Linking Biodiversity in the Deep Sea to International Management Needs

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The oceans beyond national jurisdiction have biological diversity equivalent to or exceeding that found on land. Such diversity provides goods (e.g., food for human consumption, bioactive compounds, and mineral resources) and services (e.g., related to regulation of the biosphere, carbon sequestration, nutrient supply to the photic zone) that significantly affect human well being. As the human population grows and technological prowess increases, nations are increasingly seeking resources from these global commons. However, our understanding of the diversity and distribution of organisms in the deep sea is relatively rudimentary and the ability to strategically conduct ecosystem-based management for sustainable use, a laudable but future goal. It is clear that deep sea communities are sensitive to human disturbance and precautionary approaches will be required to meet management goals. New information about the diversity and ecology of seamount communities in the Northwest Atlantic will be used as a case study to illustrate the importance of the timely communication of research results on fundamental aspects of deep sea biodiversity with the high seas management community.

Recent studies of the biological attributes of seamount coral communities in the NAFO region of the Northwest Atlantic (i.e., New England and Corner Rise Seamounts) utilized several different submersible vehicles to collect video, still photographs, and biological samples during a series of research cruises from 2001-2005. While analyses in multiple laboratories are ongoing, recent results indicate that coral communities across these seamount chains and across depth ranges within seamounts vary in terms of both composition and distribution.

For example, preliminary analyses of seafloor fauna from 210 hrs of video transects at Corner Rise and New England Seamounts (10 seamount peaks, 5 in each region from 2005) indicate that there are unique communities that are limited by depth and geographic range (from work by Walter Cho and Tim Shank, Woods Hole Oceanographic Institution). Statistical analyses revealed unique communities for shallow (700-1300 m), medium (1300-2300 m), deep (2300 – 2600 m), and very deep (2600-2700 m) survey areas. Further, community composition based on individual seamounts indicated that Corner Rise and the New England Seamounts had significantly different faunas. There was a total of 270 species across all seamounts surveyed with approximately 70 species unique to Corner Rise, approximately 60 unique to NES, and more than 130 shared amongst seamounts. Associations between a range of echinoderm and crustacean species with specific corals were evident from this and previous data, suggesting obligate relationships.

Understanding what species exist in these hard to sample places is an ongoing process. Recently, Les Watling (University of Hawaii) described four new species and one new genus of octocoral from specimens collected across the New England Seamount Chain. Work is ongoing regarding new descriptions of bamboo corals with the validity of two separate genera in question (Lepidisis and Keratoisis). Further, fifteen species of black coral were also collected across these seamount chains, including 7 species that have not previously been observed on the seamounts (Scott France, University of Louisiana at Lafayette). Some coral species are known from only a single

location (e.g., descriptions of new species by Stephen Cairns, Smithsonian Institution), so their population and conservation status remain unknown.

The geographic relationships within and between coral species across seamounts are also complex. Molecular approaches have revealed that there are four "types" of octocorals in the genus *Paramuricea* collected from 16 locations across the western North Atlantic (New England and Corner Rise seamounts, submarine canyons along the continental margin of North America, and deep basins in the Gulf of Maine) at depths between 200-2200 m. Eighty-nine of the sampled specimens could not be distinguished at a species level based on morphology but genetic data show there are at least four types, corresponding to three or four species (J.N. Thomas and S.C. France, University of Louisiana at Lafayette). All types were found on at least some seamounts, but only type 'A' was found on the continental margin (submarine canyons and Gulf of Maine). Types B & C were widely distributed on seamounts across the sampled region, although type C was absent from the four easternmost locations in the Corner Rise Seamounts, and type B was absent from the two westernmost locations (Bear and Retriever seamounts).

Observations of fishes on seamounts at 900-2500 m depth suggest that while over 40 species interact with seamount habitats only false boarfish *Neocyttus helgae* has at least a direct facultative relationship with fan and whip octocoral habitats (Peter Auster and Jon Moore from Florida Atlantic University). However, direct observations confirm that significant damage to hard coral, soft coral, and sponge communities on seamounts arise from fishing operations directed at seamount-associated species. While fishing effort and ecological response information in regards to particular gear types, in particular for deep sea habitats, is highly limited, the types and directions of impacts are well known from global literature on the subject. Recovery times of impacted communities, based on an expanding literature documenting ages of corals, will certainly be on the order of multiple decades to centuries (and over a millennia for large size classes of some species). It is worth noting that associations of species of economic importance with coral habitats are more common in other regions of the global ocean so caution is needed for interpreting linkages between corals and sustainability of exploited populations.

In summary, current research demonstrates that all seamounts within a region are not equal and management of impacts should consider this spatial variation at relatively small spatial scales, such as within seamount chains. Regional fishery management organizations and authorities should endeavor to enhance links to the wider research community not currently engaged in direct fishery management activities but focused on deep sea ecosystems. Many research programs are able to provide interim results and advice that can shape the degree of precaution needed for implementing United Nations General Assembly resolutions related to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction. Such information will need to be synthesized in order to assess the distribution of vulnerable marine ecosystems and make first-order assessments of the potential for particular types of fishing operations to produce significant adverse impacts. As our understanding of such ecosystems and the effects of human uses expands, preventive and corrective approaches can replace precautionary ones to manage in a more strategic framework.