Scoping study for the development of scientific advice on Bowie Seamount

by

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to

Pacific Marine Analysis & Research Association
Vancouver, BC

18 April 2008

Table of Contents

1. Introduction

The Bowie Seamount will soon be declared a Marine Protected Area under the Oceans Act. As part of the *management plan*, the Pacific Region Oceans program must develop a monitoring program specific to the Bowie Seamount. The general goals of the program are to develop a scientifically-based monitoring program to evaluate the effectiveness of management of the MPA against defined management objectives. The program should enable research on: 1. interactions of the Seamount's assemblages; 2. ecosystem processes; 3. endemism and connectivity; and 5. to assess the effects of human activities and sources of disturbances (e.g. fishing, research, climate change) on assemblages, habitats and processes.

To advance the development of the monitoring plan, it was agreed that a workshop should be convened to further define the research and monitoring program against management objectives. The workshop will 1. define the research and monitoring program for the Bowie Seamount management needs and ensure that this program is well fitted with the global research program; 2. engage external scientists to inform the formulation of a monitoring and research program for the Bowie Seamount; 3. identify relevant scientific resources outside the DFO that can contribute to the mandate on MPAs and ecosystem based management, and make recommendations for the structure of a scientific advisory board;

This report covers phase one of the project, that is, to scope the program of a research and monitoring workshop. The document aims to 1. briefly review the state of knowledge on Bowie Seamount to identify information gaps; 2. briefly review the status of research and monitoring in the Atlantic and the Pacific; 3. refine the objectives of the research and monitoring program; 4. identify the elements of an adequate structure that could provide long-term assistance to DFO for the Pacific Region Oceans' program; 5. propose an agenda, deliverables, and a list of delegates for the workshop; 6. propose a principal investigator for the phase 2 of the project. 7. identify elements of a code of conduct for scientific research.

2. Current management objectives and actions

2.1 Objectives

Seamounts have a high biological importance because of their physical characteristics that can generate upwelling of nutrients, that can enhanced primary production or more importantly, current regimes that trap small migrating organisms. This increase in available food attracts birds, mammals, large pelagic fish and fisheries. The benthic community is generally diverse and abundant, compared to the surrounding deep-sea, and composed of a large proportion of long-lived species. Species found on seamounts are often endemic (10-50% endemism; Stocks and Hart 2007) while others are widely distributed and sometimes also found in coastal areas. Seamounts are suspected to serve as stepping stones and refuges for some species and thus play an important role in species biogeography.

As a shallow seamount Bowie is also characterised by the presence of a photic zone and thus an algal community. The Bowie Seamount area was selected because of its high biological productivity and a diversity of oceanic, coastal, and seamount species that includes a number of species that have been listed under the *Species at Risk Act*, including the ancient murrelet, *Synthliborhamphus antiquus*, the Steller sea lion, *Eumetopias jubatus*, the killer whale, *Orcinus orca*.

Protecting the Bowie Seamount in particular is one more action to improve "our understanding of the impact of fishing in relation to environmental effects such as climate change" (Government of Canada 2008). The international dimension of seamount research is recognized and protecting Bowie demonstrates Canada's willingness "to fulfill its international commitments for ocean management and marine conservation" (Government of Canada 2008) and raise its profile internationally in marine biodiversity protection.

Three internal management zones have been defined: 1. the photic zone of the Bowie seamount (down to 250 fathom deep); 2. the rest of Bowie seamount structure and surrounding waters, seabed and subsoil; 3. Hodgkins and Davidson Seamounts (Government of Canada 2008). The management objective defined for the Bowie seamount Marine Protected Area is to conserve and protect this unique biodiversity and biological productivity (Government of Canada 2008). As per the Oceans Act, the next step is to develop a management plan which will include ongoing management, monitoring and enforcement activities in the MPA.

2.2 Actions

The regulations proposed for the Bowie seamount published in the Gazette in March 2008 (Government of Canada 2008), the sablefish fishery would only be permitted in Zone 2 while rockfish and halibut fisheries will be forbidden because they would take place in Zone 1. The permits for these fisheries required an on-board observer and biological sampling. The surface fishery for tuna is considered to have no impact on the seamount itself and could be allowed. There is also a tanker exclusion zone in place although ships usually travel a more seaward route.

There is currently no monitoring or enforcement, although a surveillance strategy has been discussed in the Gazette regulatory impacts (Government of Canada 2008). All research and exploitation activities require a permission from the Department of Fisheries and Oceans (through the Oceans directorate and the Bowie Seamount Advisory Team), and in some cases, permits from the Department of Foreign Affairs (for foreign teams) and the Department of National Defence are necessary.

Research activities are scarce on Bowie Seamount, described in the next section, and the present document will hopefully contribute towards the development of a monitoring and research plan. The outreach program, being somewhat dependent on the current knowledge and on the research program, remains to be developed.

3. State of knowledge on Bowie

This section largely summarizes the work of Canessa et al. (2003b), complemented with information from other publications where necessary. The proposed MPA encompasses the Bowie, Hodgkins and Davidson seamounts and covers about 6,131 km^2. They are part of the Kodiak to Bowie chain of seamounts. Physiographic characteristics for the Bowie Seamount have been studied although the geological formation of the seamount has not been elucidated. Weather data are available, but oceanographic characteristics have been the object of only a few research cruises and some features, such as the presence of a Taylor cap, could only be inferred from the Cobb seamount (Canessa et al. 2003b; Pitcher et al. 2007). The Bowie Seamount peak is shallow, at 25m below the surface, which allows for a community of macroalgae to develop. Directed studies were quite rare and can only hint at the richness and importance of benthic life present on Bowie. For instance, observations from a National Geographic Society underwater survey, benthic algae survey, oceanographic cruises, fisheries report and logs, and bird observations are the basis of the knowledge on the seamount (Canessa et al. 2003b). In 2000, there was an effort to develop estimation methods for rockfish using a submersible, and surveys for marine mammals and birds were conducted. The seabird surveys at the Bowie Seamount, uneven and small-scale, recorded a large variety of marine birds in the area, hinting at the seamount's ecological importance. In contrast, the surveys on the Cobb Seamount were sufficient to show a significantly higher abundance of seabirds in the vicinity of the seamount than elsewhere in the region.

The fish community is dominated by rockfishes (*Sebastes* spp) but also features Pacific halibut (*Hippoglossus stenolepis*), sablefish (*Anoplopoma fimbria*), and prowfish (*Zaproa silenus*). Based on the surveys, data from the small rockfish fishery and a genetic study, it seems that the Bowie seamount yelloweye rockfish, a long-lived, slow-growing species, is part of a large panmictic population that is present from Southeast Alaska to the Bowie Seamount. The genetic homogeneity may be due to larval dispersal since adults are rather sedentary. The age structure indicates that the rougheye population on Bowie seamount is very old, with a mean age ranging from 43-53 years old with no fish younger than 10 years old in the 6 surveys carried between 1992 and 2000 (Beamish and Neville 2003). The local age structure could be the result of local fishery mortality, the irregular influx of young individuals, and the longevity of these species. The presence of persistent eddies around seamounts, like those observed at the Cobb seamount, combined with the viviparious life history, and the larvae's positive phototactic swimming behaviour, may contribute to retain rockfish larvae and thus sustain local populations (Dower and Perry 2001). These life-history characteristics indicate high vulnerability to fishing as it is often the case on seamounts and in deep-seas. The targeted rockfish hook and line fishery on Bowie Seamount was permitted from 1992 to 1999, as a collaborative arrangement with the science branch of the DFO. The catch was assumed to have little impact on the total population and was not included in the calculation of the annual quota. Nonetheless, the catch of rougheye rockfish (*Sebastes aleutianus*), the most abundant rockfish on Bowie seamount, constituted 20% of the total commercial catch for that species (Beamish and Neville 2003).

There is a small sablefish trap fishery on the Bowie Seamount controlled by permits allocated by a draw and requires biological sampling by the fishers. Traps are set all around the seamount at depths of about 1000 m (250-1250 m). These catches are not included in the total allowable catch that is enforced in coastal waters (Beamish and Neville 2003), assuming that this fishery has no impact on the total population. Catch per trap declined between 1989 and 1993 on Bowie, which suggested that current fishing on Bowie and the other 15 exploited seamounts was not sustainable (Murie et al. 1996). Catches on the seamount reached 80 t in 2000 compared to a peak of 353 t in 1991, and catches per unit of sablefish habitat in 1991 were 23 times higher than the level observed in coastal areas (Beamish and Neville 2003). The sablefish fishery, conducted by hook and line or traps, entails a level of bycatch reaching 20% of the total catch between 1990 and 2002. The bycatch is composed predominantly by rougheye rockfish and other rockfish.

The status of the local population of sablefish, and of the nature of its link with more coastal populations are uncertain. Juvenile sablefish are highly migratory and span the whole Gulf of Alaska (Sigler et al. 2001). Sablefish are on average older on the Bowie seamount than in coastal areas and the age structure show no signs of recruitment between 1988 and 1994 (Beamish and Neville 2003). Juvenile sablefish less than 3 years have not been observed on the seamount (Murie et al. 1996). The sex ratio is generally skewed towards males on seamounts while sablefish caught at great depths are mainly females (Murie et al. 1996) while it appears that the sex-ratio is more balanced on the slope. This is an interesting observation that deserves more attention with uniform sampling methods. In addition, tagging studies show that there is perhaps regular exchange between coastal and seamount populations (Beamish and Neville 2003). Similar findings are reported for sablefish in Alaska (Maloney 2004).

Although fishing for halibut has been conducted in the Bowie seamount area since the 1950s, little significant consecutive harvest data were observed. In addition, the International Pacific Halibut Commission database cannot be used to extract specific data for the Bowie Seamount prior to 1980. Available information for 1984 to 1992 shows a cumulative catch of 139,000 pounds caught at the Bowie seamount, which seems pretty insignificant in the context of the coast-wide quota totalling 11.75 million pounds. However, verbal reports of 16,800 kg caught in 48 hours in 1990, all composed of large individuals (27-118 kg, possibly older than 12 years old) (Beamish and Neville 2003) and the strong possibility that the population may not be self-sustaining suggests that there is a risk of local depletion (Beamish and Neville undated).

Albacore tuna, caught by trolling, is fished around the Bowie seamount when warm waters come north. Fishing on the seamount is probably limited due to its remoteness but a few vessels, both Canadian and American, were known to fish in the area.

Anecdotal reports of occasional fishing activities by US boats on their way to Alaska and back are unverified or unquantified (Wood and Alder 2005). Surveillance and enforcement are difficult on Bowie because of the geographic isolation but the recent installation of an acoustic device to detect fishing activity may become an interesting option (J. Dower, U. of Victoria, pers. comm.). For the time being, the data can only be retrieved every six months, but it could become very useful for surveillance if the data was transmitted online in real-time.

Given the obvious gaps in data and basic knowledge of the Bowie seamount biota, it is not surprising that the first attempt at ecosystem modelling resulted in a simple structure with an emphasis on the exploited species (Beamish and Neville 2003). Although coarsely represented, the benthic community constituted the largest part of the model structure while the pelagic community was even less elaborated. Although results of the basic simulations should not be given too much credence, they accentuated the importance of trophic relationships in understanding the impact of fishing. Future models should also include the separation of life stages (stanzas), especially for cannibalistic species and should include new knowledge on age structure and mechanisms for recruitment (Beamish and Neville 2003).

4. Monitoring review

Seamount ecosystems are generally very scarcely documented (Pitcher et al. 2007). Several initiatives to protect seamounts, hydrothermal vents and other deep-sea features have been undertaken and reflect the concern for these fragile habitats and the interest in acquiring knowledge on the structure and function of these ecosystems, e.g. InterRidge, OASIS (integrated studies on seamounts (2002-2005), Census of Marine Life (www.coml.org) and partners such as CenSeam, http://censeam.niwa.co.nz/home, ECOMAR (the UK affiliate) and MAR-ECO (mid-Atlantic ridge) project, www.mar-eco.no.

In terms of general knowledge about physical processes and biota diversity, the Census of Marine Life proposes to classify seamounts by targeting research on a subset of seamounts based on physiography, currents, geographic location and hydrographic features (Stocks et al. 2004). These categories would direct research expeditions more efficiently and increase our knowledge and understanding globally. It is agreed that research programs should be focussing on seamount ecosystem structure and function to understand the key processes that regulate and maintain them (Stocks et al. 2004; Christiansen 2006). There is considerable uncertainty about the degree of linkage between populations across seamounts and how much a given seamount is self-sustaining. Field work should address species' population dynamics and recruitment processes and the linkage with surrounding ecosystems (e.g., deep-seas) and other seamounts. In addition, the role of seamounts in global oceanic systems in terms of productivity and biodiversity is another important research topic. Finally, oceanographic and trophodynamic modelling could be used for synthesis and functional ecology. To this effect, the project OASIS, completed in 2006, has accomplished a lot of work towards understanding the processes governing seamounts (Christiansen 2006). A few studies have been carried out to improve our understanding of the ecosystem (Koslow 1997; Fulton et al. 2007) and evaluate hypothesis about emigration (Morato 2006)

In the present state of knowledge, most expeditions aim to acquire basic knowledge on oceanography and biota, which is labour intensive and interesting given the high level of endemism in the benthic fauna alone. In the North Pacific, expeditions surveyed several US coast seamounts (see http://oceanexplorer.noaa.gov/), including Cobb (Parker and Tunnicliffe 1994; Dower and Perry 2001), Patton seamount (Hoff and Stevens 2005), Davidson seamount (De Volgelaere et al. 2005), Cordell Bank (http://sanctuarysimon.org) and several Alaskan seamounts (Bizzarro 2002; Heifetz 2002; Krieger and Wing 2002; Maloney 2004). In some cases the existence of deep-cold-water corals and the threat of fishing triggered interest to protect the habitat structure (Witherell and Woodby 2005; Stone and Shotwell 2007) while in other cases, the main interest was the impact of fishing (New Zealand examples: Clark et al. 2000; Clark et al. 2007) or assessment surveys for exploited species (Maloney 2004).

Monitoring programs of seamounts are quite rare. In the Tasmanian Seamounts Reserve (Australia), surveys are gathering basic data on habitat types and composition of the benthic biota to develop quantitative ecological indicators that could be used for monitoring and assess the degree of achievement of management goals (e.g., Williams 2007a). Although definitely oriented towards future monitoring and management needs, the research program is still in an early stage as the data from the last two surveys are still being analysed (Franziska Althaus, CSIRO Marine and Atmospheric Research, Hobart, Australia, pers. comm.). The 2006 research and monitoring plan focussed on the benthic ecosystem and proposed to review the existing information for an inventory of biodiversity and establish monitoring program that would provide baseline information on proposed reserves to help assess performance of management plan (Williams 2007b). Indicators developed, taking into account the possible frequency and the limits of sampling in fragile ecosystems, would help: 1. characterise habitat types at multiple scales as for their vulnerability and condition; 2. develop biodiversity metrics that would quantify the composition, structure and endemicity of benthic communities, and percentage of live and dead coral; 3. identify abundance of key species; 4. inform on the proportion of habitats and communities likely to be contained in the MPAs; and 5. assess impact of human activities such as habitat damage, presence of loss of fishing and scientific gear and effort that has been put into these activities (Williams 2007b). The 2007 survey partly focussed on gathering information on proposed MPAs and established MPAs, revisiting seamounts surveyed in 1998, and collect baseline georeferenced data at scientific reference sites to quantify the indicators.

In addition to the numerous biodiversity surveys, the New Zealand programme involves repeat surveys on a small cluster of seamounts off the coast. Eighteen of the 19 protected seamounts around New Zealand have been subjected to fishing before the closure, in 2001, and comparative studies show that unfished seamounts have greater coral cover and some differences in species composition (Clark and O'Driscoll 2003). Monitoring changes and possible recovery and recolonisation of benthos is carried out using repeated surveys (surveys in 2001, 2006 and scheduled for 2009). Habitat mapping and oceanographic studies are also included in the survey (Clark 2006). Finally, there are surveys planned on the Kermadec Ridge seamounts in 2008 and 2011 as part of an exploration survey associated with potential seabed mining of massive sulfide deposits on seamounts (M.R. Clarke, NIWA, Wellington, pers. comm.).

The ongoing monitoring program in the Azores is mainly focussed on exploited species (Telmo Morato, University of the Azores, Horta, Portugal, pers. comm.). The program is composed of 5 main components. 1. Longline research cruises were used to estimate inter-annual and long term variability in abundance, community composition, and population structure (size, age, sex-ratio). The sampling follow a stratified random sample design, using the same gear and vessel since 1994; 2. Shallow water visual census for fish were conducted, since 1997, around the island and some seamounts from 0 to 30-40 metres depth. Fish are counted and sized (small, medium, large, extra-large) along transects (50m x 5m area); 3. The tuna program (POPA) has observers on-board tuna fishing vessel to estimate fishing effort, catches, oceanographic conditions and other fauna associated with catches, since 1998; 4. Oceanography: Some semi-permanent moorings were deployed around the islands and some seamounts to monitor currents and perhaps other oceanographic parameters. In addition, satellite imagery with ocean colour and SST were received every day since 2000. These images are used to relate species abundance, catches, etc., with SST and chlorophylle a; 5. A system of collection of coral samples from fishing vessels was started a few years ago to inform on the trends in bycatch of cold-water corals. Finally, there is a project to install an underwater observatory on a seamount close to Faial Island (Azores). The observatory will be equipped with cameras able to take still photos and short videos every 10 minutes or so, and be connected to automatic samplers for oceanographic parameters and if possible POM (particulate organic matters) and small zooplankton.

The Cordell Bank Sanctuary (California) was a proposed MPA because of the high diversity of habitats and biota it supports. The sampling program for fish (mainly rockfish) and benthic invertebrates and habitat types started in 2002 using underwater visual surveys. They initially provided an inventory of species but are now expected to provide information on the fish-habitat relationship and the role of structure-forming biota in the ecosystem http://sanctuarysimon.org). Yearly transect surveys were carried out every year to evaluate changes in rockfish population structure (size and abundance) as a consequence of the fishery closure. To this effect, the data and methods are now being assessed for their ability to detect changes over time. The team is also looking for less costly routine survey methods to continue the project within the constraints of funding programs. As a lesson learned, it would have been more efficient to start with habitat mapping earlier; transects would have been chosen differently and perhaps more efficiently (Dale Roberts, Cordell Bank National Marine Sanctuary, Olema CA, pers. comm.).

5. Knowledge gaps and research/monitoring priorities

In spite of their importance and their interest for their productivity and their high level of biodiversity, most seamounts have not been studied except for a few that were the subject of extensive research projects. The Bowie-Hodgkins-Davidson seamounts complex proposed MPA is no exception. From section 3, it is clear that there is some cursory knowledge on the biota for Bowie Seamount but nothing more than basic bathymetry on the two others. In terms of management, the most important threats for deep-coral reefs are disturbance and destruction by fishing techniques, mining and exploration, deployment of cable and pipelines, global warming and ocean acidification (Lumsden et al. 2007). This could have impacts on the ecosystem structure (e.g., Stone and Shotwell 2007), which we do not fully understand. This is true of other seamounts globally and is likely to be important on the Bowie Seamount. In addition, species living on seamounts are generally long-lived and as such, are particularly vulnerable to directed fishing or by-catch (see Koslow et al. 2000; Koslow et al. 2001; Morato et al. 2004; Stocks 2004). Finally, occasional point-source of contaminants such as a shipping accident may have devastating effects on any fragile ecosystem. Although outside the Tanker Exclusion Zone, the Bowie Seamount is generally avoided by tankers because the most efficient route is located 18 km west of the seamount. In addition, the risk of grounding large vessels on the seamount in rough seas is well known by the industry (Canessa et al. 2003a).

Thus, based on the objectives of the MPA, the literature review (section 3 and 4), and a few interviews, we propose the following research program. This program purposefully looked in the long-term to set the basis for short-term agenda. It should be noted that the proposed program has no time frame as the actual implementation will depend on the priorities determined during the workshop (see section 7) and on the funds available.

In accordance with the management objectives of protecting its commercial and non-commercial species, studies on the effect of fishing on the seamount and the relationship between seamount and coastal sablefish populations should be prioritized (point 1 below). This mandate will only be completed by establishing a baseline on the biota, the ecosystem structure and function, fisheries and oceanographic processes of the Bowie Seamount, and put in the context of its geographical region, the Pacific Northeast, and the surrounding ecosystems, and as part of the global research on seamounts. Indeed, the research and monitoring on Bowie seamount would have limited application if the large-scale processes are not taken into account. For example, changes in species relative abundance and in recruitment level would be difficult to understand without knowledge of the connectivity of Bowie seamount populations with other ecosystems, current changes in oceanography and the role of oceanographic processes on recruitment. This part of the mandate is detailed in points 2 to 5 of the following program.

5.1 Research and monitoring program

1. In accordance with the management objectives of protecting its commercial and non-commercial species, the **consequence of fishing** in these ecosystems should be a research and management priority and could be articulated in a five-point plan:
    a. Assess the **impact of the fishing gears** on the target species, on the bycatch species, and on the seafloor and its biota, in collaboration with fishermen. Even the repetitive setting and retrieving of crab traps are known to strip the seafloor of its biotic structure in Alaska (Stone and Shotwell 2007). The impact of by-catch of rockfish in the sablefish fishery should also be examined. Finally, the Bowie Seamount, geographically isolated, is susceptible to illegal and unreported fishing. Effort should be undertaken to evaluate the importance of such activities.
    b. Understand the **recruitment mechanisms** on the seamounts and assess the importance of influx of larvae from coastal stocks, local recruitment and adult migration in the maintenance of exploited stocks (sablefish). This would inform the managers on the link with coastal stocks and guide management strategies. In addition, the connectivity between the Bowie-Hodgkins-Davidson seamounts complex should be investigated to understand the population structure and the impact of fishing on one seamount. Although pressing for exploited species, this question is also relevant for most species. This could be achieved with a mixture of approaches such as larvae sampling, tagging studies, genetic tools, etc.
    c. **Assess stock status** of seamount populations starting with sablefish to evaluate the impact of fishing on the local population and the present status of the population
        i. Commercial catches should be monitored and the resulting data made completely accessible to researchers (with appropriate guidelines on publication of the data)
    d. Define a **fishery management plan** for the MPA. The actual zoning plan for the seamount is based on historical use rather than on evidence of impacts of fishing and of fishing gear. The proposed studies above would inform managers on the necessity to modify/adjust the fishery management terms. For instance, closing part of the fishing area could be considered as a reference area in an experiment on fishing impacts on target species as well as by-catch species and benthic biota. Information on the status of the stock and its connectivity to coastal stocks is also likely to refine the management plan.

2. The first priority for the monitoring program would be to **establish a baseline** on seamount biota structure and functioning, and how the three seamounts are related to each other and to surrounding ecosystems:
    a. Conduct a detailed **physical oceanographic survey** as a part of a multi-disciplinary program to establish a baseline. The current regime should be studied using oceanographic surveys, current meters installed on the bottom for several weeks, and satellite photos to identify the Haida eddies drifting towards Bowie. This would help identify permanent eddies and understand the level of connectivity with coastal waters.
    b. **Categorise habitats** for the whole seamount system to increase the efficiency and relevance of future research, leading to a stratification system. This has been found to be important information

in defining transects at the Cordell Bank. In addition, the distribution of deep-sea coral species are linked with the substrate friability more than with currents and temperature (L. Watling, University of Hawaii, pers. comm.)

c. Identify the **species present**, covering all depths. At first, these surveys may prioritise target fish and their major prey-fish, macro-invertebrates and habitat-forming organisms, but successive research projects may expand our knowledge to other components of the ecosystem. This could be accomplished using the footage from previous expeditions, submersibles (e.g. ROPOST), direct sampling, and fisheries data. The results would contribute toward building a visual catalogue and perhaps a reference specimen collection for future studies. These surveys should also aim at providing a first estimate of abundance, spatial and depth distribution, and habitat association.
d. **Devise indices of abundance** that would be appropriate for each functional group (percentage coverage, numbers, etc) coupled with estimates of mean body weight to generate estimates of biomass. Depending on the short- and long-term priorities, species targeted and the type of studies, permanent transects visited repeatedly over the years should be considered and compared with the advantages of random sampling or strata surveys.
e. Devise **quantitative indicators** that could help monitor the state of the ecosystem and could be sensitive enough to detect changes brought by fisheries management regime or environmental changes.

3. Pursue the construction of an **ecosystem model** that would serve as a framework for the integration of data, present or future. Such a model would include the physical and biological processes that influence the ecosystem dynamics. It would also guide the prioritization of research and generate research and management questions. The first model constructed for Bowie was characterised by a simple structure (Beamish and Neville 2003) but its results allowed the identification of crucial questions that needed to be addressed (Section 3). The next step is to refine this model using additional, and already available data, and continue refining it as new information is produced.
Static model of ecosystems inform on the structure but not on the mechanisms of changes. It is the use of time series to fit a model and the inclusion of mechanisms of interactions that will allow to move towards evaluating hypotheses about what causes variations in abundance. The construction of these models requires data on population dynamics and time series.
   a. **Population dynamics** of exploited and non-exploited species should be studied: productivity, food consumption, sex-ratio, diets (stomach sampling and/or fatty acids) and mortality will also be necessary data to obtain and will necessitate direct sampling. This item would first pertain to target fish and their major prey-fish, macro-invertebrates and habitat-forming organisms, and extended to other components as need arise. Of course, work done on other seamounts for corals for example, would likely be usable in the Bowie context.
   b. Gather routine data of biomass and catches to build informative **time series** that would contribute to the understanding of the processes maintaining production on the seamounts. A well-planned repeated survey program will over the years (but not necessarily yearly), constitute an informative time series. Time series of oceanographic processes (e.g. temperature, change in currents, frequency of eddies, etc.) will also be necessary as they could explain some of the changes in biota observed on seamounts.

4. The need for time series for monitoring emphasizes the need for a central database. Thus, data should be contributed to a **central database** at DFO widely accessible and with links or contributions with larger organisations such as CenSeam, (with CoML) and SeamountsOnline. To this end, contribution

to databases should be made a requirement for research proposal on the Bowie seamounts (see Appendix A)

5. **Coordinate the research** with other researchers and research institutions to advance knowledge on Bowie seamount and other seamounts in the Pacific to have a basis for comparison and inform on geographic as well as temporal variability, and more importantly, help guide the management decisions.

Finally, the research and monitoring will lead to better understanding of the ecosystem and likely provide feedback to management. In addition the management plan should be assessed for its efficiency and short-term and long-term effects. In turn, the **MPA management plan** (zoning, regulations) should be adjusted based on new knowledge and perceived needs on a regular basis.

6. The structure of a scientific advisory board

The Oceans Branch may benefit from of a "scientific advisory board" to help with decisions about science and ecosystem-based management. We suggest a possible structure that should be discussed and refined in the proposed workshop.

We suggest that the core of the advisory board should be constituted by scientists from the DFO Science Branch with the addition of expertise from various departments and universities. In view of the international component and importance of the research, it would be important to link this committee to international organisations. Organisations like PacMARA, that have a non-partisan research and analysis interest, could continue to assist some aspects of the research.

Given the leading role of DFO in managing the Bowie MPA, the DFO Science Branch should undoubtedly be at the core of the advisory board. The use of in-house expertise in various disciplines allows to maintain and increase this expertise, in addition to keep the databases in one location where it can also be used for other projects. This core could be embedded into PICES as a working group and linked to CenSeam. PICES is a network of intergovernmental scientific organisations from both sides of the North Pacific that includes governmental and academic researchers working on various aspects of oceanography, marine environment and fisheries. The global approach and facilitation of the data and methodology sharing across the North Pacific is in line with the pan-Pacific global approach of research on seamounts.

CenSeam is a Census Of Marine Life filed project on seamounts that is intended to provide the framework needed to prioritize, integrate, expand, and facilitate seamount research effort. The project proposes to encourage seamount sampling and the creation of new knowledge and also proposes to consolidate and expand existing global databases like SeamountsOnline, and synthesize existing data (Clark et al. 2004). Their research objectives and overlap with those proposed for the Bowie Seamounts. CenSeam would be interested in collaborating with this research and monitoring program and could contribute to the research program on Bowie. CenSeam already has links with seamount researchers in all parts of the world and as such could be invaluable.

Ecosystem-based management is increasingly getting more attention in the literature and in various management agencies. The Fisheries Centre (University of British Columbia) has worked for several years at developing technical and modelling approaches to this effect (Guénette et al. 2007). Researchers from this centre, in particular Villy Christensen, would be a good addition to the Bowie seamount team for his expertise on ecosystem modelling. Practical experience on ecosystem-based management is rare and has been related to new fisheries (e.g. New Brunswick), or larger scale Integrated Management Initiative (e.g. Essim). Perhaps, advice can be sought from these organisations as needed.

Finally, the Bowie MPA would benefit from the presence of an experienced scientist to coordinate research efforts, liaise between the various organisations and ensure appropriate diffusion of results and current surveys, research activities and seek collaborative funding opportunities.

7. Workshop structure

The research program described in section 5 has two components, the international and the local perspective that complement each other. Each of these components involves a long list of interested parties with different immediate interest in the discussion. Hence, we considered two separate workshops. We thought that an international workshop would be warranted to place the research and monitoring needs of the Bowie seamount in a global perspective and link with international collaborators who may help refine the research and monitoring agenda. The rationale was to bring to attention the fact that except for fishing, most factors that influence the Bowie Seamount happen at a larger scale, which means that research should be coordinated with other institutions. This is well recognised in the scientific community with initiatives like CenSeam.

Another workshop, with a larger team of local/regional scientists, managers, fishers and NGOs, would be convened to define the research and monitoring priorities and the organisation of a scientific steering committee, and attribute research/monitoring responsibilities. This brings the problem of which workshop should come first. The immediate outputs expected from these workshops, as expressed by Dale Gueret, Coordinator of the Integrated Coastal Zone Management, are directly related to the information needed for the instauration of the monitoring program. In addition, it would be difficult to have fruitful interactions with international communities and formalise any collaborative structure or memorandum of understanding in absence of an articulated local management and research core. Hence, we suggest that the local workshop occur first. Once the local core is organised, it will then be necessary to reach to other institutions and add international expertise and collaborators. We suggest a number of ways this could be done in section 7.2.

7.1 Workshop: Canadian network and work plan

This workshop should be planned for the end of September 2008, after the field work and vacation season . During this session, the management objectives could be refined but more importantly, it would have a mandate to: 1. discuss the objectives of the research and monitoring program; 2. address the local collaboration structure among various stakeholders and organisations; 3. foster collaboration in terms of research and management; 4. elaborate a structure to support the research and monitoring program and assist the Ocean Branch in developing an ecosystem-based management program of the MPA.

The preparation of the documentation for the workshop would have been sent to all participants with instructions to prepare the following points of discussion:

1. identification research priorities and basis of the monitoring program for the short- and medium- term
2. organisation the scientific advisory board;
   a. comments on section 6;
3. organisation of the collaborative structure;
   a. interests and resources available for each participating group;
   b. possible leverage towards other funding or in kind contribution;
   c. how do see collaboration among organisations;
   d. is the creation of a consortium possible? what would be the membership?
   e. data storage (where, what links);

The workshop would start with a brief presentation of the research and monitoring program (section 5) and suggest a few priorities to start the discussion. The second session of presentations would pertain to the potential types of structure that would be possible within DFO and perhaps with PICES and highlight the points that should be resolved. The outputs of the workshop would be:

1. a draft of a refined research/monitoring plan that includes research priorities for the next five years;
   a. which activities should be undertaken, by whom, by which means, approximation of the resources needed;
   b. compiled list of intents of research proposals for funding ;
2. a draft of the structure of the advisory board;
3. a draft of the structure of the collaborative structure for research and monitoring;
   a. structure;
   b. mechanisms of collaboration;
   c. intents of contribution;
4. determination of the next steps to be undertaken;

Workshop preliminary agenda

1st day:
1. Presentation of the Bowie research and monitoring goals and needs
2. Discussion on the research program and identification of short-term research priorities. There are two themes: 1. general knowledge; 2. fishing impacts and management which may warrant 2 working groups and a plenary session
3. draft of the research/monitoring plan

2nd day:
4. Presentation of a possible structure
5. Discussion on the structure of the research advisory board
6. Discussion on collaborative structure
7. Draft of the collaborative structure and mechanisms and intents of contribution
8. Determination of the next steps to be undertaken

Potential participants

There are two lines of thinking in convening such a workshop. The list of participants could be all inclusive to bring all the stakeholders actual and potential to the meeting, or participants would be selected in terms of their immediate relevance to the research/monitoring program. The all inclusive workshop would be useful especially at the time of structuring a collaborative organisation, but it presents the risk of diluting the discussion and losing focus on the research program. The strict preparation task before the workshop may not alleviate this problem completely. That said, the following list of potential participants has been kept short and focussed on scientists and managers, and representatives of the Haida nation and the sablefish fishery. Additional guests are researchers from Parks Canada and local NGOs who could be useful and do not constitute a big addition.

Table 1. Proposed delegate list for the Canadian workshop

Name	(Alternate	Title	Institution	Reason for Inclusion	Email Contact Info	Estimated Travel Costs
John Dower		Asst. Professor, Biology Department, School of Earth and Oceans Sciences	University of Victoria	experienced seamount researcher working in BC and elsewhere; potential PI	dower@uvic.ca	mileage ~100
Verena Tunicliffe		Professor, School of Earth and Oceans Sciences; Canada Research Chair in Deep Ocean Research; Director of Project Venus	University of Victoria	worked on Cobb seamount invertebrates, dispersal strategies, and similar work on hydrothermal vents	verenat@uvic.ca	mileage ~100
Lisa Kirkendale		Curator, Invertebrate Zoology	Royal BC Museum	taxonomy, seamount collections, possible collaborations on taxonomy of benthic animals, and can contribute to genetic studies	lkirkendale@royalbcmuseum.bc.ca	mileage ~100
James Boutillier		Section Head, Shellfish	DFO-PBS	Science Branch contact on Bowie monitoring project, interested in deep-sea research	jim.boutillier@dfo-mpo.gc.ca	DFO n/a
Ian Perry		Research Scientist, Shellfish Section	DFO-PBS	work on climate and ebm, also member of PICES	ian.perry@dfo-mpo.gc.ca	DFO n/a
Villy Christensen		Researcher	UBC Fisheries Centre	ecosystem modelling expertise, including design of new models; fisheries resarch	v.christensen@fisheries.ubc.ca	flight/ferry, mileage/accomodations ~600
Sylvie Guénette		Researcher	UBC Fisheries Centre	drafted workshop research questions and delegate lists; potential PI	s.guenette@fisheries.ubc.ca	fight/ferry, mileage/accomodations ~600
Rob Kronlund (Allen)		Research Biologist, Groundfish Section	DFO-PBS	sablefish assessment and management	rob.kronlund@dfo-mpo.gc.ca	DFO n/a
Lynn Yamanaka		Research Biologist, Groundfish Section	DFO-PBS	rockfish assessment, has done surveys on Bowie	lynn.yamanaka@dfo-mpo.gc.ca	DFO n/a
Rick Stanley		Research Biologist, Groundfish Section	DFO-PBS	Rockfish specialist	rick.stanley@dfo-mpo.gc.ca	DFO n/a
John Ford		Research Scientist, Conservation Biology Section	DFO-PBS	marine mammal expertise	john.ford@dfo-mpo.gc.ca	DFO n/a
Ken Cooke OR		Section Head, Applied Technology	DFO-PBS	Hydroacoustics for zooplanton layers, dynamics of seamounts, etc	ken.cooke@dfo-mpo.gc.ca	DFO n/a
	John Holmes	Research Scientist, Conservation Biology Section	DFO-PBS	Hydroacoustics for zooplanton layers, dynamics of seamounts, etc	john.holmes@dfo-mpo.gc.ca	DFO n/a
Bill Crawford OR		Head, State of the Ocean	DFO-IOS	plankton productivity, working on P line program	bill.crawford@dfo-mpo.gc.ca	DFO n/a
	Dave Mackas	Head, Plankton Productivity	DFO-IOS	plankton productivity, working on P line program	dave.mackas@dfo-mpo.gc.ca	
Svein Vagle		Research Scientist, Local Dynamics	DFO-IOS	acoustician, remote monitoring	svein.vagle@dfo-mpo.gc.ca	DFO n/a

Name	(Alternate	Title	Institution	Reason for Inclusion	Email Contact Info	Estimated Travel Costs
				expertise		
Kim Conway OR		Scientist, Natural Resources Canada, Marine Geoscience	NRCAN (at IOS)	sea mapping and bottom typing	kconway@nrcan-rncan.gc.ca	works at IOS n/a
	Vaughn Barrie	Research Scientist, Natural Resources Canada, Marine Geoscience	NRCAN (at IOS)	sea mapping and bottom typing	vbarrie@nrcan-rncan.gc.ca	
Ken Morgan OR		Pelagic Seabird Biologist, Environment Canada, Population Conservation	CWS	seabird expertise	ken.morgan@ec.gc.ca	flight/ferry, mileage, accomodations ~600
	Bob Elner	Head, Environment Canada, Population Conservation	CWS	seabird expertise	bob.elner@ec.gc.ca	
PICES Representative	(TBD)					flight/ferry, mileage, accomodations ~2000
TOTAL= 17						
DFO Managers						
Gary Logan		DFO Regional Resource Manager, Groundfish	DFO-Vancouver		gary.logan@dfo-mpo.gc.ca	DFO n/a
Marilyn Joyce		Marine Mammal Coordinator	DFO-Vancouver		marilyn.joyce@dfo-mpo.gc.ca	DFO n/a
Russell Mylchreest		DFO Regional Resource Manager, Invertebrates	DFO-Vancouver		russell.mylchreest@dfo-mpo.gc.ca	DFO n/a
Kelly Francis		Sr. Policy Advisor, Oceans/Watershed Planning and Restoration	DFO-Vancouver		kelly.francis@dfo-mpo.gc.ca	DFO n/a
Greg Savard		Regional Director, Oceans Divison, Pacific Region	DFO-Vancouver		greg.savard@dfo-mpo.gc.ca	DFO n/a
Dale Gueret		ICZM Coordinator, Prince Rupert	DFO-Prince Rupert		dale.gueret@dfo-mpo.gc.ca	DFO n/a
Carol Cross		Policy Advisory, Oceans, Habitat and Enhancement	DFO-Vancouver		carol.cross@dfo-mpo.gc.ca	DFO n/a
TOTAL= 7						
Other External						
Cliff Robinson OR		Resource Conservation - Vancouver	Parks Canada		cliff.robertson@pc.gc.ca	flight/ferry, mileage, accomodations ~600
	Norm Sloan	Gwaii Haanas National Park Reserve and Haida Heritage Site of Canada	Parks Canada		norm.sloan@pc.gc.ca	
Russ Jones OR		Haida Fisheries (consultant)	CHN (Haida Fisheries)		rjones@island.net	flight/ferry, mileage, accomodations ~1500
	Lynn Lee	Haida Fisheries (staff)	CHN (Haida Fisheries)		lynn.lee@haidanation.net	
TOTAL= 2						
Resource Users						
Ron Macdonald (or designate)		Executive Director, CSA	Canadian Sablefish Association		ronmacdonald@rogers.blackberry.net	n/a would want to pay their own way
Other fishing rep		TBD				n/a would want to pay their own way

7.2 International perspective and network

Once the Canadian Scientific Advisory Board and the collaborative structure have been agreed upon, there will be a need for external expertise and collaborations. A workshop gathering the representatives of international organisations and of seamount programs in the United States would undoubtedly be costly and perhaps the same results could be achieved with a mixture of targeted workshop, telephone conference and formal request to review aspects of the scientific program.

There are four points that may need to be discussed with international experts:
1. Refining of the research and monitoring program and methodologies;
2. Define a procedure for information sharing and contribution to global databases;
3. Ensure that the Bowie Seamount research and monitoring program fits into the global agenda of understanding the role of seamounts in the oceans and how large-scale phenomena bring ecosystem changes on seamounts. At this point, only a few organisations have repeated surveys and even less have a monitoring program. This constitutes an opportunity for collective learning, collaborative and complementary research;
4. Define the nature of the collaborative structure and intents of collaboration.

The above list could be discussed in one international workshop which has the advantage of bringing all the experts in one room, creating professional links, and accelerating the process. It may be slightly more costly to bring international experts for 2 days though.

The alternative is to cut the work into pieces. The two first points require, at a minimum, the usual informal exchanges with experts and may lead to the formal review of a methodology document, for example. The two last points may be started by long-distance discussions but will have to be continued in a targeted workshop. The meeting would likely gather a more restricted list of guests, more focussed, and the cost may be slightly lower.

Notwithstanding the consultation format, it should produce the following products:
1. a solid methodology and time frame;
2. a plan to structure data management in such a way that it would allow to link DFO databases (on the Bowie Seamount) with each other and to international databases such as SeamountsOnline;
3. Refinement on the monitoring and research program that takes into account collaborative studies that can be done with international communities;
4. Draft of the collaborative structure;
5. List of joint projects for which funding application will be written, and for which collaborators, respective contributions and available resources have been identified.

Table 3. Proposed delegate list for the International workshop

Name	(Alternate)	Title	Institution/Agency/Organization	Reason for Inclusion	Email Contact Info	Estimated Travel Costs
Malcolm R Clark OR		Deepwater Fisheries Researcher	National Institute of Water and Atmospheric Research (NIWA) ; National Centre for Fisheries and Aquaculture, Aukland	experienced researcher in deep-sea and seamount fisheries; head of CenSeam Secretariat (Census of Marine Life Project)	m.clark@niwa.co.nz	2100 travel, 800 accomodation and food (4 nights*200) = 3100
	Thomas Schlacher	Researcher for CenSeam (Global Census of marine life on seamounts, affiliated with Census of Marine Life);Assoc. Prof. Marine Science - School of Science and Education, University of the Sunshine Coast, Queensland, Australia	CenSeam (http://censeam.niwa.co.nz) and University of the Sunshine Coast, Queensland, Australia	seamount research expertise	tschlach@usc.edu.au	2600 travel, 800 accomodation and food (4 nights*200) = 3400
Karen Stocks		Assistant Research Scientist, San Diego Supercomputer Centre; CenSeam Secretariat	University of California, San Diego; CenSeam	seamount ecologist, developed SeamountsOnline website, and OBIS (global distributed database for marine species distributions)	kstocks@sdsc.edu	500 travel, 800 accomodation and food (4 nights *200) = 1300
Tony Koslow		Sr. Principal Research Scientist	CSIRO Marine and Atmospheric Research; CenSeam; Scripps Institute of Oceanography, San Diego	ecosystem function of seamounts, deepwater ecology expert	jkoslow@ucsd.edu	500 travel, 800 accomodation and food (4 nights *200) = 1300
Les Watling		Visiting Professor of Zoology	University of Hawai'I, Honolulu	sampling and developing survey methodology for seamounts; coral taxonomy and link to substrate type; biogeography of corals in the pacific	watling@hawaii.edu	800 travel, 800 accomodation and food (4 nights *200) = 1600
Ricardo Santos		Sr. Researcher, Marine Ecology - Behavioural Ecology and Marine Conservation	University of Azores, Portugal	active seamount researcher in monitoring	ricardo@uac.pt	2000 travel, 800 accomodation and food (4 nights*200) = 2800
John Dower		Asst. Professor, Biology Department, School of Earth and Oceans Sciences	University of Victoria, BC	experienced seamount researcher working in BC and elsewhere; potential PI	dower@uvic.ca	mileage ~ 100
Alex David Rogers		Sr. Research Fellow - Institute of Zoology, London	Institute of Zoology, London	ecology, biodiversity and evolution of deep-sea ecosystems, especially, cold-water corals, seamounts, hydrothermal vents, in particular species distribution	alex.rogers@ioz.ac.uk	1200 travel, 800 accomodation and food (4 nights *200) = 2000
Alan Williams		Chief Scientist	Commonwealth Scientific and Industrial Research Organization (CSIRO)	research and monitoring program on southern Tasmanian seamounts; deep sea ecology	alan.williams@csiro.au	2600 travel, 800 accomodation and food (4 nights*200) = 3400
Peter Etnoyer		Principal	Aquanautix Consulting	pacific seamount and coral research (mapping, research protocols, communications)	peter@aquanautix.com	525 travel, 800 accomodation and food (4 nights*200) = 1325

Name	(Alternate)	Title	Institution/Agency/Organization	Reason for Inclusion	Email Contact Info	Estimated Travel Costs
Mary Yoklavitch		Habitat Ecology Team Leader	NOAA (Southwest Fisheries Science Centre)	fish ecology, seamount protocols, deep water, including Cordell Bank	mary.yoklavich@noaa.gov	500 travel, 800 accomodation and food (4 nights *200) = 1300
Gregor Caillet		Faculty ((Ichthyology, marine ecology, population biology, demography)	Moss Landing Marine Labs and Pacific Shark Research Centre (at Moss Landing)	submersible and ROV survey work, studies validating life history parameters of deep sea fishes	cailliet@mlml.calstate.edu	550 travel, 800 accomodation and food (4 nights*200) = 1350
Andrew DeVogelaera		MBNMS Research Coordinator	Monterey Bay National Marine Sanctuary	research projects involving deep-sea fishes and invertebrates and their life histories	andrew.devogelaere@noaa.gov	550 travel, 800 accomodation and food (4 nights*200) = 1350
Waldo Wakefield		Research Fish Biologist, Habitat Team Leader	NOAA Newport Facility (Oregon)	leads NOAA deep-sea program for the Pacific Coast of the USA. Has defined sampling protocol for several expeditions, including monitoring protocol for Cordell Bank, Calif	waldo.wakefield@noaa.gov	300 travel, 800 accomodation and food (4 nights*200) = 1100
Bob Stone		Research Fish Biologist, Auke Bay Marine Station	NOAA (Auke Bay, Juneau, AK)	has written deep-water coral status report chapter on Alaska	bob.stone@noaa.gov	750 travel, 800 accomodation and food (4 nights*200) = 1550
TOTAL =14						**$26,975**
DFO Scientists						
Ian Perry		Research Scientist, Shellfish Section	DFO-PBS	work on climate and ebm, also member of PICES	ian.perry@dfo-mpo.gc.ca	DFO n/a
James Boutillier		Section Head, Shellfish	DFO-PBS	Science Branch contact on Bowie monitoring project, interested in deep-sea research	jim.boutillier@dfo-mpo.gc.ca	DFO n/a
Rob Kronlund (Allen)		Research Biologist, Groundfish Section	DFO-PBS	sablefish assessment and management	rob.kronlund@dfo-mpo.gc.ca	DFO n/a
Lynn Yamanaka		Research Biologist, Groundfish Section	DFO-PBS	rockfish assessment, has done surveys on Bowie	lynn.yamanaka@dfo-mpo.gc.ca	DFO n/a
Rick Stanley		Research Biologist, Groundfish Section	DFO-PBS	Rockfish specialist	rick.stanley@dfo-mpo.gc.ca	DFO n/a
Ken Cooke OR		Section Head, Applied Technology	DFO-PBS	Hydroacoustics for zooplanton layers, dynamics of seamounts, etc	ken.cooke@dfo-mpo.gc.ca	DFO n/a
	John Holmes	Research Scientist, Conservation Biology Section	DFO-PBS	Hydroacoustics for zooplanton layers, dynamics of seamounts, etc	john.holmes@dfo-mpo.gc.ca	DFO n/a
Bill Crawford OR		Head, State of the Ocean	DFO-IOS	plankton productivity, working on P line program	bill.crawford@dfo-mpo.gc.ca	DFO n/a
	Dave Mackas	Head, Plankton Productivity	DFO-IOS	plankton productivity, working on P line program	dave.mackas@dfo-mpo.gc.ca	
TOTAL= 7						

Name	(Alternate)	Title	Institution/Agency/Organization	Reason for Inclusion	Email Contact Info	Estimated Travel Costs
DFO Managers						
Gary Logan		DFO Regional Resource Manager, Groundfish	DFO-Vancouver		gary.logan@dfo-mpo.gc.ca	DFO n/a
Marilyn Joyce		Marine Mammal Coordinator	DFO-Vancouver		marilyn.joyce@dfo-mpo.gc.ca	DFO n/a
Russell Mylchreest		DFO Regional Resource Manager, Invertebrates	DFO-Vancouver		russell.mylchreest@dfo-mpo.gc.ca	DFO n/a
Kelly Francis		Sr. Policy Advisor, Oceans/Watershed Planning and Restoration	DFO-Vancouver		kelly.francis@dfo-mpo.gc.ca	DFO n/a
Greg Savard		Regional Director, Oceans Divison, Pacific Region	DFO-Vancouver		greg.savard@dfo-mpo.gc.ca	DFO n/a
Dale Gueret		ICZM Coordinator, Prince Rupert	DFO-Prince Rupert		dale.gueret@dfo-mpo.gc.ca	DFO n/a
Carol Cross		Policy Advisory, Oceans, Habitat and Enhancement	DFO-Vancouver		carol.cross@dfo-mpo.gc.ca	DFO n/a
TOTAL= 7						
OTHER						
Sylvie Guénette		Researcher	UBC Fisheries Centre	drafted workshop research questions and delegate lists; potential PI	s.guenette@fisheries.ubc.ca	fight/ferry, mileage/accomodations ~600
PacMARA Notetaker					c/o mpatterson@pacmara.org	flight/ferry, mileage/accomodations ~600
TOTAL= 1						**$28,175**
GRAND TOTAL= 29						

Table 4. Estimated cost of the International workshop (see Note 1)

Expense categories	Estimated amounts	Details
Venues	free	IOS
Catering (light breakfast, lunch, snacks, coffee for two days)	2035	see Note 2
Facilitator fees	4500	$1500 max * 3 days + expenses + GST (3 days = 1 prep and reporting, two days for workshop
Dinner for 32 people 1st night of workshop (optional)	2000	TBD - arranged by PacMARA
Workshop Coordination/Administration/notetaking (PacMARA)	3000	10 days*300/day
Workshop supplies (pens, paper, photocopying, badges, printing, signage)	500	
Workshop panelists travel cost estimates:		See workshop 2 delegate spreadsheet for location information (estimates based on travel website research and previous PacMARA Marxan workshop actuals)
International	14700	(Australia, New Zealand, Portugal, UK)
North America	12175	(California, Oregon, Alaska, Hawaii)
Canada	1300	(Vancouver, Victoria)
Travel subtotal	28175	
TOTAL	40210	

Note 1. Budget assumptions
1. IOS has space at the time we need it
2. Catering costs based on previous experience, and in discussion with DFO IOS staff
3.Facilitator costs based on previous experience, facilitator not yet identified

Note 2. Details of catering budget
light breakfasts (32 people X 2 days X $10) = 620
snacks/coffee = $300
lunches (32 people X 2 days X 15) = 930
catering gratuity 10% = 185
TOTAL $2035

8. The PI for next phase

The proposed research and monitoring agenda for the Bowie MPA suggest that the PI for the next phase will need to be from an organisation with a strong research background and that has the facilities and support for interdisciplinary work and considerable flexibility in collaborating arrangements. Given the separation of responsibility in between DFO branches, it may be preferable that this person came from academia. The list proposed here is admittedly not final or exhaustive and should be discussed further and additional researchers could be considered.

John Dower, professor at the University of Victoria, for his continued interest in seamounts and his vast experience knowledge of current research on the subject. He has shown his ability to work in a multidiciplinary environment and he currently involved in several such projects (e.g. Venus, CenSeam). As a consequence, John is well connected in the scientific community and knows most of the international players.

Sylvie Guénette, Research Associate at University of British Columbia, would also be a good candidate for her knowledge of ecosystem modelling and synthesis, and her work on MPAs. She has demonstrated her ability to collaborate with national and international scientists. Her affiliation with the Fisheries Centre also facilitates access to a large pool of expertise from modelling to stock assessment.

Acknowledgements

We would like to thank James Boutiller, Michele Patterson, Jeff Ardron, and John Dower for their insights and helpful comments during the writing of this document. We would also like to thank all our colleagues at different institutes around the world for taking the time to provide information and helpful insights: Les Watling, Alan Williams, Malcolm Clark, Telmo Morato, Ricardo Santos, Lisa Kirkendale, Kim Juniper, Verena Tunnicliffe, Dale Roberts, Lisa Etherington, and Nancy Maloney.

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Appendix A. Guidelines for sustainable marine research in fragile environment

Several organizations have elaborated guidelines for research in fragile environment, e.g. hydrothermal vents (Fisheries and Oceans Canada 2001; Glowka 2003; Devey et al. 2007), coral reefs (http://www.gbrmpa.gov.au/corp_site/permits/research_permits), and more recently for deep and high seas (OSPAR code of conduct, in preparation). Most documents reviewed emphasized the same conservation issues and common recommendations are listed below.

If there was an interest for a code of conduct, these recommendations could be considered, and indeed, some of these considerations are already included in the pilot management DFO documents (Fisheries and Oceans Canada 2001; Government of Canada 2008). The final version of the code of conduct could resemble the version being written for OSPAR. Finally, the main comments about these principles are that they are laudable principles but often, they are not monitored nor enforced. As a consequence, research activities are carried out in the usual need to do basis, driven and constrained by the funding. This consideration should be taken into account during eventual discussion about the guidelines.

It is understood that the Bowie Seamount has been submitted to a limited level of fishing and that the impacts on the biota are not well known. In that regards, research activities may not amount to the level of impact that fishing may have occasioned. However, being dominated by long-lived species, destructive sampling that encompasses a sizable area would leave visible traces for a long time.

- For each research cruise, the researcher should submit a detailed research protocol, explicit on all activities and their impacts, and present a detailed cruise report afterward.
- All sampling require proper documentation (before and after film or photo); the cruise report should include a list of samples taken (target and non-target samples)
- sampling should be geo-referenced to establish long-time records and possible links between sampling and observed degradation/recovery
- voucher specimens and reference collections should be deposited with a competent body (museum?) or at least coordination should be ensured with the museum
- biological transplantation should be forbidden within the MPA and discourage elsewhere to minimize the risk of genetic pollution, disease transmission and the introduction of species
- avoid activities that would create a long-term disturbance in population dynamics or the destruction of an habitat. The risks should be assessed in terms of vulnerability of the species or habitat. Sampling, often necessary, should be limited to what is necessary for the completion of the research. Thus, comparison studies should be preferred over experimental design involving the use of a destructive sampling gear.
- avoid activities that will compromise other research projects (experiments and observations).
- Publication of results should be encouraged in scientific journals while protecting unpublished data (for how long: 2-3 years?)
- Information about research activities, ongoing cruise research activities should be made public (on the web?) to maintain awareness and interest and completed with the publication of an annual report/summary of research.

Additional guidelines could be added for specific studies. For instance, taxonomic and genetic studies could be submitted to the Barcode of Life guidelines (www.barcodinglife.org).