Dataset: Carbon flux for the Caribbean giant barrel sponge Xestospongia muta (Sponge-loop)

Project(s): Testing the sponge-loop hypothesis for Caribbean coral reefs (sponge-loop)

Abstract: Benthic suspension feeders are an important component of aquatic ecosystems, as they mediate benthic-pelagic coupling and the flow of energy and nutrients. There is increasing evidence that sponges are particularly important benthic suspension feeders in aquatic systems and especially on Caribbean coral reefs, where their biomass surpasses that of any other benthic group. The present study investigated the flux of particulate and dissolved organic carbon mediated by the Caribbean giant barrel sponge, Xestospongia muta. A total of 1 L of both incurrent (ambient) and excurrent seawater was collected in situ on Conch Reef, Key Largo, Florida, from 32 individuals with paired 100 mL syringes. Following seawater sample collection, the dimensions of each sponge were measured to obtain sponge volume estimates. Pumping rates were calculated from sponge volume using the relationship of McMurray et al. (2014). For a complete list of measurements, refer to the supplemental document 'Field_names.pdf', and a full dataset description is included in the supplemental file 'Dataset_description.pdf'. The most current version of this dataset is available at: http://www.bco-dmo.org/dataset/685783

Description: Sponge carbon flux

This dataset includes flux measurements of dissolved, particulate and total organic carbon associated with the Caribbean giant barrel sponge *Xestospongia muta* on Conch Reef, Key Largo, FL in June 2013.

Acquisition Description: Suspension feeding by *Xestospongia muta* was investigated *in situ* on Conch Reef (24°56'59"N; 80°27'13"W), Key Largo, Florida in June of 2013. Food availability is known to vary temporally on Conch Reef (e.g. McMurray *et al.* 2016); therefore, a total of 32 individuals were haphazardly selected for study at 20 m depth over the course of 6 days (5-6 sponges day^{-1}) to quantify feeding rates over a large natural range of food abundances. Individuals spanned a broad range of sizes, however only individuals with a single osculum were included.

A total of 1 L of both incurrent (ambient) and excurrent seawater was collected from each sponge over a 5 minute sampling interval with paired 100 mL syringes as previously described (McMurray *et al.* 2016). Following seawater sample collection, the dimensions of each sponge were measured and the morphology of *X. muta* was approximated as a frustum of a cone to obtain sponge volume estimates (McMurray, Blum & Pawlik 2008). Estimates of sponge pumping rates were derived from the equation $Q = 0.02\ V^{1.1}$ ($P < 0.001$, $R^2 = 0.78$; McMurray et al. 2014), where Q is the pumping rate (ml s^{-1}) and V is sponge volume (cm^3)

Particulate and dissolved organic carbon (POC and DOC, respectively) in incurrent and excurrent seawater was quantified as previously described (McMurray *et al.* 2016). Briefly, each sample was filtered through a 100 µm mesh and subsequently through a pre-combusted GF/F glass fiber filter. In the laboratory, POC on filters was measured using a CE Elantech NC2100 elemental analyzer; DOC in filtrate samples was measured using high temperature catalytic oxidation with a Shimadzu TOC 5050 analyzer. *Xestospongia muta* hosts symbiotic microbes which may contribute to DOC retention rates (Maldonado, Ribes & van Duyl 2012); therefore carbon flux estimates reported here consider the sponge as a holobiont.

To assess the effects of sponge feeding on POC and DOC, differences in the concentration of each food type between incurrent and excurrent seawater were analyzed using paired *t*-tests. For each sponge, POC and DOC consumed were calculated as the difference between the quantities of each food resource in incurrent and excurrent seawater samples. To investigate selective feeding on food resource types, and if relative foraging effort between food resources varied as a function of relative food availability (McMurray *et al.* 2016), the $\log_{10}$-transformed ratio of POC:DOC consumed was regressed against the $\log_{10}$-transformed ratio of incurrent POC:DOC concentration (van Leeuwen *et al.* 2013). A one-tailed *t*-test was used to test if the slope of this regression was greater than a slope of 1 to examine frequency-dependent food consumption.

Retention efficiency of each food resource was calculated as:

$$RE = (Cin - Cex)/C_{in} \times 100$$

where *RE* is the retention efficiency (%), and C_{in} and C_{ex} are the incurrent and excurrent quantities of each food resource (µM), respectively. The filtration rate for each food resource was calculated as:

$$FR = (C_{in} - C_{ex}) \times Q$$

where *FR* is the filtration rate (µmol C s^{-1}). Ordinary least squares regression was used to examine how filtration rates for each food resource scaled with sponge size. Filtration rates were standardized by sponge volume to obtain specific filtration rates (µmol C s^{-1} L^{-1}). The relationship between specific filtration rate and $\log_e$-transformed incurrent food abundance for each food resource was described by ordinary least squares regression.

These data were published in:

McMurray, S.E. 2015. The Dynamics of Sponge Populations and Benthic-pelagic

Carbon Flux on Coral Reefs. Ph.D. Dissertation. University of North Carolina Wilmington.

References:

Maldonado, M., Ribes, M. & van Duyl, F.C. (2012) Nutrient fluxes through sponges: biology, budgets, and ecological implications. *Advances in Marine Biology, Vol 62* (eds M.A. Becerro, M.J. Uriz, M. Maldonado & X. Turon), pp. 113–182. Academic Press, Amsterdam.

McMurray, S.E., Blum, J.E. & Pawlik, J.R. (2008) Redwood of the reef: growth and age of the giant barrel sponge *Xestospongia muta* in the Florida Keys. *Marine Biology*, **155**, 159–171.

McMurray, S.E., Johnson, Z.I., Hunt, D.E., Pawlik, J.R. & Finelli, C.M. (2016) Selective feeding by the giant barrel sponge enhances foraging efficiency. *Limnology and Oceanography*, **61**, 1271–1286.

McMurray, S.E., Pawlik, J.R. & Finelli, C.M. (2014) Trait-mediated ecosystem impacts: how morphology and size affect pumping rates of the Caribbean giant barrel sponge. *Aquatic Biology*, **23**, 1–13.

van Leeuwen, E., Brännström, Å., Jansen, V.A.A., Dieckmann, U. & Rossberg, A.G. (2013) A generalized functional response for predators that switch between multiple prey species. *Journal of Theoretical Biology*, **328**, 89–98.

Processing Description: Analyses were conducted with SAS (version 9.1.3 for Windows; SAS Institute) and SPSS (version 14.0.0 for Windows; SPSS) statistical software.

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 from m/d/yyyy to yyyy-mm-dd
- replaced DOCre (proportion) data with data*100 (percent)

Deployment Information

Deployment description for UNCW McMurray_UNCW

Carbon flux studies

Instrument Information

Instrument	CE Elantech NC2100 elemental analyzer
Description	Used to measure POC
Generic Instrument Name	Elemental Analyzer
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Instrument	Shimadzu TOC 5050 analyzer
Description	Used to measure DOC
Generic Instrument Name	Elemental Analyzer
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.