Sources of Information for Evaluating the Existence of Vulnerable Marine Ecosystems (VMEs) on Seamounts within the Southern Emperor-Northern Hawaiian Ridge[1]

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[*Please note that the issues and proposed solutions offered in this working paper are the author's alone and have been provided in order to stimulate discussions on how VMEs and SAIs might directly relate to the SE-NHR seamounts and there fisheries.*]

I. Introduction

The objectives of this working paper are two-fold: 1) to provide an overview of available information on the characteristics and habitats associated with the southern Emperor-northern Hawaiian Ridge (SE-NHR), and 2) to discuss the most likely vulnerable marine ecosystem (VME) associated with these seamounts and suggest how we might address significant adverse (SAIs) impacts caused by fishing on the seamounts.

II. Physical Features

The seamount bottom trawl footprint for the armorhead fishing grounds includes the southern Emperor Seamounts of Koko (35°00' N, 171°45' E), Kimmei (33°43' N, 171°30' E) , and the Milwaukee Seamounts consisting of Yuryaku (32°40' N, 172°15' E), North (N) Kammu (32°15' N, 172°47' E), and South (S) Kammu (32°02' N, 173°06' E). Southeast of the Milwaukee Seamounts, the armorhead trawl fishing grounds extend to Colahan (31°00' N, 175°55' E), C-H (30°22' N, 177°33' E), and the Hancock Seamounts consisting of Northwest (NW) Hancock (30°16' N, 178°42' E), Southeast (SE) Hancock (29°48' N, 179°04' E), and "K" Bank (29°40' N, 179°20' E). In 1977, the three summits associated with the Hancock Seamounts were incorporated into the U.S. EEZ, where a seamount fishing moratorium has been in effect since 1986 (see Figure 1). The historic Russian fishery also included the seamounts of Zapadnaya (28°50-54' N, 178°53' - 179°03' W), Dubrava (28°48' N, 179°00' W?), Prof. Berg (28°52' N, 179°31' W), and Turnif (28°55' N, 178°36' W), all east of the Hancock Seamounts and located along the northern Hawaiian Ridge.

The bottom trawl gear used to target armorhead and alfonsin at these seamounts was towed across, and typically in contact with, the substrate of the seamount summits. Trawling did not appreciably extend onto the upper slopes below the summits. Fishing captains quickly learned to avoid the locations of rugged topography on each of these summits where net hang-ups and other costly gear damage occurred.

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The SE-NHR seamounts fished in the armorhead bottom trawl fishery can be characterized by several physical features that include summit size and topography, minimum summit depth, and location and proximity of neighboring seamounts. These features have influenced the conduct of bottom trawl operations and the level of exposure to bottom trawling that particular seamounts have experienced.

SE-NHR seamounts can be roughly classified into two categories based on summit dimensions: small (<3 km wide) and large (>12 km wide). SE-NHR seamounts with small summits are guyots (flat-topped seamounts) with little to no surface relief on their summits. These include Colahan, NW Hancock, and SE Hancock Seamounts. Large summits are also considered guyots but have more varied and uneven bottom topography (higher incidence of trawl hang-ups) than small seamounts. Large seamounts include Koko, Yuryaku, N. Kammu, and S. Kammu Seamounts. Peaked seamounts have small summits but with an uneven bottom topography, like seamounts with large summits. Peaked seamounts include C-H and "K" Bank (within the Hancock Seamounts). Due to uncertainty about the identification of Kimmei Seamount among four closely associated seamounts, Kimmei will be omitted from further consideration. Likewise, due to lack of detailed information on their physical characteristics, the seamounts Zapadnaya, Dubrava, Prof. Berg, and Turnif, apparently all small seamounts, will also be omitted from further discussion.

Minimum summit depths are shallower among small seamounts (250-275m minimum depth) compared to the large and peaked seamounts (~350-550m).

Within the armorhead trawl fishing grounds, the large seamounts are all located along the southernmost portion of the Emperor chain (32-36°N latitude). Small and peaked seamounts are all located to the southeast along the northernmost portion of the Hawaiian Ridge (28-31°N latitude). A gap between the range of large seamounts and the small and peaked seamounts occurs at approximately 31-32°N latitude and 173-176°E longitude (see Figure 1).

During the 1969-1981 period of the Japan seamount trawl fishery, the majority of the armorhead catch and effort occurred at the large seamounts, particularly the Milwaukee Seamounts (Sasaki 1986). High trawl CPUEs (mt/hr) were sometimes achieved at the small and peaked seamounts but could not be sustained for more than several days. Hence, the small and peaked seamounts were commonly "pulse-fished" by trawlers for only a short period (several days) and then allowed to "cool off" as fishing effort was shifted to a nearby seamount. In this fishery, the peaked seamounts, with their deeper summits and rugged topography, were the most difficult to trawl. Small seamounts provided relatively smooth and shallower bottoms for trawling with less risk of net hang-ups. These combinations of factors may have made the small seamounts more likely to experience repeated trawling over their summits.

III. Seamount Associated Habitats

The moderate summit depths (250-550m) of the remote SE-NHR seamounts create rare access to a hard substrate within this vast oceanic region. Upwelling caused by ocean currents impinging upon the seamount slopes and summits leads to increased localized productivity which, to a varying extent, is entrained over and/or adjacent to the seamounts. Nocturnal aggregations of micronekton that occupy the pelagic waters above the summits also provide a concentrated food supply for the pelagic and benthopelagic fishes that are commercially harvested at the seamounts. High current flow along the interface between the pelagic waters and the exposed seamount substrate can promote the establishment of a highly diverse invertebrate-dominated fauna over the seamount summits and slopes.

IV. Seamount Cold-Water Coral Ecosystems

Within the past decade, diverse faunas of macroinvertebrate species have been discovered during explorations of Pacific seamounts, particularly within the southwest (SW) Pacific (Forges et al. 2000). The benthos over summits and slopes of these seamounts is characterized by a high level of invertebrate biodiversity. The diversity is supported by a few species of branching cold-water corals whose morphology provides complex structure to the benthos that creates additional habitat for other invertebrate species and shelter for small fish. Cold-water corals are a major component in the benthos of the seamounts and are recognized as keystone species of these unique deep-sea ecosystems. These particular seamounts within the SW Pacific have apparently not been exposed to previous anthropogenic activities. However, the prevalence of seamount cold-water coral ecosystems in this region remains unknown. Less than 1% of Pacific seamounts have been adequately surveyed using combinations of ship-based ROVs, submersibles, and deep-sea cameras.

IV. Information Sources to Identify VMEs on the SE-NHR Seamounts

There is limited information regarding the discovery of precious coral beds at the SE-NHR seamounts. The discovery of coral beds pre-dates the Russian discovery of vast resources of armorhead over the seamounts in November 1967 and the subsequent development of the armorhead bottom trawl fishery. Information on this precious coral discovery is contained in several publications authored by Dr. Richard Grigg (University of Hawaii) who investigated the sources of the precious corals (pink corals) after they began to appear on the world markets. Grigg reported that in the mid-1960s precious coral fishermen from Japan discovered large quantities of pink coral, *Corallium secundum*, at 400 m depths on the summits and upper slopes of the Milwaukee Seamounts (Grigg 1974, 1982, 2002). A coral drag fishery quickly developed which included fishermen from both Japan and Taiwan. The corals were harvested by fishermen who towed across the seabed an oblong-shaped weight equipped with trailing tangle nets. Expansion of this fishery beyond the Milwaukee Seamounts remains unclear. The fishery apparently peaked in the late 1960s when approximately 100 coral boats from Japan and Taiwan fished this area, harvesting a total of 150,000 kg of pink coral. The fishery declined drastically by the early 1970s. In 1978, the discovery of an unidentified deep slope (1,000-1,500m depths) pink coral (*Corallium* sp.) set off another round of intense coral drag fishing at the SE-NHR seamounts (Grigg 1982, 2002). Both Japan and Taiwan fishing vessels participated and in 1980 alone harvested approximately 200,000 kg of this coral. Statistics on annual landings of these corals are difficult to obtain since apparently no official records were maintained.

Other sources of fishery-based information include U.S. observer data recorded during 1978-1984 while a foreign-permit armorhead bottom trawl fishery at the Hancock Seamounts was administered by the U.S. A preliminary review of the observer catch records indicate that coral fragments occurred only infrequently and in small amounts in the trawl catches.

During 1985-1993, NOAA research cruises to the Hancock Seamounts were conducted to assess the relative abundance of armorhead using bottom longline gear. Rare catches of unidentified corals were obtained when the longline gear became entangled over very steep summit drop-offs, particularly off the northeast side of SE Hancock. During one of these cruises, drop-camera surveys over the summits of SE Hancock, Colahan, S. Kammu, and Koko Seamounts were conducted. Sparse patches of unidentified octocorals were recorded in some of the photographs. At the 2nd Meeting of the SWG, Japan also reported some preliminary findings of their 2006 ROV survey of the benthos over the southern Emperor seamounts. No other ROV or submersible surveys of the benthos have been conducted.

The bottom trawl fishery at the SE-NHR seamounts has been in operation for 40 years. Substrates of the seamount summits have likely been subject to repeated impacts from bottom trawls, coral drags, and other fishing gear over this period. Exposed substrates may have been completely reworked from the mechanical impacts of the fishing gear. Evidence of any pre-existing or remnant coral beds over the exposed portions of the seamount summits, may be difficult to recognize or interpret. Accordingly, in conducting coral surveys it may be advisable to not investigate the most exposed portions of seamount summits but instead concentrate on surveying summit areas whose rugged topography may have served as physical refugia for remnant coral beds.

Physical refugia on the seamount summits may take the form of two different types of features: 1) rocky outcroppings and ledges, and 2) summit depressions and overhangs along the summit edges. The first types of refugia (outcroppings and ledges) are the raised topographic features that damage bottom trawl gear. The location of these features has likely been carefully recorded by previous and current fishing captains. Access to such information would provide a valuable source of data from which future bottom surveys could be planned. The second type of refugia (depressions and overhangs) would not likely create trawl damage and therefore might not become known to fishermen. To locate overhangs, it would probably be most profitable to search summit edges, particularly those where the slope drops off rapidly. The upper slope area just below the summit edge may also provide refugia from the impact of bottom trawling.

Another source of refugia, created by management actions, is the Hancock Seamounts (NW Hancock, SE Hancock, and “K” Bank) within the U.S. EEZ. A moratorium on seamount bottom fishing has been in effect there since 1986. Over this time there has been some evidence of fishing violations by unidentified foreign vessels, particularly in the vicinity of NW Hancock, where the EEZ boundary actually bisects the summit. In a study to evaluate the effects of 22 years of fishing cessation, SE Hancock and “K” Bank

would be better study sites to compare with nearby seamounts that continued to be fished (Colahan and C-H), because the former seamounts have probably been subject to less illegal fishing.
A source of published and unpublished species records from seamounts worldwide is available within the interactive Website *SeamountsOnline* (www.seamountsonline.org). This Website holds data on seamount species that that can be accessed through a species-based relational database. This database is available to query species records for particular seamounts and has recently acquired a vast amount of invertebrate data originally collected from Russian research cruises.

V. Information to consider in evaluating possible Seamount Deep-Water Coral Ecosystems for recognition as a VME.

Within the main Hawaiian Islands, *C. secundum* is found in colonies with other species of deep-water corals and sponges. *C. secundum* forms medium-size branching colonies that often form large beds which support a high diversity of other invertebrate species (Parrish and Baco 2007). These benthic habitats have been well studied. At the SE-NHR seamounts, however, observations of the benthos are not available either prior to the precious coral fishery or the subsequent bottom trawl fishery.

The original abundance and density of *C. secundum* at the SE-NHR seamounts prior to the start of the 1960s coral drag fishery remains unknown. Based on the high catches and subsequent decline in this fishery by the early 1970s, the available coral beds were no longer economically feasible to harvest. To what extent these coral beds declined due to coral harvesting and wastage (corals dislodged during harvest but lost) is uncertain.

As the summit coral fishery for *C. secundum* began to decline, the summit bottom trawl fishery for armorhead increased. Any summit coral beds not impacted by the coral fishery would presumably have remained exposed to physical damage from the bottom trawl fishery. The bottom trawl fishery has continued now for 40 years. The current status of the original *C. secundum* beds and their associated invertebrates is unknown.

In the Hawaiian Islands, age at reproductive maturity for *C. secundum* is estimated at 12-13 years. This species appears to be relatively long-lived and slow growing (<1 cm/year). A 0.7 m high colony in Hawaii was estimated to be 80 years old. Rates of recruitment and mortality appear to be low for this species. Corals with these types of life history characteristics are less resilient to excessive exploitation. Whether these life history parameters differ for *C. secundum* inhabiting the SE-NHR seamounts is unknown (Parrish and Baco 2007).

V. Evaluating Significant Adverse Impacts (SAIs) on a Seamount Deep-Water Coral (*Corallium secundum*) VME.

If consensus agreement is reached that Seamount Deep-Water Corals (*C. secundum*) and their associated benthos are to be recognized as a vulnerable marine ecosystem (VME), then criteria will need to be developed to ascertain whether the current fishery is having significant adverse impacts (SAIs) on this ecosystem. This will be problematic as a high level of uncertainty exists due to our lack of information on the current state of the ecosystem. Certainly some form of monitoring is required. However, the density of the deep coral population may be so low, and the distribution of colonies so patchy, that efforts to monitor the corals through inspection of by-catch in the current armorhead fisheries could be entirely uninformative and/or misleading.

A more fruitful approach might rest on the assumption that if this ecosystem is to recover, it will require patches of existing deep-water coral refugia and associated benthos for eventual recolonization. As previously described, the detection of potential refugia may require photographic or direct observations of the bottom (depressions and overhangs) or in the case of outcroppings and ledges, their location may already be available from records of the fishing fleet. Available fine scale bathymetry and side-scan sonar mapping of seamount summit and upper slope areas may also be useful for determining bottom type. Deep-water coral ecosystems require low sediment, hard bottom substrate for attachment. Areas of fine sediment could be eliminated from planned habitat surveys. Once the available data are assembled and used to identify specific summit locations with sediment-free substrate and sites of previous trawl hang-ups, ROV/camera surveys can be designed to search within a better defined area for the presence of deep-water coral refugia. Unfortunately, these efforts to evaluate SAIs are highly unlikely to be completed and analyzed prior to the December 31, 2008 deadline.

An alternative, pro-active approach toward mitigating potential SAIs on deep-water coral ecosystems would be to use a combination of bottom trawl gear modifications and knowledge of summit substrate. For seamounts with limited summit areas (small and peaked seamounts), the use of rock-hopper gear, roller gear, and other devices on the foot rope that protect trawl nets from bottom damage would be eliminated. This would require the net to be towed off-bottom and ensure compliance (no bottom contact). For the large seamounts, the presence of sediment areas on the summit could provide enough of an area or “trawling corridor” to allow geographically restricted trawling in areas away from potential cold-water coral habitat. The implementation of modified off-bottom trawling and/or restricted bottom trawling on the large seamounts would be seen externally as pro-active interim measures in light of the uncertainty regarding the VME and possible SAIs. These measures would remain in effect during the time period (2-3 years?) required to organize, conduct, complete, analyze, and interpret the survey data from high resolution bathymetry, side-scan sonar, ROV/camera, and possibly submersible surveys. Such an endeavor would require substantial efforts and resources by all parties. But it was exploration and discovery that led to these seamount fisheries some 40 years ago; now new research exploration and discovery will be required to provide the information we will need to develop an informed management strategy for these fisheries that meets requirements to identify and protect the cold-water coral VME.

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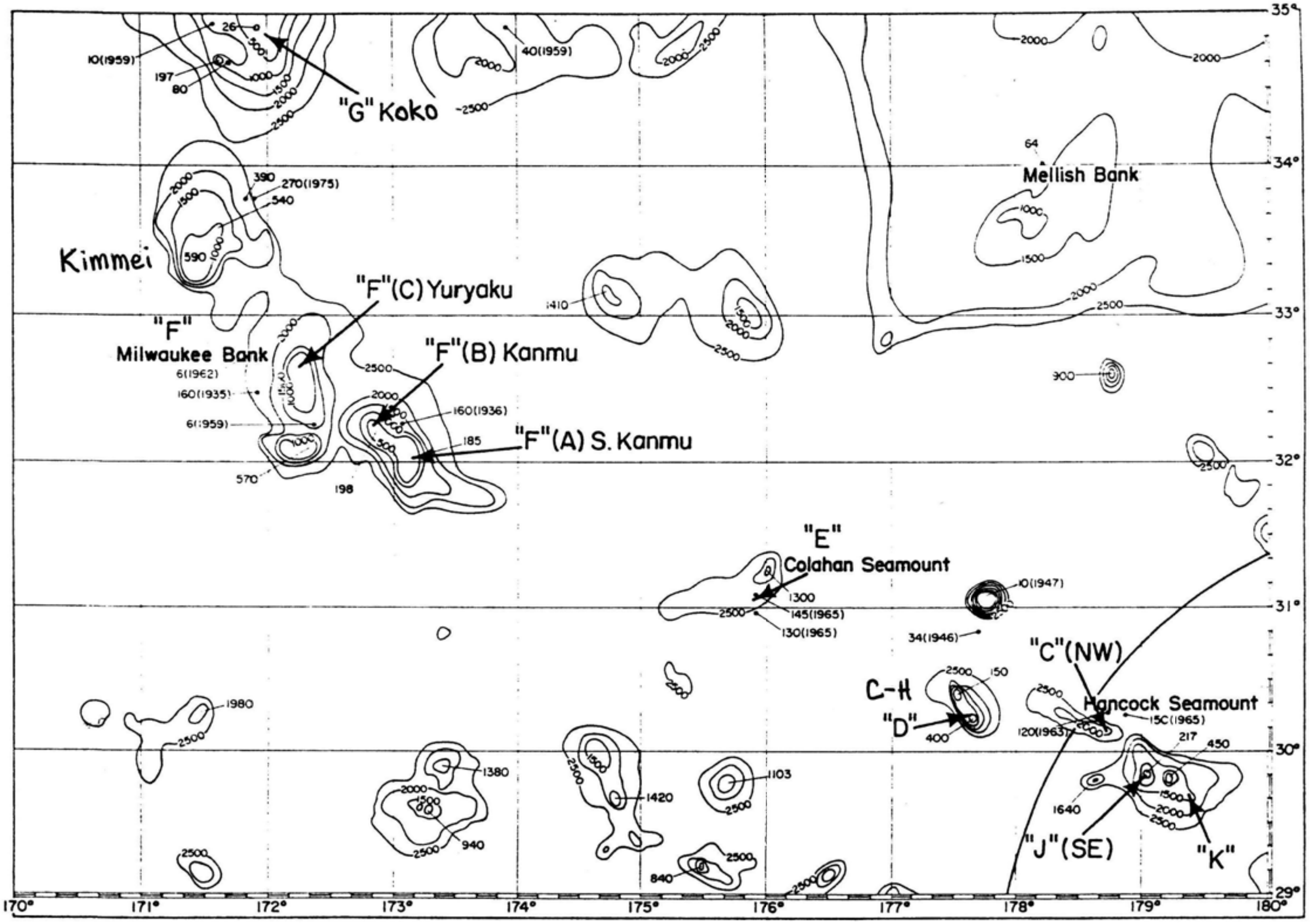

Locations of seamounts and guyots northwest of the Northwestern Hawaiian Islands. Year of discovery is indicated for each guyot, and the 200-mile line is shown. Depths in fathoms.