

# FRIDAY HARBOR LABS

UNIVERSITY of WASHINGTON



## FHL Tide Bites

#3 Nov. 2013

### Tracing algal support of marine food webs with fatty acids

By: Aaron Galloway, PhD

Aaron finished his PhD in summer of 2013 under the guidance of FHL's own David Duggins, Ken Sebens, and Megan Dethier

Marine food webs, which include many economically and ecologically important species (right on up to Orcas), ultimately depend on energy generated by primary producers such as phytoplankton, seagrass and marsh plants, and seaweeds (algae). These photosynthetic organisms create 'biomass' that all members of the food web need. In fact, primary producers supply the vast majority of omega-3 and omega-6 fatty acids to all food webs. Humans and other animals need to obtain these 'essential' fatty acids from our diet because we cannot synthesize them from scratch on our own.

In our research in the Duggins/Dethier group at Friday Harbor Labs, we are learning how invertebrate consumers use different sources of primary production by tracing "biomarkers" consisting of fatty acids and isotopes of elements from the algae up through the food web and into marine animals. Why do we care? Understanding which energy sources "fuel" the food web will ultimately enable better management of marine ecosystems. Believe it or not, scientists know very little about what most small invertebrate consumers are actually eating because many of them cannot be effectively observed (Fig. 1). In addition, these relationships may be changing in many marine habitats; for example, the declining extent of arctic sea ice is expected to affect the quantity and quality (e.g., lipid composition) of nearshore primary production, thus altering food webs that include shellfish, fishes, and marine mammals.

In my research, I am working to develop new methods for quantitatively estimating what animals are eating using these biomarkers. The basic assumption of the work is that "you are what you eat". The first step in the process is to determine whether the various "sources" of food in the environment are sufficiently different from each other that they can be tracked

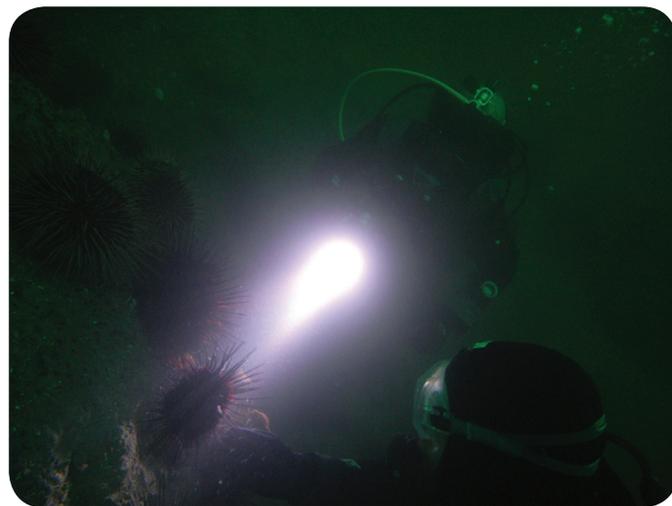


Fig. 1. Wendel Raymond (Duggins/Dethier group researcher) provides light as the author inspects a red urchin (*Strongylocentrotus franciscanus*) for algae at 30 m depth. We have found that detached drifting algae is quite common at depths far beyond where it grows, providing an 'energy subsidy' to deep water consumers. Photo by Breckie McCollum.



Fig. 2: Intertidal *Idotea vosnesenskii*, Eagle Cove. We have conducted several feeding trials with these herbivorous isopods to investigate how dietary fatty acids and stable isotopes are stored in fast-growing juveniles. Photo and lab work by Morgan Eisenlord (Duggins/Dethier group researcher).

into consumers. We have recently shown that different seaweeds and phytoplankton have very distinctive fatty acids. The second step is measuring how animals ‘modify’ and store different dietary fatty acid signatures. We have conducted feeding trials with several consumers (isopods; see Fig. 2) that have helped us to identify which biomarkers to focus our efforts on. The culminating step is to put the algal biomarker signatures into a ‘prey library’ and use some fancy math to calculate the likely contributions of these various food sources to the consumer given the consumer’s own biomarker signature.

In my current postdoctoral work, in Finland, I am developing, testing, and refining the mathematical model we use for tracking sources of energy production in lake food webs. This work is the first such effort to quantitatively model real-world consumer diets using both fatty acid and stable

isotope biomarkers simultaneously. As you can see, it’s a multi-faceted goal that required several years of extensive fieldwork, wet-lab work, chemistry-lab work, and computer modeling. When I’m not in the lab or at my computer, I can be found underwater, or as close to the water as possible (Fig. 3). Please visit my website for updates, links to our papers, funding sources, and more information about our research: <http://www.aaron-galloway.com>.

**Papers we have published on this work so far:**  
(all of these are available on my website)

Britton-Simmons, K. H., A. L. Rhoades, R. E. Pacunski, A. W. E. Galloway, A. T. Lowe, E. A. Sosik, M. N. Dethier, and D. O. Duggins. 2012. Habitat and bathymetry influence the landscape-scale distribution and abundance of drift macrophytes and associated invertebrates. *Limnology and Oceanography* 57:176-184.

Dethier, M. N., E. A. Sosik, A. W. E. Galloway, D. O. Duggins, and C. A. Simenstad. 2013. Addressing assumptions: variation in stable isotopes and fatty acids in marine macrophytes can confound conclusions of food web studies. *Marine Ecology Progress Series* 478:1-14.

Galloway, A. W. E., K. H. Britton-Simmons, D. O. Duggins, P. W. Gabrielson, and M. T. Brett. 2012. Fatty acid signatures differentiate marine macrophytes at ordinal and family ranks. *Journal of Phycology* 48:956-965.

Galloway, A. W. E., A. T. Lowe, E. A. Sosik, J. S. Yeung, and D. O. Duggins. 2013. Fatty acid and stable isotope biomarkers suggest microbe-induced differences in benthic food webs between depths. *Limnology and Oceanography* 58:1452-1462.

Taipale, S., E. Peltomaa, U. Strandberg, A. W. E. Galloway, A. Ojala, and M. T. Brett. 2013 (in press). Fatty acid composition as biomarkers of freshwater microalgae: analysis of 37 strains of microalgae in 22 genera and in 7 classes. *Aquatic Microbial Ecology* doi:10.3354/ame01671

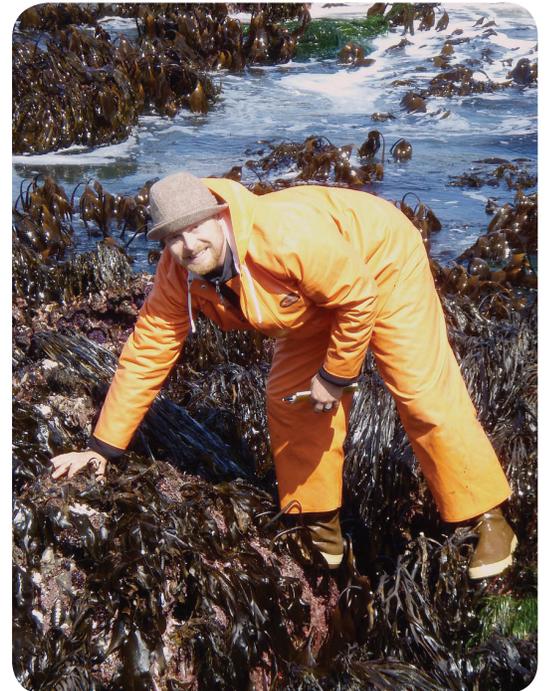


Fig. 3. The author in the field during FHL's ZooBot course field trip to the kelp covered shores of Vancouver Island. Kelps are common and productive from the intertidal to ~20 depth in temperate oceans, and are important sources of energy and fatty acids to marine food webs. Photo by Hilary Hayford.