Enabling a Data Driven Approach to Ocean Human Impact Assessment in New England -
Jarrett Byrnes, University of Massachusetts Boston

Definition of the problem
Assessing coastal health in marine ecosystems is a critical need for researchers and managers alike. Integrating data from samples taken in the ocean with measurements of human impacts, coastal features, and history of use in order to models the drivers of coastal ecosystem health is surprisingly difficult, however. Scientists and managers often want to relate data they have sampled to known information about ecosystem health – cumulative human impacts and components thereof (Halpern et al. 2008), environmental features (e.g., Mass GIS's OLIVER platform), history of coastal zoning (e.g, data from the CZM's Massachusetts Ocean Resource Information System). This requires them co combine information from site-level surveys with complex geospatial data layers. Currently, each scientist has to forge their own path to acquire this data and make it useful. They often re-invent methods used by other groups or, worse, avoid certain pieces of data due to the barriers of acquisition. **Here I propose to develop a set of open source tools to allow scientists to easily integrate sources of information about coastal oceans into their assessment of the drivers of ecosystem change.**

Objectives and expectations of outcomes,
Goal 1: Building tools to enable integration of ocean cumulative impacts – I propose to build a set of tools to quickly allow users to merge their sampled data with measures of cumulative human impacts as defined by Halpern et al. (2008, 2009) at desired spatial scales. In collaboration with Halpern's team, I will also provide measurements for the 19 different data layers that make up the score to target specific impacts or create their own scores. These tools will take the form of a package in the R open source programming language called rOceanImpacts. This approach is modeled after my previous work on evaluating global ocean climate change using the Hadley MET Centre records of sea surface temperature (https://github.com/jebyrnes/hadsstr). rOceanImpacts will enable scientists to easily utilize records of cumulative human impacts in any future analysis of ocean data.

Goal 2: Building tools to enable integration of Massachusetts state agency information on coastal features, history, and zoning – We will build a package in R that provides comparable information regarding bathymetric, habitat, and other information on coastal features and use history from Mass GIS, Mass. Coastal Zone Management's Massachusetts Ocean Resource Information System, and more. As there may be other data sources of use to both agency and academic scientists, we will hold a scoping meeting with relevant representatives from MWRA, CZM, Mass EPA, local universities, and more to identify and secure access to additional data sources. As with the cumulative impacts information, we will create a package, rMassOceans, in the open source programming language R.

Goal 3: Dissemination of tools to the larger user community – We will disseminate information about these tools in four ways. 1) Presenting it at the annual rOpenScience conference to provide an example of how other users can adopt similar strategies for their own areas. 2) At the annual Benthic Ecology Meetings to facilitate scientists to use the products in their own research. 3) At

a meeting with interested staff from local agencies and universities. 4) Publication in an open access journal (e.g., PeerJ) using the tools in combination with a case study of change in kelp abundance at several sites within the Gulf of Maine for validation. Validation data is from timeseries acquired as a part of the Kelp Ecosystem Ecology Network (http://kelpecosystems.org, PI Byrnes network co-ordinator).

Project significance

This project will enable *any* scientist – agency, academic, or citizen - who is working across multiple sites within Massachusetts waters to build a rich picture of the potential drivers of the phenomena they are observing. *It will dramatically lower the barriers to accessing data regarding our coastal ecosystems*. The solution will also be fully open source, enabling others to build tools on top of our own or adapt it for different purposes or even in different software frameworks.

Project duration

This project will take place over the course of two years. During year one, we will build the cumulative impacts package (rOceanImpacts) and conduct scoping meetings to locate additional data sources for rMassOceans. In year two, we will build this package and disseminate information about these tools.

Request Year 1 and 2

Graduate Student RA-ship: $21,000 per year for 2 years
One Undergraduate Research Assistant (8 hrs/week @$12/hr for 22 weeks): $2,112
Travel to ROpenSci Conference & Benthic Ecology Meetings: $2,000 per year for 2 years
Open Access Publication Fee: $1,250 in year 1 & 2
Full Day Meeting with Agency Stakeholders to Scope & Demonstrate tools: $350 in years 1 & 2
3.4Ghz iMac with 32MD RAM and 3TB drive: $3,200 in year 1 only
Total Direct: $29,912 year 1 and $26,712 in year 2
Indirect: $15,704 year 1 and $14,024 in year 2
Total Year 1: $45,616 – Year 2 : $40,736

Cost Share Year 1 and 2

3 weeks PI time: $6096 plus $117 in fringe in Year 1 and $6279 plus $120 in fringe in year 2
Tuition, $1944 for two years, Ed opt Fees $8,814.60 per academic year for two years
Health insurance $1715 per year for 2 years
Total direct cost share Year 1: $18,687; Year 2 $18,873
Indirect: $ Year 1 $4162; Year 2 $4260
Total year 1: $22,849; Year 2 $23,132

References

Halpern, B. S. *et al.* A Global Map of Human Impact on Marine Ecosystems. *Science* **319,** 948–952 (2008).

Halpern, B. S. *et al.* Mapping cumulative human impacts to California Current marine ecosystems. *Conservation Letters* **2,** 138–148 (2009).