



Seamounts and Submarine Canyons
Report from a Census of Marine Life KUU Workshop
Hatfield Marine Science Center, Newport, Oregon, US
22-24 August 2003

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A. Purpose and background

This workshop was convened to review the state of scientific knowledge on the biology and ecology of seamounts and submarine canyons, to determine the research priorities for future work, and to examine whether and how a CoML field project could catalyze this work.

The workshop was convened concurrently with another CoML workshop entitled “Biodiversity of Deep-Sea Sediments.” This allowed cross-fertilization of ideas and other interactions beneficial to both workshops.

B. Participation

Invited participants were international scientists with experience in biological and ecological aspects of seamount and submarine canyon research. In addition, participants representing outreach, management, or conservation communities were invited to broaden the overall perspective at the workshop. The workshop combined participants supported by the CoML and those who requested to attend at their own expense. Appendix 1 lists the participants for the workshop.

C. Agenda

The full agenda is given in Appendix 2. Day 1 opened with the Seamounts/Canyons group meeting concurrently with the CoML workshop on the Biodiversity of Deep-Sea Sediments. Overviews of the CoML and the objectives of the two workshop topics were presented, creating the context for the meetings and giving an opportunity for sharing comments. After this, the two workshops separated.

The remainder of Day 1 was devoted primarily to brief (10-minute) presentations by participants on past and planned seamount and canyon research (speakers and titles are included in Appendix 3). These talks 1) evaluated the current state of knowledge on seamounts, 2) familiarized participants with ongoing activities worldwide, and 3) provided a focus for discussions of future collaboration. Day 1 concluded with a brainstorming session on the issues and topics that should be covered during the next day's discussions.

Day 2 began with presentations on 1) management and conservation needs for scientific information; 2) existing relevant information systems (SeamountsOnline and the MBARI video annotation system); and 3) the organization and goals of two of the existing CoML field programs (ChEss and MAR-ECO).

The workshop participants then broke into separate discussion groups for seamounts and canyons. Each group was charged with defining the priority science issues in their respective habitat: specifically, to identify those topics that are currently unknown but knowable given an ambitious, 5-7 year program of coordinated international activity. Day 2 concluded with the two breakout groups re-convening to present a summary of their discussions.

On the morning of Day 3, the Seamounts/Canyons group re-convened together with the Deep Sediments group to present their results and to discuss key outcomes and common issues.

D. Recommendations

The workshop participants developed the following recommendations. Items 1 and 2 are central to a CoML project on seamounts. Items 3 and 4 are not focused on seamounts, but have larger relevance to the CoML.

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 will require directed study of seamounts to learn of their unique features. Specifically, it was noted that seamounts:

- are ubiquitous seafloor features: 30,000+ exist, and are found in all ocean basins
- are biologically distinct from other oceanic ecosystems
- support unique biological communities, often with very high levels of endemism
- can serve as model systems for studying processes that regulate marine communities in the oceans in general
- are geographically isolated, and therefore potentially fragile ecosystems
- are becoming increasingly affected by human activities. Important policy and management decisions regarding seamounts will be made in the next 5-7 years (e.g. UN

General Assembly considerations of marine protected areas) and good science will be essential for guiding management and conservation efforts.

2. A Census of Marine Life field program on seamounts could have a valuable role in energizing and coordinating seamount research.

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

3. A CoML effort on submarine canyons should not be combined with a seamount effort.

A subgroup of participants discussing canyons concluded that their interests fit more appropriately within the Margins group that evolved out of the Deep Sediments workshop. The original rationale for combining seamounts and canyons was that both are abrupt, topographically isolated, features and that they share biogeographic issues of isolation, dispersal, connectivity, etc. However, the canyons group decided that research priority should focus on the role of canyons in the movement of organic materials across the margin, and their importance as barriers to margin communities. In this context, they shared more with the margins group than the seamounts group. During the final plenary session (Day 3) there was some concern that seamounts and canyons might end up competing for the same funding streams, but the consensus was that sufficient potential existed to develop different funding sources for the two programs. The science outcomes of the Canyons group are not reported further here, as they will be included in the report from the Deep Sediments workshop.

4. Taxonomic issues might be most effectively addressed through a higher-level focus within CoML.

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 program. However, it was noted that this issue cuts across all CoML field programs, and might therefore benefit from a devoted CoML program.

E. Science Priorities

Given the above framework, the workshop defined the following 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 questions.

Theme 1: Given that there are 30,000+ seamounts globally, can we categorize seamount community structures and/or develop proxy variables in order to:

- **use our knowledge from a limited number of known seamounts to make predictions about unknown ones**
- **guide future research programs**
- **understand the key processes regulating seamount community structure**

One question that was raised was whether some minimal set of physical information (e.g. gravity anomalies and location) might be formulated to provide a biologically meaningful description/categorization scheme for seamounts. Participants identified the following list of factors, while not comprehensive, as being important to consider:

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

It was noted that this would involve an iterative process of:

- categorizing communities
- relating them to various factors
- developing hypotheses about important factors/proxy variables
- testing those ideas with (with existing or newly gathered data)
- using the results to refine community categorizations, etc.

Given its potential to guide the development of future field programs, it was decided that this theme should be addressed first, but that it should also be ongoing 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 community as well as between seamounts, and that both are important for understanding seamount ecosystems. Particular questions of interest include:

- How do the physical features of a particular seamount influence the composition of communities that occupy its various habitats?

- What are the roles of biological interactions, 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 role to larval dispersal and recruitment dynamics play in the long-term persistence of seamount populations?
- How do surrounding deep-sea habitats 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**
- 4) productivity**

This theme will involve the synthesis of seamount studies from around the world. Specifically, we propose investigating issues such as whether seamounts act as centers of speciation, as refugia for relict populations, and/or to what extent they serve as stepping-stones for trans-oceanic dispersal.

G. Activities

In order to address the research priorities stated above, participants identified several key planning and research activities. The primary focus will be on developing an international scientific program that concurrently catalyzes and coordinates field sampling and continues databasing and analysis efforts. It is stressed that the activities below are should be pursued in concert.

Activity 1. Promoting future field sampling

Given that fewer than 150 of 30,000+ seamounts have been explored, new field research will obviously be critical to a better understanding of seamount biogeography. Therefore, supporting and coordinating existing efforts and developing new projects have been identified as high priorities for a future CoML Seamounts Program. Current concerns over seamount management and policy may open funding avenues for new research, and we should leverage

from these initiatives and link to existing national agendas where appropriate. It was noted that the existing MAR-ECO program has an active seamount focus and well-developed network of experts in the Northeast Atlantic, and that our goal should be to support and expand, and not to compete with, this program and others of its sort.

A planning stage for this activity should address:

- **Standardized sampling.** A minimum set of standardized samples/data should be defined that is required/recommended for all participating field programs.
- **Scientific impacts.** Seamounts are known as potentially fragile habitats. The project may need to develop practices or recommendations to ensure research impacts are minimized, documented, and kept to acceptable levels.
- **Sampling Priorities:** Based in part on the results from Activity 1, it should be possible to draw up a prioritized list of seamounts that warrant particular attention. This could be based either on (i) lack of existing seamount data from a particular part of the world ocean, or (ii) the recognition that a particular seamount (or seamounts) is at imminent risk from fishing or other activities.
- **Defining the program scope.** Is there a need for a definition of "seamounts" within this program? While geologists have a strict definition of seamounts (a feature over 1,000m tall of restricted spatial extent) there is growing evidence that this definition is not biologically meaningful. Shorter hills and offshore banks can have many of the ecological features of true seamounts. Whether these should be included in the program is a topic for further consideration.

Activity 2. Networking and coordination

While the workshop reported here in an excellent start, the proposed goals will take significant effort. The scope of the science recommended above will require substantial coordination within the international scientific community. Geographically, many countries should participate. Scientifically, expertise from a wide range of fields (genetics, population biology, fisheries biology, physical oceanography, geology, taxonomy, ecosystem ecology, etc) will be needed. Furthermore, a variety of existing programs (MarEco, OASIS, Ocean Exploration) are undertaking seamount research. These programs typically have objectives consistent with, but generally more restricted than, the science objectives we have identified. Assuring collaboration among these projects and involvement of their key scientists in the planning and ultimate execution of a larger seamount research program will need to be facilitated.

During the planning phase, international planning workshops can serve to bring together the varied scientific expertise required and engage scientists not represented at this workshop. In this manner, we will involve a broader group of scientists and expertise to improve the design of

the scientific program. Presentations at established scientific meetings can be used to raise awareness of the project.

After the planning phase, continued networking and coordination can be facilitated by:

- an electronic bulletin board or listserv for describing upcoming cruises, samples that may be available for analysis, funding opportunities, etc.
- a contact lists of experts in various fields (e.g. to assist in taxonomic activities)
- international open science meetings, or special sessions at existing meetings, on seamount ecosystems and program 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 some cases are all but inaccessible to the scientific community. Progress to date with SeamountsOnline has demonstrated the value of bringing together existing data and undertaking syntheses, but much more remains to be done. The workshop recommends that the planning phase for a global seamount project must continue development of an online seamounts database and create an analysis/synthesis effort of existing data. This is not to say that future field programs should not be undertaken until such a synthesis is complete, but rather that full advantage be taken of existing data in the planning and refining of future field efforts of a CoML Seamount Program.

After the planning phase is complete, the database effort should continue as a repository and archive for data collected during the field program, and as the program's contribution to the Ocean Biogeographic Information System.

With respect to the database, the following recommendations were made:

- To evaluate existing systems (SeamountsOnline, the MBARI image annotation system, and the Seamount Catalog of Earthref) to determine if they meet information needs, and expand as necessary.
- To include or link to physical/geological data, including data for seamounts having no accompanying biological information. For example, access to detailed multibeam maps from otherwise unexplored seamount can aid in planning future research. This will require establishing good connections to the geological/physical community to ensure that we are aware of all relevant data sources.

The following were also noted as potential components needing further consideration:

- Data sharing: how can we ensure that data are made available? In addition to research data, fisheries datasets were noted as important sources of information that may need special efforts to access.

- Digitization/recovery/preservation of existing data. Valuable data exist that are not currently available (e.g. seamount fisheries data collected by vessels of the former Soviet Union). In many cases the marginal cost of digitization and quality control of these datasets is much less than the cost of reproducing the data with new field sampling. In addition, given that many of these data were collected in the 1960's and 70's they may provide valuable information on baseline conditions at seamounts that have since been commercially exploited.
- Translation of publications/data reports into common languages.

Activity 4. Outreach

As photogenic and exciting habitats, seamounts have a rich potential for public outreach and for K-12 education efforts. Publicity prior to and during the workshop demonstrated how the dynamic ecosystems at seamounts are able to capture the imagination of the public (the CoML Census in the News page has details of some of these articles - <http://www.coml.org/medres/medres1.htm>) . Because of the special interest in conservation issues at seamounts, communicating science results to managers and decision makers was highlighted as a special focus that a future program can provide. While it was recognized that the effort would not make policy recommendations, the science results themselves would 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.

H. Next Steps

The next actions for a potential CoML Seamounts field program will be 1) the organization of an international scientific steering committee; 2) the development of subcommittees/action groups for each of the different activities; 3) further planning meeting(s) or other means of communication to refine goals and produce a science plan, and 4) outreach efforts to contact scientists and programs not represented at the planning workshop.

Appendix 1
 Workshop Participants
 Seamounts and Submarine Canyons Workshop
 Hatfield Marine Science Station, Newport, Oregon, USA
 August 22-24, 2003

<u>Name</u>	<u>Affiliation</u>
Nancy Baron	SeaWeb/COMPASS
George Boehlert	Oregon State University, US
Jacqui Burgess	Ministry of Fisheries, New Zealand
Gregor Caillet	Moss Landing Marine Laboratories, US
Bernd Christiansen	Institut für Hydrobiologie und Fischereiwissenschaft, Germany
Sabine Christiansen	WWF International, Bremen
Judith Connor	Monterey Bay Aquarium Research Institute, US
Cynthia Decker	Office of Naval Research
John Dower	University of Victoria, Canada
Heino Fock	ecoanalysis.de
Karen Garrison	Natural Resources Defense Council
Linda Glover	Conservation International, US
Raymond Highsmith	University of Alaska, USA
Baban Ingole	National Institute of Oceanography, India
Eva Ramirez Llodra	Southampton Oceanography Centre, UK
Jon Moore	Florida Atlantic University, US
Bhavani E Narayanaswamy	Scottish Association for Marine Science, UK
Ron O'Dor	Census of Marine Life, US
Alex Rogers	British Antarctic Survey, UK
Evgeny Romanov	Southern Scientific Research Institute of Marine Fisheries and Oceanography (YugNIRO), Ukraine
Ashley Rowden	National Institute of Water & Atmospheric Research (NIWA), New Zealand
Thomas Schlacher	University of the Sunshine Coast, Australia
Tim Shank	Woods Hole Oceanographic Institution, US
Ross Shotton	FAO Fisheries, Italy
Igor Smirnov	Zoological Institute of RAS, Russia
Karen Stocks	San Diego Supercomputer Center, US
Paul Tyler	Southampton Oceanography Centre, UK
Franz Uiblein	University of Salzburg, Austria
Mike Vecchione	National Marine Fisheries Service/National Museum of Natural History
Eric Vetter	Hawaii Pacific University, US
Waldo Wakefield	NOAA National Marine Fisheries Service, US
Alan Williams	CSIRO Marine Research, Australia
Mary Yoklavich	Southwest Fisheries Science Center, US

Appendix 2: Agenda
Seamounts and Submarine Canyons Workshop
Hatfield Marine Science Station, Newport, Oregon, USA
August 22-24, 2003

Note: The Seamounts and Submarine Canyons Workshop was held in parallel with the CoML workshop on the Biodiversity of Deep Sea Sediments. The joint sessions were held in the HMSC Visitor Center Auditorium, the Seamount/Canyon sessions in the Guin Library Seminar Room, and the Sediments sessions in Meeting Room 9.

Thursday 21 August 2003

Daytime – participants arrive
Registration Desk at La Quinta manned from 16:00.

19:00 – Evening reception for all at La Quinta, 45 SE 32nd St., South Beach

Friday 22 August 2003

8:30 Shuttle vans from hotels to HMSC (will do several loops as needed between 8:30 and 8:45. Meet in the hotel lobby)

9:00 Joint plenary session with Deep-Sea Sediments workshop

9:00	Welcome (George Boehlert)
9:10	The Census of Marine Life (Ron O'Dor)
9:30	Seamounts/Canyons (Karen Stocks)
9:50	Deep-Sea Sediments (David Billett)

10:10 Break – Seamount/Canyon and Deep-Sea Sediment groups separate

10:30 – *The Known*

10:30 – 11:00	Brief self-introductions
11:00 – 11:30	Workshop goals
11:30 – 12:30	Summaries of existing and planned studies – 10 min. each, given by participants

12:30 Lunch

13:45 *The Known, continued*: Summaries of existing and planned studies, continued

16:00 Break

16:20 *The Unknown*

Discussion: gaps/strengths in current knowledge of the biogeography of seamount and canyon systems. Priority future research: regions, hypotheses to test, etc.

18:30 Transport to hotels

19:30 Transport from Hotels to Rogue Brewery

20:00 Workshop dinner at Rogue Brewery

Saturday 23 August 2003

8:30 Shuttle vans from hotels to HMSC

9:00 *Applied Considerations and New Technologies*

9:00 Information Needs for Management (Ross Shotton)

9:30 Information Needs for Conservation (Sabine Christiansen)

10:00 The SeamountsOnline information system (Karen Stocks)

10:15 Information system for video and photos (Judith Connor)

10:30 Break

10:50 Case studies from existing CoML projects:

10:50-11:00: ChEss (Eva Ramirez Llodra)

11:00-11:10: MAR-ECO (Franz Uiblein)

Tasking of Seamounts and Canyons subgroups (goal: to develop a science plan)

Seamounts. Chair: John Dower; Rapporteur: Greg Caillet.

Canyons. Chair: Paul Tyler; Rapporteur: Waldo Wakefield

11:20 Sub-group Discussion: towards a future plan. (A separate Discussion Group handout will give details)

12:30 Lunch

13:45 Sub-group Discussions continues:

15:30 Break

15:50 Plenary session

15:50 Report from Seamount sub-group

16:10 Report from Canyons sub-group

16:30 Discussion.

- Next steps.
- Plan workshop publication(s) and venue
- Formation of committees for future efforts

18:00 Transport to Hotel

19:00 Transport from hotels to Oregon Coast Aquarium

20:00 Workshop dinner at Oregon Coast Aquarium

Sunday 24 August 2003

09:00 Joint plenary session with Deep-Sea Sediments workshop (Chair: Paul Tyler)

9:00 Report from Deep-Sea Sediments workshop

9:30 Report from Seamount/Canyon workshop

10:00 Discussion of Common Issues

11:00 Adjourn

12:00 Transport departs for Coos Bay for those attending the Deep-Sea Symposium.

Appendix 3 Presentations

The following brief presentations were made during days 1 and 2 of the workshop. Note that only the presenter's name only is given for convenience, though some of the presentations had multiple authors.

- George Boehlert
Diel migrators at a seamount in the central North Pacific -- Don't forget the water column
- Jacqui Burgess
New Zealand government interest in seamount research
- Gregor Caillet
Central California studies on submarine canyons and seamounts research
- Bernd Christiansen
OASIS: OceAnic Seamounts: an Integrated Study
- Sabine Christiansen
Seamounts and canyons: Research needs seen from the conservation perspective
- Judith Connor
Video data management
- John Dower
Shallow seamounts in the NE Pacific
- Heino Fock
Seamount studies
- Baban Ignole
Indian contributions to the benthic biology of Indian Ocean
- Bhavani Narayanaswamy
Rising above the plain: The biology of the U.K.'s seamounts
- Eva Ramirez Llodra
ChEss, Biogeography of Chemosynthetic Ecosystems: An example of a recent CoML pilot project
- Alex Rogers
Seamount genetic studies
- Evgeny Romanov
A review of Soviet/Ukrainian research efforts at the seamounts of the Indian Ocean
- Ashley Rowden
Seamount research in New Zealand by the National Institute of Water & Atmospheric Research, its forerunners and collaborators
- Thomas Schlacher
Seamount & deep-sea faunal diversity in the South Pacific
- Timothy Shank
Seamount genetics: A "brief ?" summary
- Ross Shotton
Management of seamount fisheries
- Igor Smirnov
Seamount investigations in the Zoological Institute of RAS (Saint Petersburg) and the Institute of Oceanology of RAS (Moscow)

Presentations, continued

- Karen Stocks
SeamountsOnline: an online information system for seamount biology
- Franz Uiblein
MAR-ECO: the census of marine life field project. Patterns and processes of the ecosystems of the northern Mid-Atlantic
- Eric Vetter
Canyon research
- Waldo Wakefield
Summary of existing and planned studies
- Alan Williams
Seamounts and canyons: Activities in Australian waters
- Mary Yoklavich
Deepwater benthic fishes and habitats