Biodegradable dissolved organic carbon (BDOC) and associated physical and chemical measurements from a boreal first-order stream reach.

SND-ID: 2024-636. **Version**: 1. **DOI**: https://doi.org/10.5878/2nd9-fw71

Download data

Groundwater.csv *(2.42 KB)*

Incubation duration.csv *(9.91 KB)*

Lakewater.csv *(593 bytes)*

Landscape.csv *(281 bytes)*

Soil.csv *(13.23 KB)*

Streamwater.csv *(2.86 KB)*

Associated documentation

Data_description_revised_2024_01_13.txt *(30.09 KB)*

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2024-636-1.zip *(~59.37 KB)*

Citation

Reidy, M. (2025) Biodegradable dissolved organic carbon (BDOC) and associated physical and chemical measurements from a boreal first-order stream reach (Version 1) [Data set]. Umeå University. Available at: https://doi.org/10.5878/2nd9-fw71

Creator/Principal investigator(s)

Melissa Reidy - Swedish University of Agricultural Science

Research principal

Umeå University - Department of Ecology and Environmental Science

Description

Nine riparian sites along a boreal first-order stream were sampled for the purposes of assessing the percentage of biodegradable dissolved organic carbon (bDOC) in soil, groundwater, streamwater and lake water across 8 occasions between July to October 2022. These sites were sampled to encompass the variation in riparian hydrogeomorphology present within boreal headwaters, and to investigate bDOC concentrations within a land to water continuum. All water samples and soil solutions from extractions were also analysed for dissolved organic carbon, dissolved nutrients and optical properties. All soils were analysed for bulk organic matter content, extracellular enzyme activity (total of 5 enzymes) and phospholipid fatty acid (PLFA) content.
This data was collected from the Stortjärnbäcken stream reach in the Krycklan Catchment Study within the Svartberget Research Station (64°14’N, 19°46’E, Vasterbottens lan, Sweden) in collaboration with the Swedish University of Agricultural Sciences (SLU).

Data contains personal data

No

Language

English

Time period(s) investigated

2022-07-04 – 2022-10-24

Data format / data structure

Numeric

Data collection 1

- Mode of collection: Laboratory experiment
- Description of the mode of collection: We analyzed riparian soil PLFA composition from all depths and sites for each of the 4 previously detailed sampling occasions, plus 5 additional timepoints throughout the season. Prior to analysis, samples were stored frozen and then freeze-dried. Samples were extracted with a modified method of Bligh and Dyer (1959) and White et al. (1979). For analysis, samples were injected by the means of splitless injection and separated on a 60 m x 0.25 mm x 0.20 µm ZB-FAME column (Phenomenex, USA) and measured on a single quadrupole mass spectrometer. Concentrations are reported in nmol/g soil.
- Time period(s) for data collection: 2022-07-04 – 2022-10-24
- Sample: Riparian soil
  Riparian soil sampled with a bucket auger. Soils were sampled from 3 depths (0-15 cm, 15-30 cm and 30-50 cm belowground surface). Soils were sampled from a total of 9 riparian sites along the Stortjärnbäcken stream reach. After sampling, soils were kept in air tight plastic bags and transported in coolers.

Data collection 2

- Mode of collection: Laboratory experiment
- Description of the mode of collection:
  Biodegradable dissolved organic carbon (BDOC) as measured from riparian soil solutions, riparian groundwater, stream water and lake water. Soil was sampled from three depth increments from surface level to 50 cm deep (shallow: 0-15 cm, mid-depth: 15–30 cm, deep: 30-50 cm) and kept in plastic air-tight bags and chilled (°4C) until processing within 24 hours.
  The method for extracting soil water from fresh riparian soils was adapted from Werdin-Pfisterer et al., (2009) and Rousk and Jones (2010). To minimize degradation of the labile soil DOM pool the extraction process was started within 4-6 hours of the samples being taken from the site. 24 g fresh soil and 180 ml Milli-Q water were combined in 250 ml Nalgene® centrifuge bottles then shaken with orbital shaker at 260 rpm for 10 minutes then centrifuged for 15 minutes at 4°C and 14000 rpm using the AvantiTM J-20 XP centrifuge (Beckman Coulter). Soil extracts in solution were syringe filtered from the bottle (0.45 µm Filtropur S; Sarstedt AG) and then stored at +4°C or -18°C for future analysis. Samples for DOC analysis were acidified with 4% HCl prior to chilling.
  We sampled riparian groundwater with a peristaltic pump affixed to a drill and groundwater height was measured manually. Due to low groundwater levels at some sites, we were unable to take a large enough sample for incubation and analysis on certain occasions. Stream samples were taken from the middle of the stream nearest to the riparian well with an additional sample from Stortjärnen Lake taken from the same location each time. Water samples were filtered (0.45 µm Filtropur S; Sarstedt AG), then stored at +4°C or -18°C depending on subsequent analysis.
  Soil extracts, streamwater, groundwater and lake water were prepared for bDOC incubations using adapted methods from Koehler et al. (2012). 100 ml of filtered sample was aliquoted to a 200 ml

pre-autoclaved amber glass bottle. To ensure each bottle had a microbial population representative of the riparian area, an inoculum of subsamples from all lake, groundwater and streamwater from the day of sampling was collected and filtered through Whatman GF/C filters (1.2 µm pore size) and added to incubation vials at a ratio of 5 % of total incubation volume. Four blank incubations of 100 ml of Milli-Q with inoculum added were included in each bioassay. Incubation bottles were kept capped and in a light proof container at ambient temperature for the duration of 28 days. At intervals of 1, 3, 7, 14 and 28 days after incubation start, 15 ml of sample from the incubation bottle was syringe-filtered (0.45 µm Filtropur S; Sarstedt AG), to remove microbial biomass from subsamples, acidified with 4% HCl at a ratio of 100 µl HCl to 10 ml filtered sample, then all samples chilled until DOC analysis.
For all landscape components, we calculated the percentage loss of the initial DOC pool after a period of time (%bDOC) as

%bDOC = (DOC mg/L_initial – DOC mg/L_final) / (DOC mg/L_initial) x 100

where DOC_initial and DOC_final are DOC concentrations in the soil water extractions, groundwater, stream water or lake water at the beginning (initial) and end (final) of the incubation period, respectively.

For soils, we also calculated the mass loss of bDOC (‘mass_bDOC’ in mg/g soil). This term is applicable for soils only as it accounts for the variation in initial dry mass of soils, which may differ between sites due to sample water content. This calculation uses the constant 0.18 to account for the 0.18 L of Milli-Q water added during the extraction process. Using the massbDOC term allows us to move beyond a compositional assessment (i.e., %bDOC) and consider the capacity of a given soil to yield a mass of useable DOC.

mass_bDOC = (DOC x 0.18) / dry weight (g)

where DOC is the concentration in the soil water extraction and weighht is the initial dry mass of soil.

mass_bDOC = massDOC(initial) - massDOC(final)

where massDOC(initial) and massDOC(final) are the soil DOC concenrations at the beginning (initial) and end (final) of the incubation period respectively.

- Time period(s) for data collection: 2022-07-04 – 2022-10-24
- Sample: Riparian soil
  Riparian soil sampled with a bucket auger. Soils were sampled from 3 depths (0-15 cm, 15-30 cm and 30-50 cm belowground surface). Soils were sampled from a total of 9 riparian sites along the Stortjärnbäcken stream reach. After sampling, soils were kept in air tight plastic bags and transported in coolers.
- Sample: Riparian groundwater
  Riparian groundwater from 9 riparian groundwater wells that are made of PVC, screened and have diameter of 30 mm. Riparian groundwater was sampled with a peristaltic pump affixed to a drill.
- Sample: Stream water
  Stream water sampled from the Stortjärnbäcken stream directly adjacent to the corresponding riparian site. Samples were collected using grab sampling.
- Sample: Lake water
  Lake water sampled from the Stortjärnen Lake. Samples were always taken from the landing immediately at the shore of the lake.

Data collection 3

- Mode of collection: Laboratory experiment
- Description of the mode of collection:
  β-Glucosidase: β-Glucosidase activity was measured using an adapted method from Deng and Popova (2011). To 1 g of fresh soil, 0.2 mL of toluene was added to cease any microbial activity. After 15 minutes, 4 mL of Modified Universal Buffer (MUB), ph. 6, and 1 mL of p-Nitrophenyl-β-d-glucoside (PNG) solution was added. After shaking at room temperature for 1 hour, 1 mL of 0.5 M CaCl2 solution and 4 mL of tris(hydroxymethyl)aminomethane buffer (THAM), pH 12, was added to the sample. Samples were centrifuged for 3 minutes at 3000 RPM and 100 µl of supernatant analysed for absorbance at 405 nm. Activity is expressed as µmol p-Nitrophenol g-1 dry soil h-1.
  Cellulase: Cellulase activity was measured with a modified method from Deng & Popova (2011). To 1 g of fresh soil, 0.2 mL of toluene was added. After 15 minutes, 20 mL of 2% carboxymethyl cellulose (CMC) solution was added and samples shaken at room temperature for 24 hours. After 24 hours, samples were centrifuged at 3000 RPM for 3 minutes and 1 mL supernatant aliquoted and frozen until colorimetric analysis. Samples were assayed using a Glucose Assay Kit (Sigma Aldrich) with recommended protocol and analysed at 570 nm.
  Protease: Protease activity was measured with a modified method from Kandeler et al. (1996). To 0.5 g fresh soil, 2.5 mL casein substrate solution and 2.5 mL of tris(hydroxymethyl)aminomethane (TRIS) buffer, pH 8.1 was added. Samples were shaken at room temperature for 2 hours. After incubation, 2.5 µl Trichloroacetic acid (TCA) was added and samples centrifuged for 3 minutes at 3000 RPM. Supernatant was aliquoted and frozen for later analysis. For the colorimetric assay, samples were thawed and measured at 750 nm. Protease activity is expressed as ug Tyrosine g-1 dry soil h-1.
  Phenol Oxidase and Peroxidase: Phenol Oxidase and Peroxidase activity were measured simultaneously with a method modified from Saiya-Cork et al. (2002) and Prosser et al. (2011). To 1 g fresh soil, 3 mL of 50 mM Sodium Acetate buffer (ph. 5) was added. For Phenol Oxidase analysis, 2 mL of 10 mM L-3,4-dihydroxyphenylalanine (L-DOPA) was added. For Peroxidase analysis, 2 mL of L-DOPA solution and 0.2 mL 0.3% Peroxide (H2O2) solution was added. Samples were shaken for 2 hours at room temperature, then centrifuged at 3000 RPM for 3 minutes. 100 µl was analysed for absorbance at 450 nm. Phenol Oxidase activity is expressed as nmols L-DOPA g -1 dry soil h-1. Peroxidase activity is expressed as nmols L-DOPA g -1 dry soil h-1 after subtraction of Phenol Oxidase activity.
- Time period(s) for data collection: 2022-07-04 – 2022-10-24
- Sample: Riparian soil
  Riparian soil sampled with a bucket auger. Soils were sampled from 2 depths (0-15 cm and 15-30 cm). Soils were sampled from a total of 9 riparian sites along the Stortjärnbäcken stream reach. After sampling, soils were kept in air tight plastic bags and transported in coolers.

Data collection 4

- Mode of collection: Laboratory experiment
- Description of the mode of collection:
  Soil organic matter content was measured as loss on ignition (%LOI) over 5 hours at 550 °C. Mass fractions of soil C and N were measured using an isotope ratio mass spectrometer (DeltaV,Thermo Fisher Scientific, Bremen, Germany) and elemental analyzer (Flash EA 2000, Thermo Fisher Scientific, Bremen, Germany). DOC analysis was measured by combustion (870 ºC) of acidified water samples (bubbled with O2), and then analyzed with an infrared gas analyzer. The samples are analyzed on a Formacs HT-I from Skalar. TDN was analyzed on an ND25 unit connected to the Fomacs using a chemiluminescent detector. Dissolved and total nutrients was analyzed by measuring color on a photometer in a segmented flow analyzer, after various reagents have been added. NO3 (NO3+NO2) after reagents and samples passed a copperized Cd reduction coil to form an azo dye [method: MT3B Q-126-12 Rev 1]. NH4 with the salicylate method [method: Q-033-04

Rev. 8] and PO4 with the molybdenum blue method [method: MT3A Q-125-12 Rev 1]. DIN was calculated as the sum of NO3- and NH4+. Dissolved organic nitrogen (DON) was calculated by subtracting DIN from TDN.
We measured DOC quality using an Aqualog spectrophotometer (200-600 nm, 1 nm increments) of all soil extractions and water samples from each initial sampling point, in 1 cm quartz cuvettes. All spectra were corrected for blank absorption (Milli-Q). We used absorbance data to calculate SUVA254 (specific ultraviolet absorbance at 254 nm) and the absorbance ratio of A254:A365. SUVA254 is an indicator of the aromaticity of DOC, with lower values indicative of fresher, less aromatic DOC and higher values the opposite (Weishaar et al. 2003). The absorbance ratio of A254:A365 is a complementary indicator of DOC quality, with higher values indicative of lower molecular weight DOC (Dahlén et al. 1996) and positive correlations with bacterial productivity (Ågren et al. 2008).

- Time period(s) for data collection: 2022-07-04 – 2022-10-24

Geographic spread

Geographic location: Sweden, Västerbotten County

Geographic description: Svartberget Research Station/Krycklan Catchment Study 64°14′N, 19°46′E, Vasterbottens lan, Sweden. Samples were collected from the Stortjärnbäcken stream reach within the Krycklan Catchment Study site, inclusive of samples taken from Stortjärnen Lake.

Responsible department/unit

Department of Ecology and Environmental Science

Other research principals

Swedish University of Agricultural Sciences

Contributor(s)

Ryan Sponseller - Umeå University, Department of Ecology and Environmental Science

Martin Berggren - Lund University, Department of Physical Geography and Ecosystem Science

Anna Lupon - Centre for Advanced Studies of Blanes, Integrative Freshwater Ecology Group

Hjalmar Laudon - Swedish University of Agricultural Science, Department of Forest Ecology and Management

Funding 1

- Funding agency: Swedish Research Council
- Funding agency's reference number: 2018-04395_VR
- Project name on the application: Exploring new connections between land and water: the importance of tree roots in edge zones for surface water ecosystem dynamics
- Funding information: Funding for Melissa Reidy and this research was through the Swedish Research Council (VR, Grant number 2018-04395_VR).

Funding 2

- Funding agency: Swedish Research Council
- Funding agency's reference number: 2021-00164_VR
- Project name on the application: Swedish infrastructure for ecosystem research - SITES
- Funding information: The Krycklan Catchment Study infrastructure are funded by the Swedish Research Council (VR; SITES, Grant number 2021-00164_VR)

Research area

Environmental sciences (Standard för svensk indelning av forskningsämnen 2011)

Oceanography, hydrology and water resources (Standard för svensk indelning av forskningsämnen 2011)

Soil science (Standard för svensk indelning av forskningsämnen 2011)

Environment (INSPIRE topic categories)

Inland waters (INSPIRE topic categories)

Keywords

Headwater stream, Inland water, Dissolved organic matter, Riparian zone, Soil, Boreal zone

Publications

Reidy,M., Berggren, M., Lupon, A., Laudon, H., & Sponseller, R.A. (In review). Riparian zone heterogeneity influences the production and fate of biodegradable dissolved organic carbon at the land-water interface. Journal of Geophysical Research - Biogeosciences.

Point (Lon/Lat)

19.761672, 64.260947

Accessibility level

Access to data through SND
Data are freely accessible

Use of data

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Versions

Version 1. 2025-02-26

Contact for questions about the data

Melissa Reidy
melissa.reidy@gmail.com

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DataCite

DDI 2.5

DDI 3.3

DCAT-AP-SE 2.0

JSON-LD

PDF

Citation (CSL)

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