# EDI Metadata Template (2020)[[1]](#footnote-1)

Data should be in csv text file. If starting with an Excel spreadsheet, please make sure it does not contain any formulas and comments on cells. If you need comments put them in their own column. If data were used in a database and major table linking is necessary to analyze, please de-normalize into a flat file, not just database table exports.

## Dataset Title

(be descriptive, more than 5 words):

## A unified dataset of co-located sewage pollution, periphyton, and benthic macroinvertebrate community and food web structure from Lake Baikal (Siberia)

## Abstract

(include what, why, where, when, and how)

## Sewage released from lakeside development can introduce nutrients and micropollutants that can restructure aquatic ecosystems. Lake Baikal, the world’s most ancient, biodiverse, and voluminous lake, has been experiencing localized sewage pollution from lakeside settlements. Increasing filamentous algal abundance suggests benthic communities are responding to this localized pollution. We surveyed 40-km of Lake Baikal’s southwestern shoreline 19-23 August 2015 for sewage indicators, including pharmaceuticals, personal care products, and microplastics with co-located periphyton, macroinvertebrate, stable isotope, and fatty acid sampling. Unique identifiers corresponding to sampling locations are retained throughout all data files to facilitate interoperability among the dataset’s 150+ variables. The data are structured in a tidy format (a tabular arrangement familiar to limnologists) to encourage future reuse. For Lake Baikal studies, these data can support continued monitoring and research efforts. For global studies of lakes, these data can help characterize sewage prevalence and ecological consequences of anthropogenic disturbance across spatial scales.

## Investigators

(list in order as for a paper with e-mail addresses, organization and preferably ORCID ID, if you don’t have one, get it, it’s easy and free: <http://orcid.org/>) add table rows as needed

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| First Name | Middle Initial | Last Name | Organization | e-mail address | ORCID ID (optional) | Role in project |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## License

(Select a license for release of your data. We have 2 recommendations: [CCO – most accommodating of data reuse](https://creativecommons.org/publicdomain/zero/1.0/), & [CCBY – requires attribution](https://creativecommons.org/licenses/by/4.0/))

CCO

## Keywords

(List keywords and separate with commas. Using keywords from a controlled vocabulary (CV) will improve the future discovery and reuse of your data. The LTER CV is effective at describing ecological and environmental data. [Access the LTER CV here](http://vocab.lternet.edu/vocab/vocab/index.php). [Try this text mining service to extract LTER CV keywords from your abstract or methods](http://vocab.lternet.edu/keywordDistiller/). Additionally, please determine one or two keywords that best describe your lab, station, and/or project (e.g., Trout Lake Station, NTL LTER). This will help others discover your data by site/project).

Pharmaceuticals and Personal Care Products, Amphipoda, diatom, Spirogyra, Ulothrix, fatty acids, foodwebs

## Funding of this work:

Add rows to table if several grants were involved, list only the main PI, start with main grant first:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PI First Name | PI Middle Initial | PI Last Name | PI ORCID ID (optional) | Title of Grant | Funding Agency | Funding Identification Number |
| Stephanie | E | Hampton |  | Dimensions of Biodiversity | NSF | NSF-DEB-1136637 |
| Michael | F | Meyer |  | Graduate Research Fellowship | NSF | NSF-DGE-1347973 |
| Michael | F | Meyer |  | Fulbright Fellowship | US State Department |  |
| Maxim | A | Timofeyev |  |  | Russian Ministry of Science and Education | N FZZE-2020-0026 |
| Maxim | A | Timofeyev |  |  | Russian Ministry of Science and Education | N FZZE-2020-0023 |

## Timeframe

* Begin date: August 19 2015
* End date August 23 2015
* Data collection ongoing/completed: completed

## Geographic location

* Verbal description: Southwestern shore of Lake Baikal between the town of Listvyanka and the village of Bolshoe Goloustnoe
* North bounding coordinate (decimal degree): 52.02693
* South bounding coordinate (decimal degree): 51.85530
* East bounding coordinate (decimal degree): 105.4724
* West bounding coordinate (decimal degree): 104.8148

## Taxonomic species or groups

## Methods

(please be specific, include instrument descriptions, or point to a protocol online, if this is a data compilation please specify datasets used, preferably their DOI or URL plus general citation information)

*Site Information*

The vast majority of Lake Baikal’s 2,100-km shoreline lacks lakeside development (Moore et al. 2009; Timoshkin et al. 2016). Our sample collection focused on a 40-km section of Lake Baikal’s southwestern shoreline, which included three settlements of different sizes (Figure 1) during a time of the year when tourism and summertime biological succession were likely at their annual peaks. Littoral locations were chosen to capture a range of sites with varying degrees of adjacent shoreline development – from “developed” (along the waterfront of human settlements) to “undeveloped” (no adjacent human settlements and complete forest cover; Figure 1). The largest, Listvyanka, is primarily a tourist town of approximately 2000 permanent residents, although tourism can contribute significantly to the town’s population with approximately 1.2 million annual visitors (Interfax-Tourism 2018). The other two settlements are the villages Bolshie Koty and Bolshoe Goloustnoe, which have approximately 80 and 600 permanent residents, respectively. Bolshie Koty is home to two field research stations and several small tourist accommodations. Bolshoe Goloustnoe has several hotels and tourist camps.

To assess disturbance gradients and ecological responses from littoral-to-pelagic zones and laterally along the shoreline, our transect consisted of 17 sampling sites that were meant to characterize differences along these gradients. Pelagic sites were located 2 to 5 km offshore from each of the developed sites in water depths of 900 to 1300 m (Figure 1; Table 1). All littoral sites were sampled at approximately the same depth (max depth of ~1.25 m) at a distance of 8.90 to 20.75 m from shore (Table 1), which allowed us to collect samples without the need for SCUBA but precluded us from sampling deeper littoral environments. Due to this constraint, only littoral sites contain macroinvertebrate and algal samples. Otherwise, data are available for both littoral and pelagic sites. At each site, air temperature was measured with a mercury thermometer, and photographs were taken of the substrate and the shoreline. Visual inspection of substrate photographs suggested that littoral sites’ substrate was consistent among sites and generally was characterized by large, oblate rocks and gravel.

*Inverse distance weighted (IDW) population calculation for each sampling location*

We recognized that sewage indicator concentrations at each sampling location may be related to a sampling location’s spatial position relative to both the size and proximity of neighboring developed sites. Therefore, we created the inverse distance weighted (IDW) population metric to compress, into a single metric, information about human population size, density, and location along the shoreline as well as distance between developed sites and sampling locations.

Our workflow for calculating IDW population required five steps. First, we traced polygons of each lakeside development’s perimeter and line geometries of each development’s shorelines from satellite imagery for each developed site in Google Earth. Polygons were traced for the entire area of visible development. Similarly, shoreline traces only reflected shoreline length for which there was visible development. Second, polygon and line geometries were downloaded from Google Earth as a .kml file. Third, the .kml file was imported into the R statistical environment (R Core Team 2019), where using the sf package (Pebesma 2018) we calculated shoreline length, polygon area, and centroid location for each developed site. Fourth, we joined point locations of each sampling site with the spatial polygons to calculate the distance from each sampling location to each developed site’s centroid. Fifth, we calculated IDW population for each sampling location, using formula (1)

(1)

where *I* is the IDW population at sampling location *j*, *P* is the population at each of the three developed sites Listvyanka (LI), Bolshie Koty (BK), Bolshoe Goloustnoe (BGO), *A* is the area of a developed site in km2, *L* is the shoreline length at a developed site in km, and *D* is the distance from developed site *j* to each developed site’s centroid in km. As these population estimates are based on census data, they reflect current, static populations and do not account for seasonal population swings from tourism.

*Nutrients*

Water samples for nutrient analyses were collected in 150 mL glass jars that had been washed with phosphate-free soap and rinsed three times with water from the sampling location. Samples were collected at a depth of approximately 0.75 m in duplicates and immediately frozen at -20°C until processing at the A. P. Vinogradov Institute of Geochemistry (Siberian Branch of the Russian Academy of Sciences, Irkutsk). Samples were not filtered prior to freezing, meaning that nitrogen and ammonium concentrations may include intracellular nitrogen and overestimate dissolved nitrogenous forms in the water column.

For ammonium (RD:52.24.383-2018 2018) and nitrate (RD:52.24.380-2017 2018) concentrations, samples were analyzed with a spectrophotometer (SF-26). GSO 7258-96 and 7259-96 standards of 1 g/L stock concentration were used to calibrate nitrate and ammonium measurements, respectively. When nitrate and ammonium analyses could be performed within 24 h after thawing, samples were kept at 2-8°C without addition of preservative agents. When nitrate analyses were performed between 24-48 h after thawing, samples were kept at 3-5°C and chloroform was added as a preservative at a ratio of 2-4 mL per 1 L of sample volume. When ammonium analyses were performed within 24-96 h after thawing, samples were kept at 3-5°C and ~10% sulfuric acid solution was added as a preservative. Phosphorus concentration was measured with a spectrophotometer (SF-46) following the addition of persulfate (GOST:18309-2014 2016). When possible, samples were analyzed within three hours of thawing. When analyses could not be performed within three hours, samples were kept at 3-5°C and chloroform was added as a preservative at a ratio of 2-4 mL per 1 L of sample volume. Minimal detection limits were estimated as 0.01 mg/L for nitrate, 0.005 mg/L for ammonium, and 0.04 mg/L for phosphorus. Concentrations are reported in mg/L of each analyte.

For comparable methods in English, we recommend data users consult International Standards Organization (ISO) (1984) and ISO (2004) as analogs. Copies of the Russian-language methods are included in the Open Science Framework portal within the directory “Nearshore\_sampling/methods”.

*Chlorophyll a*

Water samples were collected in 1.5 L plastic bottles from a depth of approximately 0.75 m. Although we did not note the plastic bottles’ materials within the field, all bottles for chlorophyll a measurement were cleaned, beverage bottles and likely made of polyethylene terephthalate. Within 12 h of collection, three subsamples (up to 150 mL each) were filtered through 25-mm diameter, 0.2 µm pore size nitrocellulose filters. Filters were then placed in a 35 mm petri dish, which was wrapped with aluminum foil to prevent light exposure, and frozen in the dark until processing.

Chlorophyll samples were processed in a manner similar to that of Welschmeyer (1994). Nitrocellulose filters were ground in 10 mL of 90% HPLC-grade acetone, in which chlorophyll extraction was allowed to proceed overnight. Chlorophyll extract was then analyzed using a Turner Designs 10-AU fluorometer (Turner Design, Sunnyvale, CA) using an excitation wavelength of 436 nm and emission of 680 nm. 10-AU Secondary Solid Standard (P/N 10-AU-904) was used to calibrate fluorometer prior to samples being processed. Blank samples registered a raw fluorescence of approximately 0.1 FL units. Concentrations were calculated using formula 2 . Detection limits are estimated to be approximately 0.02 mg/L. Concentrations are reported as mg/L.

*Pharmaceuticals and Personal Care Products (PPCPs)*

Water samples for PPCP analysis were collected in 250 mL amber glass bottles that were rinsed with either methanol or acetone and then three times with sample water prior to collections. Following collection, samples were refrigerated and kept in the dark until solid phase extraction (SPE).

Within 12 h of collection, samples were filtered directly from the amber glass bottle using an in-line Teflon filter holder with glass microfiber GMF (1.0 µm pore size, WhatmanGrad 934-AH) in tandem with a solid phase extraction (SPE) cartridge (200 mg HLB, Waters Corporation, Milford, MA) connected to a 1-liter vacuum flask. Lab personnel wore gloves and face masks to minimize contamination. Prior to filtration, SPE cartridges were primed with at least 5 mL of either methanol or acetone and then washed with at least 5 mL of sample water. Rate of extraction was maintained at approximately 1 drop per second. Extraction proceeded until water could no longer pass through the SPE cartridge or until all collected water was filtered. Cartridges were stored in Whirlpacks at -20°C until analysis for 18 PPCP residues using liquid chromatography tandem mass spectrometry (LC-MS-MS) following methods of Lee et al. (2016) and D’Alessio et al (2018) with labeled internal standards (13C3-caffeine, methamphetamine-d8, MDMAd8, morphine-d3, and 13C6-sulfamethazine). Detection limits are estimated to be 0.001 µg/L based on a 500 mL sample volume. Concentrations are reported in µg/L.

*Microplastics*

At each location, samples were collected at a depth of approximately 0.75 m in triplicate using 1.5 L clear plastic bottles that were washed thoroughly with sample water before each collection. Samples were collected by hand for each littoral site and with a metal bucket from aboard the ship for pelagic sites.

For processing, each sample was vacuum filtered on to a 47-mm diameter GF/F filter. During filtration, aluminum foil was used to cover the filtration funnel to prevent contamination from airborne microplastic particles. After filtration, filters were dried under vacuum pressure and then stored in 50-mm petri dishes. Following filtration of all three replicates, the filtrate was collected and then re-filtered through a GF/F filter as a control for contamination from the plastic vacuum funnel or potentially airborne microplastics.

Microplastic counting involved visual inspection of the entire GF/F in a similar manner to methods described in Hanvey et al. (2017). Visual enumeration was conducted under a stereo microscope with ~100x magnification, and microplastics were classified into one of three categories: fibers, fragments, or beads. For all categories, plastics were defined as observed objects with apparent artificial colors, so as to not enumerate plastics potentially contributed from the sampling bottle itself. Fibers were defined as smooth, long plastics with consistent diameters. Fragments were defined as plastics with irregularly sharp or jagged edges. Beads were defined as spherical plastics. Although we did not measure microplastic size, this technique likely allowed us to reliably quantify microplastics as small as ~300 µm (Hanvey et al. 2017). During enumeration, GF/Fs remained covered in the petri dish to minimize potential for contamination from the air.

It is worth noting that since the time of our field sampling, evidence has accumulated that our methods likely dramatically underestimated microplastic abundance (Wang and Wang 2018; Brandon et al. 2020). Recent investigations of microplastics in Lake Baikal near Bolshie Koty (BK) used analogous methods and measured similar microplastic concentrations (Karnaukhov et al. 2020). Future studies aiming to use these data for comparison or supplementing potential data gaps should consider the minimum microplastic size that could be reliably detected by the method, so as to ensure data are comparable across methods.

*Periphyton collection and abundance estimates*

At each littoral site, we haphazardly selected three rocks representative of local substrate. A plastic stencil was used to define a surface area of each rock from which we scraped a standardized 14.5 cm2 patch of periphyton. Samples were preserved with Lugol’s solution and stored in plastic scintillation vials. Additional periphyton was collected in composite from each site for fatty acid and stable isotope analysis.

Periphyton taxonomic identification and enumeration was performed by subsampling 10 μL aliquots from each preserved sample, containing approximately 10-15 mL of preserved periphyton. For all 10 μL aliquots, cells, filaments, and colonies were counted, for the entire subsample, until at least 300 cells were identified for a given sampling replicate. If the first aliquot contained less than 300 cells, we counted additional subsamples until we reached at least 300 cells in total. In instances when 300 cells were counted before finishing a subsample, we still counted the entire aliquot. Taxa were classified into broad categories consistent with Baikal algal taxonomy (Izhboldina 2007), using coarse groupings to capture general patterns in relative algal abundance. As a result, algal groups consisted of diatoms, *Ulothrix* spp., *Spirogyra* spp.,and the green algal Order Tetrasporales.

Separate periphyton samples for stable isotope and fatty acid analyses were also collected. Instead of preserving samples in Lugol’s solution, these samples were immediately frozen at -20°C at the field station. The samples were later transferred to the lab in the U.S. via a Dewar flask with dry ice.

*Benthic macroinvertebrate collection and abundance estimates*

Three kick-net samples were collected for assessment of benthic community composition and abundance. Using a D-net, we collected macroinvertebrates by flipping over 1-3 rocks, and then sweeping five times in a left-to-right motion across approximately 1 m. After the series of sweeps, the catch was rinsed into a plastic bucket. For each replicate, bucket contents were concentrated using a 64-μm mesh and placed in glass jars with 40% ethanol (vodka; the only preservative available to us at the time) for preservation and refrigerated at 4°C aboard the research vessel. The 40% ethanol preservative was replaced with ~80% ethanol upon return to the lab within 24 to 48 hours, and samples were stored at ~4°C.

Invertebrate taxonomic identification and enumeration were performed under a stereo microscope. All adult amphipods were identified to species according to Takhteev and Didorenko (2015), whereas juveniles were identified to genus. Mollusks were identified to the family level according to Sitnikova (2012). Leeches were enumerated at the subclass level, but were likely all from the family Glossiphoniidae based on size, depth of sampling locations, and invertebrate communities sampled (Kaygorodova 2012). Like mollusks, caddisflies were also enumerated at the order level, although Baikal does contain over 14 species of caddisfly (Valuyskiy et al. 2020). Flatworms were enumerated at the phylum level. All isopods enumerated were from the family Asellidae. Aside from having limited time available to spend with Baikal taxonomists during our field campaign, our choice of taxonomic resolution ultimately was a result of relative abundance for each taxonomic group, where amphipods were the most abundant taxa and flatworms were among the least abundant taxa across all sites. All samples contained oligochaetes and polychaetes, but due to poor preservation, these taxa were not counted. Six samples of the 42 collected were not well-preserved and were excluded from further analyses, in order to reduce errors in identification. KD-1 and LI-1 were the only sites with 1 sample counted. BK-2 and KD-2 each had two samples counted.

Separate collections were conducted for invertebrate fatty acid and stable isotope analyses. Invertebrates were collected using a D-net and by hand. Organisms collected by hand included amphipod species that were observed from the community composition D-net collections but not readily observed in the stable isotope and fatty acid D-net collections. Collected organisms were live-sorted, identified to species, and then frozen at -20°C at the field station. The samples were later transferred to the lab in the U.S. via a Dewar flask with dry ice.

Due to some samples warming in transit, we only processed samples that were completely frozen upon arrival to the United States. Given the potential for fatty acids to highlight more subtle, multivariate ecological responses along our transect than stable isotopes, we prioritized both periphyton and macroinvertebrate fatty acid analyses over stable isotope analyses. As such, there is an imbalance across species’ abundance, stable isotope, and fatty acid data. Dominant taxa, such as *E. veruccosus* and *E. vittatus*, though have paired data throughout the transect, whereas less common taxa, such as *Brandtia* spp., only have abundance estimates. Table 2 summarizes data available for each variable and taxonomic group.

*Stable Isotope Analysis*

Following freeze-drying, measurements of periphyton and macroinvertebrate δ15N and δ13C values were performed on an elemental analyzer-isotope ratio mass spectrometer (EA-IRMS; Finnigan DELTAplus XP, Thermo Scientific) at the Large Lakes Observatory, University of Minnesota Duluth. Stable isotope values were calibrated against certified reference materials including L-glutamic acid (NIST SRM 8574), low organic soil and sorghum flour (standards B-2153 and B-2159 from Elemental Micro-analysis Ltd., Okehampton, UK) and in-house standards (acetanilide and caffeine).

*Fatty Acid Analysis*

Following freeze-drying, samples were transferred to 10 mL glass centrifuge vials, and 2 mL of 100% chloroform was added to each under nitrogen gas. Samples were allowed to sit in chloroform overnight at -80°C. Fatty acid extractions generally involved three phases: (1) 100% chloroform extraction, (2) chloroform-methanol extraction, and (3) fatty acid methylation. Fatty acid extraction methods were adapted from Schram et al. (2018).

After overnight chloroform extraction, samples underwent a chloroform-methanol extraction three times. To each sample, we added 1 mL cooled 100% methanol, 1 mL chloroform:methanol solution (2:1), and 0.8 mL 0.9% NaCl solution. Samples were inverted three times and sonicated on ice for 10 minutes. Next, samples were vortexed for 1 minute, and centrifuged for 5 minutes (3,000 rpm) at 4°C. Using a double pipette technique, the lower organic layer was removed and kept under nitrogen. After the third extraction, samples were evaporated under nitrogen flow, and resuspended in 1.5 mL chloroform and stored at -20°C overnight.

Once resuspended in chloroform, 1 mL of chloroform extract was transferred to a glass centrifuge tube with a glass syringe as well as an internal standard of 4 μL of 19-carbon fatty acid. Samples were then evaporated under nitrogen, and then 1 mL of toluene and 2 mL of 1% sulfuric acid-methanol was added. The vial was closed under nitrogen gas and then incubated in 50°C water bath for 16 hours. After incubation, samples were removed from the bath, allowed to reach room temperature and stored on ice. Next, we performed a potassium carbonate-hexane extraction twice. To each sample, we added 2 mL of 2% potassium bicarbonate and 5 mL of 100% hexane, inverting the capped vial so as to mix the solution. Samples were centrifuged for 3 minutes (1,500 rpm) at 4°C. The upper hexane layer was then removed and placed in a vial to evaporate under nitrogen flow. Once almost evaporated, 1 mL of 100% hexane was added and stored in a glass amber autosampler vial for GC/MS quantification. GC/MS quantification was performed with a Shimadzu QP2020 GC/MS following Schram et al. (2018). As part of our peak quantification protocol, we quantified and identified every lipid compound that showed up in the chromatogram. Each sample contained peaks that were associated with known fatty acids, and among the 59 fatty acids contained in our dataset, few fatty acids were completely absent from a sample. Consequently, it is difficult for us to definitively ascribe a minimal detection limit to this analysis, but based on standards used, we estimate that this procedure had a minimal detection limit of 1 ng/mL.

Following methylation, remaining extracts were assessed for total lipid masses. Remaining sample extracts (~0.5 mL) were allow to evaporate to dryness under a fume hood overnight. Dried samples were then left in a weigh room to acclimatize for 30-60 mins and then massed within the scintillation vials. To calculate an average lipid mass, samples were massed three times, so as to assess deviation in measurements. Lipid gravimetry is reported as the mg of lipids per g of dry-weight tissue.

**References**

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## Data Table

* Column name: exactly as it appears in the dataset. Please avoid special characters, dashes and spaces.
* Description: please be specific, it can be lengthy
* Unit: please avoid special characters and describe units in this pattern: e.g. microSiemenPerCentimeter, microgramsPerLiter, absoptionPerMolePerCentimeter
* Code explanation: if you use codes in your column, please explain in this way: e.g. LR=Little Rock Lake, A=Sample suspect, J=Nonstandard routine followed
* Date format: please tell us exactly how the date and time is formatted: e.g. mm/dd/yyyy hh:mm:ss plus the time zone and whether or not daylight savings was observed.
* Missing value code: If a code for ‘no data’ is used, please specify: e.g. -99999

Please add rows as needed

**Table name:** site information (site\_information.csv)

**Table description:** This file contains metadata for each of the pelagic and littoral sampling locations.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| year | Year sampling occurred | Year |  |
| month | Month sampling occurred | Month |  |
| day | Day sampling occurred | Day |  |
| time | Time sampling occurred | Hours:Minutes | NA |
| site | Locational identifier for each sampling site |  |  |
| lat | Latitude of sampling location | DecimalDegrees |  |
| long | Longitude of sampling location | DecimalDegrees |  |
| site\_description | Researcher description of sampling location |  |  |
| distance\_to\_shore\_m | Distance from in situ sampled location to the shoreline | Meters | NA |
| depth\_m | Depth at in situ sampling location | Meters |  |
| air\_temp\_celsius | Temperature of air at sampling location | Celsius |  |
| surface\_temp\_celsius | Temperature of water’s surface at sampling location | Celsius | NA |
| mid\_temp\_celsius | Temperature of water midway between surface and bottom at sampling location (i.e., depth\_m/2) | Celsius | NA |
| bottom\_temp\_celsius | Temperature of water near sediment at sampling location | Celsius | NA |
| comments | Notes in the field describing sampling conditions |  |  |
| shore\_photo | Whether or not photos of the shoreline were taken | YesOrNo |  |
| substrate\_photo | Whether or not photos of the substrate were taken | YesOrNo |  |
| sponges | Whether or not sponges were present at a sampling location | YesOrNo |  |
| brandtia | Whether or not brandtia (endemic amphipod) was present at a sampling location | YesOrNo |  |

**Table name:** Inverse-distance-weighted population (distance\_weighted\_population\_metrics.csv)

**Table description:** This file contains inverse distance weighted, census-based human population data for each sampled location. Although the majority of sites do not have adjacent shoreline human developments, we calculated inverse distance weighted (IDW) population for each sampling location. IDW population is a generalized representation of the size of and proximity to a sampling location’s neighboring human settlements. As these population estimates are based on census data, they reflect static populations and do not account for seasonal population deviations from tourism.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| distance\_weighted\_population | Inverse distance weighted population | NumberOfPeople |  |

**Table name:** Nutrient data (nutrients.csv)

**Table description:** This file contains nutrient concentrations for each of the associated sampling locations. Samples were collected at a depth of 0.75 m. Nutrient samples were not filtered prior to analysis, meaning that nitrogen concentrations have the potential to include intracellular nitrogen. Therefore, nitrogenous species’ concentrations may be spurious. Minimal detection limits were estimated as 0.01 mg/L for nitrate, 0.005 mg/L for ammonium, and 0.04 mg/L for phosphorus.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| replicate | Replicate for a given location |  |  |
| nh4\_mg\_dm3 | Ammonium concentration | MilligramsPerCubicDecimeter |  |
| no3\_mg\_dm3 | Nitrate concentration | MilligramsPerCubicDecimeter |  |
| tp\_mg\_dm3 | Total phosphorus concentration | MilligramsPerCubicDecimeter |  |
| tpo43\_mg\_dm3 | Total phosphate concentration, which is calculated as total phosphorus as phosphate. | MilligramsPerCubicDecimeter |  |

**Table name:** Chlorophyll data (chlorophylla.csv)

**Table description:** This file contains chlorophyll a concentrations in the water column as well as fluorometric corrections for each littoral and pelagic sampling location. Minimal detection limits were estimated to be 0.02 mg/L.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| replicate | Replicate number for a given sampling site |  |  |
| filtered\_volume\_ml | Volume filtered for a given chlorophyll replicate | milliliters |  |
| sample\_volume\_ml | Volume of sample analyte during the chlorophyll extraction process | milliliters |  |
| raw\_fluo | Raw, uncorrected fluorometric reading for chlorophyll analysis |  |  |
| adjusted\_raw | Corrected fluorometric reading for chlorophyll analysis |  |  |
| chl\_conc | Chlorophyll a concentration | milligramsPerLiter |  |

**Table name:** Pharmaceutical and Personal Care Product (PPCP) data (ppcp.csv)

**Table description:** This file contains Pharmaceutical and Personal Care Product (PPCP) concentrations in the water column at each littoral and pelagic sampling location. Detection limits are estimated to be 0.001 µg/L based on a 500 mL sample volume.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| paraxanthine | Concentration of paraxanthine, also known as 1,7-dimethylxanthine. Paraxanthine is the main human metabolite of caffeine | MicrogramsPerLiter |  |
| acetaminophen | Concentration of acetaminophen, also known as paracetamol. | MicrogramsPerLiter |  |
| amphetamine | Concentration of amphetamine. | MicrogramsPerLiter |  |
| caffeine | Concentration of caffeine | MicrogramsPerLiter |  |
| carbamazepine | Concentration of carbamezapine | MicrogramsPerLiter |  |
| cimetidine | Concentration of cimetidine | MicrogramsPerLiter |  |
| cotinine | Concentration of cotinine, which is the main human metabolite of nicotine | MicrogramsPerLiter |  |
| diphenhydramine | Concentration of diphenhydramine | MicrogramsPerLiter |  |
| mda | Concentration of MDA | MicrogramsPerLiter |  |
| mdma | Concentration of MDMA | MicrogramsPerLiter |  |
| methamphetamine | Concentration of methamphetamine | MicrogramsPerLiter |  |
| morphine | Concentration of morphine | MicrogramsPerLiter |  |
| phenazone | Concentration of phenazone | MicrogramsPerLiter |  |
| sulfachloropyridazine | Concentration of sulfachloropyridazine | MicrogramsPerLiter |  |
| sulfamethazine | Concentration of sulfamethazinein micrograms per liter. | MicrogramsPerLiter |  |
| sulfamethoxazole | Concentration of sulfamethoxazole | MicrogramsPerLiter |  |
| thiabendazole | Concentration of thiabendazole | MicrogramsPerLiter |  |
| trimethoprim | Concentration of trimethoprim | MicrogramsPerLiter |  |
| collection\_year | Year sample was collected in the field | Year |  |
| collection\_month | Month sample was collected in the field | Month |  |
| collection\_day | Day sample was collected in the field | Day |  |
| analysis\_year | Year sample was analyzed | Year |  |
| analysis\_month | Month sample was analyzed | Month |  |
| analysis\_day | Day sample was analyzed | Day |  |

**Table name:** Microplastics (microplastics.csv)

**Table description:** This file contains suspended microplastics counts for each of the pelagic and littoral sampling locations. Although we did not measure microplastic size, our enumeration techniques likely allowed us to reliably quantify microplastics as small as ~300 µm (Hanvey et al. 2017).

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| replicate | Replicate for a given location | Numerical values represent a replicate; the letter “C” represents a control. |  |
| fragments | Number of microplastic fragments observed | NumberOfMicroplastics |  |
| fibers | Number of microplastic fibers observed | NumberOfMicroplastics |  |
| beads | Number of microplastic beads observed | NumberOfMicroplastics |  |
| comments | Observer comments while enumerating microplastics |  |  |
| volume\_filtered\_ml | Volume for a given replicate filtered | Milliliters |  |

**Table name:** Periphyton abundance data (periphyton.csv)

**Table description:** This file contains periphyton abundance data, collected from rocks at each of the sampled littoral locations. For poorly preserved samples, counts are listed as NA for each taxonomic grouping, and a note in the “comments” column is provided.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| replicate | Replicate number for a given sampling site |  |  |
| subsamples\_counted | Number of 10 microliter subsamples counted for a given replicate |  | NA |
| diatom | Number of diatom cells counted for a given replicate | NumberOfCells | NA |
| spirogyra | Number spirogyra cells counted for a given replicate | NumberOfCells | NA |
| spirogyra\_filament | Number of spirogyra filaments counted for a given replicate | NumberOfFilaments | NA |
| ulothrix | Number of ulothrix cells counted for a given replicate | NumberOfCells | NA |
| ulothrix\_filament | Number of ulothrix filaments counted for a given replicate | NumberOfFilaments | NA |
| tetrasporales | Number of tetrasporales cells counted for a given replicate | NumberOfCells | NA |
| pediastrum | Number of pediastrum cells counted for a given replicate | NumberOfCells | NA |
| desmidales | Number of desmidales cells counted for a given replicate | NumberOfCells | NA |
| comments | Notes from the observer |  | NA |

**Table name:** Macroinvertebrate species counts (invertebrates.csv)

**Table description:** This file contains abundance for benthic macroinvertebrates collected at each of the 14 littoral sampling locations. Only amphipod taxa were identified to species.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| replicate | Invertebrate replicate number for a given sampling site |  |  |
| Acroloxidae | Mollusk genus | NumerOfIndividuals |  |
| Asellidae | Endemic isopod genus | NumerOfIndividuals |  |
| Baicaliidae | Mollusk genus, most of which are endemic | NumerOfIndividuals |  |
| Benedictidae | Mollusk genus, most of which are endemic | NumerOfIndividuals |  |
| Brandtia\_latissima | Endemic amphipod species | NumerOfIndividuals |  |
| Brandtia\_parasitica\_parasitica | Endemic amphipod species | NumerOfIndividuals |  |
| Caddisflies | General grouping; were not identified to species. | NumerOfIndividuals |  |
| Cryptoropus\_inflatus | Endemic amphipod species | NumerOfIndividuals |  |
| Cryptoropus\_pachytus | Endemic amphipod species | NumerOfIndividuals |  |
| Cryptoropus\_rugosus | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_capreolus | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_cruentes | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_cyaneus | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_grandimanus | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_juveniles | Endemic amphipod genus. Identification kept at genus level so as to prevent misclassification. | NumerOfIndividuals |  |
| Eulimnogammarus\_maackii | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_marituji | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_verucossus | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_viridis\_viridis | Endemic amphipod species | NumerOfIndividuals |  |
| Eulimnogammarus\_vittatus | Endemic amphipod species | NumerOfIndividuals |  |
| Flatworms | Not identified beyond order. | NumerOfIndividuals |  |
| Leeches | Not identified beyond order, although 12 endemic species do exist. | NumerOfIndividuals |  |
| Maackia | Mollusk genus, most of which are endemic | NumerOfIndividuals |  |
| Pallasea\_brandtia\_brandita | Endemic amphipod species | NumerOfIndividuals |  |
| Pallasea\_brandtii\_tenera | Endemic amphipod species | NumerOfIndividuals |  |
| Pallasea\_cancelloides | Endemic amphipod species | NumerOfIndividuals |  |
| Pallasea\_cancellus | Endemic amphipod species | NumerOfIndividuals |  |
| Pallasea\_viridis | Endemic amphipod species | NumerOfIndividuals |  |
| Planorbidae | Mollusk genus, most of which are endemic | NumerOfIndividuals |  |
| Poekilogammarus\_crassimus | Endemic amphipod species | NumerOfIndividuals |  |
| Poekilogammarus\_ephippiatus | Endemic amphipod species | NumerOfIndividuals |  |
| Poekilogammarus\_juveniles | Endemic amphipod genus Identifying to species introduced risk of misclassification. | NumerOfIndividuals |  |
| Poekilogammarus\_megonychus\_perpolitus | Endemic amphipod species | NumerOfIndividuals |  |
| Poekilogammarus\_pictus | Endemic amphipod species | NumerOfIndividuals |  |
| Valvatidae | Mollusk genus, most of which are endemic | NumerOfIndividuals |  |

**Table name:** Stable Isotopes data (stable\_isotopes.csv)

**Table description:** This file contains carbon (δ13C) and nitrogen (δ15N) values for various benthic macroinvertebrate genera and periphyton collected from the 14 littoral sampling locations.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| Genus | Amphipod genus or Periphyton |  |  |
| Species | Amphipod species |  | NA |
| C13 | Carbon-13 (δ13C) values | PerMille |  |
| N15 | Nitrogen-15 (δ15N) values | PerMille |  |
| comments | Data quality flags for samples |  |  |

**Table name:** Fatty Acid profiles (fatty\_acid.csv)

**Table description:** This file contains fatty acid concentrations for various benthic macroinvertebrate genera, periphyton, and endemic *Draparnaldia* spp. benthic algae collected from the 14 littoral sampling locations.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| Genus | Genus of the analyzed organism. Amphipods were identified to species, whereas snails and periphyton were kept as generalized groupings. *Draparnaldia* spp. is an endemic alga and was likewise not identified to species. |  |  |
| Species | Amphipod species analyzed |  | NA |
| c12\_0 | Concentration of 12:0 fatty acid | microgramsPerMilligramOfTissue |  |
| i\_14\_0 | Concentration of i-14:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c14\_0 | Concentration of 14:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c14\_1w5 | Concentration of 14:1ω5 fatty acid | microgramsPerMilligramOfTissue |  |
| i\_15\_0 | Concentration of i-15:0 fatty acid | microgramsPerMilligramOfTissue |  |
| a\_15\_0 | Concentration of a-15:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c15\_1w7 | Concentration of 15:1ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| i\_16\_0 | Concentration of i-16:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_0 | Concentration of 16:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_1w9 | Concentration of 16:1ω9 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_1w8 | Concentration of 16:1ω8 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_1w7 | Concentration of 16:1ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_1w6 | Concentration of 16:1ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_1w5 | Concentration of 16:1ω5 fatty acid | microgramsPerMilligramOfTissue |  |
| i\_17\_0 | Concentration of i-17:0 fatty acid | microgramsPerMilligramOfTissue |  |
| a\_17\_0 | Concentration of a-17:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c17\_0 | Concentration of 17:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c17\_1w7 | Concentration of 17:1ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_2w7 | Concentration of 16:2ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_2w6 | Concentration of 16:2ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_2w4 | Concentration of 16:2ω4 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_3w6 | Concentration of 16:3ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_3w4 | Concentration of 16:3ω4 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_3w3 | Concentration of 16:3ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_4w3 | Concentration of 16:4ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c16\_4w1 | Concentration of 16:4ω1 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_0 | Concentration of 18:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_1w9 | Concentration of 18:1ω9 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_1w7 | Concentration of 18:1ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_2w6t | Concentration of 18:2ω6t fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_2w6 | Concentration of 18:2ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_3w6 | Concentration of 18:3ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_3w3 | Concentration of 18:3ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_4w4 | Concentration of 18:4ω4 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_4w3 | Concentration of 18:4ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c18\_5w3 | Concentration of 18:5ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_0 | Concentration of 20:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_1w9 | Concentration of 20:1ω9 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_1w7 | Concentration of 20:1ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_2w5\_11 | Concentration of 20:2 ω5(11) fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_2w5\_13 | Concentration of 20: 2 ω5(13) fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_2w6 | Concentration of 20:2ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_3w6 | Concentration of 20:3ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_4w6 | Concentration of 20:4ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_3w3 | Concentration of 20:3ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_4w3 | Concentration of 20:4ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c20\_5w3 | Concentration of 20:5ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_0 | Concentration of 22:0 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_1w9 | Concentration of 22:1ω9 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_1w7 | Concentration of 22:1ω7 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_2w6 | Concentration of 22:2ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_4w6 | Concentration of 22:4ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_5w6 | Concentration of 22:5ω6 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_3w3 | Concentration of 22:3ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_4w3 | Concentration of 22:4ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_5w3 | Concentration of 22:5ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c22\_6w3 | Concentration of 22:6ω3 fatty acid | microgramsPerMilligramOfTissue |  |
| c24\_0 | Concentration of 24:0 fatty acid | microgramsPerMilligramOfTissue |  |
| comments | Data quality flag |  |  |

**Table name:** Total Lipid data (total\_lipid.csv)

**Table description:** This .csv contains lipid gravimetry data for periphyton and benthic macroinvertebrate tissue for each of the associated sampling locations.

|  |  |  |  |
| --- | --- | --- | --- |
| Column name | Description | Unit or  code explanation or date format | Missing value code |
| site | Locational identifier for each sampling site |  |  |
| Genus | Genus of the analyzed organism. |  |  |
| Species | Amphipod species |  | NA |
| total\_lipid\_mg\_per\_g | Total amount of lipids in a sample | MilligramsOfLipidPerGramOfTissue |  |
| deviation | Samples were weighed three times and deviation in measurement was calculated. | MilligramsOfLipidPerGramOfTissue |  |
| comments | Quality control flag |  |  |

## Scripts/code (software)

(List any software scripts/code you would like to archive along with your data. These may include processing scripts you wrote to create, clean, or analyze the data.)

|  |  |  |
| --- | --- | --- |
| File name | Description | Scripting language |
| 01\_data\_cleaning.R | This script aggregates data among replicates for a given sampling location. It outputs aggregated CSVs that are used for successive analytics scripts. | R |
| 02\_sewage\_indicator\_analysis.R | This script takes outputs from script 01 to relate each sewage indicator with inverse distance weighted population. It outputs a plot with aggregated model results and plotted data for each sewage indicator. | R |
| 03\_community\_composition\_analysis.R | This script takes outputs from script 01 to relate sewage indicators and inverse distance weighted population with changes in benthic periphyton and macroinvertebrate community composition. | R |
| 04\_fatty\_acid\_analysis.R | This script takes outputs from script 01 to analyze benthic algae and macroinvertebrate fatty acid compositions, and then relates those fatty acid profiles with sewage indicators. | R |
| 05\_table\_formatting.R | This script formats descriptive tables using the outputs from script 01. | R |
| 06\_map\_making.R | This script generates a map of the sampled locations. | R |
| 07\_foodweb\_analysis.R | This script generates a plot of stable isotope isospaces and performs a Bayesian mixing model procedure to assess macroinvertebrate fatty acids relative to potential algal resources. The code also includes a template for a sensitivity analysis that is associated with the Bayesian mixing model. | R |
| panel\_cor\_function.R | This script is sourced to analyze cross-correlation among variables. | R |

1. This document liberally borrows from similar documents at SBC and GCE [↑](#footnote-ref-1)