Importance of Seamounts to Species of Conservation Concern

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BACKGROUND: The majority of the ocean is in essence a desert for large, pelagic migrating species. With an average depth of over three and a half kilometers, the ocean floor is out of reach for most animals. Even though elephant seals have dive limits of 1500 meters, this is well above the depth of most of the ocean floor. Small portions of the seafloor, however, reach higher into the water column and these underwater islands, called seamounts, may be important oases in the ocean. There is strong anecdotal evidence scattered throughout seamount and migratory species literature suggesting that seamounts are highly predictable destinations where there is increased primary or secondary productivity, resulting in increased pelagic foraging success. Some research has shown that seamounts are important aggregation sites for species such as bigeye tuna[1,2], yellowfin tuna[1] and seabirds[3]. Little additional research has been conducted, even though seamounts may be of great importance to other species of commercial and conservation significance.

Interest in the ecology of seamounts and similar benthic ecosystem ecology is burgeoning, as indicated by the deep-sea coral session at the 2004 AAAS Meeting which included a focus on seamounts, and by the ever-increasing body of literature on the topic[4]. Of increasing concern is the vulnerability of these ecosystems[4,5]. Although the tide of scientific interest is beginning to rise, it is many years - even decades - behind that of the commercial fishing industry, which has been fishing seamounts for generations. This is particularly concerning because bottom trawls have the ability to greatly alter and destroy delicate ecosystems such as deep-water coral colonies frequently found on seamounts[6]. Most seamounts occur in international waters, making protection a daunting management challenge. However, some of the strongest international conservation agreements pertain to endangered species. These agreements create the possibility of protecting both species and seamounts if it can be proven that seamounts are critical habitat for their migratory and developmental success[7]. Determining the methods seamounts can be effectively protected in domestic and international waters is paramount.

RESEARCH: I will examine the relationship between seamounts and other large bathymetric features and the movements of satellite tagged animals which are part of the Tagging of Pacific Pelagics (TOPP) program. I will combine my knowledge of animal behavior and geographic information systems (GIS) as an analytical tool with my experience in conservation science to frame the findings in a management context. The TOPP project is being conducted primarily by my graduate advisor, Dr. Dan Costa at the University of California Santa Cruz. The TOPP program seeks to answer many questions regarding the movements of species of international conservation concern, such as seabirds, whales, seals and large fish, and determine areas of the ocean important to their protection known as "hotspots" by tagging 5000 individuals in 20 taxa using satellite and archival tags[8]. I will determine the relationship between TOPP animals and seamounts.

Research questions:

- **Behavior:** What dominant behaviors are displayed by TOPP animals near seamounts in the North Pacific? What do these behaviors indicate about the use of seamounts by TOPP animals? How does foraging behavior relate to prey distribution in the area surrounding seamounts?
- **Seamount Characteristics and Animal Distribution:** What are the characteristics of seamounts or what processes associated with seamounts drive the abundance of TOPP animals in relation to seamounts in the North Pacific?

Hypotheses:

- **Behavior:** The dominant behavior observed near seamounts will be foraging. Analysis will show that seamounts are important foraging grounds when compared to non-seamount areas. Analysis of fisheries data will show prey species of foraging animals are abundant in the region.
- **Seamount Characteristics and Animal Distribution:** Increased abundance will be caused by

increased productivity associated with changes in oceanographic conditions around seamounts which result in increased productivity or trapping of productivity near seamounts, and/or due to the increased productivity of benthic ecosystems on seamount surfaces due to coral and sponge communities and increased benthic complexity.

Methods:

My main analytical tool will be GIS, using software provided by Environmental Systems Research Institute, Inc. (ESRI). The data collected from TOPP animals can be analyzed using ESRI software, in combination with other programs such as MatLab and Surfer.

- **Behavior:** Fine scale movements within these regions will be examined. In collaboration with other members of the Costa lab, the potential behaviors of animals will be examined based on behavioral parameters such as dive depth and analyzed using first passage time and fractal analysis. Results from stomach temperature probes (which indicate foraging and other behavior) employed as part of complementary research projects will also be used to supplement spatial behavior data, particularly in relationship to foraging. Fisheries catch data will be analyzed to show presence or absence of prey species in the vicinity of the seamounts. Comparison with non-seamount movement data analyzed by other TOPP team members will allow conclusions to be drawn as to what role seamounts play in the life cycle of various individuals and species.
- **Seamount Characteristics and Animal Distribution:** The specific characteristics of seamounts which cause them to be hotspots will be determined by combining spatial behavioral and environmental data. Environmental data (sea surface temperature, surface productivity, current flow, locations of coral and sponge communities, and temperature, light level and salinity at varying depths) and proximity of behaviors to seamount surfaces will be combined with spatial behavioral data. The data will be analyzed to determine what environmental characteristics are driving increased abundance of TOPP animals.

I will also conduct a thorough literature review of domestic and international frameworks in place that could be used to protect seamount ecosystems, including consideration of protected species critical habitats in order to frame the outcomes of the project in a management context.

PROJECT DELIVERABLES: Results will be published in relevant peer-reviewed scientific journals and presented at appropriate scientific meetings. Findings will also be directly communicated to management agencies and non-profit organizations with an interest in seamount and threatened species protection by creating a summarized version of the findings and management implications that is brief and easily understood. The findings will be communicated to an audience outside the scientific community. The results will be published in related industry and general interest periodicals to reach stakeholders and the general public. Presentations will also be given at appropriate venues which reach the general public and industry. The work will be integrated with the TOPP website (www.toppcensus.org) to show how seamounts are part of the migratory journey of TOPP animals.

CONCLUSION: My aim is to form a strong basis for the protection of seamount ecosystems by creating a solid body of literature as a result of rigorous science produced with the help of the latest technologies such as GIS and satellite telemetry, and to contribute to the public's understanding of seamount ecosystems and their importance to species of conservation importance. Given the isolation of seamount ecosystems, their potential importance to the overall ocean ecosystem and the current lack of science showing how these features interact with the living ocean around them, this research is both timely and essential.

1 Sibert J et al (2000) *Aquatic Living Resources* 13:225-232. **2** Musyl MK et al (2003) Fisheries *Oceanography* 12:152-169. **3** Haney JC et al (1995) *Marine Biology* 123:1-9. **4** Stone G et al (2003) *Defying Ocean's Ends Conference*. **5** Probert PK (1999) *Aquatic Conservation: Marine & Freshwater Ecosystems* 9:601-605. **6** Koslow JA et al (2001) *Marine Ecology Progress Series* 213:111-125. **7** Alder J & L Wood (2004) *Fisheries Centre Research Reports* 12:67-78. **8** Block BA et al (2003) *Oceanologica Acta* 25:255-266.