GIS services in the Marine Sciences

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ABSTRACT

Faculty support at a research institution can be provided through a number of services by the library, including the use of Geographic Information Systems (GIS). Services span from the creation of basic maps for use in publications, to the creation and storage of metadata and digital map layers, to the fine-scale GIS processing and analysis of spatial data. This poster presents some best practices in the curation of GIS data, acquisition of easy to use marine and related terrestrial layers, and spatial analysis using examples from the authors' research in humpback whale habitat use.

WHAT IS GIS AND HOW DO LIBRARIES FIT IN?

What is GIS?

Geographic Information Systems, or Geographic Information Science:

- software and hardware tools that analyze and display spatial information
- multidisciplinary and interdisciplinary applied field of study which can combine geography, environmental science, biology, geology, political science, social science, urban planning, etc.

Examples in marine and aquatic science:

- conservation planning, marine protected area planning, monitoring species behavior, habitat modeling, disaster planning and response, and predicting changes in species distributions due to sea level rise

How do libraries fit in? Some examples….

The ***Map and Imagery Laboratory at University of California Santa Barbara***[1]

- hosts the largest collection of maps, aerial photographs, remote sensing data, and GIS data in any academic library
- serves the university, businesses, industry, federal and state government, and other domestic and foreign educational institutions
- provides access to data in house and soon data will be online for university use
- charges fees for private and commercial use, making this the only revenue-generating service the library offers

Dalhousie University Library GISciences Centre[2]

- is largest GIS library facility in Canada
- provides access to data, software, classes, training, analysis, project planning and development, and consulting
- provides downloadable access to frequently requested data sets by affiliated users
- shares links to local geospatial data providers

REFERENCES

[1] Map & Imagery Lab (2012) University of California Santa Barbara Library. Available at: http://www.library.ucsb.edu/mil

[2] GISciences Centre (2012) Dalhousie University Libraries. Available at: http://libraries.dal.ca/locations_services/services/gis_centre.html

[3] Kearns & West and The Spatial Collaborative (2011) California Marine and Coastal Geospatial Information Management Scoping Study. Available at http://www.opc.ca.gov/2011/04/california-coastal-and-marine-geospatial-information-system-scoping-study/

[4] Payne, K, Florance P, Shain S (2012) The Role of Data Repositories in Humanitarian Information Management and Crisis Mapping. *Journal of Map and Geography Libraries* 8: 118-133.

[5] McClintock Lab (2012) SeaSketch. Available at: http://mcclintock.msi.ucsb.edu/projects/seasketch

[6] Wright, DJ, Lundblad ER, Larkin EM, Rinehart RW (2005) Benthic Terrain Modeler. Oregon State University. Available at http://dusk.geo.orst.edu/djl/samoa/tools.html

[7] Esri (2008) ArcGIS Desktop: Release 9.3. Redlands, CA: Environmental Systems Research Institute.

[8] Cartwright, R, Gillespie B, LaBonte K, Mangold T, Venema A, et al. (2012) Between a Rock and a Hard Place: Habitat Selection in Female-Calf Humpback Whale (*Megaptera novaeangliae*) Pairs on the Hawaiian Breeding Grounds. *PLoS ONE* 7(5): e38004. doi:10.1371/journal.pone.0038004

[9] Roberts, JJ, Best BD, Dunn DC, Treml EA, Halpin PN (2010) Marine Geospatial Ecology Tools: An integrated framework for ecological geoprocessing with ArcGIS, Python, R, MATLAB, and C++. *Environmental Modelling & Software 25*: 1197-1207.

DATA ACQUISITION AND CURATION

Data Portals

Data portals are abundant. In marine and aquatic sciences, the typical portals used for data acquisition are:

- Regional repositories
- National repositories
- Global repositories
- Imagery
- Physical
- Theme-specific repositories (such as bathymetry)
- Event-specific repositories (such as the Deepwater Horizon oil spill)

There is a great need for repositories at high levels to make geospatial information more discoverable and in fewer locations[3].

Marine Science Data Portal Examples

- ***GOMA Portal*** – A metatdata catalog and data repository of over 800 geospatial datasets from the Gulf of Mexico Alliance. GOMAportal.org
- ***Marine Geoscience Data System*** – Worldwide geosciences data collected throughout the oceans. www.marine-geo.org
- ***Northeast Ocean Data Portal*** – A large data catalog and tools for marine spatial planning hosted on the web, aimed at the region off the coast of the Northeast United States northeastoceandata.org
- ***Ocean Data Portal*** – Access to collections of marine data from the National Oceanographic Data Centres. Data comes from Australia, Canada, Japan, UK, China, US, Bulgaria, Romania, Russia, and Ukraine oceandataportal.org
- ***Davey Jones' Locker at Oregon State University*** – Links to marine and coastal GIS data and image portals marinecoastalgis.net/data

Curation of GIS Data

Portal and repository developers need to make geospatial data accessible and secure. They might choose to create more useful data for their users by[4]:

- writing standard metadata for undocumented data sets
- editing holdings by comparing data sets with corresponding themes and geographic coverage
- publishing on the best or most recent data available
- setting up automated notification of new data sets
- periodically checking original data sources for updates
- actively developing data and services by:
  - projecting data to a common projection
  - converting data to different formats
  - writing models to convert data to different schemas
  - creating data by digitizing data from hard copy sources, extracting data from map images, or GPS field mapping
  - assessing the quality of contributed data and fixing errors
  - comparing data sets that have overlapping themes and geographic coverage to create data sets with best attribute and geometry features
  - rectifying, color balancing, and otherwise enhancing imagery
  - standardizing attributes or vocabularies
  - creating and editing topology
  - edge matching contributed data to create seamless coverage over a larger area
  - creating live services in multiple formats
  - creating custom applications that help users with geographic data work flows
  - answer queries from users seeking data, or asking for advice on appropriate data usage, data processing and management

CREATING MAPS

Software

Although there are a number of web-based and open-source GIS platforms available for use, Esri ArcGIS products have proven to be preferred by scientists. Over the years, the software has become more user-friendly and there are many experienced users, evidenced by over 15,000 attendees at the 2012 Esri International User Conference. A full list of available GIS software can be found at: http://en.wikipedia.org/wiki/List_of_GIS_software

Visualizing Data Online for Marine Planning

Using a web browser, anyone can use a new tool for marine spatial planning available for anywhere in the world. SeaSketch[5], developed from the ***California MarineMap***, allows users to design management plans (including marine protected areas, transportation zones, and renewable energy sites). This is done from a web site where users are able to:

- Initiate a project by defining a study region
- Upload map layers from existing web services
- Define "sketch classes" such as prospective marine protected areas, transportation zones or renewable energy sites
- Sketch and receive automated feedback on those designs, such as the ecological value or the potential economic impacts of a marine protected area
- Share sketches and discuss them with other users in a map-based chat forum

SPATIAL ANALYSIS

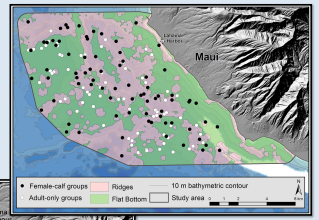
Marine Geospatial Ecology Tools

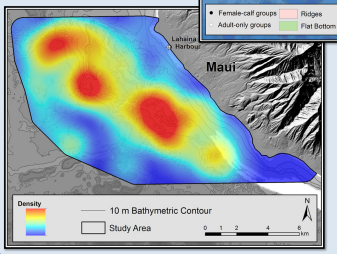
An exciting new open-source tool has been developed by the Duke Marine Geospatial Ecology Lab called Marine Geospatial Ecology Tools (MGET)[9]. It's available as a toolbox that loads directly into ArcGIS and can convert data, directly import marine data products, sample 3D and 4D products, model animal movements, detect oceanographic features in remote sensing data, map species biodiversity, conduct periodicity analysis, invoke R for statistical analysis, model species habitat, and derive topographical variables from bathymetry.
Download MGET: http://mgel.env.duke.edu/mget

The Authors' Research

The Au'au Channel between Maui and Lanai, Hawaii comprises critical breeding habitat for humpback whales (*Megaptera novaeangliae*) of the Central North Pacific stock. Studies were conducted along the busy shoreline of West Maui to determine female-calf habitat preference within this heavily trafficked area. NOAA's Benthic Terrain Modeler[6] was used in Esri ArcGIS 9.3[7] to classify areas of bathymetric topography as peaks, crests and depressions. This data was combined with a range of environmental factors; distance from shore, distance from Lahaina Harbor, and water depth. Variations in levels of use by female-calf pairs were then reviewed in relation to these environmental parameters. We found that female-calf pairs avoided shallow waters (<20m) and areas within 2km of the shoreline. Preferred regions comprised water depths between 40-60m, regions of rough bottom topography, and regions between 4 and 6km from Lahaina Harbor. This evidence contradicts previously reported trends in female-calf habitat preference and suggests that the whales may alter habitat choice due to temporal changes in locally varying pressures. Findings from this study were published in the May 2012 issue of PLoS ONE[8]. Future research will incorporate Marine Geospatial Ecology Tools with additional whale location data. The research is currently being conducted in the same region of Hawaii and in Alaska.

Ocean topography:
Female-calf groups are black circles and ridges are pink





Density of female-calf groups: Red is most dense, blue is least dense