

Towards an international field programme on seamounts within the Census of Marine Life

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Abstract

The Census of Marine Life (www.coml.org) is an international science initiative organizing field programmes to sample and survey the biology of under-explored habitats in the ocean. In August 2003, the CoML hosted a workshop to evaluate the current state of scientific knowledge on seamounts, determine the priorities for future research, and investigate the potential value of a CoML field programme on seamounts. The workshop participants concluded that a CoML programme could have a major impact on the future of seamount research. They defined a set of priority research questions on seamount ecology and outlined four areas of activity to undertake: 1) promoting future field research; 2) databasing and synthetic analysis of existing seamount data; 3) networking and coordinating the envisioned international, interdisciplinary programme; and 4) outreach to communicate results beyond the research community, particularly to seamount management and conservation bodies.

Kurzfassung

Ein internationales Forschungsprogramm an Seebergen als „Census of Marine Life“-Projekt

Das „Census of Marine Life“-Programm (CoML, www.coml.org) zielt auf die Förderung der internationalen Forschungskoordination für bislang weitgehend unerforschte Meeresökosysteme. Auf Einladung des CoML wurde im August 2003 ein internationaler Workshop durchgeführt, um die Prioritäten zukünftiger Seebergforschung als auch die mögliche Einbindung in und Förderung durch das CoML-Programm zu bestimmen. Übereinstimmend wurde der große Nutzen eines CoML-Programms zur Unterstützung der Seebergforschung festgestellt. Als prioritäre Aufgaben für die Forschungskoordination wurden festgestellt: (1) Planung nationaler Felduntersuchungen, (2) Erstellung von Datenbanken und Synthese des bisherigen Kenntnisstandes, (3) Schaffung von Netzwerken zur internationalen interdisziplinären Forschungskoordination, sowie (4) Veröffentlichung und Kommunikation von Forschungsergebnissen für Management- und Naturschutzbelange.

Introduction

As other articles in this special issue of the *Archive of Fishery and Marine Research* demonstrate, seamounts represent unique marine communities. While the true number of seamounts is unknown and depends on how one defines a seamount, they are common and widely

distributed seafloor features. Smith and Jordan (1988) estimate that there are over 30 000 seamounts in the Pacific alone that rise more than 1000 m above the seafloor; the number is much higher for smaller hills. Seamounts are particularly noted for high rates of endemism: several major recent studies have reported that > 30 % of the species found were new to science and potential endemics (Parin *et al.* 1997; Richer de Forges *et al.* 2000; Koslow *et al.* 2001). Any comprehensive effort to census the oceans would be incomplete without accounting for these pools of biodiversity. Furthermore, seamount research may act as a window into some of the processes underlying patterns of diversity in the oceans in general; it has been hypothesized that seamounts act as centers of speciation, refugia for relict populations, and stepping stones for trans-oceanic dispersal.

The Census of Marine Life (CoML) is a worldwide science initiative promoting research to assess and explain the diversity, distribution, and abundance of species throughout the world's oceans (www.coml.org; Decker and O'Dor 2003). As one of several activities, the CoML fosters international field programmes to facilitate research into under-explored marine ecosystems. Recognizing the growing scientific interest in seamounts, the Census of Marine Life hosted an international workshop on seamounts on 22 – 24 August 2003 at the Hatfield Marine Science Center in Newport, Oregon, USA. The goals of the workshop were to

- 1) evaluate the existing state of knowledge of seamounts,
- 2) determine the priorities for future seamount research,
- 3) outline the next steps required to address these research priorities, and
- 4) evaluate the potential role of the CoML in fostering research progress through an international field programme.

Workshop participants are listed in the Acknowledgements. In the remainder of this paper we present the recommendations of the workshop with respect to

- 1) prioritization of future seamount research,
- 2) necessary activities to enable research, and
- 3) the benefits of a CoML field project on seamounts.

Results

General recommendations

The workshop participants developed the following overall recommendations.

1. Seamounts are critical, yet relatively unexplored, habitats that warrant further study

It was decided that seamounts represent important ecosystems for study that have not, to date, received scientific attention consistent with their biological and ecological value. A comprehensive understanding of ocean biodiversity and biogeography, such as that being sought by the CoML, *will* require directed study of seamounts to learn of their unique features. Furthermore, it was noted that seamounts are becoming increasingly affected by human activities (*e. g.* Koslow *et al.* 2001). Important policy and management decisions regarding seamounts will be made in the next 5–7 years (*e. g.* UN General Assembly consid-

erations of marine protected areas) and scientific evidence will be essential for guiding management and conservation efforts. While the role of the CoML is not to provide policy recommendations *per se*, it nevertheless has a timely opportunity to contribute to the scientific knowledge base for important management decisions.

2. A Census of Marine Life field programme on seamounts would play a valuable role in energizing and coordinating seamount research

The presentations on past and planned seamount research during the workshop highlighted that seamounts are an area of active research. However, the key science questions outlined below will not be addressed by simply continuing with “business as usual.” In particular, there is a compelling need for an international effort to promote and coordinate future field efforts and synthesize existing knowledge in order to extend our results beyond individual seamount ecosystems.

Science priorities

Based on the above framework, the workshop participants defined the following overall priority science question for future seamount research: “What roles do seamounts play in the biogeography, biodiversity, productivity, and evolution of marine organisms, and what is their effect on the global, oceanic ecosystem?” This primary theme was further sub-divided into three specific research themes.

Theme 1: Given the large number of seamounts globally, can we categorize seamount community structures and/or develop proxy variables in order to

- 1) use our knowledge from a limited number of well-known seamounts to make predictions about unknown ones;
- 2) efficiently guide future research programmes; and
- 3) understand the key processes regulating the structure and maintenance of seamount communities. One topic considered was whether some minimal set of physical factors might be formulated in order to provide a biologically meaningful description and categorization scheme for seamounts.

Although by no means exhaustive, the following list of factors was identified as being important to consider in any such scheme:

- physical and geological setting of the seamount (age, substrate type, *etc.*)
- geography: latitude, ocean basin, distance from nearest continental margin, *etc.*
- seamount size, depth, shape, and physiography
- productivity of the overlying water column and its associated hydrographic characteristics (*e. g.* localized upwelling, presence of recirculating eddies such as Taylor columns, and relationships to mesoscale oceanographic features)

Given the potential for a classification scheme of this sort to guide the development of future field studies, this theme will be addressed first but will also be an ongoing effort as new data are collected and new ideas arise.

Theme 2: How do seamount communities, both within and between seamounts, differ in ecological structure and function?

This theme explicitly recognizes that there can be substantial patchiness within a given seamount as well as between seamounts, and that variability at both scales is important for understanding seamount ecosystems. Particular questions of interest include:

- How do the physical characteristics of a given seamount influence the composition of communities that occupy its various habitats?
- What are the roles of biological interactions (*e. g.* trophic structure and food web function) both within seamount communities and with surrounding ocean communities?
- How vulnerable are seamount ecosystems to disturbance, and how might the structure of these ecosystems change in response to natural (*e. g.* seasonal variability, inter-annual cycles, climate change) and anthropogenic (*e. g.* overfishing) influences?
- What roles do larval dispersal and recruitment dynamics play in the long-term persistence of seamount populations?
- How do the surrounding deep-sea communities interact with seamounts?
- On what scales do seamounts influence the biological and physical structure of adjacent oceanic habitats? What is the spatial and ecological “footprint” of a seamount or seamount chain in the surrounding ocean?

Theme 3: On a broader scale, what roles do seamounts play in global oceanic ecosystems with respect to 1) biogeography, 2) biodiversity, 3) evolution, and 4) productivity?

This theme will involve the synthesis of seamount studies from around the world. Specifically, workshop participants proposed investigating issues such as whether seamounts act as centers of speciation or as refugia for relict populations, to what extent seamounts serve as stepping-stones for trans-oceanic dispersal, and whether they represent regional hotspots of biological production (which may be important for, for example, migratory species).

Proposed activities

In order to address the priorities stated above, workshop participants identified several key planning and research activities. The primary focus will be on developing an international scientific programme that concurrently catalyzes and coordinates field sampling while continuing databasing and data analysis efforts.

Activity 1: Promoting future field sampling

Given that fewer than 150 of the tens of thousands of seamounts have been explored in any detail, new field research is obviously critical to improving our understanding of seamount biogeography. Therefore, supporting and coordinating existing field efforts and developing new collaborative projects have been identified as high priorities for a future CoML seamount programme. While funding is always a limiting factor for expedition work, the growing concerns within many countries and internationally over human impacts on seamounts may open new funding channels. In addition to leveraging funds for new initiatives, future seamount research should also be linked to existing sampling programmes and, where ap-

appropriate, national agendas (*e. g.* several nations, including Australia, New Zealand and Canada, already have programmes underway to protect certain seamounts within their Exclusive Economic Zones).

Workshop participants recommended that a planning stage for this activity address:

- *Standardized sampling.* A minimum set of standardized samples and data should be defined that is required or recommended for all participating field programmes.
- *Scientific impacts.* Seamounts are already known as potentially fragile habitats. The project may need to develop practices or recommendations to ensure that negative impacts from research activities (*e. g.* sample collection) are minimized and documented.
- *Sampling priorities.* Based in part on the results from Activity 3 (below), it should be possible to draw up a prioritized list of seamounts that warrant particular attention. This could be based either on 1) lack of existing seamount data from a particular part of the world ocean or a category of seamount, or 2) the recognition that a particular seamount (or seamounts) is at imminent risk from fishing or other destructive activities.
- *Defining the programme scope.* Is there a need for a definition of “seamounts” within this programme? While geologists have a strict definition of seamounts (a feature over 1000 m tall of restricted spatial extent) there is growing evidence that this definition is not biologically meaningful. Even relatively small hills and offshore banks can have many of the ecological features of “true” seamounts (*e. g.* Probert *et al.* 1997; Koslow *et al.* 2001; Rowden *et al.* 2002). If seamounts are defined too narrowly within this programme, there is little incentive for groups working in allied hill and bank systems to participate in the programme and provide valuable comparative data.
- *Taxonomy.* Workshop participants highlighted that the lack of taxonomic expertise, and the need for quality control and standardization of taxonomy, will be challenges for a seamount field programme. This is an issue that cuts across all CoML field programmes, however, and might therefore benefit from a devoted CoML initiative.

Activity 2: Networking and coordination

The scope of the science recommended above will require substantial coordination within the international scientific community. Geographically, it is desirable (indeed essential) that many countries participate, given how widely distributed seamounts are and how many lie in international waters. Scientifically, expertise from a wide range of fields (*e. g.* genetics, population biology, fisheries biology, physical oceanography, geology, taxonomy, ecosystem ecology, etc) will be needed. Furthermore, a variety of existing programmes (*e. g.* MAR-ECO, mareco.imr.no/index.html; OASIS, www.rrz.uni-hamburg.de/OASIS/; NOAA Ocean Explorations, oceanexplorer.noaa.gov) are undertaking seamount research. These programmes typically have objectives that are consistent with the science objectives identified in this workshop, and can provide established networks of experts. Facilitating collaboration among these projects, and not competing with them, will be critical.

During the planning phase of a CoML seamount project, international planning workshops will bring together the varied scientific expertise required and help to engage scientists who were not represented at the initial CoML seamount workshop. By these means we will be able to involve a broader group of scientists and expertise to improve the design of the

scientific programme. Presentations at established scientific meetings will be used to raise awareness of the project.

After the initial planning phase, continued networking and coordination can be facilitated by activities such as: 1) an electronic bulletin board or listserv for publicizing, for example, opportunities to participate in upcoming seamount cruises, samples available for analysis or identification, or new funding opportunities; 2) contact lists of experts in various fields (*e. g.* to assist in taxonomic activities); and 3) international open science meetings (or special sessions at existing international meetings) on seamount ecosystems and programme progress.

Activity 3: Databasing and retrospective analyses

A substantial body of work exists on seamount biogeography and ecology. To date, however, these data remain fragmented and, in many cases, are all but inaccessible to the scientific community. Several information systems relevant to seamount biology were demonstrated at the workshop: SeamountsOnline (seamounts.sdsc.edu), the Seamount Catalog of EarthRef (earthref.org) and the MBARI Video Annotation and Reference System (www.mbari.org/vars/). The workshop participants recommended that the planning phase for a global CoML seamount project must continue the development of an online seamounts database and help create an analysis and synthesis effort on existing data. This is not to say that future field studies should not be undertaken until such a synthesis is complete, but rather that full advantage must be taken of existing data to assist in the planning and refining of future field efforts.

After the planning phase is complete, databasing efforts should continue as a repository and archive for new data collected during the field programme, and as the programme's legacy to the Ocean Biogeographic Information System (Zhang and Grassle 2003; www.iobis.org).

The following were also noted as important considerations. First, data sharing: how can we ensure that relevant data are made available? In addition to research data, commercial fisheries datasets were noted as valuable sources of information that will require special efforts to access. Second, the need for digitization, recovery and preservation of existing data was recognized. Important data sets exist that are not currently available (*e. g.* seamount fisheries data collected by vessels of the former Soviet Union). In many cases the cost of digitization and quality control of these datasets is far less than the cost of reproducing the data with new field sampling. Furthermore, given that many of these data were collected in the 1960s and 70s, they may provide valuable historical information on baseline conditions at seamounts that have since been commercially exploited. Finally, the translation of publications and data reports into common languages would increase information accessibility.

Activity 4: Outreach

As photogenic and exciting habitats, seamounts have a rich potential for public outreach and for pre-collegiate education efforts. Publicity prior to and during the CoML seamounts workshop demonstrated how the dynamic ecosystems at seamounts are able to capture the imagination of the public. Because of the emerging interest in conservation issues at seamounts – such as national and international efforts to site marine protected areas on seamounts and

management seamount fisheries – communicating science results to managers and decision makers was highlighted as a special emphasis for a future CoML seamounts programme. While it is beyond the scope of the CoML to make policy recommendations, scientific outcomes from seamount research are likely to be critical to decision making. Because the traditional lines of communication between science and management (i.e. publication in the primary research literature) are often not effective, new mechanisms should be considered.

The next steps

The next actions towards realizing a Census of Marine Life International Field Programme on seamounts will be further outreach efforts to scientists not represented at the workshop, further refinement of the science plan, and the development of a programme secretariat for coordination. Anyone interested in participating in this effort or learning more can contact the authors or visit seamounts.sdsc.edu and follow the links to the CoML Seamount Programme.

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