

Table 3: 210Pb, 210Bi, and 210Po activities in quagga mussels (*Dreissena rostriformis bugensis*) from Lake Michigan in 2018, from Waples (2020) *Limnol. Oceanogr. Methods*.

Website: <https://www.bco-dmo.org/dataset/809898>

Data Type: Other Field Results

Version: 1

Version Date: 2020-04-22

Project

» [The measurement and use of bismuth-210 as a tracer of particle flux in aquatic systems](#) (Bi 210 measurement)

Contributors	Affiliation	Role
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Abstract

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Coverage

Spatial Extent: Lat:43.017829 Lon:-87.904407

Temporal Extent: 2018-11-29

Dataset Description

Pb-210, Bi-210, and Po-210 activity measurements in dreissenid (Quagga) mussels collected at the School of Freshwater Sciences' slip in the Milwaukee Inner Harbor on Lake Michigan, Nov. 2018. This is table 3 in Waples (2020), *Limnol. Oceanogr. Methods*.

Acquisition Description

A detailed description of the methods for determining in situ 210Pb, 210Bi, and 210Po activities is given by Waples (2020).

A second manuscript describing the use of Pb-210, Bi-210, and Po-210 as particle tracers in aquatic systems is currently in review for *Limnology and Oceanography* (March/2020).

Water samples collected by submersible pump were weighed and filtered through nitrocellulose filters (0.45 μm , 293 mm, Millipore) within two hours of sample collection to separate dissolved and particle-bound nuclide fractions of ^{210}Pb , ^{210}Bi , and ^{210}Po . Yield monitors of ^{207}Bi and ^{209}Po (Eckert & Ziegler Isotope Products) were then added to both fractions. No lead monitor was required. Dissolved nuclide fractions ($< 0.45 \mu\text{m}$) of ^{210}Pb , ^{210}Bi , and ^{210}Po were co-precipitated onto newly formed ferric hydroxide and collected by filtration. Both particle-bound and dissolved nuclide fractions were then digested in concentrated nitric acid. Bismuth and polonium were completely separated from lead on EmporeTM anion solid phase extraction (SPE) disks (3M, 47 mm, product number 2252, now manufactured by CDS Analytical). Eluate from the particle-bound fraction was re-spiked with ^{207}Bi and set aside for ~one month for the determination of particle-bound ^{210}Pb (via ^{210}Bi in secular equilibrium with its parent). Anion SPE disks were then counted– first for ^{210}Bi via β -decay on a low background gas-flow proportional detector with anticoincidence circuitry (G542 System, Gamma Products), then for ^{207}Bi via γ -emission to determine yield. Polonium was then removed from the SPE disks, plated to copper, and α -counted for ^{210}Po and the yield monitor ^{209}Po . Total ^{210}Pb was determined in a separate water sample via ^{210}Bi that had grown into secular equilibrium with its parent. Activity calculations including uncertainty propagation and decay corrections are all fully described by Waples (2020).

Quagga mussels (*Dreissena rostriformis bugensis*) were collected from the slip wall (43.017829, -87.904407) on 29 November 2018. Each mussel was measured for shell length and sorted into two groups of large (range: 18–22 mm; geometric mean: 19 mm; $n = 10$) and small (10–16 mm; geometric mean: 13 mm; $n = 20$) mussels. Mussel tissue was separated from the shell, pooled by group into two glass beakers, and digested in concentrated HNO_3 . Shell-free biomass was estimated using the allometric equation $m = 0.0018 \times L^{3.11}$, where m is the tissue dry weight in mg (DW mg) and L is the mussel shell length in mm (Waples et al. 2017).

Software used:

- Maestro software (v. 6.04 and 6.06, Advanced Measurement Technology)
- SigmaPlot (v. 11, Systat Software)
- Excel (v. 2002, Microsoft)

Processing Description

BCO-DMO Processing Notes:

- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- re-formatted date-time from m/d/yy H:M to yyyy-mm-ddTHH:MM:SS
- added column for ISO_DateTime_UTC
- split standard deviations into separate columns
- added columns for calculation method which were originally indicated by italic values

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Related Publications

Waples, J. T. (2020). Measuring bismuth-210, its parent, and daughter in aquatic systems. *Limnology and Oceanography: Methods*, 18(4), 148–162. doi:[10.1002/lom3.10352](https://doi.org/10.1002/lom3.10352)
Results

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Parameters

Parameter	Description	Units
sample	sample identifier	unitless
ISO_DateTime_Local	sample collection local date and time; ISO formatted yyyy-mm-ddTHH:MM:SS (UTC- 6 hr)	unitless
ISO_DateTime_UTC	sample collection date and time; ISO formatted yyyy-mm-ddTHH:MM:SSZ (converted to UTC from local: UTC- 6 hr)	unitless
latitude	latitude; north is positive	decimal degrees
longitude	longitude; east is positive	decimal degrees
depth	sample depth	meters
Pb_dpm	Lead 210Pb activity in total (T); dissolved (D); or particulate (P) fraction of sample	disintegrations per minute per gram (DPM g-1)
Pb_stdev	standard deviation of 210Pb activity	disintegrations per minute per gram (DPM g-1)
Bi_dpm	Bismuth 210Bi activity in total (T); dissolved (D); or particulate (P) fraction of sample	disintegrations per minute per gram (DPM g-1)
Bi_stdev	standard deviation of 210Bi activity	disintegrations per minute per gram (DPM g-1)
Po_dpm	Polonium 210Po activity in total (T); dissolved (D); or particulate (P) fraction of sample	disintegrations per minute per gram (DPM g-1)
Po_stdev	standard deviation of 210Po activity	disintegrations per minute per gram (DPM g-1)

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Instruments

Dataset-specific Instrument Name	low background gas-flow proportional detector with anticoincidence circuitry (G542 System, Gamma Products)
Generic Instrument Name	Gamma Ray Spectrometer
Generic Instrument Description	Instruments measuring the relative levels of electromagnetic radiation of different wavelengths in the gamma-ray waveband.

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Project Information

The measurement and use of bismuth-210 as a tracer of particle flux in aquatic systems (Bi 210 measurement)

Coverage: Lake Michigan 43.0 N 87.9 W

Naturally occurring radioactive nuclides provide invaluable "clocks" with which to investigate a wide range of processes in earth and environmental sciences. Nuclides with shorter half-lives are well suited to studying rapid processes, but are often present at very low concentrations and are particularly difficult to measure. The goal of this Early Concept Grant for Exploratory Research (EAGER) is to develop and demonstrate a new analytical method for measuring bismuth-210 (half life, 5 days) in lake water, seawater, and associated particles. Because bismuth tends to become associated with particles more than its parent isotope lead-210 (half life, 22 years), the bismuth-210/lead-210 daughter/parent pair can potentially be used to investigate very short time-scale processes associated with particle (sediment) formation and cycling in lakes and the coastal ocean. Knowledge about such processes is important to understanding carbon and nutrient cycling in these productive and dynamic areas. The specific goals of this exploratory project are to 1) demonstrate an improved method for measuring the lead-210/bismuth-210/polonium-210 trio in aquatic system samples; 2) measure lead-210/bismuth-210/polonium-210 in Lake Michigan; and 3) explore the feasibility of using bismuth-210/lead-210 disequilibrium as a proxy for particle flux. The project would support an undergraduate student researcher for the summer.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1639865

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