x			2.9	427
7050	x	x		x		x	x	x		x		3.6	798
7051	x	x		x		x	x	x				6	295

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
7052	x	x		x		x	x	x	x			6.1	341
7053	x	x		x		x	x	x	x			7.4	417
7054	x	x		x		x	x	x	x			7.7	207
7055	x	x		x		x	x	x	x			7.6	224
7056	x	x		x		x	x	x	x			7.5	221
7057	x	x		x		x	x	x	x			7.9	99
7058	x	x		x		x	x	x	x			8	165
7059	x	x		x		x	x	x	x			8.1	217
7060	x	x		x		x	x	x	x			7.7	162
7061	x	x		x		x	x	x	x			8.2	230
7062	x	x		x		x	x	x	x			7.8	364
7063	x	x		x		x	x	x	x			8.1	227
7064	x	x		x		x	x	x	x			8.3	607
7065	x	x		x		x	x	x	x			7.6	234
7066	x	x		x		x	x	x	x			7.2	153
7067	x	x		x		x	x	x	x			7.9	90
7068	x	x		x		x	x	x	x			6.7	1126
7069	x	x		x		x	x	x	x			6.9	727
7070	x	x		x		x	x	x	x			8.3	730
7071	x	x		x		x	x	x	x			8.5	418
7072	x	x		x		x	x	x	x			8.5	494
7073	x	x		x		x	x	x	x			8.3	590

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
7074	x	x		x		x	x	x	x			8.1	867
7075	x	x		x		x	x	x	x				747
7076	x	x		x		x	x	x	x				442
7077	x	x		x		x	x	x	x				410
7078	x	x		x		x	x	x	x				341
7079	x	x		x		x	x	x	x				1260
7080	x	x		x		x	x	x	x				585
7081	x	x		x	x	x	x	x	x				40
7082	x	x		x		x	x	x	x				1393
7083	x	x		x	x	x	x	x	x				83.7
7084	x	x		x	x	x	x	x	x				183
7085	x	x		x		x	x	x	x				231
7086	x	x		x	x	x	x	x	x				454
Peel 05-jul-2019	x	x		x	x	x	x	x	x				
Peel 12-jul-2019	x	x		x	x	x	x	x					
Peel 16-jul-2019	x	x		x	x	x	x	x	x				
Peel 25-jul-2019	x	x		x		x	x	x	x				
Peel 03-aug-2019	x	x		x	x	x	x	x	x				
Blank 1				x					x				
Blank 2				x					x				
Blank 3				x					x				

Sample ID	Anions	Cations	DOC (AWI)	DOC (VU)	$\Delta^{14}C$-DOC	Stable Isotope Water	DIC (VU)	CDOM	POC, TSS	Bio-marker	Sedi-ment	pH	Electrical Conductivity [µS/cm]
Blank 4				x					x				
Blank 5				x					x				
Blank 6				x					x				
Blank 7				x									
Blank 8				x									
Blank 9				x									

A.3 Sampling protocol

Sampling considerations:
- label the bottle/wine bag before taking the sample. It is always important to rinse the sampling bottles/ wine bags three times with the river/stream water that you are about to sample.
- When sampling with a bottle take the sample so that no air will be left in the bottle (close the lid under water if possible).

How to filter and subsample:

Needed (for standard filtration; additional for large volume filtration):

- *1 liter bottle (completely, no bubbles) filled with sample*
- pre-labeled sampling bottles for:
  - water isotopes (10 mL narrow neck PE bottle)
  - DIC (12 ml exetainer with white cap, glass)
  - CDOM (15 ml falcon tube with blue cap, plastic)
  - DOC/δ^{13}C-DOC (40 ml Amber bottle, glass)
  - anions (8 mL wide-mouth Nalgene bottle, plastic)
  - cations (15 mL centrifuge tube, plastic)
- ca. 100mL glass beaker
- syringe 30 or 60 mL
- syringe filters (25mm diameter, 0.7 um GF/F)
- 47 mm plastic filter tower
- hand vacuum pump
- gloves (Nitril)
- pre-weighed and pre-combusted 47mm fiberglass filters (GF/F) in petrislides
- tweezers
- Pure HCl acid 37 %
- Suprapure 65% HNO_3 acid
- 90 mm stainless steel filtration unit
- Pre-combusted 90 mm fiberglass filters (GF/F)
- VWR ziplock bags for storing the 90 mm fiberglass filters (GF/F)
- pre-labeled bottle for Δ^{14}C-DOC and DOM composition (250 ml polycarbonate bottles).

Notes:

- Always write down how much water (volume!) you filter! (either before or after filtration)
- For representative analyses of suspended sediments, always shake right before you decant sample water from the sample container. This is to ensure that the remaining sample water in the sample container contains the same amount of particles as the sample water that was decanted.
- If the sample is VERY turbid, decant less than 500mL into the filter tower (see step 2) to not overload your GF/F filter.

AT <u>EVERY</u> STATION, standard filtration (car and canoe), follow steps in the below order:

<u>1. for water isotopes and DIC</u>

shake-and-decant 50mL out of the 1L sample bottle into a clean beaker

<u>1a. water isotopes</u>: use pre-labeled 10 mL narrow-neck PE bottles
fill from the beaker into the pre-labeled bottle, fill completely (no bubbles!), cap.
preservation: store cold (AWI)

<u>1b. DIC:</u> use pre-labeled glass exetainer 12mL
- use gloves as there is a drop of KI (potassium iodine) in the bottom of the exetainers that might cause skin irritation if spilled
- fill a syringe with ca. 25mL sample water from the beaker, then attach the filter holder with GF/F filter on it.
- rinse filter with 10mL sample (push out and discard water)
- then fill 12mL exetainer with 12mL sample till the top of the vial (no bubbles/air inside).

preservation: store cold (VU)

<u>2. for the remaining parameters</u>

Filter the remaining sample water on the 47mm filter tower as follows:

- make sure the filter tower is clean
- disconnect the top part of the filter tower
- place a 47 mm GF/F filter (pre-weighed, pre-combusted and pre-labeled on petrislides) onto the filter grid (use gloves and tweezers), and re-attach the top part of the filter tower.
- Attach the hand vacuum pump (see photo) to the lower part and apply vacuum by hand.

Shake-and-decant about 500mL sample water into the filter tower. **NOTE EXACT WATER VOLUME** in notebook and on petrislide (see photo). Use vacuum pump to filter the water through until the filter is nearly dry.

<u>2a. TSS and POC</u>:
Carefully remove the filter with forceps (without disturbing the collected POC and/or the filter) and place it in a petrislide. Note down volume (mL water) and sample station on petrislide. Wrap tape around petrislide to keep it closed.
preservation: frozen, in the dark (VU)

The filtrate (what has gone through the filter) is now divided over four bottles

2b. CDOM: use pre-labeled 15 mL falcon tube with blue cap
- fill falcon tube with ca. 12 mL of filtrate (not completely, to avoid bursting in freezer!)

preservation: freeze, store in dark (VU)

2c. DOC/δ^{13}C-DOC: use pre-labeled 40mL amber glass bottle
- fill glass bottle with about 30mL of filtrate
- add 30 µL of concentrated pure HCl acid (37%)

preservation: store cool, and dark (VU)
(*At some locations please take DOC samples for AWI as well – in clear glass 20 mL vials acidified with 20-50 µL 30% suprapure HCl acid!!*)

2d. Anions: use pre-labeled 8 mL wide-mouth Nalgene bottle
- fill with about 6 mL of filtrate (not completely filled)
preservation: store cool, and dark (AWI)

2e. Cations: use pre-labeled 15 mL centrifuge tube
- fill centrifuge tube with 15 mL of filtrate
- Add 250 uL of 65% suprapur HNO_3 acid
preservation: store cool, and dark (AWI)

AT SELECTED STATIONS (ca. 15-25), larger volumes.
Additional water is collected in 5L or 10L wine bags. This is filtered using the 90 mm stainless steel filtration unit.

- make sure the filter unit is clean (rinse with a little bit of your sample water?)
- disconnect the filter tower of the lower part by unscrewing the screws at the bottom
- place a 90 mm GF/F filter onto the filter grid (use gloves and tweezers), and re-attach the top part of the filter tower.
- put a (clean!) bucket or a measuring cup under your filter tower because you want to collect the filtrate for $\Delta^{14}C$-DOC!
- shake-and-decant (not too violently) ca. 1 L of water into the filter unit and **NOTE EXACT WATER VOLUME** in notebook.
- attach lid onto filtration unit, tighten screws
- attach bike pump and apply pressure until sample water has gone through.
- if filter is not clogged (i.e. sample runs through faster than dripping speed), remove the lid of the filtration unit and add more sample water again shaking prior to decanting, and keeping track of the volume!
- remove the bike pump hose carefully: one has to push onto the hose connection while simultaneously pulling it out (otherwise you tear the hose).
- when the filter is clogged: unmount the filter unit.

3a. POM-composition
- fold the 90 mm GF/F filter twice using tweezers while keeping it on the filter holder. Take the folded filter off with tweezers and store it in a pre-labeled VWR ziplock bag (write water volume on the bag).
preservation: freeze, in the dark (VU)

Use the filtrate for:

3b. $\Delta^{14}C$-DOC: use pre-labeled 250 mL polycarbonate bottle
- fill polycarbonate bottle with ca. 210 mL (so not completely to avoid bursting in freezer!)
preservation: freeze, in the dark (VU)

3c. DOM-composition: use pre-labeled 100 mL glass bottles (red screw caps)
- use gloves! fill glass bottle to the top, avoid bubbles when possible
preservation: dark and cold (GFZ) (don't forget the occasional filter blank!)

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