Metadata template for datasets of *LO-Letters* articles

Metadata provides sufficient structured information for other scientists to understand and use your data. To prepare your metadata, you will need the following information:

- Title of the dataset and an abstract that describes the study and associated data in text form
- Keywords
- People and organizations associated with the data
- Usage Rights
- Research Project information
- Coverage details (including spatial coverage of the sample sites and temporal coverage)
- Methods and Sampling
- Detailed description of the variables and units for each column of the dataset

Instructions:

1. Fill in the 2 tables below for your dataset that you will be making available. If you have more than one dataset, then fill both tables for each dataset separately, although, most of the information will be the same for Table 1.
2. Save this word file in either Word or PDF format and upload your metadata to the *LO-Letters* website when you submit your manuscript.
3. Timing of depositing your data in a repository: You should plan on submitting your data to a repository at the time of submission, however, you do not need to provide the link to the data until the paper is provisionally-accepted. During the review process, we will review your metadata. If your paper has been accepted, then we require the data to be posted in a data repository for our review. In some circumstances, reviewers may ask for the data during the review stage, at which point you need to make it available.

Table 1. Description of the fields needed to describe the creation of your dataset.

Title of dataset	Daily benthic metabolism rates, annual integrated rates, biomass turnover rates, and spatial upscaling estimates.
URL of dataset	https://doi.org/10.5061/dryad.p0g4t96
Abstract	This submission consists of 40 eddy covariance datasets collected from six shallow sites in the Baltic Sea over an 18 month period. Hourly fluxes were extracted from the high-density data streams and were used to compute daily rates of benthic metabolism (gross primary production (GPP), respiration (R), and net ecosystem metabolism (NEM); in mmol O_2 m^{-2} d^{-1}). These were converted to C assuming an O_2 : C of 1.0 for GPP and R. A description of the flux data processing protocol is given in the manuscript. These datasets were used to compute annual rates of GPP, R, and NEM at each habitat site. The annual rates were then used to investigate (i) phototrophic biomass turnover rates, by comparing the GPP rates with standing phototrophic biomass measurements, and (ii) the regional importance of benthic metabolism, by upscaling the annual rates to habitat distribution maps. This dataset includes all data on standing biomass and habitat extent.
Keywords	Primary production, respiration, biodiversity, rocky substrates, macrophytes, sediments
Dataset lead author	Karl M. Attard

Position of data author	Post-doctoral researcher
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Organization associated with the data	*Organization associated with the data if other than the organization of the data author or contact person*
Usage Rights	Publicly available and free to use
Geographic region	Hanko, Gulf of Finland, Baltic Sea
Geographic coverage	Six study sites located nearby the Tvärminne Zoological Station in Finland (59.844° N, 23.249° E)
Temporal coverage - Begin date	May 10th 2016
Temporal coverage - End date	December 8th 2017
General study design	Discrete measurements of benthic oxygen fluxes were performed in situ using aquatic eddy covariance seasonally at six study sites to compare their metabolic rates on a seasonal and annual timescale.
Methods description	Eddy covariance instrumentation was deployed on 40 occasions between May 2016 and December 2017, and was left to record for several days at a time. The high-density velocity and oxygen concentration datasets were processed to extract oxygen fluxes, and from these, daily rates of GPP, R, and NEM were computed and compared.
Laboratory, field, or other analytical methods	Eddy covariance deployment: We followed standard guidelines for instrument setup and data processing (Donis et al. 2015; Lorrai et al. 2010). The velocimeter and microsensors were mounted onto a sturdy tripod frame, with the measurement volume located 15-25 cm above canopies or other seabed surface features. Additional sensors located on the AEC frame logged transmitted (seabed) PAR (LI-192, Li-Cor), water temperature and salinity (U24 HOBO), and dissolved oxygen concentration (U26 HOBO) every 15 min. The AEC frames were deployed by divers who used lift bags to lower and carefully level the instrument on the seafloor. Eddy covariance fluxes: Velocity and oxygen microsensor output were logged in continuous sampling mode at 32 Hz, with individual deployments lasting 3-5 days. Benthic oxygen fluxes, in mmol m^{-2} h^{-1}, were extracted from the velocity and oxygen microsensor data streams for consecutive 15 min intervals using the open-source software SOHFEA (McGinnis et al. 2014). The 32 Hz data was bin-averaged to 8 Hz, and for each 15 min interval, turbulent fluctuations were isolated from the mean using linear detrending (sand site, deep aphotic site, mixed macrophytes site, *Z. marina* site) or a running mean (*F. vesiculosus* site, *M. trossulus* reef) (Attard et al. 2019). A time-lag correction was not applied to the data, because its bias was estimated to be small (< 8 %), and the presence of short-period surface waves and low flow velocities may increase, rather than reduce, the

	flux bias (Berg et al. 2015). Once extracted and quality-checked, the fluxes at the shallow photic sites were corrected for oxygen storage following the approach described in Rheuban et al. (2014). Daily metabolism: Computing daily metabolism rates from the 15 min fluxes followed a three-step process. First, multiple days of quality-checked oxygen fluxes and PAR were averaged by the time of day to produce a single continuous 24 h time series. The fluxes were then separated into daytime fluxes ($FLUX_{day}$; when PAR > 0.0 μmol m^{-2} s^{-1}) and nighttime fluxes ($FLUX_{night}$; when PAR < 0.0 μmol m^{-2} s^{-1}), and the PAR time series was used to determine the number of daylight hours (h_{day}). Daily gross primary productivity (*GPP*, mmol O_2 m^{-2} d^{-1}) was computed as $GPP = FLUX_{day} + |FLUX_{night}| * h_{day}$. Respiration rates (*R*, mmol O_2 m^{-2} d^{-1}) were calculated as $R = |FLUX_{night}| * 24$. Net ecosystem metabolism (*NEM*) was computed as the difference between daily *GPP* and *R*. Positive *NEM* indicates surplus organic C and O_2 production (autotrophy); negative *NEM* indicates net heterotrophy. Daily *GPP*, *R*, and *NEM* were converted to C equivalents (g C m^{-2} d^{-1}) assuming a quotient of 1.0 for both primary productivity and respiration. Annual metabolism: Discrete daily metabolism measurements were integrated over the year (mathematical area) to compute annual rates. Spatial upscaling: Habitat distribution models were obtained from Elina Virtanen at the Finnish Environmental Institute (SYKE). The annual metabolism rates were multiplied by the habitat extent within a 93 km^2 area that includes all of our study sites. Pelagic estimates were obtained from literature values and were scaled linearly to water depth. Biomass turnover rates: Biotic sampling for macrophytes and microphytobenthos was performed seasonally at the five photic habitats to estimate the standing autotrophic biomass (g C m^{-2}). A detailed description of this procedure is given in Rodil et al. (2019). Daily GPP (g C m^{-2} d^{-1}) was divided by the standing biomass (g C m^{-2}) to compute the biomass turnover rate (d^{-1}). **References** Attard et al. (2019). Seasonal metabolism and carbon export potential of a key coastal habitat: the perennial canopy-forming macroalga *Fucus vesiculosus*. Limnology and Oceanography 64: 149-164 Berg et al. (2015). Technical note: Time-lag correction of aquatic eddy covariance data measured in the presence of waves. Biogeosciences 12: 6721-6735 Donis et al. (2015). An assessment of the precision and confidence of aquatic eddy correlation measurements. Journal of Atmospheric and Oceanic Technology 32: 642-655 Lorrai et al. (2010). Application of oxygen eddy correlation in aquatic systems. Journal of Atmospheric and Oceanic Technology 27: 1533-1546 McGinnis et al. (2014). Quantifying tidally-driven benthic oxygen exchange across permeable sediments: An aquatic eddy correlation study. JGR Oceans 119: 6918–6932 Rheuban et al. (2014). Multiple timescale processes drive ecosystem metabolism in eelgrass (*Zostera marina*) meadows. Marine Ecology Progress Series 507: 1-13 Rodil et al. (2019). Towards a sampling design for characterizing habitat-specific benthic biodiversity related to oxygen flux dynamics using aquatic eddy covariance. PLoS ONE 14: e0211673

Quality control	Quality-control measures were implemented following established guidelines detailed above.
Additional information	

Table 2. Description of the variables (i.e., columns) in the dataset in sufficient detail for another user to understand and use the data. If there are 10 variables (i.e., columns) in the dataset, then there should be 10 rows in this column that describe each column.

Column name	**Definition**	**Units**
The name of the variable in the dataset	*A detailed definition of the variable*	*Units the variable is measured in*
Start date	Date when the eddy covariance instrument started recording	Date
Data duration	Duration of flux dataset	Hours
Daily PAR	Daily integrated near-seabed PAR	mol PAR m^{-2} d^{-1}
Temperature	Water temperature measured ~25 cm above the seabed. Presented as a bulk average of discreet 15 min measurements for the duration of the flux dataset	°C
GPP	Seabed gross primary production rate computed from the eddy covariance fluxes	g C m^{-2} d^{-1}
R	Seabed respiration rate computed from the eddy covariance fluxes	g C m^{-2} d^{-1}
NEM	Seabed net ecosystem metabolism computed as the difference between daily GPP and R	g C m^{-2} d^{-1}
Spatial extent	Extent of habitat in our study area	km^2
Standing autotrophic biomass	Estimated biomass of primary producers in each habitat	g C m^{-2}
Biomass turnover rate	Rate of autotrophic biomass turnover, estimated as the ratio between daily GPP (g C m^{-2} d^{-1}) and the standing autotrophic biomass (g C m^{-2})	d^{-1}