



Bioturbation Database for Benthic Invertebrates

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Introduction

Bioturbation, the reworking of sediment particles, can contribute to contaminant transport in marine environments through burrowing in the sediment and mixing the particles of the sediment into the water. Understanding how bioturbation affects each area is, therefore, crucial in order to understand the marine ecosystem and how contaminants may be transported. In this study, we adopted standard trait-based rating system proposed by Solan et al. to estimate community-level bioturbation and modified further to enhance its applicability. The original potential of community-level bioturbation (BP_c) proposed by Solan et al. as

$$BP_c = \sum_i^n \sqrt{\frac{B_i}{A_i}} \times A_i \times M_i \times R_i$$

- B_i : Biomass
- A_i : Abundance
- M_i : Mobility (1-4)
- R_i : Types of sediment reworking (1-5)

The modified potential of community-level bioturbation (BP_c') is defined as

$$BP_c' = \sum_i^n L_i^\alpha \times A_i \times M_i \times R_i$$

- L_i : Size of taxon
- α : Scaling exponent (0.5 – 1.5)

Methods

The database of benthic invertebrate originates from Euro DB, which assigns semi-quantitative bioturbation traits for 1033 benthic invertebrates in northwest Europe. We extended Euro DB with full taxonomic information extracted from World Register of Marine Species (WoRMS) using Aphia ID. Size data was collected from the Marine Macrofauna Genus Trait Handbook, the World Register of Marine Species (WoRMS), and the Marine Species Identification Portal and made into a range. The data was incorporated into the Extended European Database (Figure 1).

Case Study

Using code established for the extended EuroDB, we move to the first case study in the Northeast of the United States. The Northeast Fisheries Science Center (NEFSC) from the National Oceanic and Atmospheric Administration (NOAA) constructed huge database of benthic survey data, which were collected from more than 20,000 sampling sites, during 1881 to present. The master list of invertebrates consists of over 3000 species.

The R code matches the taxon between the NEFSC data and the Extended EuroDB to assign size and bioturbation traits to the organisms in the NEFSC dataset. Figure 2 shows part of the NEFSC data table it is run through the R-code. The database continuous growth will lead to some of the “NoMatch” organisms to having a match, so that the community-level bioturbation potential will become more accurate.

AphiaID	Phylum	Class	Order	Family	Genus	Ri	Mi	MatchMode	Lower	Upper	MatchMode	Size
1	1436202	Mollusca	Gastropoda	Littorinimorpha	Rissoiidae	Frigidovalva	2	3	Family	0.1	0.14285714285714	Family
2	1436202	Mollusca	Gastropoda	Littorinimorpha	Rissoiidae	Frigidovalva	2	3	Family	0.1	0.14285714285714	Family
3	1424673	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	Tubicolva	2.42857142857143	3.74603174603175	Order	1.85396825396825	5.95655555555556	Order
4	1424659	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	Rathbunia	2.42857142857143	3.74603174603175	Order	1.85396825396825	5.95655555555556	Order
5	1424477	Arthropoda	Hexanauplia	Scapelliformes	Scapelliformes	Wellnerium	0	0	NoMatch	0	0	NoMatch
6	1424477	Arthropoda	Hexanauplia	Scapelliformes	Scapelliformes	Wellnerium	0	0	NoMatch	0	0	NoMatch
7	1424477	Arthropoda	Hexanauplia	Scapelliformes	Scapelliformes	Wellnerium	0	0	NoMatch	0	0	NoMatch
8	1279630	Onidaria	Arthropoda	Pennatulacea	Pennatulidae	Pistula	2	2	Family	50	60	Family
9	135594	Annelida	Polychaeta	Terebellida	Fiabelligeridae	Bradystyssa	3	2	Exact	1	6	Exact
10	1340252	Annelida	Polychaeta	Otroidae	Locadamas	Locadamas	4	3	Family	10.4	33	Family
11	1342053	Mollusca	Gastropoda	Cephalapoda	Haminoidae	Haminella	2	3	Order	0.8	0.88888888888889	Order
12	1328406	Arthropoda	Malacostraca	Amphipoda	Talitridae	Speziochestia	1.94047619047619	2.7202380952381	Order	0.35297619047619	1.71787614285714	Order
13	1307570	Arthropoda	Malacostraca	Cumacea	Lampiroidea	Alamprops	2	3	Family	0.1	0.8	Family
14	1297885	Annelida	Polychaeta	Eunicoidae	Eunicoidae	Paucibranchia	4	3	Exact	20	50	Exact
15	1297885	Annelida	Polychaeta	Eunicoidae	Eunicoidae	Paucibranchia	4	3	Exact	20	50	Exact
16	1264347	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	Pinnulala	2.42857142857143	3.74603174603175	Order	1.85396825396825	5.95655555555556	Order
17	1255502	Arthropoda	Malacostraca	Amphipoda	Typhrosidae	Wacomedon	2	3	Family	0.5	0.92222222222222	Family
18	1255501	Arthropoda	Malacostraca	Amphipoda	Typhrosidae	Wacomedon	2	3	Family	0.5	0.92222222222222	Family
19	1252733	Arthropoda	Malacostraca	Decapoda	Epiplatidae	Miryotryncha	2.42857142857143	3.74603174603175	Order	1.85396825396825	5.95655555555556	Order
20	1061759	Arthropoda	Malacostraca	Decapoda	Portunidae	Portunus	2.42857142857143	3.74603174603175	Order	1.85396825396825	5.95655555555556	Order
21	1059632	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	Siphonocetes	1.66666666666667	1	Genus	0.233333333333333	0.733333333333333	Genus
22	1059478	Bryozoa	Gymnolaemata	Chelostomatida	Cibicides	Cibicides	0	0	NoMatch	0	0	NoMatch
23	1056517	Arthropoda	Malacostraca	Decapoda	Sergestidae	Robustosergia	2.42857142857143	3.74603174603175	Order	1.85396825396825	5.95655555555556	Order
24	1053399	Arthropoda	Malacostraca	Amphipoda	Epimeridae	Epimeria	1.94047619047619	2.7202380952381	Order	0.35297619047619	1.71787614285714	Order

Figure 2. Northeastern invertebrate database

Scientific Name	Aphia ID	Ri	Mi	Fri	Kingdom	Phylum	Class	Order	Family	Genus	lower_lim	upper_lim	Size range	Size source	Raw Data (cm)
Eumida	129446	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Eumida	11	20	11-20 cm	WoRMS	11-20 cm
Eumida bahusensis	130641	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Eumida	5	15	5-15 cm	GTH	5-15 cm
Eumida sanguinea	130644	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Eumida	5	15	5-15 cm	GTH	5-15 cm
Eumida	129446	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Eumida	5	15	5-15 cm	GTH	5-15 cm
Hesionura elongata	130649	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Hesionura	0.1	1	< 1 cm	GTH	< 1 cm
Hypereteone foliosa	152250	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Hypereteone	6	30 to 60	30 to 60	WoRMS	6 to 30
Mysta picta	147026	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Mysta	1	2.5 to 2.5	MSIP	up to 2.5	up to 2.5
Nereiphylla rubiginosa	130659	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Nereiphylla	1	10 to 10	WoRMS	1 to 10	1 to 10
Paramatis kostertiensis	130662	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Paramatis	1	8.5 to 8.5	MSIP	up to 8.5	up to 8.5
Phyllodoce (Anatides) gro	130668	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	30 to 30	family taxon	made from 334508	made from 334508
Phyllodoce groenlandica	334506	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	30 to 30	family taxon	made from 334508	made from 334508
Phyllodoce lammosa	130670	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	30 to 30	family taxon	made from 334508	made from 334508
Phyllodoce lineata	334508	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	10	20 to 20	MSIP	up to 20	up to 20
Phyllodoce longipes	130673	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	3 to 3	MSIP	up to 3	up to 3
Phyllodoce maculata	334510	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	10 to 10	MSIP	up to 10	up to 10
Phyllodoce mucosa	334512	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	10	15 to 15	MSIP	up to 15	up to 15
Phyllodoce rosea	334514	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	3.5 to 3.5	MSIP	up to 3.5	up to 3.5
Phyllodoce	129455	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	25 to 25	genus taxon	made from 334508	made from 334508
Pirakia punctifera	147104	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Pirakia	20	25 to 25	MSIP	up to 25	up to 25
Pseudomyssidies limbata	130683	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Pseudomyssidies	0.6	1	GTH	0.6-1 cm	0.6-1 cm
Sige fusigera	130690	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Sige	1	5 to 5	MSIP	up to 5	up to 5
Phyllodoce	931	4	3	B	Animalia	Annelida	Polychaeta	Phyllodocea	Phyllodoceidae	Phyllodoce	1	30 to 30	family taxon	made from 334508	made from 334508

Future Work

- Data analysis for case study (BP_c')
- Apply Extended EURO DB for other benthic data: Ex. SF Bay Area, East coast, Gulf of Mexico
- Assess impact of BP_c' on compound availability

References

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Figure 1. Extended European database (Euro DB): scientific name, Aphia ID (blue), bioturbation traits (green), taxonomic classification (orange), and size traits (purple).