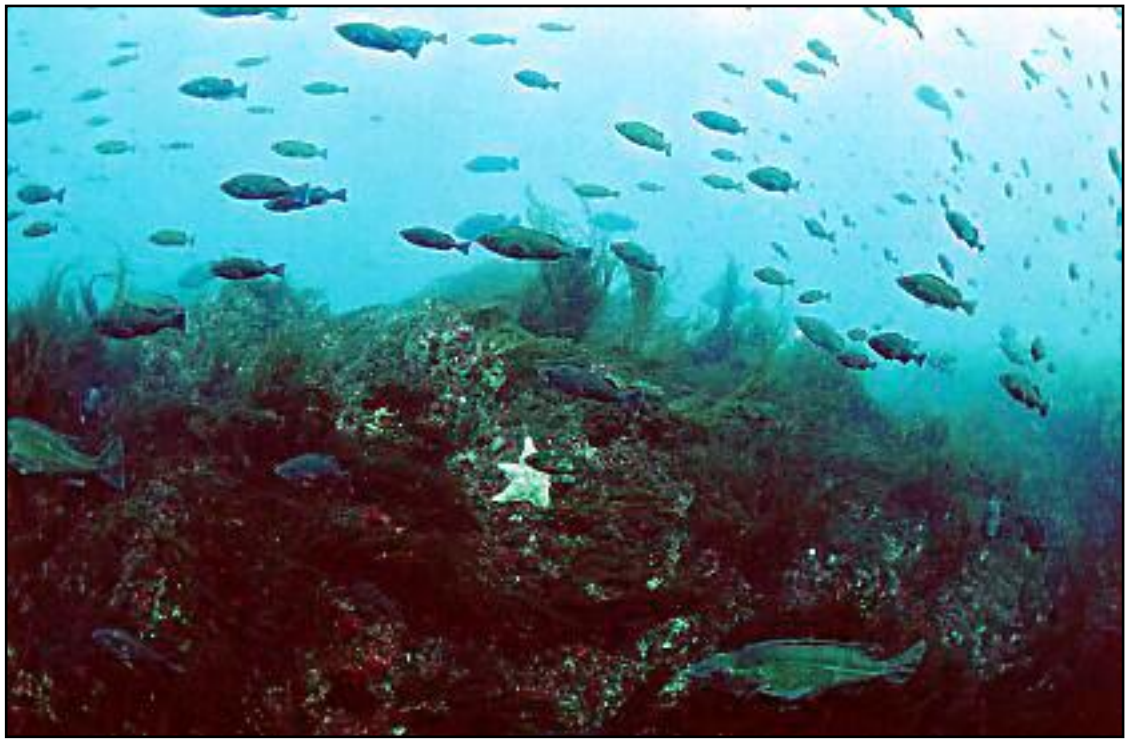
Biological Observations at Bowie Seamount

August 3-5, 2003



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BOWIE SEAMOUNT is located 180 km west of the Queen Charlotte Islands in the northeast Pacific Ocean. The summits of most seamounts are hundreds of metres deep, but Bowie rises from the ocean floor at a depth of 3100 m to within 24 m of the surface (Halcro, 2000). It is known to be a highly productive ecosystem, with an abundance of rockfish and a rich benthic community.

The first bathymetric survey of Bowie Seamount is believed to have been carried out during the 1940s by the US Navy and US Coast and Geodetic Survey group. Bowie Seamount's relatively shallow peak makes it the only seamount off the Canadian Pacific coast that is accessible using scuba. In March 1969, dives were made at the seamount by Canadian Navy divers from the CSS *Parizeau* during a preliminary survey for instrument package placement (Scrimger and Bird, 1969). Two dives were made to the summit, photographs were taken to determine the nature of the bottom and a few biological samples were collected to identify potential fouling organisms. These specimens were identified at the Pacific Biological Station, Nanaimo, resulting in a list of 11 species of benthic invertebrates.

In August 1969, Canadian Navy divers made several dives during oceanographic studies by the Fisheries Research Board of Canada (Herlinveaux, 1971). They noted dense schools of large rockfish hovering over the summit and a diversity of bottom life. Some black and white photographs were taken and some seaweeds were collected for identification (Scagel, 1970), but no species inventory was made of other forms of marine life.

The November 1996 issue of *National Geographic Magazine* included the article "Realm of the Seamount," describing dives made at Bowie Seamount by Bill Curtsinger and Eric Hiner (Curtsinger, 1996). They explored the seamount down to depths of 50 m with scuba while a Remotely Operated Vehicle (ROV) was used by Emory Kristof and Mike Cole to record the slopes of the undersea mountain down to 150 metres. Their pictures revealed a jagged pinnacle covered with bushy seaweeds and colourful benthic invertebrates. Dense schools of juvenile rockfish were observed on the steep slopes.

Dr. Bill Austin of Khoyatan Marine Lab reviewed video footage obtained during the National Geographic dives to determine the nature of the benthic community. From the video, he identified some of the most conspicuous invertebrates and noted that some species more typical of intertidal and shallow habitats were found deeper than might ordinarily be expected, and were larger than usual (Austin, 1999).

In 1998 Fisheries and Oceans Canada announced that the Bowie Seamount Area had been declared a Pilot Marine Protected Area in order to encourage more science needed to better understand this natural ecosystem, its vulnerabilities and assets.

Dower and Fee (1999) prepared a background report on Bowie Seamount, providing a general summary of current knowledge. They noted that "From a biological perspective, Bowie Seamount has been relatively unexplored…Our knowledge of what species exist on Bowie is based on the data collected by divers in the 1960s, plus the very limited fisheries data collected by commercial vessels. What is needed is a full biological survey of the seamount community to establish the current level of biodiversity."

In July 2000, a workshop was convened in Vancouver in order to bring together various organizations concerned with Bowie Seamount (AXYS Environmental Consulting, 2000). The workshop summary described the known biological components of Bowie, emphasizing, "There has been no formal attempt to survey the zooplankton or benthic invertebrates at Bowie."

A recent ecosystem review (Canessa *et al,* 2003) summarizes the various biological studies that have been carried out on or near Bowie Seamount, listing a total of 158 species. This includes 14 species of algae, three protozoans, 53 invertebrates, four salps, 60 fishes, 16 birds and eight mammals. Many of the records are based on submersible operations or commercial longline and trap fisheries. Very little information has been obtained thus far by scuba diving biologists.

The lack of a thorough survey of the benthic invertebrates, fishes and algae has been acknowledged as one of the primary data gaps for Bowie Seamount. The main objectives of this survey were to carry out a comprehensive biological survey of the summit and to document the area with both still photography and digital video. This basic information will add an invaluable component in the understanding of how the seamount community functions, and is an important step toward its establishment as a Marine Protected Area.

Survey Dates and Level of Effort

The five-member team of divers travelled to Bowie Seamount aboard the 18-m packer *Danny & David*, arriving late in the evening of August 2. Using known GPS coordinates and a depth sounder, the shallowest peak was located within 10 minutes. The survey took place August 3-5, with a total of 25 dives representing approximately 10 hours of bottom time. Surface sea state was usually 1.5 m or less and winds varied from five to 20 knots from the NW or W. All dives were made using air with 40% Nitrox breathed during ascent.

The 18-m packer *Danny & David*.

Specific Objectives

1/ To compile a comprehensive list of all conspicuous marine invertebrates, fishes and algae inhabiting the summit of Bowie Seamount down to a depth of 40 metres.

2/ To record both close-up and wide-angle colour photographs to document the physical and biological features of the summit and to establish a photographic inventory of the marine life.

3/ To record underwater video in order to document various physical and biological features.

Methods

1/ Marine Life Collections

Marine life collections were made using numbered plastic bags, dip nets and MS222 anaesthetic. Depths of collection were recorded on a dive slate and transferred to a dive log after each dive. Live hold containers were used to maintain marine life while transporting to the dive vessel. Fishes with bladders were suspended at 10 m for four hours and later had excess gas removed by means of a surgical needle. Biota was either preserved or maintained alive on board and returned to a holding facility at DFO/UBC Center for Aquaculture and Environmental Research (CAER) in West Vancouver.

Algae were preserved using three methods: dried using plant presses, dried in bags containing silica gel as a desiccant, or put in ethyl alcohol in glass jars.

Invertebrates were preserved in ethyl alcohol in glass jars.

2/ Still Photography
Still photographs were taken using four separate Nikon 35 mm cameras in underwater housings fitted with submersible flash units. A variety of colour negative and transparency films were used, ranging from 64 to 1600 ISO.

3/ Video Record
Underwater video was recorded using two Sony VX1000 Mini-DV cameras in underwater housings fitted with submersible lights.

Hydrographic Observations

1/ Water Colour and Clarity
Unlike the characteristic emerald green of British Columbia coastal waters, the water at Bowie Seamount is deep blue. A Secchi disc reading was 25 metres. Horizontal visibility on the summit of the seamount was approximately 15 metres, although this varied from dive to dive.

2/ Water Temperatures
Surface water temperatures as recorded by digital depth gauges were 15 degrees C. Water temperatures on the summit of the seamount at a depth of approximately 27 m were similar or only slightly less than at the surface. A thermocline was observed near the summit on a few of the dives.

3/ Currents and Surge
Water currents over the seamount generally flowed W to E, usually in a similar direction to the prevailing winds from the NW or W. Current velocities were usually 0.5 knot or less and varied from dive to dive. Occasionally currents increased to the point where the mooring line had to be used by the divers to pull themselves to the bottom. Mild surge was present on the seamount summit, but did not hinder diving operations.

4/ Wave and Swell Conditions
Wave and swell height were generally less than 1.5 m during the three diving days, and dropped to less than 1 m when the winds became light on August 5.

Geological Observations

The summit of Bowie Seamount is composed of weakly cemented volcanic tephra (Canessa, 2003). This material is quite brittle and is fairly easily broken as the divers discovered when they tried to drive a wedge into a crack to secure a mooring. The bottom topography is very rugged and uneven, with many angular ridges, crevices and cracks. There are some column-like pillars with vertical sides more than three metres high. Between some of the ridges are pockets of coarse volcanic sand as well as scattered boulders and cobbles.

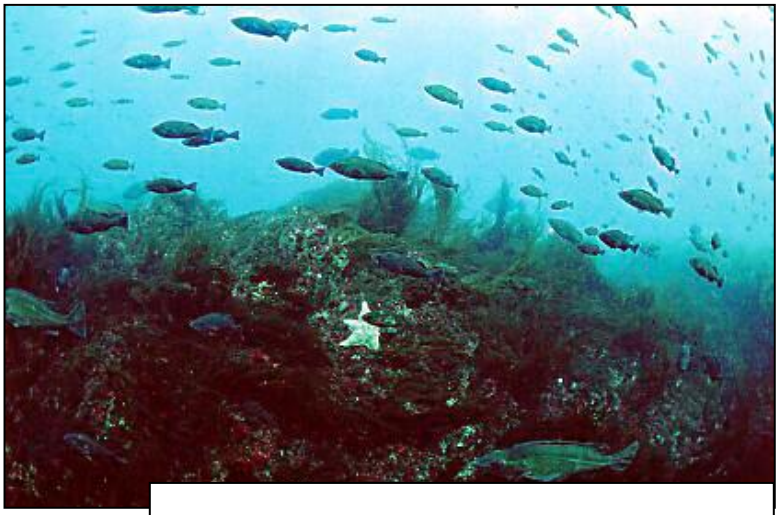
Due to the fragile nature of the substrate, a temporary mooring line was secured to the bottom so that the inflatable dive tender could be stationed over the dive site. The *Danny & David* stood by with radio communication to the dive tender.

Biological Observations

General Observations

Overall, the summit of Bowie Seamount was found to have relatively low species diversity compared to rocky subtidal habitats along the coast of the Queen Charlotte Islands. A total of 18 taxa of algae, 83 taxa of invertebrates and 12 taxa of fishes were observed.

Water clarity at the seamount is very good, resulting in high levels of light penetration to depths of 40 metres or more. Consequently, brown and red seaweeds are diverse and abundant. Brown seaweeds dominate the upper parts of the reef, while red algae are more widely distributed.



The top of the seamount showing schools of rockfish and a dense growth of the flattened acid kelp.

The summit is an extremely dynamic environment, washed by strong swells and currents. The rugged, cratered and fissured tephra substrate provides many different living spaces for marine life. The most conspicuous invertebrates on vertical surfaces are zoanthids, giant barnacles, grey ridge sponge, sea stars and anemones. A thick turf of less conspicuous forms such as bryozoans, encrusting sponges

and hydroids covers most surfaces, except the top of the reef which is dominated by brown seaweeds.

Fishes are abundant, including several species that live in crevices and caves and others that swim freely in large schools over the reef. Several unusual species were observed that are not frequently seen by scuba divers in British Columbia waters.

The following is a more detailed discussion of the various groups of algae, invertebrates and fishes.

ALGAE

Despite its significant depth (shallowest point 24.3 m below datum), brown and red algae were abundant on the peak of Bowie Seamount. 18 taxa of algae were recorded from our samples (S. Lindstrom, pers. comm.), including five taxa of brown algae and 13 taxa of red algae (Table 1). No green algae were collected.

The largest and most conspicuous alga was the flattened acid kelp (*Desmarestia ligulata*). This brown alga was very abundant on horizontal surfaces at the top of the seamount, where it reached 50 to 80 cm in length. Another large brown alga that was observed in small clusters was the suction-cup kelp (*Laminaria yezoensis*). This species was found at depths of 38 metres.

Below the peak of the seamount, several different brown and red algae were observed, many inconspicuous species forming part of the “turf” of marine life growing on rocky substrate.

A comparison of these observations with those of Scagel, 1970, indicates that of the 12 taxa he reported, nine taxa are represented in the present collections, along with nine taxa not previously reported from Bowie Seamount.

For most species, presence at this seamount represents a new depth record. The considerable depths at which these algae are found has been attributed to the clarity of the water (Scagel, 1970). He noted that benthic marine algae are rare deeper than 20 m in turbid coastal waters.

MARINE INVERTEBRATES

Eighty-three taxa of marine invertebrates were observed, including 71 taxa not previously reported from Bowie Seamount (Table 1). The Mollusca (bivalves, snails, nudibranchs and chitons) were the most diverse group found, represented by 20 taxa. Following this were Arthropoda (crabs, barnacles, amphipods), 18 taxa; Cnidaria (anemones and hydroids), 10 taxa; Echinodermata (sea stars, urchins and brittlestars), nine taxa; and Porifera (sponges), seven taxa and Bryozoa (moss animals), seven taxa.

Porifera (sponges):
Encrusting sponges were common on the seamount, especially on vertical rock surfaces. The most conspicuous species was the grey ridge sponge (*Penares cortius*) [Plate 15], which formed extensive thick ridges. Most of the other sponges observed were less conspicuous forms, including at least three encrusting species [Plate 18] and two unidentified species of calcareous sponges.

Cnidaria (hydroids, anemones, jellyfish)
The most abundant and conspicuous benthic cnidarian was the zoanthid (*Epizoanthus scotinus*) [Plate 5] which formed extensive mats on vertical surfaces. Several species of anemones were observed, including the plumose anemone (*Metridium farcimen*), crimson anemone (*Cribrinopsis fernaldi*) [Plate 2], fish-eating anemone (*Urticina piscivora*) and white-spotted anemone (*Urticina lofotensis*).

A dense mat of zoanthids.

Interestingly, no shrimps were found living on the crimson anemone, a species that usually hosts these commensals.

The most conspicuous pelagic cnidarian was a siphonophore (*Nanomia bijuga*) which was very abundant, especially near the surface. The largest hydroid medusa observed was *Solmissus* sp.

Ctenophora (comb jellies)
These pelagic jellies were very abundant in the surface waters. The most conspicuous species was *Bolinopsis infundibulum*.

Annelida: Polychaeta (segmented worms)
Segmented worms were not common at the seamount. The most conspicuous species observed was the calcareous tubeworm *Serpula vermicularis*, which was found on vertical rock faces amongst other encrusting organisms.

Bryozoans (moss animals)
Bryozoans made up a very significant component of the marine life "turf" found at the seamount. This dense, tangled mat was comprised mostly of small branching bryozoans. Preliminary analysis revealed that at least six different species are present.

Mollusca: Bivalvia (bivalves)
Bivalve mollusks were relatively abundant. The largest species observed was the rock scallop *Crassadoma gigantea* [Plate 17]. Clusters of the California mussel *Mytilus californianus* were found on rocky edges, their large shells almost obscured by encrusting marine growth.

Mollusca: Gastropoda (snails and nudibranchs)
Gastropod mollusks were relatively diverse and abundant. The largest and most conspicuous gastropod was the Oregon triton *Fusitriton oregonensis*. Several smaller species of snails were observed in large numbers, including *Amphissa* sp. Six species of nudibranchs were observed, the largest the lemon nudibranch *Anisodoris nobilis* [Plate 16], a predator of sponges. Other species included the opalescent nudibranch *Hermissenda crassicornis*, orange-spotted dorid *Triopha catalinae*, alabaster nudibranch *Dirona albolineata*, *Dendronotus frondosus* and *Janolus fuscus*.

An Oregon triton amongst zoanthids and bryozoans.

Mollusca: Polyplacophora (chitons)
The large gumboot chiton *Cryptochiton stelleri* was the only chiton observed.

Arthropoda: Cirripedia (barnacles)
The giant barnacle *Balanus nubilus* [Plate 10] formed large clusters on the edges of rock outcrops, their shells totally obscured by encrusting bryozoans, sponges and other growth.

Arthropoda: Decapoda (crabs)
Crabs were not common on the summit of the seamount. Only three species were observed: the moss crab *Loxorhynchus crispatus* [Plate 14], the hairy cancer crab *Cancer oregonensis* and the spider crab *Chorilia longipes*. The moss crab is a very large spider crab that actively decorates itself with marine life. Its sighting at Bowie represents a new northern range extension for this species. The hairy cancer crab was observed living inside the empty shells of giant barnacles.

Arthropoda: Amphipoda (amphipods)
Caprellid amphipods were very abundant, especially amongst the "turf" of bryozoans, algae and sponges on the vertical faces of rock. Several small species of amphipods, as well as tanaids, isopods, ostracods, mysids and copepods were also found.

Echinodermata: Asteroidea (sea stars)
Sea stars were relatively conspicuous on the reef summit. The most abundant species was the blood star *Henricia leviuscula* [Plate 15], known to predate on sponges. The leather star *Dermasterias imbricata* [Plate 11] was found mostly on the top of the reef amongst various seaweeds. Other sea stars found in small numbers included the painted star *Orthasterias koehleri* [Plate 3], the sunflower star *Pycnopodia helianthoides*, the mottled star *Evasterias troschelii* and the long ray star *Stylasterias forerri*.


A leather star.

Echinodermata: Echinoidea (sea urchins)
Despite the presence of many species of algae on the seamount, sea urchins were relatively rare. A few specimens of the purple urchin *Strongylocentrotus purpuratus* were found in crevices on the reef.

Echinodermata: Ophiuroidea (brittlestars)
The daisy brittlestar *Ophiopholis aculeata* was fairly common in crevices and amongst encrusting marine life.

Echinodermata: Holothuroidea (cucumbers)
No cucumbers were found in any of the collected samples or observed by the dive team.

Urochordata (tunicates, salps)
Tunicates were not common at the seamount. The most conspicuous species was the red tunicate *Ritterella rubra* [Plate 12].

FISHES

12 taxa of fishes were observed at the summit Bowie Seamount, two of which had not been previously reported (Table 1).

Osteichthyes (Bony fishes)
Bowie Seamount is a very "fishy" site. Rockfish, especially, are very abundant. One of the most abundant species of rockfish was the yelloweye rockfish (*Sebastes ruberrimus*) with large specimens reaching 60 cm or more. This species tended to congregate near the bottom, especially in the many gullies and crevices that riddle the reef. These yelloweye rockfish are extremely dark in colour, an unusual characteristic that has been previously reported (Yamanaka *et al.* 2000). Juvenile yelloweye rockfish, conspicuous due to their bands of white, were very abundant, generally hiding close to reef crevices and cracks. Stomach analysis of several adult yelloweye rockfish showed that their prey included smaller rockfish of various species.

A juvenile yelloweye rockfish displaying the dark colouration typical at Bowie.

Other rockfish observed included widow rockfish (*Sebastes entomelas*) and harlequin rockfish (*Sebastes variegatus*). Widow rockfish were observed in loose schools hovering over and alongside the reef summit. These rockfish were smaller than the yelloweye rockfish, averaging 20 to 30 cm long. Harlequin rockfish, a smaller species with a maximum recorded length of 30 cm, were also found in mixed schools. Solitary individuals of the tiger rockfish (*Sebastes nigrocinctus*) were observed in crevices on the flanks of the reef.

Other benthic fishes observed included the kelp greenling *Hexagrammos decagrammus* (not previously reported), the red Irish lord sculpin *Hemilepidotus hemilepidotus* [Plate 4], the wolf-eel *Anarrhichthys ocellatus*, and the Alaskan ronquil *Bathymaster caeruleofasciatus* (not previously reported) [Plate 7]. Wolf-eels were fairly common with many dens available in the reef. The Alaskan ronquil was also abundant, living in small crevices on the reef slopes.

The prowfish *Zaprora silenus* [Plate 8] was found living in caves on the reef, and was also encountered swimming in the open. These peculiar fish were extremely curious and would often approach divers very closely. On several occasions they followed divers nearly to the surface, nibbling at plastic bags they thought might be edible jellyfish.

Prowfish were common at Bowie, often swimming in the open.

Halibut (*Hippoglossus stenolepis*) were observed swimming over the summit of the reef. Some small cottids were observed, but we were not able to collect them for identification.

A Comparison with Bowie Seamount Observations of Scrimger and Bird (1969)

In March 1969 Canadian Navy divers took the first photographs of the summit of Bowie Seamount and collected some biological samples during a preliminary survey for instrument placement (Scrimger and Bird, 1969). This resulted in a list of 11 invertebrate taxa, nine of which were found in our survey. Interestingly, the sea cucumber *Cucumaria quinquesemita* was reported in these samples, whereas we observed no holothuroids.

A Comparison with Bowie Seamount Observations of Herlinveaux (1971)

Herlinveaux (1971) reported that rock samples were collected by Navy divers from Bowie in August 1969 and that the attached algae were examined by Dr. Scagel at the Department of Botany, UBC. Scagel (1971) identified 12 taxa of brown and red algae and attributed the occurrence of marine algae at great depth to the very clear water conducive to photosynthetic activity.

Samples taken during this survey included nine of the 12 taxa reported by Scagel plus an additional nine taxa not previously reported (Lindstrom, pers. comm.). Both surveys occurred during the month of August, so the increased number of species identified during this survey may be attributable to larger samples collected bearing several inconspicuous forms of red algae.

Herlinveaux reported that fish caught by hook and line while over Bowie Seamount consisted primarily of three species: widow (*Sebastes entomelas*), yelloweye (*Sebastes*

ruberrimus) and redstripe (*Sebastes proriger*). The depths of capture were not given. It is noteworthy that the dense schools of large (40 cm) widow rockfish depicted in Herlinveaux's report were not observed during this survey.

The Navy divers also reported "a few six-foot fish and many one-foot eel-like fish." Based on our observations, it is probable that the former were wolf-eels and the latter prowfish. Several "sturgeon-like" fish were also observed. We cannot speculate on what these might have been.

A Comparison with Cobb Seamount Observations of Birkeland (1971)

The only other seamount in the northeast Pacific Ocean that reaches depths shallow enough to be explored by divers is Cobb Seamount, discovered and named in the late 1950s by scientists working on the R.V. *John Cobb*. Cobb Seamount lies 435 km west of Grays Harbor, Washington and rises to within 34 m of the surface.

In contrast to Bowie Seamount's convoluted, fractured tephra surface that is riddled with caves and crevices, Birkeland (1971) described Cobb Seamount as generally flat basalt with small dips, potholes and rises. The only interstices available were those formed by the bases of attachment of sessile organisms such as rock scallops and tubeworms.

Birkland noted the presence of five species of algae, six species of fishes and 41 species of invertebrates, not including several unidentified species. A comparison of Birkeland's species list with this study reveals a small degree of overlap. For example, of the 41 taxa of invertebrates reported from Cobb, only 10 were found at Bowie. No hydroids or barnacles were seen at Cobb, whereas the giant barnacle *Balanus nubilus* is abundant at Bowie as well as various species of hydroids. The red urchin *Strongylocentrotus franciscanus* is the most conspicuous animal at Cobb with densities estimated at 2.6 per square metre. Urchins are rare at Bowie; during the course of 25 dives only a few were found. The sunflower star *Pycnopodia helianthoides*, a major predator of urchins, is very common at Cobb, but only a few were observed on the summit of Bowie.

The rock scallop *Crassadoma gigantea* is found at both seamounts, but at Cobb it dominates vertical surfaces, forming a secondary substrate. At Bowie, the zoanthid *Epizoanthus scotinus* dominates vertical surfaces. The leather star *Dermasterias imbricata*, a conspicuous sea star at Bowie, has not been reported from Cobb Seamount. The painted seastar *Orthasterias koehleri*, the blood star *Henricia leviuscula* and the sunflower star *Pycnopodia helianthoides* are found on both seamounts.

Amongst the algae, *Desmarestia viridis,* a brown alga known for its acidity, is found at both seamounts. *Polysiphonia pacifica* is common at Bowie, while an unidentified species of *Polysiphonia* (also known to be distasteful to urchins) was reported from Cobb. Birkeland noted that "In general, the variety of life was greatly reduced from that expected on a comparable area of basalt on the mainland. However, those species present seemed to be abundant and species diversity would be high if calculated on a "number of individuals per species" basis." Our observations at Bowie generally support this observation. We found that while species diversity at Bowie was relatively low, those species present were found in high numbers. By comparison, at a rocky reef near Cape St. James (south end of the Queen Charlotte Islands), we found species diversity to be much greater than at Bowie.

Biological Collections
Several samples of the tephra substrate were collected intact in order to document the inconspicuous forms of marine life living on them. This material was examined using dissecting microscopes and a preliminary sorting was made of many specimens barely visible to the naked eye. The identification of these samples is beyond the scope of this preliminary report, however the samples will be made available for further study by interested taxonomic specialists.

Underwater Still Photography
180 underwater photographs were taken to corroborate visual observations on the seamount. These included wide-angle views of the summit and close-up shots detailing marine colonization of the reef. Appendix 1 contains 18 colour plates depicting marine life and physical features of Bowie Seamount.

Underwater Video
90 minutes of digital video were recorded to confirm visual observations and to provide a general perspective of the biology and topography of the summit.

Recommendations

1/ Due to the fragile nature of the substrate at Bowie Seamount, the anchoring of large vessels should be prohibited. A large anchor and heavy chain would cause significant damage to the reef summit and its associated marine life. All permitted diving operations should be required to secure a minimal-impact mooring to the reef to permit safe diving operations from a tender.

2/ All commercial and sport fishing should be prohibited within one kilometre of the summit of Bowie Seamount. The resident populations of large, decades-old rockfish are particularly vulnerable to localized overfishing and could easily be decimated. Heavy fishing gear and nets could cause significant damage to the relatively brittle substrate.

3/ Further scientific research, especially using photography and videography to document the summit of the seamount, should be encouraged and supported.

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Dr. J. D. McPhail provided advice and materials for preserving fishes.

Dr. Colin Levings provided the use of laboratory equipment at the Center for Aquaculture and Environmental Research (CAER) (formerly West Van Labs).

Dr. Elaine Humphries provided high-resolution light microscope and SEM images of selected samples.

Table 1: Species Observed on the Summit of Bowie Seamount to 40 m depth, August 3-5, 2003 (NR: New Record)

GROUP	SCIENTIFIC NAME	COMMENTS
ALGAE		
Phaeophyta (brown algae)	*Laminaria yezoensis*	Patch at 38 m depth
	Desmarestia foliacea	
	Desmarestia ligulata	(formerly *D. herbacea*)
	Desmarestia viridis	
	Spacelaria norrisii	NR
Rodophyta (red algae)	*Antithamnion defectum*	
	Callophyllis flabellulata	
	Callophyllis sp.	NR
	Encrusting coralline	
	Cf. *Fauchea laciniata*	NR
	Fryeella gardneri	
	Cf. *Haraldiophyllum nottii*	NR
	Hommersandia maximicarpa	NR
	Membranoptera sp.	NR
	Opuntiella californica	NR, abundant
	Phycodrys cf. *isabellae*	NR
	Polysiphonia pacifica	abundant
	Ptilota sp.	
INVERTEBRATES		
Porifera (sponges)	*Penares cortius*	NR, abundant
	Leucosolenia sp.	NR
	Encrusting species A	NR, orange, rough
	Encrusting species B	NR, crème, puffy
	Encrusting species C	NR, orange, flat
	Calcareous sponge A	NR, vase shaped
	Calcareous sponge B	NR, elongated tube
Cnidaria (hydroids, anemones, jellyfish)	Hydroid species A	NR
	Hydroid species B	NR
	Plumularia sp.	NR
	Epizoanthus scotinus	Very abundant
	Metridium farcimen	NR
	Urticina lofotensis	NR
	Urticina piscivora	NR
	Cribrinopsis fernaldi	NR
	Solmissus sp.	NR, pelagic
	Nanomia bijuga	NR, pelagic, very abundant
Ctenophora (comb jellies)	*Pleurobrachia bachei*	NR, pelagic
	Bolinopsis infundibulum	NR, pelagic
	Beroe sp.	NR, pelagic

Annelida: Polychaeta (worms)	*Serpula vermicularis*	
	Polychaete species A	NR
	Polychaete species B	NR
Bryozoa (moss animals)	*Bugula californica*	NR, abundant
	Bryozoan species A	NR, black spots at nodes
	Bryozoan species B	NR, branching
	Bryozoan species C	NR, encrusting
	Bryozoan species D	NR, branching with bristles
	Bryozoan species E	NR, clustered tubes
	Bryozoan species F	NR, open branching
Mollusca: Bivalvia (bivalves)	*Mytilus californianus*	
	Crassadoma gigantea	
	Chlamys hastata	NR
	Entodesma navicula	Abundant
	Pododesmus macrochisma	NR
Mollusca: Gastropoda (snails and nudibranchs)	*Fusitriton oregonensis*	NR
	Dirona albolineata	NR
	Janolus fuscus	NR
	Anisodoris nobilis	NR
	Dendronotus frondosus	NR
	Hermissenda crassicornis	NR
	Triopha catalinae	NR
	Diodora aspera	NR
	Amphissa sp.	NR
	Snail species A	NR, rough spire
	Snail species B	NR, smooth spire
	Snail species C	NR, *Calliostoma*-like
	Snail species D	NR, brown, moonsnail-like
	Snail species E	NR, small brown spire
	Snail species F	NR, small rough spire
Mollusca: Polyplacophora	*Cryptochiton stelleri*	
Arthropoda: Cirripedia	*Balanus nubilus*	abundant
Arthropoda: Decapoda (crabs)	*Cancer oregonensis*	NR
	Loxorhynchus crispatus	NR, northern range extension
	Chorilia longipes	NR
Arthropoda: amphipods, isopods, mysids, tanaids, ostracods, pycnogonids, copepods	Amphipod species A	NR, pale eyes, few
	Amphipod species B	NR, common
	Amphipod species C	NR, abundant
	Amphipod species D	NR
	Amphipod species E	NR
	Caprellid species A	very abundant

	Isopod species A	NR, elongated, brown, abundant
	Isopod species B	NR, elongate, broad
	Isopod species C	NR, very broad, long legs
	Tanaid species A	NR, black-tipped chelipeds
	Tanaid species B	NR, elongated
	Mysid species A	NR, few
	Pycnogonid species A	NR, few
	Ostracod species A	NR, few
	Copepod species A	NR
Echinodermata: Asteroidea (sea stars)	*Dermasterias imbricata*	common
	Henricia leviuscula	common
	Pycnopodia helianthoides	few
	Evasterias troschelii	NR, rare
	Orthasterias koehleri	NR
	Stylasterias forreri	NR, rare
Echinodermata: Echinoidea	*Strongylocentrotus purpuratus*	NR, rare
Echinodermata: Ophiuroidea	*Ophiopholis aculeata*	common
	Brittlestar species A	NR
Sipunculida	Sipunculid species A	NR
Urochordata (tunicates, salps)	*Ritterella rubra*	NR
	Tunicate species A	NR, on *Loxorhynchus* carapace
	?Salpa fusiformis	NR, pelagic
VERTEBRATES		
Osteichthyes (bony fishes)	*Sebastes ruberrimus*	Abundant, schooling near bottom
	Sebastes nigrocinctus	Solitary in crevices
	Sebastes entomelas	Abundant, schooling over reef
	Sebastes variegatus	Abundant, schooling over reef
	Zaprora silenus	common
	Hemilepidotus hemilepidotus	Cryptic, rarely seen
	Hexagrammos decagrammus	NR
	Cottid species A	Not collected
	Bathymaster caeruleofasciatus	NR
	Anarrhichthys ocellatus	common
	Hippoglossus stenolepis	Swimming over seamount
	Mola mola	At surface over seamount

Appendix 1: Photographs from Bowie Seamount
(All images copyright Neil G. McDaniel)

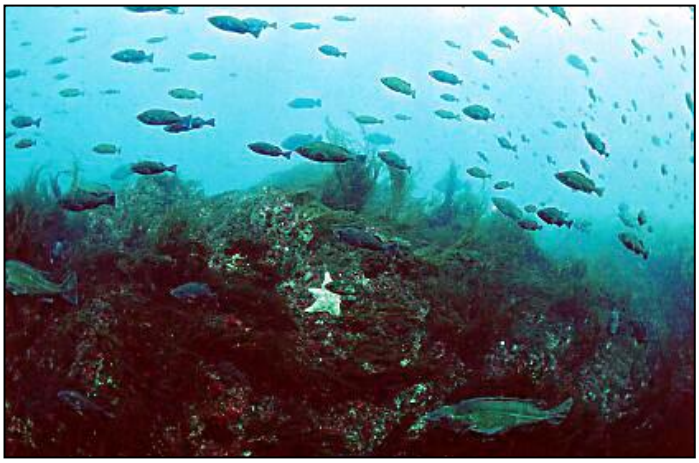

Plate 1: Twenty-five metres below the surface, the clear blue water above the summit of Bowie Seamount swarms with schools of widow (*Sebastes entomelas*) and harlequin rockfish (*S. variegatus*). The top of the volcanic peak is covered with stringy brown seaweeds known as acid kelps. Many species of algae are found deeper here than anywhere else in British Columbia waters.

Plate 2: Reaching 15 cm in diameter, crimson anemones (*Cribrinopsis fernaldi*) are common on the summit, mostly on the steeper flanks of the reef. They have stinging cells in their tentacles that are used to capture small prey.

Plate 3: The painted star (*Orthasterias koehleri*) is relatively uncommon at Bowie, but its bright colour makes it stand out conspicuously from the dark volcanic substrate. A predator of bivalves and tunicates, this sea star has long rays and a small central disc.

Plate 4: The red Irish lord (*Hemilepidotus hemilepidotus*) is a colourful sculpin that reaches 30 cm long. An ambush predator, it lies absolutely still on the bottom, capturing prey in its capacious mouth.

Plate 5: Colonial zoanthids (*Epizoanthus scotinus*) are very abundant on the flanks of the reef summit. They form carpets of feeding polyps that cover several square metres.

Plate 6: A juvenile yelloweye rockfish (*Sebastes ruberrimus*) rests in a crevice. With their two bold horizontal stripes, these young specimens were once thought to be a separate species since they look quite unlike adult yelloweyes.

Plate 7: A wary reef dweller, the Alaskan ronquil (*Bathymaster caeruleofasciatus*) is well adapted to life amongst the crevices and caves on the summit of the seamount. It is rarely seen in British Columbia waters, except in northern areas.

Plate 8: The only member of its family in the world, the prowfish (*Zaprora silenus*) reaches a metre in length. Those at the seamount were extremely curious, often approaching the divers closely. Individuals could be recognized by their distinctive yellow markings on the head and sides.

Plate 9: Converted for use as a packer in the seafood harvesting industry, the 18-m *Danny & David* proved to be the ideal vessel for the trip to Bowie Seamount. Its fish-hold was flooded to provide a means of transporting live specimens back to Vancouver.

Plate 10: Clusters of giant barnacles (*Balanus nubilus*) crowded the edges of the rocky pinnacles, their shells overgrown with a dense turf of bryozoans, sponges, hydroids and zoanthids. Hairy cancer crabs (*Cancer oregonensis*) often occupied empty barnacle casings.

Plate 11: The broad-rayed leather star (*Dermasterias imbricata*) is common on the summit. It is known to consume a variety of prey, including anemones. It reaches 20 cm in diameter.

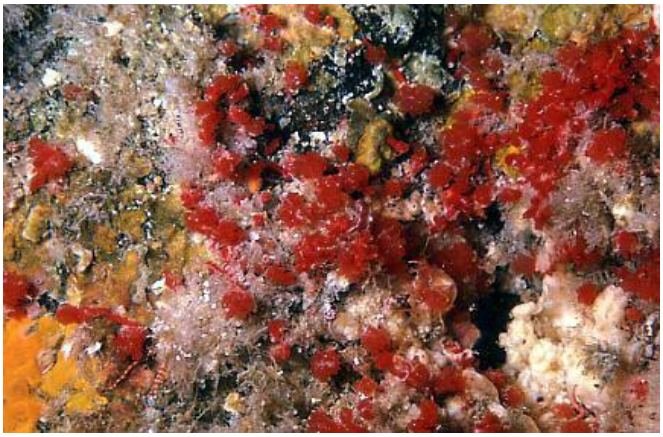

Plate 12: Tunicates were not common on the summit, however the red tunicate *Ritterella rubra* was common on vertical rock faces.

Plate 13: Randy Haight, Donnie Reid and Doug Swanston examine a moss crab (*Loxorhynchus crispatus*) collected from the seamount. This is the farthest north that this spider crab has ever been collected.

Plate 14: The moss crab (*Loxorhynchus crispatus*) is an expert at self-decorating. The carapace and legs of this specimen are totally obscured by zoanthids, sponges and bryozoans that the crab has attached to itself.

Plate 15: Blood stars (*Henricia leviuscula*) were common, eating various species of sponges. To the left is the grey ridge sponge *Penares cortius*.

Plate 16: The lemon nudibranch (*Anisodoris nobilis*) was the largest nudibranch found on the summit, with specimens reaching 20 cm in length. It preys upon sponges.

Plate 17: Rock scallops (*Crassadoma gigantea*) were common on the summit, their shells compeletely obscured with encrusting growth such as sponges, bryozoans, red algae and zoanthids.

Plate 18: Several different species of sponges were observed on the summit, including this puffy encrusting species. Samples were collected for identification.