North West Pacific Ocean

REPORTS ON IDENTIFICATION OF VMEs AND ASSESSMENT OF IMPACTS CAUSED BY BOTTOM FISHING ACTIVITES ON VMEs AND MARINE SPECIES

NOAA Fisheries, U.S.A.

December 23, 2008

1. Name of the Participating State

U.S.A.

2. Name of the fishery

A. Bottom trawl fishery

B. Bottom gillnet fishery

C. Bottom longline fishery

D. Pot fishery

E. Coral drag fishery

3. Status of the fishery

A. Bottom trawl fishery

The bottom trawl fishery is an existing fishery that began with the discovery of large concentrations of armorhead over the summits of the southern Emperor Seamounts by Russia in November 1967 (Komrakov 1970). The fishery was most recently conducted by Japan, Russia, and Korea during all or a portion of 2001-2007.

B. Bottom gillnet fishery

The bottom gillnet fishery is an existing fishery; the start date of this fishery is unknown. The fishery was most recently conducted by Japan and Russia during all or a portion of 2001-2007.

C. Bottom longline fishery

The bottom longline fishery is an existing fishery; the start date of this fishery is unknown. The fishery was most recently conducted by Russia and Korea during a portion of 2001-2004. Japan participated in this fishery during the 1970s.

D. Pot fishery

The pot fishery for deep-water crabs is an existing fishery; the start date of this fishery is unknown. The fishery was most recently conducted by Russia during 2002-2003. Exploratory crab pot fishing was undertaken by Japan in 1977 (Sasaki 1978). Japan and Korea are not currently participating in this fishery.

E. Coral drag fishery

The shallow (400-450 m depth) coral drag fishery for *Corallium secundum* started around 1965 and ended by the mid-1970s. The deep (1,000-1,500 m depth) coral drag fishery for *Corallium* sp. nov. began around 1978 and ostensibly ended around 1992. Coral drag vessels of Japan and Taiwan participated in both the shallow and deep coral drag fisheries.

Although the coral drag fisheries are thought to have ceased, recent sightings of coral drag vessels in the vicinity of the Emperor Seamounts suggest otherwise (Anon. 2008a).

4. Target species

A. Bottom trawl fishery

The primary target species of the bottom trawl fishery has been North Pacific armorhead *Pseudopentaceros wheeleri* (hereinafter armorhead) since the inception of the fishery in 1968. The other target species, particularly when armorhead catches are low, is the splendid alfonsino, *Beryx splendens* (hereinafter alfonsino). The catch of alfonsino in the bottom trawl fishery is predominantly juveniles (16-22 cm FL).

B. Bottom gillnet fishery

The primary target species of the Japan bottom gillnet fishery are primarily adult sized alfonsino *Beryx splendens* and the oreo *Allocyttus verrucosus.* The primary target of the Russian gillnet fishery is presumably the mirror dory *Zenopsis nebulosus*; this is the only identified species in the Russian catch report (see “Catch by Species” table of the datafile “footprint_ALL_081111”).

C. Bottom longline fishery

The primary target of this fishery is rockfishes of the genus *Helicolenus* (likely composed of *Helicolenus avius* and one or more other con-generics). Although Japan has not participated in the bottom longline fishery during 2002-2007, anecdotal records published in Suisan Sekai (1976) from an interview with a Japan fishing captain indicate that Japan vessels conducted bottom longline fishing in the 1970s. The reported target species were adult sized alfonsino (presumably *Beryx splendens*), ako (*Sebastes* sp.; probably referring to *Helicolenus* sp. but this identification can not be currently verified), and kue (*Epinephelus* sp.; probably referring to *Hozukius guyotensis* but this identification also can not be currently verified).

D. Pot fishery

The primary target of this fishery, conducted solely by Russia, is species of crab of the genera *Geryon* and *Lithodes*.

E. Coral drag fishery

The coral drag fishery was conducted by fishing vessels of Japan and Taiwan and targeted the precious coral *Corallium secundum* (pink coral) at 400-450 m depths. A deeper (1,000-1,500 m depths) fishery targeted a lower quality, un-described new species of pink coral, *Corallium* sp. nov.

<u>5. Bycatch species</u>

A. Bottom trawl fishery

By-catch species for which catch statistics are available for Japan, Russia, and Korea include mirror dory *Zenopsis nebulosa*, butterfish *Hyperogylphe japonica*, rockfishes *Helicolenus* spp., broad alfonsino *Beryx decadactylus*, cods (family Moridae), giant skillfish *Erilepus zonifer*, lanternfishes (family Myctophidae), sharks (various species), and “others”.

B. Bottom gillnet fishery

If armorhead is not considered a target of this fishery, it would appear to be the major by-catch species. If not, then fish categorized as “others” would be the major by-catch component (see “Catch by Species” table of the datafile “footprint_ALL_081111”. Data on the species composition within the category “others” are not available.

C. Bottom longline fishery

By-catch from the bottom longline fishery is lumped within the category “others”. Data on the species composition within the category “others” are not available.

D. Pot fishery

By-catch from the pot fishery is lumped within the category “others”. Data on the species composition within the category “others” are not available.

E. Coral drag fishery

No records are currently available on the identity of any by-catch species caught in either the shallow or deep *Corallium* targeted coral drag fisheries.

<u>6. Recent level of fishing effort</u>

(1) <u>Number of fishing vessels</u>

A. Bottom trawl fishery

The annual number of fishing vessels (by Participating States) engaged in seamount bottom trawl fishing is presented in the “Vessel Summary” table of the datafile “footprint_ALL_081111” assembled by the NWP/RFMO ScientificWorking Group (SWG).

B. Bottom gillnet fishery

The annual number of fishing vessels (by Participating States) engaged in seamount bottom gillnet fishing is presented in the “Vessel Summary” table of the datafile “footprint_ALL_081111” assembled by the SWG.

C. Bottom longline fishery

The annual number of fishing vessels (by Participating States) engaged in seamount bottom longline fishing is presented in the “Vessel Summary” table of the datafile “footprint_ALL_081111” assembled by the SWG.

D. Pot fishery

The annual number of fishing vessels (by Participating States) engaged in seamount pot fishing is presented in the “Vessel Summary” table of the datafile “footprint_ALL_081111” assembled by the SWG.

E. Coral drag fishery

The shallow (400-450 m depths) *C. secundum* targeted fishery was conducted from 1965 to the mid-1970s at the Emperor Seamounts by vessels of Japan and Taiwan. Data on fishing effort are very limited. Anecdotal information derived from an interview with a Nagasaki-based precious coral fisherman indicated that in 1966, 100 coral boats from Japan were operating in this fishery but this declined to only 8 boats by 1970 (Grigg 1970).

The deep (1,000-1,500 m depths) *Corallium* sp. nov. targeted fishery was conducted from 1978 to 1992 by vessels of Japan and Taiwan. Both the shallow and the deep fisheries are referred to in the Japan coral fishing industry as “Midway Deep Sea Coral” although the fishing grounds coincide with Koko and the Milwaukee Seamounts. Slightly more information is available on effort in this fishery but data are still limited. The All Japan Coral Fisheries Association (JCFA) operated 17 coral drag vessels in this fishery in 1981. The JCFA did not send any vessels in 1987 and 1988 and only one vessel in 1989 (Niemeier 1989). One hundred coral fishery vessels from Taiwan were reported to be fishing at the Emperor Seamounts as of 1981 (Grigg 1982). Reported landings in 1983 indicate that 20 vessels from Taiwan and 14 vessels from Japan were operating in this fishery.

(2) Tonnage of each fishing vessel

A. Bottom trawl fishery

Listings of fishing vessels and their gross tonnage (by Participating States) are presented in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

B. Bottom gillnet fishery

Listings of fishing vessels and their gross tonnage (by Participating States) are presented in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG. Additional information on Japan gillnet vessels is provided in Anon. (2008f).

C. Bottom longline fishery

Listings of fishing vessels and their gross tonnage (by Participating States) are presented in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

D. Pot fishery

Listings of fishing vessels and their gross tonnage (by Participating States) are presented in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

E. Coral drag fishery

No information was found on the tonnage of vessels involved in the *C. secundum* coral drag fishery.

Information provided in Grigg (1982) indicates that in 1981, 100 Taiwan coral fishery vessels were engaged in the "Midway Deep Sea Coral" fishery (presumably the deep fishery targeting *Corallium* sp. nov.); these vessels were in the 100 ton size class. Additional information reported by Niemeier (1989) also indicates that in 1981, JCFA operated 17 vessels each of which was 100 GRT.

(3) Number of fishing days or days on the fishing grounds

A. Bottom trawl fishery

A compilation of fishing days by year, vessel, and Participating States, are listed in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

B. Bottom gillnet fishery

A compilation of fishing days by year, vessel, and Participating States, are listed in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

C. Bottom longline fishery

A compilation of fishing days by year, vessel, and Participating States, are listed in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

D. Pot fishery

A compilation of fishing days by year, vessel, and Participating States, are listed in the "Number and Size of Vessels" table of the datafile "footprint_ALL_081111" assembled by the SWG.

E. Coral drag fishery

No documentation was available on either the Japan or Taiwan coral drag fisheries. Anecdotal information provided in Grigg (1982) indicates that the large 100 ton coral fishery vessels of Japan and Taiwan remained at sea (presumably the Emperor Seamounts) for periods of 3-6 months at a time.

(4) <u>Fishing effort (total operating hours for trawl, # of hooks per day for longline, # of pots per day for pot, total length of net per day for gillnet)</u>

A. Bottom trawl fishery

Annual bottom trawl fishing effort, in number of fishing days for Japan, Russia, and Korea is listed in the "Number and Size of Vessels-ALL" table within the datafile "footprint_ALL_081111". Annual fishing effort by trawling hours is also available for Japan only for the period 2002-2007 in the "Catch by Species" table of the datafile "footprint_ALL_081111".

Additional data from the early period of the Japan bottom trawl fishery list effort (in trawling hours) by seamount and year for armorhead and alfonsino (Table 2 of Sasaki 1986).

A cooperative exchange of data between the NRIFSF and the then NMFS Honolulu Laboratory provided access to annual catch and effort data (by seamount) for the Japan trawl fleet covering the period 1983-2002.

B. Bottom gillnet fishery

Annual bottom gillnet fishing effort, in number of fishing days for Japan and Russia is listed in the "Vessel Summary" and "Number and Size of Vessels-ALL" tables within the datafile “footprint_ALL_081111”. Fishing effort in units of “tans” was not available.

C. Bottom longline fishery

Annual bottom longline fishing effort, in number of fishing days for Russia and Korea is listed in the “Vessel Summary” and “Number and Size of Vessels-ALL” tables within the datafile “footprint_ALL_081111”. Fishing effort in units of “number of hooks per day” was not available.

D. Pot fishery

Annual pot fishing effort, in number of fishing days for Russia is listed in the “Number and Size of Vessels-ALL” table within the datafile “footprint_ALL_081111”. Fishing effort in units of “number of pots per day” was not available.

E. Coral drag fishery

Detailed data on fishing effort for the shallow *C. secundum* or deep *Corallium* sp. nov. fisheries are not available for either the Japan or Taiwan fisheries.

(5) Total catch by species

A. Bottom trawl fishery

Annual bottom trawl catch (in mt) for Japan, Russia, and Korea, is listed in the “Catch Summary” “Catch by Species” tables within the datafile “footprint_ALL_081111”. Annual catches are listed for both target species (armorhead and alfonsino) and for the major by-catch species or species-groups.

Additional catch data from the early period of the Japan bottom trawl fishery listed catch by seamount and year for the target species and major by-catch species appears in Table 2 of Sasaki (1986).

A cooperative data exchange began in the 1980s between the National Research Institute of Far Seas Fisheries and the then National Marine Fisheries Service Honolulu Laboratory that provided access to catch and effort data (by seamount) from the Japan seamount bottom trawl fleet for the period 1983-2002.

B. Bottom gillnet fishery

Annual bottom gillnet catch (mt) for Japan and Russia is listed in the “Catch Summary” and “Catch by Species” tables within the datafile “footprint_ALL_081111”. Annual catches are listed for both target species (alfonsino, oreo, and mirror dory) and major by-catch (armorhead and “others”). Annual catches by species were aggregated among seamounts fished.

C. Bottom longline fishery

Annual bottom longline catch (mt) for Russia and Korea is listed in the "Catch Summary" and "Catch by Species" tables within the datafile "footprint_ALL_081111". Annual catches are listed for both target species (alfonsino and rockfishes, presumably species of *Helicolenus*) and major by-catch (armorhead, alfonsino, and "others"). Annual catches by species were aggregated among seamounts fished.

D. Pot fishery

Annual pot fishery catch (mt) for Russia is listed in the "Catch Summary" and "Catch by Species" tables within the datafile "footprint_ALL_081111". Annual catches are listed for the target species (unidentified species of crab) and major by-catch ("others"). Annual catches were aggregated among seamounts fished.

E. Coral drag fishery

Annual estimated harvest by Japan coral drag fishery vessels fishing the Emperor Seamounts is presented for 1965 to 1985 (Anon. 2008a). These data are not separated by the two target species of *Corallium*. Estimated catch of *C. secundum* by the Taiwan fleet during the shallow fishery is not available. Landings of *Corallium* sp. nov. harvested in the deeper fishery by Japan are reported in Grigg (1993) and appear similar to that reported in SWG4/WP9. Additional post-1985 landings of *Corallium* sp. nov. from the Japan Emperor Seamounts fishery for 1986 to 1992 are as follows:

1986	1.650 mt	1989	1.961 mt
1987	0.585 mt	1990	0 mt
1988	0.217 mt	1991	0 mt

Landings of *Corallium* sp .nov. from the Taiwan coral drag fishery for the period 1979-1991 appear in Grigg (1993) but are combined for the Emperor Seamounts and other outside areas.

(6) <u>Names of seamounts fished or to be fished</u>

A. Bottom trawl fishery

The bottom trawl fishery of Japan and Russia was conducted on Yomei, Nintoku, Jingu, Ojin, North Koko and Koko, Kimmei, Milwaukee, Colahan, and C-H seamounts. The Korea bottom trawl fishery operated on a smaller number of seamounts that included all of the above except Yomei and Nintoku. This information is specified in the "Area Fished" table within the datafile "footprint_ALL_081111".

B. Bottom gillnet fishery

The bottom gillnet fishery of Japan was conducted on Suiko, North Koko and Koko, Kimmei, Yuryaku, Kammu, Colahan, and C-H seamounts. This information is specified in the "Area Fished" table within the datafile "footprint_ALL_081111".

C. Bottom longline fishery

The bottom longline fishery of Russia was conducted on Ojin and Koko seamounts. Korea conducted fishing on Nintoku, Ojin, Koko, Milwaukee, Colahan, and C-H seamounts. This information is specified in the "Area Fished" table within the datafile "footprint_ALL_081111".

D. Pot fishery

The pot fishery of Russia was conducted on Showa, Yomei, Nintoku, and Koko seamounts. This information is specified in the "Area Fished" table within the datafile "footprint_ALL_081111".

E. Coral drag fishery

The coral drag fishery for *C. secundum* was reported by Grigg (2002) to have been conducted at the southern Emperor Seamounts; presumably Koko, Yuryaku, and Kammu. It is uncertain whether this fishery expanded to the southeast to include the small seamounts of the northern Hawaiian Ridge (Colahan, C-H, and the Hancocks). The second fishery for *Corallium* sp. nov. was presumably conducted on the seamount slopes of Koko, Yuryaku, and Kammu. It is also uncertain whether this fishery expanded to the southeast to include the small seamounts of the northern Hawaiian Ridge (Colahan, C-H, and the Hancocks) and perhaps to the deeper seamounts north of Koko.

7. Fishing period

A. Bottom trawl fishery

The bottom trawl fishery began in November 1967 with the discovery of large concentrations of armorhead made by a Russian commercial trawler at the southern Emperor Seamounts. Russia began its bottom trawl fishery in 1968 and Japan entered the fishery in 1969. The Russian trawl fleet apparently left the trawl fishery after the fishery crashed in the mid-1970s. The Japan trawl fishery has continuously fished the seamounts since 1969. The start date of Korea's entry into the bottom trawl fishery in unknown. Data assembled by the SWG cover the more recent period of 2001-2007.

B. Bottom gillnet fishery

Information on the start date of the bottom gillnet fishery was unavailable as well as other historical information regarding this fishery. Data assembled by the SWG covers the more recent period of 2002-2007; Japan is the only country currently active in this fishery.

C. Bottom longline fishery

The bottom longline fishery appears to have been first initiated at the Milwaukee Seamounts by Japan sometime around 1973 (Suisan Sekai 1976). Data assembled by the SWG cover the more recent period of 2001-2004; Korea and Russia are currently active in this fishery.

D. Pot fishery

Information on the start date of the pot fishery was unavailable as well as other history regarding this fishery. Data assembled by the SWG cover the more recent period of 2002-2003; Russia is the only country currently active in this fishery. Some exploratory pot fishing at Nintoku, Ojin, and Koko was conducted by Japan in 1977 (Sasaki 1978).

E. Coral drag fishery

The *C. secundum* fishery was conducted by Japan and Taiwan coral drag vessels at the Emperor Seamounts beginning in 1965 and the fishery is effectively ended sometime around the mid-1970s due to sustained low catches (Grigg 1993).

The *Corallium* sp. nov. fishery was also discovered by Japan coral drag vessels in 1978 (Grigg 1993) and the fishery ended for Japan in 1992 (Anon. 2008a). The Taiwan fleet was also operating in this fishery during the same period, however, new information indicates that some fishing may still be occurring, as recently as 2008 (Anon. 2008a).

8. Analysis of status of fishery resources

(1) Data and methods used for analysis

A. Bottom trawl fishery

For the bottom trawl fishery, catch, effort, and nominal CPUE statistics for armorhead and alfonsino (by year and seamount) are contained in the publication by Sasaki (1986) which also describes the Japan trawl fleet during the period 1969-1982. Additional Japan trawl statistics covering the period 1983-2002 were received periodically over the intervening years as part of a collaborative exchange of seamount data between the National Research Institute of Far Seas Fisheries and the then National Marine Fisheries Service Honolulu Laboratory. Additional catch statistics (2002-2007) were obtained from participating fishing countries during the recent SWG meetings.

Estimates of armorhead stock size during the early period were reported by Borets (1975, 1976). Other published armorhead stock assessments for the entire SE-NHR seamounts (Wetherall and Yong 1986) and for only Southeast Hancock Seamount (Somerton and Kikkawa 1992) are available. No more recent stock assessment of armorhead in the bottom trawl fishery has been conducted.

A recent assessment of the alfonsino caught in the seamount bottom trawl fishery was completed by Japan for the SWG (Nishimura and Yatsu 2008) and the results were reviewed for this report. Another concurrent report to the SWG (Anon. 2008b) containing a description of the fishery and management recommendations was also reviewed.

Life history information on armorhead is available from a number of published literature sources. The initial description of the armorhead life cycle was reported by Borets (1980). Armorhead undergo an initial 2+ year pre-recruit pelagic phase in surface waters of the temperate and subarctic North Pacific (Boehlert and Sasaki 1988; Humphreys 2000). During this pelagic phase, armorhead undergo somatic growth but remain non-reproductive (Humphreys et al 1989). Armorhead return to the southern Emperor-northern Hawaiian Ridge (SE-NHR) seamounts (consisting of Koko, Yuryaku, North and South Kammu, Colahan, and C-H Seamounts outside the U.S. EEZ and Northwest and Southeast Hancock Seamounts inside the U.S. EEZ) and recruit to the summits and upper slopes of these seamounts (Humphreys et al. 1993). Recruitment to the bottom trawl fishery and to the seamounts is synonymous; these full-size adults recruit to the seamounts primarily during late spring-early summer (Humphreys et al. 1993). After recruitment, armorhead cease somatic growth, develop reproductively, and spawn annually at the seamounts during November-February (Bilim et al. 1978; Humphreys et al. 1989; Yanagimoto and Humphreys 2005). Armorhead size and age composition across the SE-NHR seamounts are similar (Borets 1979). Post-recruit movement of armorhead between seamounts is considered unlikely. Population genetics studies indicate that armorhead consists of a single seamount-wide population (Martin et al. 1992; Yanagimoto et al. 2008a). The populations inhabiting the SE-NHR seamounts are thought to form a metapopulation. Armorhead may survive up to 4-5 years at the seamounts; however, individuals gradually become emaciated; undergoing an irreversible decline in somatic weight and body depth (fatness) with age (Somerton and Kikkawa 1992). Annual increases in armorhead biomass at these seamounts are therefore solely dependent on new recruitment. A background report to the SWG (Anon. 2008c) on armorhead life history and the current fishery was also reviewed.

Regarding the known life history of alfonsino at the seamounts, spawning seems to occur during the summer based on the occurrence of larvae collected at the seamounts (Mundy 1990) and the spawning period reported around Japan (Honda et al. 2004). Little is known of the pelagic phase and it is presumed that juveniles recruit to the seamounts at about age 1 (Chikuni 1971). At the seamounts juveniles tend to associate with depth zones above and adjacent to the summits while adults typically occur deeper along the seamount slopes. This species is considered benthopelagic and adults are presumed to be capable of conducting extensive vertical movements at the seamounts. Ages up to 15 years at a size of 40-43 cm FL have been reported with sexual maturity attained at a size of 28-32 cm FL and age 3-4 years (Honda et al. 2004; Yanagimoto and Nishimura (2007). In the South Pacific off New Caledonia, evidence of ontogenetic migrations to seamounts of deeper summit depth has been reported (Lehodey et al. 1994 and 1997). Whether these types of movements are occurring within the SE-NHR seamounts remains unknown. Population studies of morphometrics and mtDNA indicate no stock separation within the

SE-NHR region (Anon. 2008b). Alfonsino populations inhabiting the SE-NHR seamounts are thought to form a metapopulation.

B. Bottom gillnet fishery

For the bottom gillnet fishery, only spatially aggregated fishing statistics covering the most recent years of the fishery (2002-2007) compiled by the SWG were available for review. Japan provided details on vessel characteristics of its fleet and configuration and specifications of the gear (Anon. 2008f). Specific information on the length composition of target species, depth ranges fished, type of slope fished for each seamount, whether summits were fished, and other detailed catch and effort statistics were not available. No information was available for review on the history and development of this seamount fishery.

C. Bottom longline fishery

For the bottom longline fishery, only aggregated fishing statistics covering the most recent years of the fishery (2002-2007) compiled by the SWG were available for review. Specific information on target species, mesh size and gear specifications, depth zones, whether summits were fished and detailed catch and effort statistics were not available. No information was available for review on the history and development of this seamount fishery.

D. Pot fishery

For the pot fishery, only aggregated fishing statistics covering the most recent years of the fishery (2002-2007) compiled by the SWG were available for review. Specific information on target species, pot size and pot type, depth zones, and detailed effort statistics were not available. No information was available for review on the history and development of this seamount fishery.

E. Coral drag fishery

For both the *C. secundum* and *Corallium* sp. nov. fisheries, the data were limited to aggregated catch by year for the Japan fleet. Catch data from the Taiwan fleet were not available as the seamount fishery catches were lumped with catches from other areas. Effort data for Japan and Taiwan were not available, nor were any detailed information of catch.

(2) Results of analysis

A. Bottom trawl fishery

No stock assessment for armorhead was conducted.

A review was conducted of the procedures and results of the alfonsino stock assessment as documented in Nishimura and Yatsu (2008) and Anon. (2008b). The proposed 24% reduction in F to attain F_{MSY} is considered to be an underestimate, as the actual values of the management parameter benchmarks (e.g., F_{MSY} and B_{MSY}) remain uncertain and additional analyses are required to obtain more accurate estimates.

B. Bottom gillnet fishery

Total catch reported in the Japan bottom gillnet fishery varied by over an order of magnitude during the six-year time series (2002-2007) available. Similar variation occurred within each of the four species categories. The dominant species in the catch appeared to switch among years. There was also one anomalous year (2004) where "others" was almost the highest catch component.

Based on the description of a typical gear set in the Japan gillnet fishery (Anon. 2008f), a single panel of gillnet (tan) is 30m in length and 7m high. Floats are attached to the top of the net and concrete sinkers hold the net on bottom. Gillnet gear is configured such that it fishes 0.7m off-bottom. Gillnets consist of nylon webbing with a typical mesh size of 120mm. A typical set would consist of 56 nets (tans) connected together, with weights and surface buoys at both ends of the set. An accurate assessment of the status of this fishery cannot be conducted given the lack of any detailed information about targeting, fishing location, size composition, and effort.

C. Bottom longline fishery

The data indicate a decline, by two orders of magnitude, in catch for rockfishes (=*Helicolenus* sp.) and "others" in the Russian fishery over the course of the four years for which data are available. However, using the available effort (in annual number of fishing days) for only the first two years, nominal CPUE shows the reverse trend. A longer time-series of catch and effort data is required to evaluate any trends in the fishery. Furthermore, this fishery lacks virtually any available documentation and supporting data for the location of sets, fishing depths, hook size, and size distribution of the catch. The status of this fishery can not be assessed at this time.

D. Pot fishery

No results can be provided based on only two years of catch data and lacking information on effective effort (only number of vessels is provided). This fishery lacks virtually any available documentation and supporting data for the identity of crab species caught, location of pot sets, fishing depths, trap type, and the size distribution of the catch. The status of this fishery cannot be assessed at this time.

E. Coral drag fishery

The decline in catches for both *C. secundum* and *Corallium* sp. nov. in the Japan fisheries would appear to indicate that these resources were rapidly depleted. Without some reliable measure of catch and effort, however, an informed analysis can not be provided.

(3) Identification of uncertainties in data and methods, and measures to overcome such uncertainties

A. Bottom trawl fishery

Armorhead

An armorhead stock assessment using the available time series of data (1968-2007) is the most important priority in evaluating the status of the primary target species of this fishery. Without a current assessment, the status of this fishery remains uncertain and open to divergent interpretations regarding the degree to which the stock has been overfished and the extent of current overfishing. This lack of information makes it difficult to arrive at a common view as to the extent of management measures that will be needed to reduce fishing mortality to a sustainable level. We suggest that the best approach would be to conduct stock assessments that include the two recent armorhead recruitment events (1992 and 2004 recruitment pulses) that occurred at the SE-NHR seamounts. Since the fishery quickly responded to these recruitment events by ramping up effort after each recruitment pulse, stock abundance (both aggregated and spatially disaggregated by seamount) could be estimated using one or more of the currently existing stock depletion models (Leslie method, DeLury model, etc.). Estimates of natural mortality, catchability, and other parameters derived in the report by Somerton and Kikkawa (1992) could serve as a starting point for needed input parameters to initially run the assessment models of the fishery.

For armorhead, substantial uncertainties exist regarding the effects of environmental changes during the long (2+year) pelagic growth stage. Environmental conditions are thought to control the level of subsequent recruitment and to have produced the episodic recruitment pulses to the seamounts in 1992 and 2004. Whether high recruitments or improved fishing techniques were responsible for the apparent high catches of armorhead early in the fishery (1972-1973) remains uncertain. The unpredictable, episodic nature of these infrequent high armorhead recruitments (in 1972-1973, 1992, and 2004) is in striking contrast to the typical low level of annual recruitment for the last 30 years. Whether the low level of abundance over the last 30 years is the product of recruitment overfishing, environmental conditions controlling recruitment, or a combination of the two cannot be determined at this time.

Alfonsino

A number of factors are contributing to uncertainties surrounding the most recent alfonsino stock assessment as documented by Nishimura and Yatsu (2008). The alfonsino population inhabiting the SE-NHR seamounts is likely to constitute a metapopulation. However, in this assessment there is no accounting for spatial patterns or changes in fishing effort in the CPUE series. For example, from the available Japan trawl data, it appears that Koko Seamount has received a larger share of the recent annual trawl effort. If the fishery over other seamounts has declined and more recent fishing has indeed been focused at Koko Seamount, then the actual pattern of stock decline over the seamounts region may be underestimated.

Another source of uncertainty involves possible changes in catchability (q) over time. The assessment treats the 1976-2006 fishing period as if the fishing fleet was homogeneous through time with no changes in fishing technology and no learning about fishing grounds. If this assumption is not true, then fishing effort directed at alfonsino may be underestimated or overestimated over different time periods. If fishing vessels have learned which fishing areas are most productive for alfonsino over time, then recent effort targeting the productive areas may be more effective than previous effort and as a result, recent CPUE may be over-estimating relative abundance of alfonsino.

The inclusion of the 1979-1982 CPUE data was problematic as it produced implausible biomass and fishing mortality estimates in the ASPIC model used by Nishimura and Yatsu (2008). The decision to exclude this time series of data, however, may be ignoring the possibility that the spatial pattern of the fishery differed through time, thereby affecting the use of aggregate CPUE as a measure of relative abundance. Regardless, excluding the apparent increasing trend in alfonsino CPUE during 1979-1982 from the surplus production analyses implies that the remaining CPUE series (1985-2006) is effectively a "one-way trip" of a declining trend. In this case, estimates of surplus production model parameters and biological reference points may not be reliably determined since there is little contrast in the CPUE data and few if any observations at low effective fishing effort targeting alfonsino. One generally needs to have some observations at low fishing effort and high or low alfonsino abundance to obtain robust reference point estimates.

Lastly, the reversal in the dominant species in the trawl catch from armorhead to alfonsino starting around 1978-1979 has been attributed to an increase in alfonsino abundance and the re-targeting of the bottom trawl fishery to selectively fish alfonsino. At around this time, the armorhead catch had already plummeted and was at the lowest level since the fishery began. An alternate explanation for this reversal in catch levels between these species may behavioral interactions. At higher abundances, armorhead appear to preferentially occupy the summit areas en masse while alfonsino schools (primarily juveniles) may be present but displaced higher off the bottom into the water column or at the edges of the armorhead schools. When armorhead abundance is low, alfonsino schools would no longer be physically displaced by armorhead schools and could occupy areas over the summits. As this occurs, these schools of juvenile alfonsino would become either more susceptible or targeted for trawl capture and their catch rates would increase. This hypothesis would account for the higher catches of alfonsino during the post-historic period (1979-1982) and also explain why there subsequent lower catches (compared to armorhead) only occur in the wake of the two armorhead recruitment events in 1992 and 2004.

B. Bottom gillnet fishery

This fishery remains poorly documented. The entire time-series of this fishery needs to be made available in order to determine whether any long-term trends are occurring in this fishery. If effort (in tans) was recorded, these data should also be made available to better quantify unit effort. Available information on depth range, location, and mesh size would provide an opportunity to better understand the catch variations in the dataset. Also biological information on the size composition of the target species is needed to help evaluate the effects of fishing over time.

C. Bottom longline fishery

Available effort data are too coarse for establishing trends in CPUE. A longer time-series of catch and effort data is required to evaluate any trends in the fishery. Furthermore, this fishery lacks virtually any available documentation and supporting data for the location of sets, fishing depths, hook size, and size distribution of the catch.

D. Pot fishery

Available effort data are too coarse for establishing trends in CPUE. A longer time-series of catch and effort data is required to evaluate any trends in the fishery. Furthermore, this fishery lacks virtually any available documentation and supporting data for the identity of crabs caught, location of pot sets, fishing depths, pot size, types of pots fished, and size distribution of the catch.

E. Coral drag fishery

The lack of available effort data for both fisheries and for both the Japan and Taiwan coral drag fleets impedes any analysis at this time. Furthermore, the complete lack of location data does not allow for an evaluation of whether serial depletion by area has occurred. Serial depletion is a particularly relevant issue to consider when analyzing these types of fisheries. The sessile nature of the target species and the physical dislodgement of corals by the harvesting gear are characteristics quite different from most other fisheries. In fact, the operation of a coral drag fishery is more similar to mining than to fishing in that the resource initially remains concealed, but once discovered, it cannot evade extraction. Furthermore, there may be little incentive to conserve the resource since harvested corals can be stockpiled indefinitely and the rapid harvesting of the resource minimizes competition from other fishermen.

9. Analysis of status of bycatch species resources

(1) Data and methods used for analysis

A. Bottom trawl fishery

Data on the density of the top five species collected in research trawls by Russia were provided to the Participating States. The species included the two target species (armorhead and alfonsino) and the top three by-catch species which include the broad alfonsino *Beryx decadactylus*, pencil cardinalfish *Epigonus denticulatus*, and mirror dory *Zenopsis nebulosa*. Density of these five species was calculated based on a swept area method for research trawl hauls:

Density = M / A; density in units of kg / km^2

where M = biomass of species in kg

and A = 1.852vt(a/1000) (v is speed in knots; t is time in hours; a is trawl width).

A myriad of other by-catch species can occur in trawl hauls at the SE-NHR seamounts (Table 1 in Humphreys et al. 1984) but the identities of the by-catch species categorized as "other" were not available. Density data were also partitioned into three depth strata by seamount; 200-400 m, 400-600 m, and 400-700 m. Density data for the five species were available from research trawl hauls conducted at Koko, Yuryaku, Kammu, Milwaukee, Colahan, and C-H Seamounts.

B. **Bottom gillnet fishery**

The presumed by-catch of the bottom gillnet fishery is armorhead and "others". The only data available for analysis are in the "Catch by Species" and "Vessel Summary" tables for 20021-2007 assembled by the SWG in datafile "footprint_ALL_081111".

C. Bottom longline fishery

The presumed by-catch of the bottom longline fishery is armorhead and "others". The only data available for analysis are in the "Catch by Species" and "Vessel Summary" tables for 2001-2004 assembled by the SWG in datafile "footprint_ALL_081111".

D. Pot fishery

The by-catch of the pot fishery is identified solely as "others". The only data available for analysis are in the "Catch by Species" and "Vessel Summary" tables for 2001-2004 assembled by the SWG in datafile "footprint_ALL_081111".

E. Coral drag fishery

No data were available on by-catch from either the *C. secundum* or *Corallium* sp. nov. fisheries.

(2) Results of analysis

A. Bottom trawl fishery

Based on the limitations of these data as explained in section 3 below, it is difficult to interpret any trends in the data with the possible exception of the rapid decline in armorhead density during the years 1969-1970 and its rapid increase during 1972-1973. These trends in the data coincide with concurrent trends in the armorhead CPUE of the Japan bottom trawl fleet.

B. Bottom gillnet fishery

The available data are insufficient to provide an analysis of the status of the by-catch resources in this fishery. The high catch of "others" in the 2004 Japan catch cannot be explained given the limited data available.

C. Bottom longline fishery

The available data are insufficient to provide an analysis of the status of the by-catch resources in this fishery. Although the catch of "others" declined over the four years for which data are available, the catch data cannot be interpreted with confidence since the time series is too short and other information on the gear, hook size, locations fished, and species composition is not provided. Without further information, the decline in by-catch could be interpreted as deleterious or due to changes in fishing techniques or mesh size that minimizes by-catch.

D. Pot fishery

The available data (for only a two-year period) are insufficient to provide any type of analysis that could gauge the status of by-catch resources in this fishery.

E. Coral drag fishery

No data were available to conduct an analysis on by-catch from either the *C. secundum* or *Corallium* sp. nov. fisheries.

(3) <u>Identification of uncertainties in data and methods, and measures to overcome such uncertainties</u>

A. Bottom trawl fishery

Examination of the sampling effort by depth strata revealed that the number of trawls conducted below 400 m is typically an order of magnitude smaller than those conducted at 200-400m. This contributed to the much higher level of variance associated with the density estimates for the deeper strata. Conclusions based on these data should be made with caution as density estimates were based on research trawl hauls and not commercial hauls. Furthermore, frequent zero catches for *Beryx decadactylus,* and to a lesser extent *Zenopsis nebulosa,* contributed additional variance to density estimates of these species.

Another difficulty with the data is that aside from armorhead, the other four species are benthopelagic as opposed to true benthic fish species such as bothids. The density of true benthic fish species may respond quite differently to long-term trawl exposure than the density of benthopelagic species. Furthermore, no invertebrate by-catch data are presented and these would also be expected to show declining densities over time.

B. Bottom gillnet fishery

This fishery and the species composition of the by-catch remains poorly documented. The entire time-series of by-catch in this fishery needs to be made available in order to determine whether any long-term trends in by-catch are occurring. If effort (in tans) was recorded, these data should also be made available to better quantify unit effort. Available information on depth range, location, and mesh size would provide an opportunity to better understand by-catch variations in the dataset. Also biological information on the size composition of the by-catch species is needed to help evaluate the effects of fishing over time.

The densities of true benthic fish species may respond quite differently to long-term bottom gillnet fishing. Furthermore, the tangling nature of this gear would be expected to produce by-catch of invertebrate species as well as benthic fishes; however, no invertebrate by-catch data are available for this fishery.

C. Bottom longline fishery

Available effort data are too coarse for establishing trends in CPUE. Relegating by-catch to an unidentified group of "other" species hinders efforts to examine trends in species abundance over time. A longer time-series of catch and effort data is required to evaluate any trends in the fishery. Furthermore, this fishery lacks virtually any available documentation and supporting data for the location of sets, fishing depths, hook size, and size distribution of the by-catch.

D. Pot fishery

Available effort data are too coarse for establishing trends in CPUE. Relegating by-catch to an unidentified group of "other" species hinders efforts to examine trends in species abundance over time. A longer time-series of catch and effort data is required to evaluate any trends in the fishery. This fishery lacks virtually any available documentation and basic fishery data regarding location of pot sets, fishing depths, pot size, types of pots, and size distribution of the catch.

E. Coral drag fishery

The *C. secundum* and *Corallium* sp.nov. fisheries have no available documentation and no basic fishery data regarding by-catch, effort, fishing location, fishing area, and species composition of by-catch. It is also unknown whether such data were ever recorded in the Japan and Taiwan coral drag fleets.

10. Analysis of existence of VMEs in the fishing ground

(1) Data and methods used for analysis

A. Bottom trawl fishery

For the bottom trawl fishery, several potential sources of data were gathered to identify possible physical refugia (summit to upper slope areas containing sessile invertebrates that remain protected from the physical impacts of bottom trawl gear) on the trawled seamounts. Refugia are thought to include areas of both elevated relief (outcrops, mounds, ridges, or ledges) and substrate depressions (crevices, holes, trenches, etc.). Areas of elevated relief cause damage to bottom trawl gear and would have been encountered early in the historic fishery and subsequently avoided by fishing captains. Substrate depressions which probably do not affect trawl gear may remain undetected and provide refugia within frequently trawled grounds. Of particular focus was the possibility that refugia can protect patches of deep-water corals (particularly *Corallium secundum*) and other associated deep-water coral and invertebrate species. Both types of refugia are likely to be small in spatial extent (on the scale of meters to tens of meters) and difficult to locate by direct observation of the bottom. A number of data sources were requested in order to help locate possible refugia or regions within the summits and upper slopes most likely to harbor refugia. Participating States provided available information on 1) detailed seamount bathymetry, 2) trawl catches of possible VME indicator species such as deep-water corals, 3) locations of trawl hang-ups and gear loss, 4) locations of trawling corridors or pathways over smooth bottom not associated with obstacles, and 5) remote observations of the seamount summits and slopes via drop-camera photography and benthic video observations from ROV surveys.

Bathymetry: Published 2-dimensional bathymetry charts derived from multibeam surveys of trawled seamounts (fishing footprint) along the Emperor Chain (Yomei, Nintoku, Jingu, Ojin, and Koko) were extracted from the publication by Smoot (1986) and made available to the 4th SWG. Similar multibeam-derived 2-dimensional bathymetry charts were extracted from Smoot (1985) for the other Emperor Seamounts located south of Koko Seamount (Kimmei, and the Milwaukee Seamounts Group consisting of Yuryaku and the north and south summits of Kammu). Resolution of bathymetry contour intervals in the Smoot (1985; 1986) publications is 100 fathoms (=183 meters). Detailed bathymetry for the northern Hawaiian Ridge Seamounts (Colahan, C-H, and the Hancocks) has been undertaken by the U.S. Naval Oceanographic Office but access to these maps and data remains classified. Bathymetry maps of the summits and upper slopes of Colahan and the northern peaked summit of C-H were produced from depth sounder surveys during a 1983 U.S. research cruise; depth contours are in 100 fathom (=183 m) intervals. Bathymetry of the two summits of the Hancock Seamounts were also produced over the course of several U.S. research cruises during the 1980s (contour resolution 100 m) and were made available to the SWG. Bathymetry was not available for the southeastern-most peaked summit of the Hancocks (referred to by the Japan trawl fleet as “K” Bank).

Detailed 2- and 3-dimensional bathymetric charts for the Emperor Seamounts (Yomei, Nintoku, Jingu, Ojin, Northern Koko, Koko, Kimmei, Yuryaku, and Kammu) and 2-dimensional charts for seamounts of the northern Hawaiian Ridge (Colahan, C-H, and the Hancocks) were produced by research surveys conducted by Japan and provided by Yanagimoto (2008a) for the use of the SWG.

Incidental Coral Captures: Data on seven trawl locations associated with incidental capture of corals were provided by Russia to the 4th SWG (Anon. 2008d). A compilation of incidental coral captures by both Russia and Japan was provided to the 5th SWG by Yanagimoto (2008b).

Documented Trawl Hang-ups: A list of 91 locations associated with trawl net hang-ups was provided by Russia to the 4th SWG (Anon. 2008e). A compilation of trawl net loss and hang-ups recorded by both Russia and Japan was provided to the 5th SWG by Yanagimoto (2008c).

Trawling Corridors: No information was made available to the 4th or 5th SWG regarding the locations of trawling corridors or pathways along the summits.

Remote Observations of Seamount Benthos: Results of ROV video observations over the summits and upper slopes of Koko, Yuryaku, north and south Kammu, and Colahan Seamounts were initially made available by Yanagimoto (2007) at the 2nd SWG. Data on drop-camera, ROV, and dredge surveys for the deep-water precious coral *Corallium secundum* were made available at the 4th SWG (Yanagimoto 2008d) and 5th SWG (Yanagimoto et al. 2008b). Additionally, results of drop-camera photography conducted by the U.S. in 1986 and 1988 over the summits of Koko, south Kammu, Colahan, and SE Hancock were presented at the 4th SWG (Humphreys 2008) and these data were also distributed in CD format.

B. Bottom gillnet fishery

Bathymetry: See text in the above “Bathymetry” section for the bottom trawl fishery.

Incidental Coral Captures: No data were available to the SWG on the incidental capture of deep-water corals in the bottom gillnet fishery.

Documented Gear Hang-ups: No data were available to the SWG on the incidence and locations of gear hang-ups in the bottom gillnet fishery.

Fishing Corridors: No information was made available to the SWG regarding the locations of unobstructed bottom gillnet fishing corridors or pathways along the summits and slopes of particular seamounts.

Remote Observations of Seamount Benthos: See text in the above “Remote Observations of Seamount Benthos” section for the bottom trawl fishery.

C. Bottom longline fishery

Bathymetry: See text in the above “Bathymetry” section for the bottom trawl fishery.

Incidental Coral Captures: No data were available to the SWG on the incidental capture of deep-water corals in the bottom longline fishery.

Documented Gear Hang-ups: No data were available to the SWG on the incidence and locations of gear hang-ups in the bottom longline fishery.

Fishing Corridors: No data were made available to the SWG regarding the locations of unobstructed bottom longline fishing corridors or pathways along the summits and slopes of particular seamounts.

Remote Observations of Seamount Benthos: See text in the above "Remote Observations of Seamount Benthos" section for the bottom trawl fishery.

D. Pot fishery

Bathymetry: See text in the above "Bathymetry" section for the bottom trawl fishery.

Incidental Coral Captures: No data were available to the SWG on the incidental capture of deep-water corals in the pot fishery.

Documented Gear Hang-ups: No data were available to the SWG on the incidence and locations of gear hang-ups in the pot fishery.

Fishing Corridors: No data were available to the SWG regarding the locations of unobstructed pot fishing corridors or pathways along the summits and slopes of particular seamounts.

Remote Observations of Seamount Benthos: See text in the above "Remote Observations of Seamount Benthos" section for the bottom trawl fishery.

E. Coral drag fishery

Bathymetry: See text in the above "Bathymetry" section for the bottom trawl fishery.

Incidental Coral Captures: Not applicable

Documented Gear Hang-ups: Not applicable

Fishing Corridors: No detailed fishing locations are available for the *C. secundum* or *Corallium* sp. nov. fisheries.

Remote Observations of Seamount Benthos: Previous commercially exploited beds of *C. secundum* have not been identified and have not been surveyed in previous drop-camera photography and ROV survey efforts. See text in the above "Remote Observations of Seamount Benthos" section for the bottom trawl fishery.

Drop-camera photography and ROV surveys have not been conducted in the deep *Corallium* sp.nov. fished habitat of 1,000-1,500 m.

(2) Results of analysis

A. Bottom trawl fishery

Bathymetry: The available summit bathymetry charts for the Emperor Seamounts Chain and northern Hawaiian Ridge seamounts revealed some evidence for the existence of elevated features over the summit areas of several seamounts. The Smoot (1986) bathymetry chart for Koko Seamount displayed various elevated features within the north-central area of the summit (summit depth ~365 m) and on an elevated plateau (plateau depth ~365 m) in the far northwest portion of the summit. Bathymetry available for Kimmei and Yuryaku Seamounts displayed no elevated features on there summits. An elevated feature to the northwest of south Kammu summit (at 550 m depth) appears in the bathymetry chart by Smoot (1985). A single instance for the presence of an extensive depression feature on a seamount was recorded for Colahan Seamount. This presumed depression feature has a north-south orientation across the eastern portion of the summit with an expanse of ~1.5 km. The presumed depression was recorded during a sounding survey of Colahan summit by a U.S. research vessel in 1983. The summit edge of this depression is ~275 m depth and the deepest recorded portion of the depression is at ~550 m depth. This summit depression, however, is not present in the other bathymetry charts available for Colahan, so its existence is considered doubtful.

Small scale (<1 m) crevices, depressions, and outcroppings were recorded via drop-camera photography (Humphreys 2008). These features were infrequent and observed only on the summit of south Kammu. Due to shadows created by the strobe light source, the interior of these features could not be observed to ascertain the occurrence of deep-water corals.

Trawl Captures of Corals: Trawl captures of corals are documented from Russian research surveys in 1969-1988 (Anon. 2008d)) and were primarily confined to the Hancock Seamounts (one instance at SE Hancock and three instances associated with the peaked summit of “K” Bank). One trawl capture of corals was associated with the northern edge of north Kammu summit and the other at the extreme southeast edge of Koko. All of these recorded trawl captures occurred in the second half of 1970. Quantity and species identification of these corals were not available. No documented trawl captures of corals were available from the Russian commercial trawl fleet.

Documented trawl captures of corals recorded from Japanese research surveys occurred three times in 1972; all occurred at Kammu Seamounts (Yanagimoto 2008b). Quantity and species identification of these corals were not available. No documented trawl captures of corals were available from the Japanese commercial trawl fleet.

Documented Trawl Hang-ups: A documented list of dates and locations of trawl hang-ups provided by Russia (Anon. 2008e) indicates that the number of trawl hang-ups (total of 91 incidents) coincides with, in descending order, Kammu (46), Koko (19), the Hancocks (13 hang-ups distributed among the three summits), Colahan (11), and C-H (1). Within seamounts, areas of highest hang-ups coincided with the southern to eastern summit edges of south Kammu summit (n=25), the pinched southeastern summit-upper slope area of Koko (n=17), and the summit edges along north Kammu summit (n=14). These three areas accounted for 62% (56 of 91) of the recorded trawl hang-ups from early (primarily 1969-1971) in the historic armorhead bottom trawl fishery.

A compiled list of dates and locations of trawl hang-ups for Russian and Japanese vessels (Yanagimoto 2008c) indicates that the number of trawl hang-ups during the 1972 and 1973 JAMARC surveys were highest at Colahan Seamount. Hang-up rates were actually higher at Koko and Yuryaku but were discounted due to the low level of trawling effort (<10 trawls per year) conducted there. Kammu and the Hancock Seamounts had the second highest levels of trawl hang-ups.

Trawling Corridors: No data on trawling corridors or pathways were provided by the fishing industry; fishing captains were reportedly reluctant to divulge fishing information considered proprietary. Examination of the literature revealed one source of such information for the summit area of Koko. A research survey conducted by the Aomori Prefectural Fisheries Experimental Station (Aomori Prefectural Fisheries Experimental Station 1976, fig. 4) indicates an extensive region along the north to eastern summit edge and a smaller central summit area; both areas were reported to have smooth soft substrates easy for trawling and without obstacles. The total expanse of this area was estimated at 284 km^2 and was situated within a depth range of 300-400 m.

No other literature information regarding potential trawling corridors was available.

Remote Observations of Seamount Benthos: Drop-camera photography performed along the central eastern portion of Koko summit revealed a sand rippled bottom throughout that particular survey. As reported at the 4th SWG by Humphreys (2008), this area apparently coincides with the area reported above in the report of the Aomori Prefectural fisheries Experimental Station (1976).

Results of a 2006 Japan ROV survey over the seamount summits and upper slopes of Koko, Yuryaku, the two summits of Kammu, and Colahan were provided in the report by Yanagimoto (2007). A list of observed invertebrates included some 30 identified taxa of deep-water corals and 11 taxa of echinoderms. Further analysis of these data by Yanagimoto (2008d) and Yanagimoto et al. (2008b) indicates that several small colonies (a colony refers to a single stalked coral) of *Corallium* spp. were observed on the upper slopes adjacent to the southeastern summit edge of Koko Seamount at a depth of 425 m. No other colonies of *Corallium* spp. were observed in any of the other ROV or drop-camera surveys on other portions of Koko or at the other seamounts surveyed. Furthermore, dredge surveys using a Niino type dredge and two types of beam trawls did not collect any specimens of *Corallium*.

A drop-camera survey conducted during two U.S. research cruises in the mid-1980s provided additional photographic data of the seamount summits (Humphreys 2008). This survey of the summits of SE Hancock, Colahan, south Kammu, and Koko found 12 different taxa of deep-water corals, although no colonies of *Corallium* were detected. Each summit had a different composition of corals with the highest densities occurring on the summit of SE Hancock (200-250 colonies per frame; Nidallidae). Most frames had less than 10 small corals. Corals were almost all of low relief except for the whip corals and *Primnoa* spp. These corals were frequently found to have attached invertebrates (crinoids on whip corals and galathaeid crabs on *Primnoa* spp.). Much of the hard bottom substrate surveyed at Koko and Kammu was barren with only a few other invertebrates (mainly echinoderms) observed. Remnant piles of dead coral (presumably Dendrophyllidae) were observed at Koko; it was uncertain whether these coral fragments could have resulted naturally or from the physical impacts of trawling. Similarly, broken pieces of rocks frequently observed in the summit photos at Colahan could not be attributed with certainty to the physical impacts of trawling.

Based on the above results and available knowledge of the early coral drag fishery and its general fishing grounds, target species, and potential habitat overlap with the bottom trawl fishery, the most likely potential VME at the seamounts is that of deep-water corals with *C. secundum* as the primary component species.

Vulnerable Characteristics of a *C. secundum* Associated VME

Uniqueness or rarity: Within the Hawaiian Archipelago, known locations of dense coral beds of *C. secundum* outside of the Emperor Seamounts are few and geographically distant (Westpac Seamount, the Makapuu Bed on Oahu, and Cross Seamount). These beds of *C. secundum* occur at depths of 350-450 meters and at densities up to 120 colonies per 100 m^2 at Westpac and Makapuu (Parrish 2007). The existence of an expansive seamount summit habitat composed of hard substrate, subject to high current flow, and with summit depths of 350-450 m is unique to the southern Emperor Seamounts within the central North Pacific. In comparison, the seamounts located along the northern Hawaiian Ridge have small shallow (<300 m depth) summits while the Emperor Seamounts north of Koko have summits considerably deeper.

Functional significance of the habitat: No scientific investigations of the seamount benthos were undertaken prior to the coral drag and bottom trawl fisheries. Furthermore, there are no summit areas within the southern Emperor Seamounts that remain pristine. The functional significance of the deep-water coral habitat remains unknown.

Fragility: In morphology, *C. secundum* is an erect branching coral that is highly susceptible to fragmentation and dislodgement by physical impact. This species is expected to be highly susceptible to degradation caused by physical contact with bottom trawl gear.

Life-history traits: Knowledge of the life history traits of the component species, *C. secundum*, has primarily originated from studies conducted in the Hawaiian Archipelago. Radial growth rate of the colony base is slow and was estimated at 170 microns/year (Roark et al. 2006). Age at maturity is late, occurring at 12-13 years (Grigg 1993) and is likely to be higher based on the new growth data of Roark et al. (2006). Estimates of natural mortality and recruitment rates based on a study at the Makapuu Bed site (Grigg 1988, 1993) were low (~6-8% in the bed site population) and the population appears to be recruitment limited. Recent radiocarbon measurements of age and growth rates indicate that *C. secundum* are long-lived reaching ages of 67 to 71 years old for a colony up to 28 cm tall (Roark et al. 2006). The mean density of *C. secundum* on the Makapuu Bed was measured at 0.3 colonies/m^2 and abundance was estimated at 120,000 colonies over a bed area of 4.3 km^2 (Grigg 2002).

Structural complexity: The erect morphology of *C. secundum* provides structural complexity to the benthos supporting a number of associated anemones and deep-water corals (various octocorals and antipatharians) and attached commensal fauna including crinoids, ophiuroids, and polychaetes (Parrish and Baco 2008).

Identification of Potential VME Sites

No baseline comparison involving photographic or dredge surveys conducted prior to or during the early portion of the bottom trawl fishery was available for comparison. The only data available pertaining to potential VMEs prior to the inception of the bottom trawl fishery come from information available for the shallow coral drag fishery that targeted pink coral, *C. secundum*, during the period from 1965 to the mid-1970s. Information on other corals and associated invertebrates captured in the early coral drag fishery is lacking. The only direct evidence for existing *C. secundum* colonies comes from recent ROV video observations some 40 years after the inception of the bottom trawl fishery. Colonies of *C. secundum* were only found at the southeastern-most portion of Koko Seamount. The occurrence of *C. secundum* at 425 m depth at Koko coincides with the reported seamount grounds (Koko and the Milwaukee Seamounts) and depth range (400-450 m) targeted in the *C. secundum* coral drag fishery. Furthermore, the observed locations of these colonies coincide with the area in which the second highest rates of trawl hang-ups were reported by Russia (Anon. 2008e) and the only recorded position of incidental coral caught during Russian trawl surveys at Koko (Anon. 2008d).

Based on the limited available information, *Corallium secundum* is considered to be both a primary component species and indicator species of a potential deep-water coral based VME which may still persist among protected benthic habitats (refugia) at depths of 400-450m. The most likely locations of any existing VMEs would be in the original coral drag fishing grounds (Koko and the Milwaukee Seamounts) and in areas associated with numerous trawl gear hang-ups. These potential refugia would likely have been avoided by bottom trawl fishing captains after initially encountered during the early period of the fishery. These potential VME sites may coincide with the three areas identified in the Russian data as having the highest incidences of trawl hang-ups. The highest priority site coincides with the extreme southeastern summit-slope area of Koko; defined as the area of Koko below 35° 05' N latitude. Yanagimoto (2008b) shows positions for two other sites on Koko Seamount (a northwest pinnacle beyond the main summit and the eastern edge of summit) where coral drag vessels operated in 1977. These areas were not specifically surveyed by drop-camera or ROV operations so the presence of any remaining *Corallium* at these two sites remains unknown.

B. Bottom gillnet fishery

Bathymetry: See text in the above "Bathymetry" section for the bottom trawl fishery. Aside from the summit, this fishery is also conducted over the seamount slopes although the depth range of the fishery is not known.

Incidental Coral Captures: No data were available for analysis.

Documented Gear Hang-ups: No data were available for analysis. The very nature of this gear typically results in hang-ups with the bottom and gear damage. Unlike bottom trawl gear, gillnets are a passive-type fishing gear and much more expendable. The nature of this gear is such that damage from hang-ups with the bottom is much more frequent, particularly on smaller obstacles, and thus recorded incidents of hang-ups would be much less informative than those of bottom trawls.

Fishing Corridors: No data were available for analysis.

Remote Observations of Seamount Benthos: See "Remote Observations of Seamount Benthos" in section on "Bottom Trawl Fishery" above. However, drop-camera photography and ROV video recorded observations did not appreciably cover the deeper slope areas. The bottom gillnet fishery is thought to be conducted primarily below the summit level along the upper slopes and coverage in this region was limited.

Vulnerable Characteristics of a *C. secundum* Associated VME

. See "Vulnerable Characteristics of a *C. secundum* Associated VME" in the section on "Bottom Trawl Fishery" above.

A second species of precious coral, *Corallium* sp. nov., currently undescribed, became the target of a new coral drag fishery after the *C. secundum* fishery ceased in the mid-1970s. This second coral fishery began in 1978 at the Emperor Seamounts. This species was targeted at depths of 1,000 to 1,500 m; presumably along the deeper flanks of the Emperor Seamounts. The bottom gillnet fishery is not thought to operate at depths that would overlap with *Corallium* sp. nov., but this needs to be verified.

Identification of Potential VME Sites

See “Identification of Potential VME Sites” in the section on “Bottom Trawl Fishery” above.

There are currently no data regarding potential locations and the spatial extent of any *Corallium* sp. nov. associated VMEs on the seamounts.

C. Bottom longline fishery

Bathymetry: See text in the above “Bathymetry” section for the bottom trawl fishery. Aside from the summit, this fishery is also conducted over the seamount slopes although the depth range of the fishery is not known.

Incidental Coral Captures: No data were available for analysis.

Documented Gear Hang-ups: No data were available for analysis. Longline hooks and line can foul with the bottom. Unlike bottom trawl gear, bottom longlines are a passive type fishing gear and much more expendable.

Fishing Corridors: No data were available for analysis.

Remote Observations of Seamount Benthos: See “Remote Observations of Seamount Benthos” in section on “Bottom Trawl Fishery” above. However, drop-camera photography and ROV video recorded observations did not appreciably cover the deeper slope areas. Since the bottom longline fishery is thought to be conducted primarily below the summit level along the upper slopes, there has been very little coverage in this region.

Vulnerable Characteristics of a *C. secundum* Associated VME

. See “Vulnerable Characteristics of a *C. secundum* Associated VME” in the section on “Bottom Trawl Fishery” above.

A second species of precious coral, *Corallium* sp. nov., which has never been described, became the target of a new coral drag fishery after the *C. secundum* fishery ceased in the mid-1970s. This new coral fishery began in 1978 at the Emperor Seamounts. This species was targeted at depths of 1,000 to 1,500 m, presumably along the deeper flanks of the Emperor Seamounts. The bottom longline fishery is not thought to operate at depths that would overlap with *Corallium* sp. nov., but this needs to be verified.

Identification of Potential VME Sites

See “Identification of Potential VME Sites” in the section on “Bottom Trawl Fishery” above.

There are currently no data regarding potential locations and the spatial extent of any *Corallium* sp. nov. associated VMEs on the seamounts.

D. Pot fishery

Bathymetry: See text in the above "Bathymetry" section for the bottom trawl fishery. Aside from the summit, the pot fishery is also conducted over the seamount slopes although the depth range of the fishery is not known.

Incidental Coral Captures: No data were available for analysis.

Documented Gear Hang-ups: No data were available for analysis. Pots and line can foul with the bottom. Unlike bottom trawl gear, pots are a passive type fishing gear and the gear more expendable.

Fishing Corridors: No data were available for analysis.

Remote Observations of Seamount Benthos: See "Remote Observations of Seamount Benthos" in section on "Bottom Trawl Fishery" above. However, drop-camera photography and ROV video recorded observations did not appreciably cover the deeper slope areas. Since the pot fishery is thought to be conducted primarily below the summit level along the upper slopes, there has been very little coverage in this region.

Vulnerable Characteristics of a *C. secundum* Associated VME

. See "Vulnerable Characteristics of a *C. secundum* Associated VME" in the section on "Bottom Trawl Fishery" above.

A second species of precious coral, *Corallium* sp. nov. which has never been described, became the target of a new coral drag fishery after the *C. secundum* fishery ceased by the mid-1970s. This second coral fishery began in 1978 at the Emperor Seamounts. This species was targeted at depths of 1,000 to 1,500 m presumably along the deeper flanks of the Emperor Seamounts. The pot fishery is not thought to operate at depths that would overlap with *Corallium* sp. nov., but this needs to be verified.

Identification of Potential VME Sites

See "Identification of Potential VME Sites" in the section on "Bottom Trawl Fishery" above.

There are currently no data regarding potential locations and the spatial extent of any *Corallium* sp. nov. associated VMEs on the seamounts.

E. Coral drag fishery

The coral drag fisheries for *C. secundum* and *Corallium* sp. nov. are unique in being the only seamount fisheries in which the target species and their associated habitat are potential VMEs.

Bathymetry: See text in the above “Bathymetry” section for the bottom trawl fishery.

Incidental Coral Captures: Not applicable.

Documented Gear Hang-ups: Not applicable.

Fishing Corridors: No data were available for analysis.

Remote Observations of Seamount Benthos: See “Remote Observations of Seamount Benthos” in section on “Bottom Trawl Fishery” above.

Drop-camera photography and ROV video recorded observations did not cover the deep slope habitat of *Corallium* sp. nov. at 1,000-1,500 m depths.

Vulnerable Characteristics of a *C. secundum* Associated VME: See “Vulnerable Characteristics of a *C. secundum* Associated VME” in the section on “Bottom Trawl Fishery” above.

The deeper species of precious coral, *Corallium* sp. nov., is likely to have the same characteristics as *C. secundum*, which make it a potential candidate VME indicator species. However, the life history and ecology of this species has yet to be studied.

Identification of Potential VME Sites

For *C. secundum*, see “Identification of Potential VME Sites” in the section on “Bottom Trawl Fishery” above.

There are currently no data regarding potential locations and the spatial extent of any *Corallium* sp. nov. associated VMEs on the seamounts.

(3) Identification of uncertainties in data and methods, and measures to overcome such uncertainties

A. Bottom trawl fishery

Evaluation of the available seamount bathymetry is limited by the spatial resolution of the data. Resolution of summit features on the order of meters or several tens of meters high were likely not to have been incorporated into these bathymetry charts. Depression type features of similar scale on the summits are also likely not to have been resolved. Future efforts to conduct high-resolution bathymetry focusing on the summit and upper slope areas would help. An important priority of such a survey would be to first map the three areas identified previously as potential VME habitat.

The reluctance of the fishing industry to release data on trawling corridors or pathways utilized at each seamount has impaired the ability of the SWG to recognize and designate summit areas of low probability as potential VME habitat. The SWG urges industry to reconsider its position and release this information to the SWG in the near future.

Efforts to remotely visualize the seamount summit benthos from drop-camera photography and ROV video observations have been informative but will require much more survey effort, particularly directed at prioritized sites. If the fishing industry makes available to the SWG its locations of its trawling corridors, comparative surveys could be conducted between trawl pathways and adjacent protected relief areas (presumed refugia). These comparisons would allow a more objective elevation of what constitutes deep-water coral refugia (in terms of substrate characteristics) and the composition of species associated with such refugia.

B. Bottom gillnet fishery

See text above under “Identification of uncertainties in data and methods, and measures to overcome such uncertainties” in the section on “Bottom Trawl Fishery” above.

In regard to the potential deeper-water (1,000-1,500 depth) *Corallium* sp. nov. associated VME, additional fishery data are needed to verify that the bottom gillnet fishery does not fish into the 1,000-1,500 m depth zone and potentially overlap into *Corallium* sp. nov. habitat. Further remote observational surveys of the summits and the deeper slope zones at 1,000-1,500 m are needed.

C. Bottom longline fishery

See text above under “ Identification of uncertainties in data and methods, and measures to overcome such uncertainties” in the section on “Bottom Trawl Fishery” above.

In regard to the potential deeper-water (1,000-1,500 depth) *Corallium* sp. nov. associated VME, additional fishery data are needed to verify that the bottom longline fishery does not fish into the 1,000-1,500 m depth zone and potentially overlap into *Corallium* sp. nov. habitat. Further remote observational surveys of the summits and the deeper slope zones at 1,000-1,500 m are needed.

D. Pot fishery

See text above under “Identification of uncertainties in data and methods, and measures to overcome such uncertainties” in the section on “Bottom Trawl Fishery” above.

In regard to the potential deeper-water (1,000-1,500 depth) *Corallium* sp. nov. associated VME, additional fishery data are needed to verify that the pot fishery does not fish into the 1,000-1,500 m depth zone and potentially overlap into *Corallium* sp. nov. habitat. Further remote observational surveys of the summits and the deeper slope zones at 1,000-1,500 m are needed.

E. Coral drag fishery

A concerted effort is needed to recover all available information from both the Japan and Taiwan fisheries for *C. secundum* and *Corallium* sp .nov. The lack of basic information regarding fishing location and depths indicates that a significant amount of time will need to be invested to try to recover these data (if available) before an analysis of the spatial distribution of these species can be undertaken.

11. Impact assessment of fishing activities on VMEs or marine species including cumulative impacts, and identification of SAIs on VMEs or marine species, as detailed in Section 5 above, Assessment of SAIs on VMEs or marine species

A. Bottom trawl fishery

Assessment of SAIs on VMEs

The intensity or severity of the impact at the specific site being affected: We currently lack detailed positional data for the bottom trawl fishery in order to evaluate whether past and recent trawl hauls were conducted through the three sites identified as potential *C. secundum* associated VMEs. We therefore cannot assess the intensity or severity of impact on these sites. However, there is also the issue of cumulative impacts that needs to be considered. The shallower coral drag fishery is surmised to have had a significant impact on *C. secundum* colonies inhabiting the 400-450 m depth habitats over the summits and upper slopes. By significant, we mean in this instance that the shallow coral drag fishery targeting *C. secundum* colonies was no longer economically viable by the mid-1970s. What this means in terms of the proportion of virgin biomass remaining is unclear. The shallow coral drag fishery is thought to have been conducted over all types of bottom terrain because of the simplicity and expendable nature of the fishing gear. Thus, the cumulative impacts of this fishery and the subsequent bottom trawl fishery would be mostly on the exposed (relatively unobstructed) bottom areas. Whether these exposed areas contain colonies of *C. secundum* remains unknown.

The spatial extent of the impact relative to the availability of the habitat type affected: We currently lack detailed positional data that would allow for a review of the spatial distribution of trawling effort over each seamount. Industry has not yet released details on trawling corridors or pathways at particular seamounts. Furthermore, our knowledge of the habitat type associated with potential *C. secundum* associated VMEs is rudimentary at best and there is substantial uncertainty as to the availability of this presumed habitat type. We do suspect that early in the fishery, the entire summit area of each seamount was susceptible to bottom trawling. Over time, sites deemed untrawlable due to gear hang-ups and net damage were recorded and later avoided. These sites are thought to be potential refugia for *C. secundum* associated VMEs

The sensitivity/vulnerability of the ecosystem to the impact: *C. secundum* and associated benthic fauna are sessile or of restricted mobility, are highly fragile, and have no defense from the direct mechanical impacts of bottom trawl gear.

The ability of an ecosystem to recover from harm, and the rate of such recovery: In the previous section under "Life-history traits", *C. secundum* is characterized as a *K*-selected species with slow growth, high longevity, late maturation, low natural mortality, and low recruitment. The generation time for *C. secundum* is estimated at 25 years based on the studies of Grigg (1988, 1993), however, this estimate of generation time may have been underestimated given the slower grow rates recently reported by Roark (2006). In areas exposed to trawling, reoccurring impacts to the substrate by the trawl gear would likely prevent re-establishment of pre-existing colonies of exposed *C. secundum*. The population of *C. secundum* is thought to be recruitment limited. Any potential existing refugia containing *C. secundum* would be available for potential re-seeding, but the required spatial extent and number of refugia needed to supply a sufficient number of recruits is unknown.

The extent to which ecosystem functions may be altered by the impact: Current information is lacking regarding the minimum spatial extent and density of *C. secundum* and associated deep-water coral beds that would be sufficient to continue ecosystem function. Furthermore, we cannot yet determine the threshold below which recruitment limitations for *C. secundum* and associated fauna begin to occur due to sub-optimal spawning biomass.

The timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages: The generation time of *C. secundum* has been estimated at 25 years; reproductive maturity occurs at 12-13 years. However, this estimate of generation time and reproductive maturity may have been underestimated given the slower grow rates recently reported by Roark (2006). Potential habitat overlap into trawling areas would expose these habitats to sustained trawl impacts throughout the year. Habitats in areas protected from cumulative long-term trawling (refugia) are required for *C. secundum* to potentially re-establish a viable population.

Assessment of SAIs on Target Species

The immediate risks to both target species (armorhead and alfonsino) include 1) the typically occurrence of these species to form schools, presumably even at low abundance; 2) the efficiency with which modern trawlers can electronically detect, then target and capture these schools; 3) the continued pursuit of this fishery after the crash of the historic fishery in 1977, despite low annual catches during most years; 4) the increasing trend in fishing effort of the Japan trawl fleet from 1,825 nominal trawling hours in 1990 to 10,107 nominal hours in 2007; 5) the notion that the next recruitment pulse of armorhead can be safely "fished up" at sustainable levels; and 6) the high trawl selectivity for juvenile stage alfonsino.

Unlike most low-productivity teleosts harvested from seamounts, armorhead possesses life history traits in-between the classic *r*- and *k*-selected species, with intermediate values for longevity (6-7 years), age at maturity (3-4 years), and age at maximum length (2-3 years). Fifteen years after the armorhead fishery crashed in 1977, a high recruitment pulse occurred across the seamounts in 1992, followed by a similar recruitment pulse 12 years later in 2004. In the aftermath of the 1992 recruitment, however, fishing effort increased and the recruiting biomass was fished down after two years. While armorhead catches remained low afterwards, effort continued at a high level during the intervening years prior to the next recruitment pulse in 2004. The same pattern is being repeated after the 2004 recruitment pulse. As before, the trawl fishery has continued to expend high levels of effort well after catches of armorhead have declined. There is a potential danger that the sustained high levels of effort may cause recruitment overfishing of armorhead by driving the spawning stock to increasingly lower levels of abundance. This cycle of increasing effort may not be sustainable and likely impedes recovery of the seamount populations in the near term. These episodic recruitments are the only opportunity for the stock to re-build out of the stable low population levels that have prevailed since the late 1970s. There is currently no armorhead stock assessment and no re-building plan for armorhead at the SE-NHR seamounts

Alfonsino tends to be more benthopelagic than armorhead, with juveniles forming schools in the water column above the seamounts and close to the summits. Adults typically inhabit deeper depths where they are not exposed to the trawl fishery. The bottom trawl fishery selectively harvests juveniles (16-22 cm FL) well before the size at first maturity (28-32 cm FL). The more highly prized larger alfonsino are fished deeper along the seamount slopes using bottom gillnet and bottom longline gear. Based on the alfonsino stock assessment reported in Nishimura and Yatsu (2008), Japan has proposed a reduction in *F* of 24% for alfonsino in the bottom trawl fishery.

B. Bottom gillnet fishery

Assessment of SAIs on VMEs

The intensity or severity of the impact at the specific site being affected: No information is available to evaluate the severity of the impact of this fishery. Generally, bottom gillnets have the potential to become entangled with deep-water corals and fragmenting and/or dislodging corals upon gear haulback.

The spatial extent of the impact relative to the availability of the habitat type affected: There is no available information on spatial distribution and depth range of effort in this fishery, therefore the spatial extent of impact cannot be evaluated.

The sensitivity/vulnerability of the ecosystem to the impact: See text in same section under "Bottom Trawl Fishery"

The ability of an ecosystem to recover from harm, and the rate of such recovery: See text in same section under "Bottom Trawl Fishery"

The extent to which ecosystem functions may be altered by the impact: See text in same section under "Bottom Trawl Fishery"

The timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages: See text in same section under "Bottom Trawl Fishery"

Assessment of SAIs on Target Species

A lack of detailed fishery statistics over the entire history of this fishery precludes our ability to make an assessment at this time.

C. Bottom longline fishery

Assessment of SAIs on VMEs

The intensity or severity of the impact at the specific site being affected: No information is available to evaluate the severity of the impact of this fishery. Generally, bottom longlines are thought to have less impact than bottom trawl and bottom gillnet gear.

The spatial extent of the impact relative to the availability of the habitat type affected: There is no available information on spatial distribution and depth range of effort in this fishery, therefore the spatial extent of impact cannot be evaluated.

The sensitivity/vulnerability of the ecosystem to the impact: See text in same section under "Bottom Trawl Fishery"

The ability of an ecosystem to recover from harm, and the rate of such recovery: See text in same section under "Bottom Trawl Fishery"

The extent to which ecosystem functions may be altered by the impact: See text in same section under "Bottom Trawl Fishery"

The timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages: See text in same section under "Bottom Trawl Fishery"

Assessment of SAIs on Target Species

A lack of detailed fishery statistics over the past and recent history of this fishery precludes our ability to make an assessment at this time.

D. Pot fishery

Assessment of SAIs on VMEs

The intensity or severity of the impact at the specific site being affected: No information is available to evaluate the severity of the impact of this fishery. Generally, pots are thought to have less impact than bottom trawl and bottom gillnet gear.

The spatial extent of the impact relative to the availability of the habitat type affected: There is no available information on spatial distribution and depth range of effort in this fishery, therefore the spatial extent of impact cannot be evaluated.

The sensitivity/vulnerability of the ecosystem to the impact: See text in same section under “Bottom Trawl Fishery”

The ability of an ecosystem to recover from harm, and the rate of such recovery: See text in same section under “Bottom Trawl Fishery”

The extent to which ecosystem functions may be altered by the impact: See text in same section under “Bottom Trawl Fishery”

The timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages: See text in same section under “Bottom Trawl Fishery”

Assessment of SAIs on Target Species

A lack of detailed fishery statistics over the entire history of this fishery precludes our ability to make an assessment at this time.

E. Coral drag fishery

Assessment of SAIs on VMEs

The intensity or severity of the impact at the specific site being affected: See same section under “Bottom trawl fishery” for *C. secundum* fishery.

The *Corallium* sp. nov. targeted coral drag fishery by Japan and Taiwan is likely to have had the greatest impact compared to any of the other on-going seamount fisheries. Furthermore, coral dragging of this resource is suspected to be continuing (Anon. 2008) and is likely further impacting remaining coral beds inhabited by Corralium sp. nov. and associated fauna of *Corallium* sp. nov. The lack of known locations of this fishery continues to hinder efforts to be able to assess the intensity or severity of these continuing impacts.

The spatial extent of the impact relative to the availability of the habitat type affected: See same section under "Bottom trawl fishery" for *C. secundum* fishery.

For the *Corallium* sp.nov. targeted coral drag fishery, no information is currently available.

The sensitivity/vulnerability of the ecosystem to the impact: See same section under "Bottom trawl fishery" for *C. secundum* fishery.

The deeper species of precious coral, *Corallium* sp. nov. and its associated fauna are likely to have the same vulnerability as *C. secundum*, and are likely to be just as vulnerable to ecosystem impacts caused by coral drag gear.

The ability of an ecosystem to recover from harm, and the rate of such recovery: See same section under "Bottom trawl fishery" for *C. secundum* fishery.

The deeper species of precious coral, *Corallium* sp. nov. and its associated fauna are likely to have the same slow rate of recovery and lack of resiliency as *C. secundum.* However, the basic lack of biological information on this coral and its associated fauna limits a more definitive conclusion at this time.

The extent to which ecosystem functions may be altered by the impact: See same section under "Bottom trawl fishery" for *C. secundum* fishery.

There is currently no information regarding this topic with respect to *Corallium* sp. nov. and its associated fauna; no determination can be made at this time.

The timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages: See same section under "Bottom trawl fishery" for *C. secundum* fishery.

There is currently no information regarding this topic with respect to *Corallium* sp. nov. and its associated fauna; no determination can be made at this time.

12. Other points to be addressed

A. Bottom trawl fishery

In 1977, the Hancock Seamounts came under U.S. jurisdiction with the adoption of the 200-mile EEZ. From 1978-1984, a limited access foreign bottom trawl fishery was permitted at the Hancocks. Annual total catches were set at 2,000 mt and 11 fishing trips were conducted by Japan trawlers (Uchida and Tagami 1984). Annual catches consistently fell short of the 2,000 mt annual allocation and catches continued to decline into the early 1980s. The fishery ceased in 1985, and since 1986 all fishing for seamount groundfish has been prohibited on the three summits that constitute the Hancock Seamounts. The fishing closure at the Hancock Seamounts represents the only management action that this fishery has received. The Hancock Seamounts, however, amount to only about 5% of the available trawl grounds among the SE-NHR seamount trawl grounds. However, along with the other smaller sized seamounts (Colahan and C-H) of the northern Hawaiian Ridge, the Hancock Seamounts have historically produced high catches of armorhead (although the available effort data are limited). The Japan trawl fishery obtained high catches by pulse-fishing these smaller seamounts. Pulse-fishing was characterized by 1-2 consecutive days of trawling that ceased after catch rates dropped off; the seamount was then abandoned and allowed to "recover". This fishing tactic was very different compared to fishing practices on the large summits of the Emperor Seamounts, where sustained fishing effort was exerted over these much more expansive fishing grounds. Aggregations of armorhead over the smaller seamounts would appear to be more susceptible to harvest than at the larger Emperor Seamounts. It remains an open question whether smaller seamounts (Colahan and C-H) are capable of supporting a sustainable bottom trawl fishery. Given the uncertainty around this issue and the small amount of fishing effort currently expended at the smaller seamounts (Colahan and C-H), a strategy of temporarily closing small seamounts while leaving large seamounts open provides a sensible balance between sustaining the bottom trawl fishery and conserving a portion of the resource for stock rebuilding.

B. Bottom gillnet fishery

Available catch and effort statistics for the bottom gillnet fishery are currently inadequate to conduct a stock assessment, assess the sustainability of this fishery, or evaluate impact of this fishery on potential VMEs.

C. Bottom longline fishery

Available catch and effort statistics for the bottom longline fishery are currently inadequate to conduct a stock assessment, assess the sustainability of this fishery, or evaluate the impact of this fishery on potential VMEs.

D. Pot fishery

Available catch and effort statistics for the pot fishery are currently inadequate to econduct a stock assessment, assess the sustainability of this fishery, or evaluate the impact of this fishery on potential VMEs.

E. Coral drag fishery

The destructive nature of the coral drag fishery on both *C. secundum* and its associated fauna and *Corallium* sp. nov. and its associated fauna are highly likely to have produced significant adverse impacts (SAIs) in both fisheries. The *C. secundum* fishery apparently ended in the mid-1970s so further SAIs by the coral drag fishery on this potential VME have ceased. However, recent evidence of continued coral fishing activity presumably on *Corallium* sp. nov., indicates the potential for further destructive impacts (Anon. 2008). It is important to determine if the *Corallium* sp. nov. fishery has indeed continued, and if so, the extent to which new developments in materials, dragging techniques, and shipboard electronics have increased the efficiency of this fishery.

13. Conclusion (whether to continue or start fishing with what measures, or stop fishing)

A. Bottom trawl fishery

If bottom trawl fishing is to continue on a sustainable basis, it will require adopting a precautionary approach to achieve a pair of management objectives:

1) Protect potential *Corallium* associated VMEs

2) Reduce fishing mortality, *F,* on armorhead and alfonsino and protect portions of the stocks for rebuilding.

The following interim conservation measures are designed to achieve these objectives.

Additional Proposed Interim Measures for Potential VME Sites:

1) Adoption of a zonal closure encompassing the highest priority area identified as habitat for an indicator species, *Corallium,* of a seamount VME. This area will be temporarily closed (for a renewable 6-year period) to bottom trawling and all other bottom fisheries. The proposed zonal closure encompasses the extreme southeastern summit-slope area of Koko Seamount below 35° 05' N latitude.

2) Develop and execute a research plan to survey the proposed zonal closure area at Koko Seamount (see above interim measure #1). Surveys would include multi-beam bathymetry and side-scan sonar mapping and imaging of the benthos via drop-camera, ROV, and/or submersible operations. Results of the surveys would be reviewed by the SWG to determine whether the zonal closure should end, be renewed for another 6-year period, or made permanent.

Additional Interim Measures for Marine Species:

3) Adopt the proposed 24% reduction in *F* for armorhead and alfonsino stocks targeted in the bottom trawl fishery, through an equivalent reduction in nominal effort, as indicated in the results of the most recent alfonsino stock assessment (Nishimura and Yatsu 2008).

4) Adopt an annual cessation of the bottom trawl fishing at all seamounts during the peak months of the armorhead spawning season. Exact months are to be determined.

5) Adopt Colahan Seamount as marine stock rebuilding area (SRA) that would be temporarily closed to bottom trawling and all other bottom fishing operations for a period of up to 6 years. This temporary closure could also be rotated among other seamounts.

This closure would coincide with the closure currently in effect at the nearby Hancock Seamounts within the U.S. EEZ. This action would expand the available seamount fishing grounds under protection from all fishing pressure. The intent of this action is to help rebuild the spawning stocks of both armorhead and alfonsino. The proposed Colahan Seamount SRA would be subject to review by the SWG within a 6-year period in order to decide whether to renew, modify, or terminate this SRA based on conclusions reached under proposed interim measure #6 below.

6) As soon as possible prior to the end of the 6-year temporary SRA closure at Colahan Seamount, spatially structured stock assessments for armorhead and alfonsino, based on the best available science, will be completed and made available for consideration and deliberation. The SWG would develop and evaluate the assessments and reach agreement on whether to continue the SRA closure for Colahan Seamount, to rotate and/or expand SRA closures to other seamounts, or to remove the closure and re-open the area to fishing.

B. Bottom gillnet fishery

If bottom gillnet fishing is to continue, it is contingent on the addition of the following interim measure:

<u>Additional Interim Measures for Potential VME Sites</u>:

None

<u>Additional Interim Measures for Marine Species:</u>

7) Require that more detailed data on the bottom gillnet fishery be collected by all Participating States to include records of effort in tans and soak time; gear specifications such as mesh size and net height; depth range for each set; start and end positions; fishing depth off-bottom; identity and quantity of targeted species caught per set; identity and quantity of incidental species takes, including deep-water corals, per set; and length data on target species caught.

C. Bottom longline fishery

If bottom longline fishing is to continue, it is contingent on the addition of the following interim measure:

<u>Additional Interim Measures for Potential VME Sites</u>:

None

<u>Additional Interim Measures for Marine Species:</u>

8) Require that more detailed data on the bottom longline fishery be collected by all Participating States to include records of effort in hooks per set and soak time; gear specifications such as hook size; depth range for each set; start and end positions; identity and quantity of targeted species caught per set; identity and quantity of incidental species takes, including deep-water corals, per set; and length data on target species caught.

D. Pot fishery

If pot fishing is to continue, it is contingent on the addition of the following interim measure:

Additional Interim Measures for Potential VME Sites:

None

Additional Interim Measures for Marine Species:

9) Requirement that more detailed data on the pot fishery be collected by all Participating States to include records of effort in pots per set and soak time; gear specifications such as pot type and size; depth range for each set; start and end positions; identity and quantity of targeted species caught per set; identity and quantity of incidental species takes, including deep-water corals, per set; and length data on target species caught.

E. Coral drag fishery

Additional Interim Measures for Potential VME Sites:

10). Prioritize efforts of the SWG to establish contacts with Taiwan fisheries officials and industry to collect information on the location of past and present deep-water coral harvesting within the existing footprint of the Emperor-Northern Hawaiian Ridge seamounts.

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