Chapter 3 Affected Environment

3.1 Introduction

Chapter 3 describes the existing environment and resources potentially affected by the management alternatives described in Chapter 2. The information presented here builds upon the information presented in the 2001 Pelagics FEIS (NMFS 2001), and the 2004 Pelagics SEIS (WPRFMC 2004b), supplemented by recent BiOps prepared by NMFS and the USFWS, Council action documents and the Biological Assessment prepared by the HLA and WPRFMC (2004). The information on seabird interactions in the Hawaii-based longline fishery incorporates the most recent available information from the NMFS observer program. The information about the Japanese squid jigging fishery was obtained from a Council-funded project to translate and summarize recent Japanese reports and scientific papers (Bower 2004).

3.2 The Western and Central Pacific Ocean Pelagic Environment

3.2.1 Oceanography

The descriptions of the physical and biological pelagic environment of the WCPO contained in the 2001 FEIS (NMFS 2001a) are complete and accurate accounts of that ecosystem and those descriptions are incorporated by reference here. Since the publication of the 2001 FEIS there has been an increasing awareness within the scientific community of the occurrence and importance of long-term (decadal-scale) oceanographic cycles (e.g., Chavez et al. 2003, SCTB 15) and of their relationship to cycles in the population sizes of some species of fish such as California sardines and North Atlantic bluefin tuna. These naturally occurring cycles can either mitigate or accentuate the impact of fishing mortality on target species and, in general, the scientific community is becoming more aware of the need to recognize the possibility of large natural swings in the populations of exploited species and to incorporate this dynamism into management models. Meso-scale events such as El Niño and shorter term phenomena such as cyclonic eddies near the Hawaiian Islands (PFRP Newsletter 8(1), 2003) also impact the recruitment and fishing vulnerability of PMUS.

3.2.2 Essential Fish Habitat and Habitat Areas of Particular Concern

In considering the potential impacts of a proposed action on Essential Fish Habitat (EFH), all designated EFH must be considered. EFH was defined for PMUS in the Pelagics FEIS (NMFS 2001a) and updated for all of the Council's FMPs in the SEIS (WPRFMC 2004b). An update was necessary because of the approval of the CRE FMP and designation of CRE EFH and Habitat Areas of Particular Concern (HAPC). The resulting list of EFH for all Council FMPs is shown in Table 3.2-1.

Table 3.2-1 Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC) for all Western Pacific FMPs.

FMP	EFH (Juveniles and Adults)	EFH (Eggs and Larvae)	HAPC
Pelagics	Water column down to 1,000 m	Water column down to 200 m	Water column above seamounts and banks down to 1,000 m
Bottomfish and Seamount Groundfish	Bottomfish: Water column and bottom habitat down to 400 m Seamount Groundfish: (adults only) water column and bottom from 80 to 600 m, bounded by 29°-35°N and 171°E-179°W	Bottomfish: Water column down to 400 m Seamount Groundfish: (including juveniles) epipelagic zone (0-200 m) bounded by 29°-35°N and 171°E-179°W	Bottomfish: All escarpments and slopes between 40-280 m, and three known areas of juvenile opakapaka habitat Seamount Groundfish: not identified
Precious Corals	Keahole Point, Makapuu, Kaena Point, Westpac, Brooks Bank, 180 Fathom Bank deep water precious corals (gold and red) beds and Milolii, Auau Channel and S. Kauai black coral beds	Not applicable	Makapuu, Westpac, and Brooks Bank deep water precious corals beds and the Auau Channel black coral bed
Crustaceans	Bottom habitat from shoreline to a depth of 100 m	Water column down to 150 m	All banks within the NWHI with summits less than 30 m
Coral Reef Ecosystems	Water column and benthic substrate to a depth of 100 m	Water column and benthic substrate to a depth of 100 m	All MPAs identified in FMP, all PRIAs, many specific areas of coral reef habitat (see FMP)

Source: WPRFMC 2004b. All areas are bounded by the shoreline and the outer boundary of the EEZ, unless otherwise indicated.

3.2.3 Contaminants in the Environment

Contaminants in the marine environment consist of dissolved, suspended or adsorbed chemical pollutants and solid debris. Contamination in the marine environment is not a focal point of this EIS, but Appendix A summarizes recent information regarding the nature, extent and risks associated with contaminants in the pelagic marine environment.

Laysan albatross chicks are susceptible to lead poisoning from deteriorating lead-based paint on buildings on Midway Atoll. This situation is described further in Section 3.6.1.1.3.

3.3 Pelagic Management Unit Species

A thorough review of the descriptions of the biology and status of the stocks of the PMUS as described in the 2001 FEIS (NMFS 2001a) indicates that these are comprehensive and accurate reports and that by and large, no new data have emerged since that time that would invalidate or contradict those descriptions. Similarly, the 2004 SEIS also contains concise accounts of the status of the stocks of the various PMUS. Consequently, these sections of the 2001 FEIS and 2004 SEIS are incorporated by reference here. The salmon shark (*Lamna ditropis*) has been added as a PMUS since the 2001 FEIS (NMFS 2001a) and a brief description of its biology is included in the current document. Deliberations of the SCTB in 2002 and 2003 (reported in SCTB Reports 15 and 16) indicate that generally, no major changes in stock assessments for any of the PMUS have occurred since the 2001 FEIS. There have been some changes in perspective regarding the SCTB's assessment of bigeye tuna stock status and these are noted in the current document in the appropriate section (3.3.2.1). Much of the uncertainty regarding the status of bigeye stocks concerns whether recent large catches of juvenile bigeye are having an undue influence on estimates of recruitment (which are high) and whether these high levels of recruitment are sustainable. The most recent assessments of the SCTB (SCTB 16) concerning the status of PMUS stocks have been appended in the pertinent sections.

Of particular pertinence to this EIS are results from ongoing studies of feeding habits of yellowfin and bigeye tuna in Hawaiian waters. Squid of the family Ommastrephidae are the second most common group of cephalopods found in the stomachs of these fish but cephalopods as a whole comprise less than 10% of the food taken by these tuna species (Kim Holland, Hawaii Institute of Marine Biology, pers. comm.).

Meyers and Worm (2003) claim that the abundance of top predators in the world's oceans has declined by 90%, but this conclusion has been hotly contested within the scientific community. This dialog has served to energize the field of top predator population assessment. The claims of 90% reduction are in contrast with the fact that total tuna harvest in the WCPO is at record levels and recruitment of both bigeye and skipjack tuna seems to be on an upward trend. This dialog was retrieved on February 28, 2005 from the Pelagic Fisheries Research Program web page: www.soest.hawaii.edu/PFRP/large_pelagic_predators.html.

Since the 2001 FEIS (NMFS 2001a), research has continued in Hawaii to elucidate the impacts of fish aggregating devices (FADs) and seamounts on the feeding ecology of yellowfin and bigeye tuna (SCTB 15).

3.3.1 Status of Billfish Stocks

Concise definitions of the various criteria used to analyze current levels of harvest exploitation and the status of PMUS stocks can be found in Boggs et al. (2000). Additionally, the 2003 NMFS Report to the U.S. Congress (NMFS 2004b) contains the best estimates of the current status of PMUS stocks.

3.3.1.1 Swordfish (*Xiphias gladius)*

There is considerable debate concerning the stock structure of swordfish in the Pacific. Several studies have been unable to reject the hypothesis that there is a single, Pacific Ocean-wide stock while some recent evidence indicates that there may, in fact, be some delineation of separate stocks in different parts of the Pacific Ocean (Ward and Elscot 2000). As reported by the thirteenth meeting of the SCTB, quantitative measures of the Pacific Ocean swordfish stock have yet to be completed (SCTB 2000), but trends in overall catch and size composition of animals comprising Hawaii landings indicate that the swordfish population that supports the fishery within the Council's jurisdiction appears to be capable of sustaining current levels of effort (Kleiber and Yokawa 2002). This interpretation that the swordfish population is not overfished is congruent with that of Boggs et al. (2000) and the 2003 NMFS report to Congress (NMFS 2004b) and with the most recent report (16^{th}) of the SCTB.

3.3.1.2 Black Marlin (*Makaira indica)*

The current status of the black marlin stock is unknown.

3.3.1.3 Blue Marlin (*Makaira mazara)*

Based on the assumption that there is a single, Pacific Ocean-wide stock, various recent analyses characterize the blue marlin population as stable and close to that required to support the average maximum sustainable yield (AMSY) (Boggs et al. 2000, IATTC 1999, PFRP 1999, Hinton and Nakano 1996). The most recent review by the thirteenth meeting of the SCTB (SCTB 2000) indicates that current catches are below Maximum Sustainable Yield (MSY) and recent landings in Hawaii do not show any consistent trends in either CPUE or size composition. Recent catches fall within the decadal averages (WPRFMC 1998). However, blue marlin stocks are probably closer to MSY levels than other PMUS and consequently this species should continue to receive close scrutiny (Boggs et al. 2000). Kleiber et al. (2003) used a MULTIFAN-CL analysis to conclude that, at worst, Pacific blue marlin are close to fully exploited and that this has been the case for the past 30 years, even in the face of increasing longline effort.

3.3.1.4 Striped Marlin (*Tetrapturus audax)*

Little is known about the overall status of the putative northern stock that supports the fishery in the management area, although longline CPUE has demonstrated a declining trend in recent years (WPRFMC 1999). Hinton and Bayliff (2002) presented an assessment of EPO striped marlin. The trends for the catch rates of the northeastern and northwestern areas of the central-eastern Pacific Ocean are not significantly different. The same is the case for catch rates in the EPO north and south of 10°N. These results suggest that the fish in the EPO belong to one stock. Reexamination of published genetic data by Hinton and Bayliff (2002) suggests that there is a stock located in the southwestern Pacific Ocean (Australia), but provided no clear resolution of separate stocks for the Ecuador-Hawaii-Mexico triad of sampling locations.

The current biomass of striped marlin in the EPO is apparently equal to that which would produce the average maximum sustainable yield of about 4,500 metric tons (mt) Retained catch and standardized fishing effort for striped marlin decreased in the EPO from 1990-1991 through 1998, and preliminary estimates indicate that nominal fishing effort in the area has continued to decrease during the 1999-2001 period. This may result in a continued decrease in standardized fishing effort for striped marlin, with an associated continuing increase in their biomass in the EPO.

3.3.1.5 Shortbill Spearfish (*Tetrapturus angustirostris)*

The current status of the shortbill spearfish stock is unknown.

3.3.1.6 Sailfish (*Istiophorus platypterus)*

The current status of the sailfish stock is unknown.

3.3.2 Status of Tuna Stocks

3.3.2.1 Bigeye Tuna (*Thunnus obesus)*

Genetic analyses indicate that there is a single pan-Pacific stock of bigeye tuna (Grewe and Hampton 1998). The most recent stock assessment of bigeye tuna was presented at the SCTB 's 17th meeting held in August 2004 (Hampton et al. 2004b). The assessment uses the stock assessment model and computer software known as MULTIFAN-CL (Fournier et al. 1998).The bigeye tuna model is both age (40 age-classes) and spatially (5 regions) structured and the catch, effort, size composition and tagging data used in the model are classified by 17 fisheries and quarterly time periods from 1950 through 2007. The last four to five years (depending on the fishery) constitute a projection period in which the last year's fishing effort for each fishery is assumed to continue into the future. The data used in the assessment were the same as those used in 2003, with the exception that pre-1965 Japanese longline size composition data became available recently and were used in the assessment, and an additional year of fishery data (2002 for longline, 2002 for Philippines and Indonesia, 2003 for purse seine) was included. Recruitment showed an increasing trend from the 1970s on, while biomass declined through the 1960s and 1970s after which it was relatively stable or declining slightly. The fisheries are estimated to have reduced overall biomass to around 40% of unfished levels by 2003, with impacts more severe in the equatorial region of the WCPO, particularly in the west. Yield analyses suggest that recent average fishing mortality-at-age is approximately equivalent to the fishing mortality at MSY, although the probability distribution of $F_{MSY}/F_{Current}$ is skewed such that the probability of the ratio being greater than 1.0 (i.e., overfishing is occurring) is 0.67−0.77, depending on assumptions regarding the stock-recruitment steepness coefficient. On the other hand, the current level of biomass is estimated to be high, around 1.7−2.3 times the equilibrium biomass expected at MSY. Current biomass has remained high because of above average recruitment since about 1990. The analysis in which catchability in the main longline fisheries was allowed to vary over time produced more pessimistic results than the constant catchability models − absolute levels of recruitment and biomass are lower (although the trends are similar), fishing mortality and fishery impact are higher, and recent average levels of fishing mortality are estimated to substantially exceed MSY levels ($F_{Current}/F_{MSY}$ = 1.7). Current biomass is estimated to exceed the MSY level ($B_{Current}/B_{MSY}$ = 1.25) but is at a lower level than estimated by the constant longline catchability models. On the basis of all of the results presented in the assessment, it was concluded that maintenance of current levels of fishing mortality carries a high risk of overfishing. Should recruitment fall to average levels, current catch levels would result in stock reductions to near and possibly below MSY-based reference points. Reduction of juvenile fishing mortality in the equatorial regions would have major benefits for both the bigeye tuna stock and the longline fishery.

3.3.2.2 Albacore (*Thunnus alalunga)*

Albacore stocks appear to be in good condition and are experiencing moderate levels of exploitation. The most recent stock assessment of the southern albacore stock was presented at the SCTB 's 16^{th} meeting held in June 2003 by Labelle and Hampton (2003), using the MULTIFAN-CL stock assessment model. They concluded that current biomass is estimated to be about half of the maximum estimated levels and about 60% of the estimated equilibrium unexploited biomass. The impact of the fisheries on total biomass is estimated to have increased over time, but is likely to be low, a reduction of about 3% from unexploited conditions. The model results continue to indicate that recent catches are less than the MSY, aggregate fishing mortality is less than F_{MSY} and the adult biomass is greater than B_{MSY}.

North Pacific Ocean albacore stocks are assessed at one to two year intervals by the North Pacific Albacore Workshop, comprising the U.S., Japan, Canada and Taiwan. According to the latest assessment (NPALW 2000), the albacore stock is healthy and not being overfished (F/F_{msy} = 0.5-0.9; B/B_{msy} = 1.10 > Minimum Stock Size Threshold), even though present catches are in the estimated MSY and OY range. Stock and catches are both increasing due to the continuation of a high productivity oceanic regime. More recently, the Fourth Meeting of the Interim Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean reviewed the status of North Pacific albacore (ISC 2004). ISC reviewed the methods and results generated from length-based, age-structured stock assessments, including virtual population analysis (VPA) based on ADAPT models and preliminary, fully-integrated statistical models based on MULTIFAN-CL software. Results from the ADAPT models indicated that annual estimates of biomass over the last decade were relatively 'high' (i.e., compared with estimated biomass in the mid 1970s through the late 1980s); however, very recent population estimates suggest a 'leveling off' of the stock at large. Estimated recruitment is quite variable and suggests two oceanographic regimes: a low 'productivity' period from 1975 to 1989; and a higher 'productivity' period since that time. Based on recent and forecasted catch and recruitment levels, fishing mortality is relatively high, either in excess of that required to produce MSY assuming a low productivity scenario or roughly at the MSY level assuming a high productivity scenario and proxy biological reference points for this species.

3.3.2.3 Yellowfin Tuna (*Thunnus albacares)*

Some genetic analyses suggest that there may be several semi-independent yellowfin stocks in the Pacific Ocean including possible eastern and western stocks, which may diverge around 150°W (Grewe and Hampton 1998, Itano 2000). On the other hand, tagging studies have shown individual animals are capable of large east - west movements that would suggest considerable pan-Pacific mixing of the stock. In fact, earlier mitochondrial deoxyribonucleic acid (mtDNA) analysis failed to distinguish the presence of geographically distinct populations (Scoles and Graves 1993, Ward et al. 1994).

The most recent stock assessment of western Pacific yellowfin was presented by Hampton et al. (2004a) at the SCTB 's 17th meeting held in August 2004, employing the MULTIFAN-CL model. The yellowfin tuna model was age (28 age-classes) and spatially (5 regions) structured and the catch, effort, size composition and tagging data used in the model were classified by 17 fisheries and quarterly time periods from 1950 through 2007. The last four to five years (depending on the fishery) constitute a projection period in which the last year's fishing effort for each fishery is assumed to continue into the future. Five independent analyses were conducted to test the impact of using different methods of standardizing fishing effort in the main longline fisheries, using estimated or assumed values of natural mortality-at-age, and assuming fixed or variable catchability for the main longline fisheries. The data used in the assessment were the same as those used in 2003 with the exception that an additional year of fishery data (2002 for longline, 2002 for Philippines and Indonesia, 2003 for purse seine) was included. For both sets of analyses, the current results are more pessimistic than the previous year's results with lower overall recruitment, lower equilibrium yields, higher current exploitation rates, and higher impacts due to fishing. It is also important to note that the key reference points are sensitive to initial assumptions regarding the nature of the stock-recruitment relationship. The assumed prior distribution for the steepness parameter for the stock and recruitment relationship is highly influential. Moreover, a relaxation of this assumption results in a more pessimistic assessment despite the lack of any evidence of a strong relationship between spawning stock biomass and recruitment. For future assessments, a comprehensive review of appropriate values of stock-recruitment steepness for yellowfin is required to determine appropriate values for inclusion in a range of sensitivity analyses. The main reference points from the stock assessment indicate that the long-term average biomass should remain above that capable of producing MSY, and that there is limited potential to expand long-term yields from the fishery at the current pattern of age-specific selectivity. The authors note, however, that this apparently healthy situation arises mainly from low levels of exploitation in sub-equatorial regions of the WCPO. Reduction of juvenile fishing mortality in the western equatorial region, principally the Indonesian fishery, would have major benefits for both the yellowfin tuna stock and the longline fishery.

3.3.2.4 Bluefin Tuna (*Thunnus thynnus)*

Bluefin tuna are slower to become sexually mature than other species of tuna, which makes them more vulnerable to overfishing. Variability in CPUE in the eastern Pacific Ocean seems to be due to variability in the number of fish migrating from the western Pacific Ocean to the coast of North America. This variability may be driven by changes in the forage base available in the western Pacific Ocean. Conceivably, these variations in trans-Pacific movements could effect the catch rates of Hawaii-based vessels.

The Inter-American Tropical Tuna Commission reviews the status of bluefin tuna (IATTC 2001). Catches have decreased since the late 1950s, but now appear to be increasing. Evidence for overfishing or for persisting decline in the stock, which is mainly in the western Pacific Ocean, is lacking. An MSY has not been determined, but a proxy value has been established by the Pacific Fishery Management Council (PFMC 2003) of 20,000 mt (44 million pounds), with OY 75% of that MSY.

More recently the Fourth Meeting of the ISC presented the result of a MULTIFAN-CL stock assessment of Pacific bluefin (PBF) conducted on data from 1952 to 2002 (ISC 2004). The PBF fishery has been sustained for over 50 years while taking annual catches similar to those taken in recent years. PBF biomass and spawning stock biomass (SSB) have fluctuated widely over the fifty-year history examined in the stock assessment. These fluctuations have been driven mainly by recruitment changes (without trend) over this period. Biomass appears to have recovered from a record low level in the late 1980s to a more intermediate level in recent years, largely due to better than average recruitment during the 1990s (particularly the strong 1994 year-class). Despite good recruitment, however, the SSB has generally declined since 1995 and if the estimated recent fishing mortality rates (F) continue, SSB would likely continue to decline at least over the 2003-2005 period. Recent F is greater than F_{max}, which has economic implications (too much fishing effort for the yield returned) and is also generally taken as an indicator of biological concern. In particular, the high F on young fish (ages 0-2) and older fish (ages 6+) may be cause for concern with respect to maintaining a sustainable fishery in future years. ISC recommended that there be no further increases in F for any of the fisheries taking PBF. Further, ISC also recommended that every effort should be made to reduce the uncertainty associated with the assessment results by undertaking improvements in the data collection, data analyses, and assessment models used in the PBF stock assessment process.

3.4.2.5 Skipjack Tuna (*Katsuwonus pelamis)*

It is assumed that the skipjack tuna in the Pacific Ocean belong to a single population (Shomura et al. 1994). All recent analyses indicate that harvest ratios are appropriate for maintaining current catch levels and that overall the stocks are very healthy (Boggs et al. 2000). Although local depletions and variability may occur in response to local environmental conditions and fishing practices, the overall stock is healthy and can support existing levels of fishing (PFRP 1999, SCTB 2000).

The most recent stock assessment for western Pacific stocks was presented at the SCTB's 16th meeting (Langley et al. 2003) using the MULTIFAN-CL method. The results showed that biomass trends are driven largely by recruitment, with the highest biomass estimates for the model period being those in 1998-2001. The model results suggest that the skipjack tuna population in the WCPO in recent years has been at an all-time high. The impact of fishing is predicted to have reduced biomass by 20-25%. An equilibrium yield analysis confirms that skipjack is currently exploited at a modest level relative to its biological potential. The estimates of F/F_{msy} and B/B_{msy} suggest that the stock is neither being overfished nor in an overfished state. Recruitment variability and influences of environmental conditions will continue to be the primary determinants of stock size and fishery performance.

3.3.2.6 Kawakawa (*Euthynnus affinis)*

The status of the kawakawa stock is unknown.

3.3.3 Status of Shark Stocks

3.3.3.1 General Life History Characteristics of Sharks

Sharks are notable in that they produce relatively small numbers of young. Sharks are either oviparous (egg laying) or viviparous (producing living young instead of eggs from within the body). Viviparity reduces the susceptibility of young to predation but the production of comparatively few, well-developed offspring also makes sharks vulnerable to overfishing. Hoenig and Gruber (1990) state that, unlike teleost fish, sharks can be characterized as "K-selected species" and "the relationship between stock and recruitment in the elasmobranchs is quite direct, owing to the reproductive strategy of low fecundity combined with few, well-formed offspring." Many shark species give birth or lay eggs at specific nursery grounds, which are often habitats removed from the distribution of the adults. The main predators on juveniles appear to be other sharks (Castro 1987). Thus, the availability of predator-free nursery grounds may be an important factor in regulating population (Springer 1967).

Branstetter (1990) describes Atlantic Carcharhinid and Lamnid sharks' reproductive strategies in terms of various permutations of size at birth and growth rate. Slow growing species tend to utilize bays and estuarine areas as nursery grounds, where there are turbid waters and large predators are comparatively few. On the other hand, pelagic sharks tend to have quite large young that grow comparatively fast. These include some species found in the Council's management area.

The silky shark *(C. falciformis*) depends on rapid neonate (first 28 days of life) growth for survival and also has relatively large neonates. According to Springer (1967) neonates are found on deep reef areas and move into the pelagic environment at about six months of age. Alopiids (thresher sharks) and some Lamnids (salmon sharks and mako sharks) have similar strategies, although *Isurus oxyrinchus* (shortfin mako) has smaller neonates but compensates with large litter sizes. Alopiids produce two to four young of intermediate size. Rapid growth in the young of these species allows greater swimming efficiency and speed in order to escape predators.

Sexual segregation in schools is often observed in sharks and may be related to reproduction. Strasburg (1958) discusses sexual segregation in blue sharks based on longline data (refer to the blue shark habitat description).

Blue sharks comprise approximately 95 percent of the sharks taken in the Hawaii pelagic longline fishery (Ito and Machado 1999). Consequently, this is the only species that will be extensively covered here in terms of natural history. Other species that are taken very occasionally in the fishery will be covered comparatively briefly.

3.3.3.2 Blue Shark (*Prionace glauca)*

The most current stock assessment of blue shark in the Pacific Ocean was conducted by Kleiber et al. (2001) using a MULTIFAN-CL model. All outputs of the model indicated a decline in the blue shark population during the 1980s followed by some level of recovery during the 1990s. The decline in the 1980s coincided with the existence of an extensive small-mesh driftnet fishery in the North Pacific Ocean and recovery of the stock occurred following the banning of the driftnet fishery. On the basis of the most pessimistic estimate of stock size, MSY is estimated to be approximately twice the current take (averaged between 1994 and 1998) by all fisheries in the North Pacific Ocean. In this scenario, the fishing mortality at MSY (F_{msy}) is approximately twice the current level of fishing mortality (average of fishing mortality from 1994 through 1998) by all fisheries in the North Pacific Ocean. Other, equally plausible estimates indicate that the stock could support an MSY up to four times current take levels and F_{msy} up to 15 times current fishing mortality.

3.3.3.3 Miscellaneous Sharks (Families Carcharhinidae, Alopiidae, Sphyrnidae, and Laminidae)

Data from the NMFS longline observer program indicate that blue sharks comprise approximately 93% of the sharks caught on Hawaii vessels carrying observers. The remaining sharks fall into four families: Alopiidae, Lamnidae, Charcharhinidae and Sphyrnidae. Within these families, only the thresher sharks, oceanic whitetip and mako occur as over 1% of the shark catch. All other species are taken in extremely low numbers.

3.3.3.3.1 Family Alopiidae

This family includes the thresher sharks. In California, 94 percent of the total thresher shark commercial landings are taken in the driftnet ("drift gillnet") fishery for swordfish, where it is the second most valuable species landed. Catches peaked early in this fishery with approximately 1,000 mt taken in 1982 but declined sharply in 1986 (Hanan et al. 1993). Since 1990, annual catches have averaged 200 mt (1990-1998 period) and appear stable (Holts et al. 1998). CPUE has also declined from initial levels.

Declines in CPUE indicate a reduction in the thresher shark population (K. Hill and D. Holts unpub. data, Holts et al.1998). However, the decline in the driftnet CPUE as a measure of the magnitude of the decline of the stock is confounded by the effects of various area and time closures, the offshore expansion of the fishery, and the changed emphasis from shark to swordfish among most of the fishers. Based on the estimated rate of population increase (Smith et al. in press, Au et al. in press), the common thresher MSY is estimated to be as little as 4-7 percent of the standing population that existed at the beginning of the fishery.

3.3.3.3.2 Family Lamnidae

This family includes mako sharks and salmon sharks which recently have been added to the list of PMUS. Salmon sharks (*Lamna ditropis*) are widely distributed across the entire width of the North Pacific Ocean between about 30° and 65°N. This species is abundant in water temperatures ranging from 5°C to 18°C, and high catches have been recorded in sea surface temperatures (SST) of 9°C-16°C (Nakano and Nagasawa 1996). Salmon sharks occur in both the nearshore and oceanic environments. Adult salmon sharks typically range in size from 180-210 cm PCL, and can weigh upwards of 220 kg. Length-at-maturity in the western North Pacific Ocean has been estimated to occur at approximately 140 cm PCL (age five) for males and between 170-180 cm PCL (ages eight to ten) for females. Salmon sharks are opportunistic feeders, sharing the highest trophic level of the food web in Subarctic Pacific waters with marine mammals and seabirds. They feed on a wide variety of prey including salmon and other fishes (Goldman and Musick in press).

Nothing is known about the stock structure or population status of salmon sharks although, as with most shark species, there is concern over their ability to sustain high levels of exploitation due to their low reproductive potential.

Mako sharks are also taken primarily by the California driftnet fishery for swordfish. Although current catches are only about 80 mt/yr in the California fishery, the mako shark is still the second most valuable species taken in the fishery. Like the common thresher, shortfin mako catches have been affected by the changes that occurred in the driftnet fishery. Catches peaked soon after the fishery started (240 mt in 1982) and then declined. Makos are also taken in smaller amounts (<10 mt/yr) by California-based longliners operating beyond the EEZ (Vojkovich and Barsky 1998). This fishery takes primarily juveniles and subadults, probably because the area serves as a nursery and feeding area for immature stages (Hanan et al. 1993). The mako shark distribution is affected by temperature, with warmer years being associated with more northward movement. According to the PFMC (2003) west coast stocks are thought to be not overfished.

Crocodile sharks *(Pseudocarcharius kamoharia*) are also PMUS and are occasionally taken in pelagic fisheries. Very little is known about this small, cylindrical shark with very large eyes. Males mature at about 74 cm and females between 89 cm and 102 cm. Pups (four per litter) are born at a length of 41 cm; maximum size is 110 cm, making it the smallest of the Lamnid sharks. It ranges to a depth of 300 m (Compagno 1984). Captured specimens have small fishes, squid and shrimps in their gut.

3.3.3.3.3 Family Carcharhinidae

This is one of the largest and most important families of sharks, with many common and wide-ranging species found in all warm and temperate seas. The silky (*Carcharinus falciformis*) and oceanic whitetip (*C. longimanus*) are the most important as far as Hawaii's fisheries are concerned. The silky shark is one of the three most abundant pelagic sharks, along with the blue and oceanic whitetip sharks (Compagno 1984). Bonfil (1994) estimated 19,900 tons of silky sharks were caught from the SPC zone in the central and south Pacific in 1989. Stevens (1996) estimated 84,000 tons of silky sharks were caught in the international Pacific Ocean high-seas fisheries (purse seine, longline, and drift-net). Oshiya (2000) has conducted a stock assessment of Pacific silky sharks, with an estimated Pacific Ocean-wide standing stock of 170,000 to 240,000 mt, from which 15,000 and 20,000 mt is caught annually by longline vessels.

The oceanic whitetip shark is one of the three most abundant sharks (Compagno 1984). Bonfil (1994) estimated 8,200 tons of oceanic whitetips were caught from the WCPO in 1989. Stevens (1996) "roughly estimated" 50,000 to 239,000 tons of oceanic whitetips were caught by the international Pacific Ocean high-seas fisheries (purse seine, longline, and drift-net) in 1994. Although silky sharks represent more of the fisheries catch, oceanic whitetips are believed to be more abundant (Straurg 1958). There have been no quantitative assessments of Pacific oceanic whitetip shark populations published to date.

3.3.4 Stock Status of Miscellaneous PMUS

3.3.4.1 Mahimahi (*Coryphaena hippurus*) and Wahoo (Ono) (*Acanthocybium solandri*)

Stock characteristics for *C. hippurus* are not known. A preliminary analysis of mahimahi in the central and western Pacific Ocean was presented at the 16th SCTB in June 2003 (Dalzell and Williams unpublished). Annual mahimahi catches in the Pacific Islands were generally small, of the order of a few hundred mt, but Taiwan, with its large longline fleet, landed on average almost 7,000 mt per year. Plots of mahimahi and wahoo across the WCPO showed that catch rates of these species were highest in sub-tropical latitudes. Catch rates were also strongly seasonal, with on average a three-fold difference between low and high season CPUEs. Longline catch rates of mahimahi and wahoo showed strong stratification by depth (as expressed by distance of the hook from the float line), with mahimahi CPUE highest on the shallowest hook, and wahoo CPUE highest on the third hook from the float line.

Catches of both species have been variable in both longline and troll fisheries in the U.S. Pacific Islands, but have increased markedly in American Samoa due to the rapid expansion of the longline fishery after 2000. Troll and longline catches have increased over the past 20 years in Hawaii. Catch rates have also been variable, but both troll and longline CPUE data show reasonably similar trends in Hawaii and American Samoa. Similar CPUE trends for mahimahi and wahoo were noted for troll fisheries in Guam and Northern Mariana Islands. The average size of wahoo in troll and longline catches in Hawaii had remained relatively stable over the past two decades, as did the troll caught mean size of mahimahi. Hawaii longline caught mahimahi showed a major decline in mean size between the 1980s and 1990s. The average size of mahimahi and wahoo were larger in longline compared to troll catches. Troll caught wahoo declined in size in American Samoa. The average sizes of mahimahi in Guam and the Northern Mariana Islands were similar, but wahoo were slightly larger in the Northern Mariana Islands troll fishery.

3.3.4.2 Opah or Moonfish (*Lampris guttatus*)

Stock status is unknown.

3.3.4.3 Pomfret (*Eumegistus illustris)*

Stock status is unknown.

3.3.4.4 Snake Mackerels (Family Gempylidae)

Stock status is unknown.

3.4 Potential Squid PMUS

Synopses of the biology and ecology of the three species of squids with commercial value in the western Pacific region are presented in this section. More extensive accounts, with additional documentation, are found in Appendix B. Following the descriptions of potential squid PMUS is a brief summary of other cephalopods commonly encountered in the region, and rationale for their exclusion from consideration as PMUS. The section concludes with a description of bycatch in the squid jigging fishery.

3.4.1 Neon Flying Squid (*Ommastrephes bartrami*)

3.4.1.1 General Description

The neon flying squid occurs in mostly subtropical to temperate waters throughout the world's oceans. At the peak of its exploitation prior to 1993, over 300,000 mt of this squid were taken annually in the North Pacific Ocean. In the North Pacific, females reach a larger size, over 56 cm mantle length (ML) and about 6 kg total weight, than males, 40 cm ML and about 1.5 kg. Females presumably spawn large egg masses with perhaps 100,000 or more eggs per egg mass with batch fecundity of about 1.5 million eggs. Spawning occurs throughout the year mostly in subtropical waters with peaks in the fall-winter and winter-spring periods. Eggs are about 1 mm in diameter and the paralarva reaches a size of about 7 mm ML a month after hatching and over 100 mm ML at 3 months and nearly 300 mm ML by six months. Growth rates, however, are highly variable. Males mature at about 300 mm ML at about 6 months of age and females at a bit under 500 mm ML at nearly nine months of age. Growth presumably slows after maturity when energy must be spent on gametes, although this has yet to be documented. Females appear to spawn repeatedly but the frequency is unknown. Maximum life span for both males and females appears to be about one year.

Squid appear to occupy the upper 50 m depths during the nighttime and about 150-300 m depths during the day at high latitudes, and the upper 100 m during the nighttime and 400-700m or deeper during the daytime in clearer subtropical waters. These squid are prey during various times in their life cycle for a large variety of seabirds, fishes and mammals. The squid feed mostly on crustaceans when small, and fishes and squids when large.

While spawning occurs year-round mostly in subtropical waters (approximately 25-35°N), the peak fishing season is from June to December and occurs mostly in the SAFZ (approximately 41-43°N). The squid therefore, undergo a south to north migration for feeding and a north to south migration for spawning. Details of the migrations, however, are poorly known. With year-round spawning, differential sizes between males and females, north-south migrations, highly variable growth rates, and the large size of the habitat, population structure and dynamics have been difficult to unravel. Females generally arrive on the fishing grounds before males and depart earlier, and the commercial catch is dominated by females. This may have population and food web implications should fishing effort increase greatly. Because this squid has an annual life cycle, if females are preferentially removed from the population, it could depress recruitment the following year. Two major cohorts comprise most of the commercial catch: an autumn (period of hatching) cohort with females of larger size (> 55 mm ML) and a winter-spring cohort with smaller females (< 46 mm ML). Both cohorts contribute to the harvest across much of the North Pacific Ocean, but the autumn cohort predominates in the central and eastern Pacific Ocean and the winter-spring cohort in the western Pacific Ocean. The reasons for the size differences are thought to relate to the productivity of the waters at the time of hatching and subsequent growth.

Much of the productivity of the spawning grounds varies with the seasonal movement of the Transition Zone Chlorophyll Front.

3.4.1.2 Status of the Stock

Estimates of potential productivity or natural mortality rates for *O. bartrami* are not available. However, it is assumed that both of these attributes are high. The squid grows rapidly, has a short life span and a relatively high reproductive potential (production of many small eggs), and there appears to be no shortage of predators. *O. bartrami*'s high position on the trophic pyramid (level 4-5), the rapid turnover time (short lifespan) suggest that its stock size is highly dependent on environmental conditions and thus, subject to high inter-annual and longer-term variability. Its year-round spawning, however, can be considered a hedge against unfavorable environmental variability. Its high potential productivity suggests resilience in the face of fishery-related stock-depletion if natural mortality rates remain stable.

The standing stock of *O. bartrami* in the North Pacific Ocean has been estimated at about 0.5 - 1.5 million tons. The combined annual catch by the Japanese, Taiwanese and Korean fisheries for 1985-1990 ranged from 248,000-378,000 mt (328,000 mt average) (Murata and Nakamura 1998). *O. bartrami* has been fished commercially in the North Pacific Ocean since 1974 (Yatsu, et al. 2000). An intense fishery for *O. bartrami* began in 1978 with the introduction of driftnet fishing, and driftnet fishing dominated the fishery until the end of 1992 when a moratorium on large-scale driftnet-fishing was instigated (Yatsu et al. 2000). Catch rates from driftnet fishing greatly exceeded those of jigging when fishing in the same area (1.5 - 3.8 times greater) (Murata 1990), and driftnet catches represented about 87% of the Japanese total catch between 1985-1990 (Murata and Nakamura 1998). Prior to the moratorium, data were insufficient to assess the population size, but there was some indication from declines in the stock size index and the size of individual squid that the population in the eastern region might be declining (Murata 1990). The CPUE for the Japanese driftnet fishery, however, showed a peak in 1990 and good values in 1991 and 1992 (Yatsu and Watanabe 1996). The major fishery, before the moratorium, operated primarily from June through December with most fishing occurring in the SAFZ (Araya 1983, Murata 1990, Murata and Hayase 1993). The current jigging fishing grounds lie at about 40-42°N and 150-170°E (Yatsu et al. 1997). Research catches using jigging and small-size driftnets starting in 1980 show high catches beginning in 1994 indicating that the population recovered rapidly after the termination of commercial driftnet fishing (Yatsu et al. 2000). In the western region total catches in the jigging fishery ranged from 50 kilotons (Kt) to 80 Kt during 1994-1998 and fell to 30 Kt in 1999 and 2000 (Yatsu 2003 cited in Bower 2004). In the central region, beginning in 1996 the Japanese *O. bartrami* jigging fishery showed increasing catches to 1998 then declining catches (1997 - 12 Kt, 1998 - 21 Kt, 1999 - 12 Kt, 2000 - 5 Kt. Numerous Chinese jigging vessels, estimated to be about 400-600 in number with a catch equal to or greater than the Japanese catch), along with Korean and Taiwanese vessels operating in the general area of the Japanese fishing grounds may contribute to the declining catches (Ichii 2003 and Yatsu 2003, both cited in Bower 2004).

3.4.2 Diamondback Squid (*Thysanoteuthis rhombus*)

3.4.2.1 General Description

T. rhombus, the only member of its family, occurs in tropical and warm-temperate waters throughout the world's oceans but is rarely abundant; however, it supports small fisheries in the Sea of Japan and in waters around Okinawa. The total annual Japanese fishery yield is about 6,000 tons. Males and females are nearly the same size with males reaching about 800 mm ML and females about 850 mm ML and weights ranging up to 24 kg. Females spawn large sausage-shaped egg masses that float at the ocean surface with 24,000 to 180,000 eggs. Batch fecundity is about 140,000 eggs. Seasonal variation in spawning is uncertain. Eggs are about 1.7 mm in diameter. Growth rates of paralarvae are unknown. Juveniles reach 90 mm ML at three months. Maximum growth rates at approximately 300 - 400 mm ML reach 80-140 mm per month. Growth appears to slow after maturity. Females may spawn 8-12 egg masses over a three to four month period. Maximum lifespan for both males and females appears to be about one year.

T. rhombus is found during the day at depths between 300-600 m and at night between depths of 0-150 m. These squid are prey during various times in their life cycle for a large variety of fishes and mammals but the frequency of occurrence is usually low. Young squid are rarely found in the stomachs of seabirds. Large squid feed mostly on small fishes and squids. The trophic level of subadult and adult *T. rhombus* has not been calculated.

T. rhombus apparently migrates into the Sea of Japan from August to October where they are fished commercially. Details of their movements in the Sea of Japan are poorly known. The occasional captures in temperate waters around the world provide the only other evidence of extensive horizontal migrations for this species.

3.4.2.2 Status of the Stock

The world-wide standing stock of *T. rhombus* is unknown, although Nigmatullin and Arkhipkin (1998), based on night-light observations and trawl catches, estimate 1.5-2.5 million tons. This “educated guess” is, apparently, the only estimate that exists. Estimates of potential productivity or natural mortality rates for *T. rhombus* are not available. However, it can be expected that productivity is high and, perhaps, natural mortality also, but there is little evidence for the latter. The squid grows rapidly, has a short life span and a relatively high reproductive potential (production of many small eggs) but differs from *O. bartrami* and *S. oualaniensis* in having somewhat larger eggs and a lower batch fecundity. Little is known about natural predators. The rather high position of *T. rhombus* on the trophic pyramid (probably comparable to *S. oualaniensis* even though *T. rhombus* is much larger), and its rapid turnover time (short lifespan) suggest that its stock size is highly dependent on environmental conditions and, thus, subject to high inter-annual and longer variability. While spawning is seasonal around Okinawa, year-round spawning in more tropical waters is likely providing a hedge against environmental variability. Its predominately tropical habitat lessens the potential effects of some types of environmental variability. Its high potential productivity suggests resilience in the face of fishery-related stock-depletion if natural mortality rates remain stable. The large biomass of individuals and its high quality as a human food make it an attractive fishery target. Its distribution in generally very small groups over a broad geographical area suggests resilience to fishery mortality. However, the possible low local population mobility may indicate low resilience to fishery mortality at the local level.

The fishery off Okinawa, which started in 1989 and uses drop-line and longline fishing methods, catches about 1600-2000 mt/yr (Kato et al. 2001). The total Japanese fishery yield of *T. rhombus* was nearly 6000 mt in 2001 (Bower 2004). Experimental fishing in the South China Sea produced almost no catches (Dickson et al. 2000).

3.4.3 Purpleback Flying Squid (*Sthenoteuthis oualaniensis)*

3.4.3.1 General Description

S. oualaniensis, a member of the same family (Ommastrephidae) as *O. bartrami*, occupies tropical and subtropical waters of the Indo-Pacific region. The population structure of *S. oualaniensis* is complex, with a variety of forms that may or may not be genetically distinct. Although considered the most abundant large squid in Indo-Pacific waters, the general lack of highly concentrated populations has prevented exploitation except for a few local fisheries (Taiwan and nearby islands, Hawaiian Islands). In the North Pacific Ocean, females reach a larger size, 335 mm ML and 1.6 kg total weight, than males, 210 mm ML and under 0.4 kg. Females presumably spawn large egg masses with perhaps 100,000 eggs per egg mass with batch fecundity of about 250,000 eggs. Spawning occurs throughout the year in tropical waters with an apparent peak in Hawaiian waters in late summer. Eggs are just under 1 mm in diameter, and the paralarva apparently reaches a size of about 4 mm ML a month after hatching and about 100 mm ML at 3 months but strong disagreement exists in calculated growth rates. Males mature at about 140 mm ML and females about 200 mm ML. Growth presumably slows after maturity when energy must be spent on gametes, although this has yet to be documented. Females appear to spawn repeatedly but the frequency is unknown. Maximum lifespan for both males and females appears to be about one year.

Purpleback flying squid occur in near-surface depths during the nighttime and are thought to descend to depths of over 600 m during the day. These squid are prey during various times in their life cycle for a large variety of seabirds, fishes and mammals. The squid feed mostly on crustaceans when small, and fishes and squids when large. Subadult and adult squids are thought to occupy a lower trophic level than large *O. bartrami.*

Unlike *O. bartrami*, *S. oualaniensis* does not make major migrations from low to high latitudes and back, although the habitat may expand somewhat with the season following the movement of the subtropical front. This squid, however, does exhibit distinct distribution patterns around islands that may involve local migration.

3.4.3.2 Status of the Stock

The world-wide standing stock of *S. oualaniensis* is unknown, although it has been roughly estimated at about 3 to 4 million tons. The biomass of *S. oualaniensis* in the South China Sea Area III (west of the Philippines) was estimated from jigging surveys at 283,000 mt (Labe 2000).

Zuev et al. (2002) estimated, based mostly on visual survey methods, the total instantaneous stock size of *S. oualaniensis* at 3-4 million tons (1.9-2.4 million tons for the middle-sized form) and an annual production to biomass ratio for adult squids of 8.0-8.5.

Estimates of potential productivity or natural mortality rates for *S. oualaniensis* are not available. However, it is assumed that both of these attributes are high. The squid grows rapidly, has a short life span and a relatively high reproductive potential (production of many small eggs) and there appears to be no shortage of predators. *S. oualaniensis'*s rather high position on the trophic pyramid (probably one level below large *O. bartrami*) and the rapid turnover time (short life span) suggest that its stock size is highly dependent on environmental conditions and thus, subject to high inter-annual and longer-term variability. Its year-round spawning, however, can be considered a hedge against unfavorable environmental variability and its tropical habitat lessens the effects of some types of environmental variability. Its high potential productivity suggests resilience in the face of fishery-related stock-depletion if natural mortality rates remain stable. The relatively small size of individuals and its rather low quality as a human food make it less attractive as a fishery target. Its distribution in generally highly dispersed small groups over a broad geographical area suggests resilience to fishery mortality, although the extent of population mobility between geographical areas is unknown.

S. oualaniensis has been commercially fished off Okinawa (in the Ryukyu chain), Taiwan and Hawaii. Fishing grounds existed on the southwestern coasts of Taiwan and beyond the 200 m isobath of the Ryukyu chain (Okutani and Tung 1978). The fishing season in Taiwan is from March to November with a peak in May-August. Fishing was most productive at SSTs of 26°-28°C. The annual landings of squid and cuttlefish in Taiwan and Okinawa from 1947-1969 averaged 325 tons with 70 percent being *S. oualaniensis* (Okutani and Tung 1978). The *S. oualaniensis* catch is used for tuna bait and for human consumption (Okutani and Tung 1978). According to Lu (pers. comm. 2003) the fishery never was very successful as, due to its toughness, the squid had low value for human consumption relative to other squid. He states that at present there is no longer a targeted fishery for *S. oualaniensis* but fishers still take incidental catches of the squid. In Hawaii the fishery began with immigrants from Okinawa that fished off Hilo at night in small boats with handlines; however, it soon became apparent that they could also catch tuna and quickly tuna became the target of the fishery with squid being used as bait for the tuna or as incidental catch (Yuen 1979; *S. oualaniensis* misidentified as *Nototodarus hawaiiensis* in this paper). This nighttime handline fishery has become known as the *ika-shibi* (squid-tuna) fishery. Between 1973 and 1975 the annual squid catch varied between 0.5 and 5.0 tons (Yuen 1979). Between 1976 and 1992 the annual squid landings in Hawaii varied from about 1-12 tons with large year-to-year fluctuations and no clear trends (unpublished data from the Hawaii Division of Aquatic Resources [HDAR]).

3.4.4 Other Pelagic Cephalopods of the Western Pacific Region

The status of pelagic cephalopod species found in the western Pacific region is poorly known, except for those in Hawaiian waters. In Hawaiian waters there are about 70 species of pelagic cephalopods, most of which are mesopelagic[20] species. There are three additional species of

[20]Relating to oceanic depths from about 600 to 3,000 feet (200 to 1,000 meters).

squids in the family Ommastrephidae (*Eucleoteuthis luminosa*, occurring at the northern limits of the Hawaiian EEZ; *Nototodarus hawaiiensis*, a demersal species found near the Hawaiian islands; and *Hyaloteuthis pelagicus*, a small species, less than 100 mm ML). None of the three is common or fished commercially. There are three species of *Onychoteuthis* that are rather muscular and presumably edible but they are rather small (less than 200 mm ML) and infrequently encountered. Other squids are mostly very small or weakly muscled and none occur in commercial quantities. A large pelagic octopod, *Tremoctopus gracilis*, has a muscular mantle but the animal is rare in Hawaiian waters. Another large, muscular octopod, *Ocythoe tuberculata*, is found north of Hawaiian waters and is occasionally encountered by Hawaiian fishermen targeting *O. bartrami*. Neither of these octopods appears to occur in commercial quantities and neither is commercially targeted by fisheries.

A similar cephalopod fauna, although with mostly different but related species, is assumed to exist in the other areas of the western Pacific region. In those areas there are also neritic[21] and often demersal[22] cephalopods (loliginid squids and sepiid cuttlefishes) that may be fished for personal consumption.

3.4.5 Bycatch in the Squid Jigging Fisheries

Bycatch, including interactions with marine mammals, seabirds and sea turtles can be substantial in fisheries that harvest squid with nets (e.g., Weeber 2004), but available information suggests that jig fisheries have very low rates of bycatch and interaction with protected species. Jigs are utilized in both the nascent high-seas fishery targeting red flying squid north of Hawaii and in the small-scale fisheries operating in coastal waters off west Kauai and east Hawaii.

3.4.5.1 Marine Mammals

Some species of marine mammals prey on squid and, therefore, might approach jigging vessels. Dolphins and small-toothed whales are adept at not being hooked while they steal hooked catches from slowly moving gear. Jigs pulled through the water column in a faster rhythmic jerking movement might pose a greater danger of accidental hooking to these species. More likely than hooking, however, is that an active marine mammal searching for squid beneath high-seas vessels could become entangled in several jig lines because of their close spacing on large vessels (21-38 jig machines each driving two reels). Depending on their size, marine mammals that are accidentally entangled might: a) break off the line, b) be pulled over the rollers onto the deck, or c) stop or break loose from the line at the rollers. Logbooks and anecdotal reports (B. Endreson pers. comm. 10/03) from limited squid jigging in the North Pacific Ocean by four U.S. vessels provide no evidence of interactions with marine mammals.

Crespo et al. (1997) report on the results of monitoring interactions between marine mammals and the squid jigging fleet that fishes coastal waters (100-200 m depths) off the central Patagonian coast. The fleet numbers at least 110 vessels, and targets the shortfin squid (*Illex*

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[21]Relating to the belt or region of shallow water adjoining the seacoast.

[22]Living near the bottom of the sea.

argentinus). The fishing area overlaps in part with sea lion foraging habitat. Interactions between the jigging fishery and marine mammals were documented, but not quantified. Southern sea lions and Commerson's dolphins were reported to entangle lines of jigging machines, prey on squid, and scatter the schools.

A cooperative squid jigging survey was conducted by U.S. and Japanese participants in the EEZ off Oregon and Washington in 1990 (June and Wilkins 1991). Four Japanese squid jigging catcher/processor vessels occupied 142 fishing stations during August and September. No marine mammals were observed to be directly affected by the fishing gear or operations. Marine mammals were observed in the vicinity of the squid fishing operations during daylight. Dall's porpoise, Pacific white-sided dolphins, unidentified seals, and Sei whales were observed in the vicinity of the vessels during night fishing operations, but none were observed interacting directly with the fishing gear. The Japanese fishing masters indicated that marine mammals are rarely, if ever, encountered during active fishing operations.

A jig fishery operates in the waters around southern Australia, and a Bycatch Action Plan was recently prepared for this fishery by the Australian Fisheries Management Authority (AFMA 2004). The AFMA observer program reported an interaction with a little penguin (hooked in the flipper). Seals sometimes follow the vessels in this fishery and take squid from the hooks, but there are no reports of seal hooking or entanglement (AFMA 2004). One of the small-scale jig fisheries in Hawaii targets purpleback flying squid in coastal waters off western Kauai, relatively close to Hawaiian monk seal colonies on the islands of Niihau and Kauai. It is uncertain whether Hawaiian monk seals might behave similarly to seals in southern Australia, but there are no reports of hookings or entanglements of monk seals or any other marine mammals in Hawaii's small-scale jig fisheries (D. Itano, fishery biologist, pers. comm. to Tony Beeching, NEPA fisheries analyst, WPRFMC, Jan. 7, 2004).

Boat collisions with whales occur in the North Pacific Ocean, but none have been reported in U.S. squid jig fisheries.

3.4.5.2 Seabirds

Squid is a primary prey item for albatrosses. The U.S. high-seas jig fishery for red flying squid and foraging habitat for Laysan and black-footed albatrosses are in the same oceanic fronts and transition zone of high biological productivity at latitudes north of Hawaii. Elevated squid concentrations attract these seabirds. Albatrosses feed close to the ocean surface, so are unlikely to be hooked on pointed jigs that are deployed 30-100m below the surface. However, seabirds may perch on the vessel waiting to plunge at squid near the surface, thereby becoming entangled. Depending on their size, seabirds that are accidentally entangled might: a) break off the line, b) be pulled over the rollers onto the deck, or c) stop or break loose from the line at the rollers.

Squid jigging has been done at night when black-footed albatross are not feeding. Because of the bright lights used on high-seas jig vessels (large vessels may have two above-deck rows with 25-50 2,000-4,000 watt lamps per row), some concerns have been expressed about Laysan albatross (which have better vision and may feed at night) becoming disoriented and colliding with squid vessels. The U.S. vessels recently have been fitted with submerged lights to allow for squid jigging at greater depth during daylight. Submerged lights during daytime squid jigging should not impact albatrosses.

Newell's shearwater fledglings are attracted to lights during their first flight to the ocean from their nesting grounds. When attracted to manmade lights, fledglings become confused and may suffer temporary night blindness. They often fly into utility wires, poles, trees and buildings and fall to the ground. If squid vessels were to fish within sight during fledging, the bright lights might attract the birds to the vessel.

Offal discard during onboard processing of squid might also attract seabirds. Logbooks and anecdotal reports (B. Endreson, pers. comm. 10/03) from limited squid jigging in the North Pacific Ocean by four U.S. vessels provide no evidence of interactions with seabirds.

In the cooperative squid jigging survey conducted by U.S. and Japanese participants in the EEZ off Oregon and Washington in 1990 (June and Wilkins 1991) no birds were observed to be directly affected by the fishing gear or operations.

The AFMA observer program reported that none of the seabirds (1 shy albatross and 2 short-tailed shearwaters) sighted near vessels jigging for squid in southern Australia were observed to interact with either the boats or fishing gear.

Small-boat fishermen use low-wattage surface and underwater lights to attract purpleback flying squid to lures deployed in coastal fisheries. There are no reports of hookings or entanglements of seabirds in Hawaii's small-scale jig fisheries (D. Itano, fishery biologist, pers. comm. to Tony Beeching, NEPA fisheries analyst, WPRFMC, Jan. 7, 2004).

3.4.5.3 Sea Turtles

Sea turtles migrate through the North Pacific Transition Zone where red flying squid are concentrated. Loggerhead turtles are particularly known to be attracted to squid. The Hawaii longline swordfish fishery was re-opened in 2004 with a prohibition on squid bait. Loggerhead turtles obviously bite squid when it is baited on longline hooks that are slowly drifting, but whether a loggerhead turtle would chase squid hooked on jigs being more rapidly moved upward is uncertain. If accidentally hooked or entangled in this manner, a sea turtle would be brought to the surface. Depending on its size, sea turtles that are accidentally entangled might: a) break off the line, b) be pulled over the rollers onto the deck, or c) stop or break loose from the line at the rollers. Some of the lures used in squid jig fisheries are luminescent in various colors. Whether any of the colors might attract sea turtles close enough to become entangled in jig gear is uncertain. Submerged lights are employed by large-scale U.S. jig vessels to allow day jigging for squid at greater depths than night jigging. Whether sea turtles might be attracted to underwater lights is uncertain.

Logbooks and anecdotal reports (B. Endreson, pers. comm. 10/03) from limited squid jigging in the North Pacific Ocean by four U.S. vessels provide no evidence of any interactions with sea turtles. There are no reports of any hookings or entanglements of sea turtles in Hawaii's small-scale squid jig fisheries (D. Itano, fishery biologist, pers. comm. to Tony Beeching, NEPA fisheries analyst, WPRFMC, Jan. 7, 2004).

3.4.5.4 Fish

Squid jig fisheries have very low fish bycatch and are reported to be a highly selective fishing method (Rathjen 1991, Alverson et al. 1992 cited in Harris and Ward 1999). The most common fish bycatch by the high seas U.S. squid jig fleet are small numbers of blue shark whose weight often breaks the 30-60 lb test lines before the shark is boated (B. Endreson, pers. comm., 10/03). Four U.S. vessels submitted logbooks for limited squid jigging in the North Pacific Ocean during 2001-2003. Only the logbooks for 2001 provide any records of bycatch, which consisted of small numbers of squid that dropped off the jigs before being boated and small numbers of blue shark that broke off the line before being boated. In the somewhat similar Australian fishery, the most common bycatch species includes small quantities of blue shark (*Prionace glauca*), garfish (*Hyporhamphus* spp.) and baracouta (*Thyrsites atun*) (AFMA 2004).

In the cooperative squid jigging survey conducted by U.S. and Japanese participants in the EEZ off Oregon and Washington in 1990 (June and Wilkins 1991), bycatch rates were low. Besides the target species, *O. bartrami*, five additional species of cephalopods (51.7 kg/mt of target species; 59.56% of the bycatch) and seven species of fish were caught. Pacific pomfret was the most common incidentally caught species of fish during the survey (9.7 kg/mt of target species; 11.12% of the bycatch). Blue shark was also commonly taken (7.1 kg/mt of target species; 8.15% of the bycatch). Many of the fish and cephalopods taken incidentally were returned to the sea with only minor damage. Larger specimens usually fell off the hooks. Blue sharks sometimes damaged or consumed the target squid during line retrieval, and sometimes became hooked by the jigs and entangled in other lines. Blue sharks accounted for most of the gear loss which was minor and limited to several jigs with attached terminal weights.

3.5 Other Species, Including Non-Target, Associated, or Dependent Pelagics Species (NADS)

NMFS observers recorded more than 60 different species caught by the Hawaii-based longline fleet between 1994 and 1997. Non-PMUS species captured by the longline fleet are discarded and represent about six percent of the total number of fish caught. Based on NMFS observer data for 1994-1997, which amounts to between four and five percent of the annual total number of longline fishing trips, the discarded non-PMUS species include lancet fish, pelagic stingray, snake mackerel, escolar, remora, crocodile shark and *mola mola*, among others. Bycatch of these species in the Hawaii-based longline fishery and other Pacific Ocean fisheries is described in the 2001 FEIS (NMFS 2001a) and more information may be found there.

3.6 Protected Species

This section describes the biology, ecology and habitat of the seabirds, sea turtles and marine mammals present in the area fished by the Hawaii-based longline fleet.

3.6.1 Seabirds

NMFS observer records show that Hawaii-based pelagic longline fishing operations inadvertently hook, entangle and kill black-footed albatrosses (*Phoebastria nigripes*) and Laysan (*P. immutabilis*) albatrosses. On rare occasions, wedge-tailed (*Puffinus pacificus*), sooty (*P. griseus*) and fleshfooted (*P. carneipes*) shearwaters are also incidentally hooked. Only seven shearwaters of various species were observed hooked by Hawaii longline vessels between 1994 and 2004. A total of five shearwaters have been caught and killed by the fishery, one fleshfooted shearwater, two sooty shearwaters and two unidentified shearwaters (NMFS PIRO observer data). NMFS observers have also reported boobies hovering over baited hooks and that some birds may actually attempt a dive, however, no boobies have been reported hooked.

The short-tailed albatross (*P. albatrus*) and Newell's shearwater (*Puffinus auricularis newelli*) are two seabird species listed under the ESA present in the area where the Hawaii longline fishery operates. No short-tailed albatross or Newell's shearwaters have been recorded caught or killed by the Hawaii-based longline fishery. A sighting of a short-tailed albatross near a Hawaii longline vessel was recorded on January 23, 2000, by a NMFS observer at 33°09′N, 147°49′W. The short-tailed albatross sighted was a juvenile bird. Recently, there have been two additional sightings of short-tailed albatrosses from Hawaii-based longline vessels, but further information about those sightings is not yet available (H. Freifeld, USFWS, pers. comm.). No sighting of a Newell's shearwater has been recorded for the fishery, and one is unlikely given the difficulty of distinguishing a Newell's shearwater from other shearwater species when in flight.

Between August 19, 2002 and October 28, 2002, NMFS observers collected information onboard pelagic vessels operating out of American Samoa and reported no seabird interactions. No albatross species are present in American Samoa. There are some shearwater species present, such as the wedge-tailed shearwater, that have the potential to lethally interact with longline gear. No reports or observed information on seabird/fishery interactions are available from pelagic fisheries operating in other areas under the Pelagics FMP. Therefore, the focus of this assessment is on the seabird species that are observed or have the potential to interact with the Hawaii-based longline fishery.

3.6.1.1 Albatrosses (Order Procellariiformes, Family Diomedeidae)

Three species of albatross breed and forage in the North Pacific Ocean: the short-tailed albatross, the black-footed albatross and the Laysan albatross (Table 3.6.1-1). NMFS observer data show that fishery-seabird interactions occur between the Hawaii-based longline fishery and two species of albatross: the black-footed albatross and the Laysan albatross. Neither the black-footed albatross nor the Laysan albatross are listed as endangered under ESA. Both seabirds are protected under the Migratory Bird Treaty Act (MBTA). Under the International Union for Conservation of Nature and Natural Resources (IUCN), the black-footed albatross is listed as "endangered" and the Laysan albatross as "vulnerable." The short-tailed albatross is listed as endangered under ESA and is considered "vulnerable" under IUCN. There have been no reports of interactions between the short-tailed albatross and the Hawaii-based longline fishery.

Albatross populations are particularly vulnerable to large-scale unnatural mortalities. Although albatrosses are long-lived (up to 60 years) they mature late (7-12 years) (Marchant and Higgins 1990, Robertson 1995, Bergin 1997), produce only a single chick every one to three years (Marchant and Higgins 1990) and both parents are typically required to successfully fledge their chick (Fisher 1971, 1975). Thus, the loss of one parent may lead to the loss of the pair's chick as well as to the less successful mating of the remaining member of the pair for years to come (Richdale 1950, Fisher 1972, Cousins and Cooper 2000). Albatrosses may return to the breeding colonies at two or three years of age, but the average age at first breeding is seven or eight years (Rice and Kenyon 1962, Hasegawa and DeGange 1982). Albatrosses fit the model of a "K-selected" species (MacArthur and Wilson 1967, Pianka 1970): slow development, late reproduction, large body size and a low potential rate of population growth. Populations of K-selected species do not bounce back rapidly from severe declines in population size.

Albatrosses are nest site specific and lay a single egg during a breeding season. Albatrosses may not breed every year. Albatrosses must take time from breeding to molt and grow new flight feathers. As a consequence, it is estimated that at any one time approximately 25% of an albatross population may not return to breed (Cochrane and Starfield 1999)

Table 3.6.1-1 Numbers of Breeding Pairs of Black-footed, Laysan and Short-tailed Albatrosses at Each Known Breeding Locality followed by the Year of the Survey.

Breeding Locality	Black-footed	Laysan	Short-tailed
Kure Atoll	2,020[1] -2000	3,899[1] -2000	--
Midway Atoll	21,829 -2004	408,133 -2004	--
Pearl and Hermes Reef	6,116[1] -2003	6,912[1] -2003	--
Lisianski Island	3,737[1] -2002	26,500 -1982	--
Laysan Island	21,006 -2004	140,861 -2004	--
French Frigate Shoals	4,259 -2004	3,226 -2004	--
Necker Island	112[1] -1995	500[1] -1995	--
Nihoa Island	31[1] -1994	0 -1995	--
Kauai Island	0 -2004	159 -2004	--
Lehua Island	10[1] -2002	12[1] -2002	--
Niihau Island	unknown	175 -1998	--
Kaula Island	0[2] -1998	63 -1993	--
Oahu Island	0 -2002	13[1] -2003	--
Subtotal	59,120	590,453	--
Senkaku Islands (Kita-Kojima)	56[1] -2002	0 -2002	50 -2003
Bonin Island (Chichijima)	405 -2003	14	--

Breeding Locality	Black-footed	Laysan	Short-tailed
Izu Island (Torishima)	1,560[1] -2003	0 -2003	276 -2003
Subtotal	2,021	14	326
Guadalupe Island	0 -2003	193 -2000	--
Other Mexican Islands	0 -2003	23 -2003	--
World Total	61,141	590,683	326

[1] Indicates an extrapolation to total eggs from chicks counted later in the season (assumes 75% reproductive success).
[2] Survey at Kaula was done 16-17 November 1998, which is slightly early to rule out that eggs were laid after this date. Nine birds were present on the island.
Source: E. Flint and H. Hasegawa, unpub. data.

3.6.1.1.1 Short-tailed Albatross (*Phoebastria albatrus*)

The short-tailed albatross is the largest seabird in the North Pacific Ocean, with a wingspan of more than 3 m (9 ft) in length. The short-tailed albatross bill is larger than the bills of Laysan and black-footed albatrosses, and is characterized by a bright pink color with a light blue tip and defining black line extending around the base. The plumage of a young fledgling (i.e., a chick that has successfully flown from the colony for the first time) is brown and at this stage, except for the bird's pink bill, the seabird can be easily mistaken for a black-footed albatross. As the juvenile short-tailed albatross matures, the face and underbody become white and the seabird begins to resemble a Laysan albatross. In flight, however, the short-tailed albatross is distinguished from the Laysan albatross by a white back and by white patches on the wings. As the short-tailed albatross continues to mature, the white plumage on the crown and nape changes to a golden-yellow.

The short-tailed albatross is known to breed only in the western North Pacific Ocean, south of the main islands of Japan. Although at one time there may have been more than ten breeding locations (Hasegawa 1979), today there are only two known active breeding colonies, Minami Tori Shima Island ("Torishima") (30º29´N, 140º19´E) and Minami-Kojima Island (25°56´N, 123°42´E). On December 14, 2000, one short-tailed albatross was discovered incubating an egg on Yomejima Island of the Ogasawara Islands (southernmost island among the Mukojima Islands).

A few short-tailed albatross have also been observed attempting to breed, although unsuccessfully, at Midway Atoll National Wildlife Refuge ("Midway")(28°12´N, 177°20´W) in the NWHI. Midway lies roughly 1,750 miles east and slightly to the north of Torishima. It is unknown if short-tailed albatross historically bred in the NWHI. Visits to the NWHI by short-tailed albatross were first recorded on Midway in 1938, when a female was seen incubating an infertile egg (Hadden 1941, Munro 1944). Sighting and banding records (Table 3.6.1-2) show that between 1938 and 2003, at the most, 22 short-tailed albatross visited the NWHI, with only one or two sighted on the same island at any one time. The first time two short-tailed albatross were known to be present on Midway at the same time, although at different locations on the island, occurred in February 1981. One of these birds, a female, returned to Midway nearly every year from 1989 to 2002, and laid several infertile eggs (Table 3.6.1-2).

Table 3.6.1-2 Short-tailed Albatross Observations in the Northwestern Hawaiian Islands.

Year	Month	Location	Birds	Description
1938	Dec	Midway Atoll, Sand Is.	1	Immature
1939	Dec	Midway Atoll, Sand Is.	1	Injured then died
1940	Nov	Midway Atoll, Sand Is.	1	Immature
1962	Winter	Midway Atoll, Sand Is.	1	Adult
1965	Winter	Midway Atoll	1	Immature
1966	Mar	Midway Atoll, Eastern Is.	1	Banded[1]
1972	Nov	Midway Atoll, Sand Is.	1	Band 558-30754
1973	May	Midway Atoll, Sand Is	1	Band 558-30754
1973 - 1974	Fall - Winter	Midway Atoll, Sand Is	1	Band 558-30754
1974 - 1975	Fall - Winter	Midway Atoll, Sand Is	1	Band 558-30754
1976	Mar	Laysan Island	1	Immature-unbanded
1976	Winter	Tern Island	1	Immature-unbanded
1976	Winter	Midway Atoll, Sand Is.	1	Band 558-30754
1977	Dec	Midway Atoll, Sand Is.	1	Band 558-30754
1978	Oct	Midway Atoll	1	Band 558-30754
1979	Jan	Midway Atoll	1	--
1979	Nov	Midway Atoll, Sand Is.	1	Band 558-30754
1980	Jan	Midway Atoll	1	Band 558-30754
1980	Jan	Tern Island	1	--
1980	Dec	Midway Atoll, Sand Is.	1	Band 558-30754
1981	Oct - Dec	Midway Atoll, Sand Is.	1	Band 558-30754
1982	Jan	Tern Island	1	--
1982	Nov	Midway Atoll	1	Band 558-30754
1983	Feb	Midway Atoll	1	Band 558-30754
1984	Dec	Midway Atoll, Sand Is.	1	000 white[2]
1985	Nov	Midway Atoll, Sand Is.	1	000 white
1987	Feb - Mar	Midway Atoll, Sand Is.	1	000 white
1988	Dec	Midway Atoll, Sand Is.	1	000 white
1989	Dec Dec	Midway Atoll, Sand Is.	2	015 yellow[3]/000 white (at different locations)
1990 -1991	Fall – Winter	Midway Atoll, Sand Is.	2	000 white/015 yellow
1991 -1992	Dec - Mar	Midway Atoll, Sand Is.	2	000 white/015 yellow
1992 -1993	Dec - Jan	Midway Atoll, Sand Is.	2	000 white/015 yellow
1993 -1994	Oct Jan Feb-Mar	Midway Atoll, Sand Is.(First time birds seen together)	2	000 white/015 yellow sitting on infertile egg
1994	Feb - Mar Mar	French Frigate Shoals Kure Atoll, Green Is.	1	Band 043 yellow[4]
19941995	Nov Nov - April	Midway Atoll, Sand Is.	2	000 white/015 yellow
1995 -1996	Nov Jan Dec - Feb	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	2	015 yellow sitting on infertile egg 051 red[5]
1996	Feb	Midway Atoll, Sand Is.	1	172 black[6]
1997-1998	Nov	Midway Atoll, Sand Is.	1	015 yellow sitting on infertile egg

Year	Month	Location	Birds	Description
1998-1999	Jan-Mar Oct Feb-May	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	2	015 Yellow 057 Blue[7]
1999-2000	Oct Nov Dec-Feb	Midway Atoll, Sand Is. (057 Blue moved to female - 10 min dance) Midway Atoll, Eastern Is.	3	015 Yellow 057 Blue 051 Red
2000-2001	Oct-Apr Jan Oct-Apr Mar	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	4	057 Yellow/ 133 Black[8] 051 Red/ 057 Orange[9]
2001-2002	Oct-Apr Oct-Apr	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	2	015 Yellow sitting on infertile egg; colored band removed; metal band on left leg 051 Red
2002-2003	Oct-Mar Jan Nov-Mar	Midway Atoll, Sand Is. Midway Atoll, Eastern Is.	3	Bird with metal band on left leg[10] Unknown juvenile Unknown male wearing a metal band
2003-2004	Oct-Apr	Midway Atoll, Eastern Is.	1	Unknown adult male, metal wearing band 130-01319?[11]

[1] Chandler Robbins placed two USFWS bands (nos. 767-95701 and 767-95702) on the bird.
[2] Bird was banded as a chick on Torishima March 20, 1979.
[3] Bird was first banded as a chick on Torishima, March 24, 1982.
[4] Bird was first banded as a chick on Torishma, April 19, 1989.
[5] Bird was first banded as a chick on Torishma, April 14, 1987.
[6] Bird was first banded as a chick on Torishima, April 4, 1993; Bird had all dark plumage.
[7] Bird was first banded as a chick on Torishima, April 11, 1988.
[8] Bird was first banded as a chick on Torishima, April 8, 1993.
[9] Bird was first banded as a chick on Torishima, April 18, 1990.
[10] Most likely 015 Yellow.
[11] Most likely banded as a chick on Torishima, March 24, 1982.
Source: Data from R. Pyle, Bishop Museum, Honolulu, and USFWS Refuge reports.

Historically, the short-tailed albatross ranged along the coasts of the entire North Pacific Ocean from China, including the Japan Sea and the Okhotsk Sea (Sherburne 1993), to the west coast of North America. Prior to the harvesting of the short-tailed albatross at their breeding colonies, this albatross was considered common year-round off the western coast of North America (Robertson 1980). The short-tailed albatross ranges from approximately 66°N to 10°N latitude (King 1981) and are known to occur near St. Lawrence Island, north to the Bering Strait, south to the Barren Islands in Lower Cook Inlet and in the Gulf of Alaska (DeGange 1981). Other Bering Sea records include sightings around the Komandorskie Islands, Diomede Islands, and Norton Sound (AOU 1961). A sighting of a short-tailed albatross has been reported in the waters surrounding the NWHI. On January 23, 2000, a sighting of a juvenile short-tailed albatross was made by a NMFS observer at 33.09°N latitude and 147.49°W longitude (approximately 1,800 nm northeast of Oahu). Recently, there have been two additional sightings of short-tailed albatrosses from

Hawaii-based longline vessels, but further information about those sightings is not yet available (H. Freifeld, USFWS, pers. comm.).

Prior to the 1880s, the short-tailed albatross population was estimated to be in the millions, and it was considered the most common albatross species ranging over the continental shelf of the U.S. (DeGange 1981). Between 1885 and 1903, an estimated five million short-tailed albatross were harvested from the Japanese breeding colonies for the feather, fertilizer, and egg trade, and by 1947 only three birds remained. By 1949 the species was thought to be extinct (Austin 1949). In 1950, ten short-tailed albatross were observed nesting on Torishima (Tickell 1973).

In an effort to protect the short-tailed albatross from feather hunters, Torishima was declared a "Kinryoku" (no hunting area) in 1933, but the regulation was not enforced (Yamashina cited in Austin 1949). In 1956 the Japanese government declared the short-tail albatross a protected species and declared Torishima a National Monument (Tickell 1975). In 1972, Japan further designated the short-tailed albatross a special bird for protection (King 1981). Currently, under the IUCN criteria for identification of threatened species, the conservation status for the short-tail albatross is vulnerable (Croxall and Gales 1998). The species is also listed in the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (CITES; July 1, 1975) which protects the endangered species by prohibiting its commercial import or export or the trade of its parts across international borders. Currently, the short-tailed albatross is listed as an endangered species throughout its range under the ESA (65 FR 46643, July 31, 2000).

Today, the breeding population of the short-tailed albatross is estimated at approximately 326 breeding pairs: 276 pairs on Torishima (Table 3.6.1-3) and 50 pairs on Minami-Kojima (Figure 3.6.1-1). The short-tailed albatross has an annual survival rate of 96% and a population growth rate of 7.8% (65 FR 46643, July 31, 2000; Hasegawa 1997). Because of the robust growth of the population at Torishima, and the fact that short-tailed albatross do not return to the colony until three or four years of age, a large number of these birds are dispersed at sea. At least 25% of the reproducing adults also remain at sea during each breeding season (Cochrane and Starfield 1999). As a consequence, the exact number of individuals in the population is unknown. The population size has been estimated at about 1,900 (P. Sievert, pers. comm.). This estimate is based on a deterministic model that was fit to observed numbers and incorporated age-specific survivorship data collected for short-tailed albatross on Torishima.

Table 3.6.1-3 Short-tailed Albatross Census Counts at Torishima, Japan, Between 1977 and 2004.

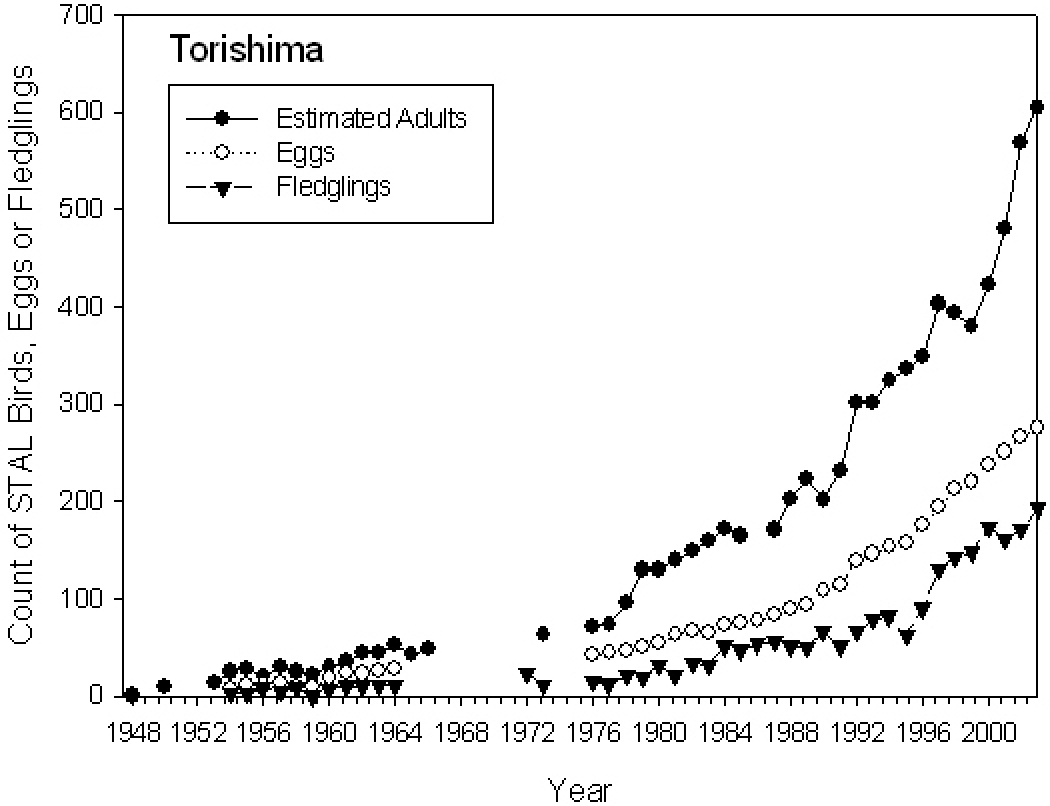
Breeding Season	Breeding Pairs	Adults	Sub-adults	Eggs	Chicks	Chicks Fledged
1977 – 1978	--	73	12	40	12[1]	12
1978 – 1979	--	96	12	--	--	22
1979 – 1980	--	130	32	50	20	20[1]
1980 – 1981	--	130	--	54	--	32
1981 – 1982	--	140	--	63	--	21
1982 – 1983	--	150	--	67	--	34
1983 – 1984	--	160	--	65	--	32
1984 – 1985	--	172	--	73	--	51
1985 – 1986	--	165	--	76	--	47

Breeding Season	Breeding Pairs	Adults	Sub-adults	Eggs	Chicks	Chicks Fledged
1986 – 1987	--	146[1]	--	77	64[1]	53
1987 – 1988		171	--	84	58[1]	57
1988 – 1989	--	203[1]	--	89	--	51
1989 – 1990	--	223	--	94	--	50
1990 – 1991	115[1]	202	--	108	66	66
1991 – 1992	--	232	--	115	--	51
1992 – 1993	--	302	--	139	--	66
1993 – 1994	--	301	--	146	--	79
1994 – 1995	--	324	--	153	--	82
1995 – 1996	--	337	--	158	--	62
1996 – 1997	--	349	--	176	--	90
1997 – 1998	--	388	--	194	--	130
1998 – 1999	--	426	--	213	--	143
1999 – 2000	--	440	--	220	–	148
2000 - 2001		476		238		173
2001 - 2002		502		251		161
2002 - 2003		534		267		171
2003 - 2004		552		276		193

[1] There are uncertainties associated with these data (i.e., very few observations).

Sources: Tickell 1975, Sanger 1972, Hasegawa 1977. Sub-adults were not always differentiated from adults in some years.

Figure 3.6.1-1 Counts of Short-tailed Albatross Adults, Eggs and Fledglings on Torishima Between 1947 and 2003 (Sources: Tickell 1975, Sanger 1972, Hasegawa 1977, H. Hasegawa and P. Sievert, pers. comm.).



Longline fisheries in the WCPO began their expansion in the early 1950's, coincident with the recovery of the short-tailed albatross population. Despite an increasing population, there have been no interactions with Hawaii-based longline vessels.

3.6.1.1.2 Black-footed Albatross (*Phoebastria nigripes*)

The NWHI contain the primary breeding colonies of the black-footed albatross population (Table 3.6.1.1). A comparatively smaller population, estimated at about 11,000 black-footed albatrosses, breeds on Torishima (P. Sievert, pers. comm.). Although the at-sea distributions of Hawaiian and Japanese black-footed albatrosses overlap both in the western Pacific Ocean and around the NWHI, these two populations have been reproductively separated (genetically distinct units) for no more than three quarters of a million years (Walsh and Edwards in review). Due to an absence of any significant gene flow between Hawaiian and Japanese populations of black-footed albatrosses, Walsh and Edwards (in review) suggest that Hawaiian and Japanese black-footed albatrosses fulfill the criteria for separate phylogenetic species and should be designated full species (*P. nigripes* and *P. nihonus*, respectively).

Descriptively, the black-footed albatross has a dark bill, legs and feet at all stages of their development. The black-footed albatross is slightly larger and heavier than the Laysan albatross, (Harrison et al. 1983, Whittow, pers. comm.). The Japanese black-footed albatross is reported to be slightly smaller than its Hawaiian counterpart (H. Hasegawa, pers. comm.). The plumage colorations for both the immature and adult black-footed albatrosses are extremely similar; brown with a white band at the base of their bill and a white sweep defining their eyes. One of the distinguishing features between adult and juvenile (i.e., young-of-the-year) black-footed albatrosses are that the juveniles lack the white plumage at the base of their tail. The plumage of the immature birds can be, but is not always, slightly darker in coloration than the adult birds. Generally, as the juvenile black-footed albatrosses mature, they tend to become more gray or dusty in appearance (Miller 1940).

The feather and egg trade in the early 1900s destroyed nesting colonies on Izu, Wake, Bonin and Marcus Islands, as well as colonies on Johnston and Taongi Atolls (Rice and Kenyon 1962, McDermond and Morgan 1993). However, a small population of approximately 1,106 - 1,206 black-footed albatrosses have recolonized the Japanese Islands of Torishima (Rice and Kenyon 1962, Hasegawa 1984, Ogi et al. 1994) and there have been recent observations of black-footed albatrosses visiting Wake Island (Rauzon et al., in prep.) and two mated pairs have been sighted over Minami Iwo Jima in 1982 (E. Flint, USFWS, pers. comm.). Since 1998, there have been no reports of visitations by black-footed albatross to Johnston Atoll or to Marcus Island (E. Flint, USFWS, pers. comm.).

Black-footed and Laysan albatrosses range throughout the North Pacific Ocean between 20°N and 58°N. Knowledge of their distribution comes primarily from reports of encounters with banded birds, from scientific transects, and from observations. A few birds have been tracked over long distances by satellites (Anderson and Fernandez 1998). Researchers used satellite telemetry to study the movements of a male black-footed albatross during its pelagic travels off the coast of California (Hyrenbach and Dotson 2001). This albatross covered a distance of 5,067 kilometers (km) during 35 days, and moved over a broad range of ocean water temperatures (22–15°C). The rate of movement of the tracked albatross varied considerably during different periods of the day, and was influenced by ambient light levels during the night (Hyrenback and Dotson 2001).

The black-footed albatross occurs regularly in large numbers off the west coast of Canada and the U.S. and off the East Coast of Japan. The Laysan is common in the Gulf of Alaska, the Aleutian Islands and Bering Sea.

The current world population of breeding black-footed albatrosses is estimated at over 300,000 individuals, with 61,141 breeding pairs in 12 colonies (Table 3.6.1-1). Nine of the colonies are located in the NWHI comprising the majority of the breeding population (96.7% or 59,120 breeding pairs).

Seventy-five percent of the NWHI breeding pairs nest in three colonies that are routinely surveyed by the USFWS: Laysan Island, Midway Atoll and French Frigate Shoals (Figure 3.6.1-2). The two largest black-footed albatross colonies, accounting for approximately 70% of the world population, are on Midway Atoll and Laysan Island. French Frigate Shoals accounts for about 6% of the world population. A complete, direct nest count of Midway's albatrosses was done at the end of December 2004. 21,829 black-footed albatross nests were counted, an increase of 8.2% from the previous complete census in 2001. Nonbreeding birds were not counted (USFWS 2004b). Three black-footed albatross colonies are also located in the western Pacific Ocean (estimated 2,021 breeding pairs) accounting for 3.3% of the world population. On, Torishima, six black-footed albatross chicks were successfully reared in 1957, and since then the number of chicks reared has increased from 914 in 1998, to 1,560 in 2003 (H. Hasegawa, unpubl. data). The black-footed albatross populations on Bonin and Senkaku Islands have also modestly increased (Table 3.6.1-1).

Many albatrosses do not return to breed each year, taking time away from breeding to molt their flight feathers. Counts of returning albatrosses may also be affected by changes in oceanographic productivity (Polovina et al. 1994). Consequently, annual counts of breeding pairs may not be representative of the entire breeding population, and may not reflect population trends. Factors affecting population size can be both environmental and human-related, such as oceanographic conditions, prey availability, and nesting habitat. Recent reductions in bycatch may account for some of the observed population increases (Harrison 2004b).

A recent modeling study (Lewison and Crowder 2003) concluded that Pacific Ocean longline fisheries may kill as many as 10,000 black-footed albatross per year, precipitating declines in the population. Several assumptions used in that study however, may be questioned. The interaction rates extrapolated to all Pacific Ocean longline fleets are those from the Hawaii observer program from 1994-1999 (Section 3.6.1.4.5) are overestimates, although by how much is unknown. The analysis ignores operational differences in the various fisheries, including areas fished, gear used, time of day fished, bait, etc. The analysis also ignores recent changes in the Hawaii fleet such as the suspension of shallow-setting in 2001 and the imposition of mandatory interaction avoidance measures. The adoption of seabird interaction avoidance measures in the Japanese fleet is also ignored.

The status of the black-footed albatross population is currently being investigated in several on-going studies. PFRP has funded development of a "General Bayesian Integrated Population Dynamics Model for Protected Species" which will incorporate both spatial and age-structured population parameters. The term of the current grant expires in 2005. When available, the model will be applied to the Hawaii population of black-footed albatross and the effect of longline fisheries on the population. NMFS will review the modeling results when they become available, in light of its requirements for use of seabird avoidance measures in longline fisheries.

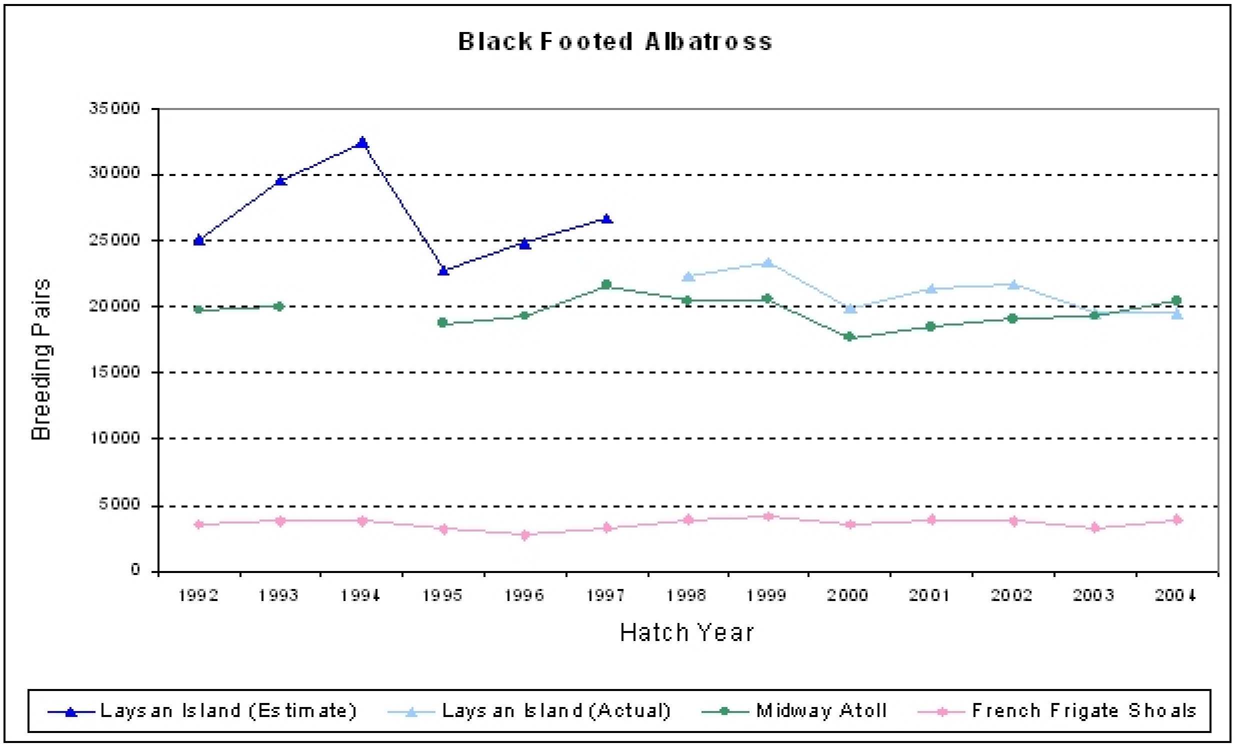
PFRP is also funding integrated statistical modeling for Hawaiian albatross populations. This work is intended to quantify the effects of past and present levels of bycatch of Laysan and black-footed albatross, and to provide a basis for answering the following questions:
1) Are the estimated levels of bycatch having a biologically significant effect on population growth?

2) How do the effects of bycatch compare to the roles of natural environmental variation on ocean productivity, and pollutants and plastic ingestion, in driving variation in the bird population dynamics?
3) Are the albatross populations declining?
4) Are changes in recruitment rates correlated with changes in the population densities?
5) Are they correlated with the time course of development of the longline fishery?

In addition, there is an ongoing study of banding data from black-footed albatrosses in the NWHI, an analysis of reproductive success from three monitoring sites in the NWHI, and the USFWS has funded a study to produce a status assessment of both black-footed and Laysan albatross species by late 2005.

There are substantial uncertainties regarding the black-footed albatross population trajectory, and differing interpretations of the existing data are possible at this time. Nevertheless, the actual population trajectories of black-footed (and Laysan) albatrosses, whatever they may be, do not affect the nature of the proposed seabird action. The objective of the action is to cost-effectively reduce the adverse effects of the Hawaii longline fishery on all seabirds. The (assumed positive) impacts of this action will be superimposed on the population trajectories and the number of birds ultimately saved will potentially contribute to growth of the populations.

Figure 3.6.1-2 Counts of Black-footed Albatross Breeding Pairs at French Frigate Shoals, Midway Atoll and Laysan Island, NWHI for Years 1992 to 2004. Counts of breeding pairs for Laysan Island were extrapolated from plot counts of eggs for years 1992 to 1997. All other data points were obtained from direct counts of breeding birds.



3.6.1.1.3 Laysan Albatross (*Phoebastria immutabilis*)

Laysan albatrosses are characterized by white plumage on their head, neck and chest, and sooty brown plumage on their upper wings, back and tail. The Laysan albatross underwings have variable patches of dark and white plumage and are distinguished by dark leading edges and wing tips. Laysan albatrosses have fleshy-pink colored legs and webbed feet, and in flight the feet project beyond the tail. The Laysan albatross eye is defined with gray and black plumage that extends to a thin line behind the eye. There are no distinguishing characteristics between sexes or between adult and immature phases.

Over the past century, the Laysan albatross population experienced several disturbances. It is estimated that before the feather hunters reached Marcus Island, the island had a population of one million Laysan albatrosses (Rice and Kenyon 1962). Feather hunters also raided Laysan albatross colonies in the NWHI, taking at least 300,000 birds from Laysan Island in 1909 (Dill and Bryan 1912). To protect the colonies from further devastation, President Theodore Roosevelt established the Hawaiian Islands Bird Reservation on February 3, 1909 (Executive Order 1019). The Reservation initially included all of the NWHI except for Midway Islands, which were under the jurisdiction of the U.S. Navy (Clapp and Kridler 1977). Jurisdiction over the Reservation was transferred to the Department of the Interior on 25 July 1940. However, tens of thousands of birds were killed during WWII, and then later thousands more were killed by the U.S. Navy in an attempt to reduce bird strike hazards to aircraft (Robbins 1966). In 1996, Executive Order 13022 transferred the administration of Midway Atoll to the Department of Interior to be managed by the USFWS as a National Wildlife Refuge. The current world population of breeding Laysan albatrosses has moderately recovered from past disturbances.

Today, it is estimated that the Laysan albatross population is approximately 3.4 million individuals, with 590,683 breeding pairs in 15 colonies (Table 3.6.1-1). Twelve of the colonies are located in the NWHI comprising of the majority of the breeding population (590,453 breeding pairs). The largest Laysan albatross colony (69% of the world population) is on Midway Atoll (Figure 3.6.1-3). Laysan Island has the second largest colony (24% of the world population). A complete, direct nest count of Midway's albatrosses was done at the end of December 2004. 408,133 Laysan albatross nests were counted, an increase of 49.9% from the previous complete census in 2001. Nonbreeding birds were not counted (USFWS 2004b). Factors affecting population size can be both environmental and human-related, such as oceanographic conditions, prey availability, and nesting habitat. Recent reduction in bycatch may account for some of the observed population increases (Harrison 2004b).

A Laysan albatross colony located on Bonin Island is comprised of 14 breeding pairs while three other colonies (with a total of 216 breeding pairs) are located in the Eastern Pacific Ocean on Guadalupe (Dunlap 1988), the San Benedicto Islands, and Isla Clarion, Mexico (Howell and Webb 1992). Since 1998, there have been no reports of visitations by Laysan albatrosses to Johnston Atoll or to Marcus Island (E. Flint, USFWS, pers. comm.).

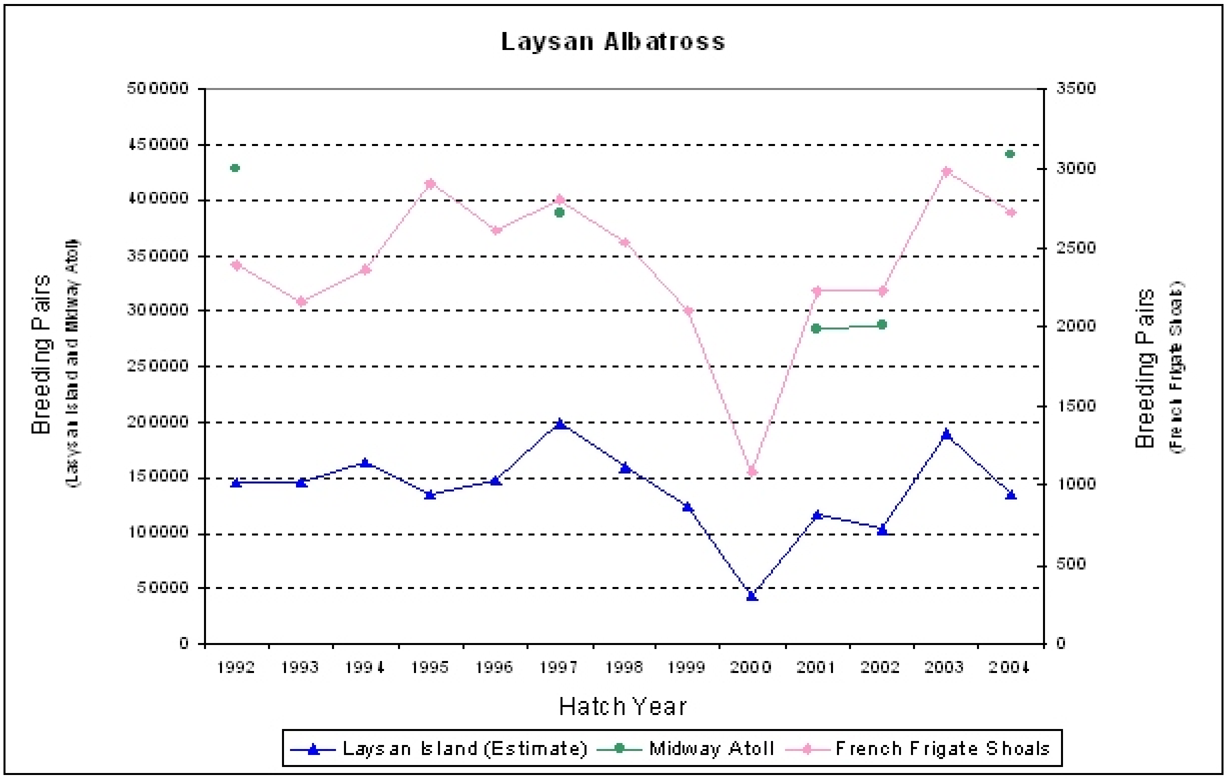
More Laysan albatross sightings are being reported on the California coast, perhaps due to the colony in Mexico. It is unknown at this time if the colony is growing due to juvenile recruitment or to immigration from other colonies. The great majority of pelagic encounters of Laysan albatross have come from west of the 180° meridian (Robbins and Rice 1974).

A serious problem for the Laysan albatross population is lead poisoning of chicks from weathering lead-based paint on old buildings on Midway Atoll. Chicks raised in nests close (< 5 m) to buildings ingest deteriorating paint directly from the buildings or paint chips that have fallen in and around their nests. Blood lead concentrations in chicks near buildings average 440 µg/dL, compared to an average blood lead concentration of 6 µg/dL in chicks nesting more than 100 m from buildings. For comparison, the Centers for Disease Control's blood level of concern for children is 10 µg/dL. The chicks near buildings frequently exhibit a condition of peripheral neuropathy called "droopwing." These chicks cannot raise their wings, leading to broken bones and open sores. They die either as a direct result of lead poisoning or from starvation when their parents stop feeding them. It is estimated that chicks suffering serious detrimental effects from lead exposure on Midway's Sand Island could number in the thousands per year (Finkelstein 2004).

As for the black-footed albatross, there is uncertainty regarding the population trajectory of the Laysan albatross. The IUCN elevated its designation to "threatened." The studies currently underway by the USFWS and PFRP have the potential to clarify the status of the Laysan albatross population.

Figure 3.6.1-3 Counts of Laysan Albatross Breeding Pairs at French Frigate Shoals, Midway Atoll and Laysan Island, NWHI for Years 1992 to 2004. Counts of breeding pairs for Laysan Island were extrapolated from plot counts of eggs for years 1992 to 2003. All other data points were obtained from direct counts of breeding birds.

3.6.1.2 Shearwaters (Order Procellariiformes, Family Procellariidae)



Three species of shearwaters breed in the Hawaiian Islands and forage in the area in which the Hawaii longline fishery operates. These are the wedge-tailed shearwater (*Puffinus pacificus*), the Christmas shearwater (*P. nativitatis*) and the Newell's shearwater (*P. auricularis newelli*). Other shearwaters, including the short-tailed shearwater (*P. tenuirostris*), the sooty shearwater and the fleshfooted shearwater, migrate from their breeding areas in the Southern Hemisphere. The short-tailed shearwater (*P. tenuirostris*), breeds in Australia but migrates to foraging areas at Kotzebue Sound which is north of the Arctic Circle in Alaska. Short-tailed shearwaters may be present in Hawaiian waters between September and May during their annual migration. The sooty shearwater is one of the most abundant birds in the world. It raises its single chick in the southern summer and migrates to the North Pacific between late March and early May (Oliver 2000). The fleshfooted shearwater breeds on islands off Australia, New Zealand, and in the southern Indian

Ocean. Its migrations extend over much of the Indian Ocean and across the western Pacific Ocean.

More details are provided below about the shearwaters that breed in Hawaii, especially the Newell's shearwater, which is listed as threatened under the ESA and is considered vulnerable by the IUCN. The Newell's shearwater has been given this conservation status because of its small population size, approximately 14,600 breeding pairs, their isolated breeding colonies, and the numerous hazards affecting them at their breeding colonies, including urban development and introduced predators like rats, cats, dogs and mongoose (Ainley et al. 1997). The conservation status of the Christmas shearwater to date is unknown. Harrison (1990) estimated that there were approximately 3,100 Christmas shearwaters nesting in the Hawaiian Islands in the late 1980s. Given that the Hawaiian Islands are at the species' most northern boundary, it is possible that the Christmas shearwater population is more abundant near breeding colonies located in the mid- and South Pacific Ocean. The wedge-tailed shearwater is one of the most abundant seabirds in the Hawaiian Islands with an estimated 1,330,000 birds (Harrison 1990). Worldwide there is an estimated 5.2 million wedge-tailed shearwaters (Whittow 1997).

Shearwaters are known to forage in the area where Hawaii longline vessels operate, but lethal interactions between shearwaters and the Hawaii-based longline fishery are rare events. A total of five shearwaters have been caught and killed by the fishery, one fleshfooted shearwater, two sooty shearwaters and two unidentified shearwaters (NMFS PIRO observer data). No Newell's shearwaters have been recorded caught or killed by the Hawaii-based longline fishery. Both the Newell's and wedge-tailed shearwaters are known to prefer foraging areas of either low water temperature, such as the cool upwelling waters of the North Pacific Transition Zone, or high salinity (Gould 1983, Spear et al. 1999). However, high densities of these birds are seen in the southeastern portion of the Hawaii longline fleet's area of operations (Spear et al. 1999). It is not unusual for a petrel to accidentally fly onto a vessel during rough weather and high seas. Usually, these birds remain on board for a brief period, or overnight, before they depart back to sea.

Shearwaters are most active in the day and skim the ocean surface while foraging. During the breeding season, shearwaters tend to forage within 50 - 62 miles (80 -100 km) of their nesting burrows (Harrison 1990). Shearwaters also tend to be gregarious at sea and only the Newell's and short-tailed shearwaters are known to occasionally follow ships (Harrison 1996). Shearwaters feed by surface-seizing and pursuit-plunging (Warham 1990). Often shearwaters will dip their heads under the water to site their prey before submerging (Warham 1990). Shearwaters are efficient swimmers as their pelvises are narrow and their legs are placed far back on their body, however, adaptions to swimming make shearwaters extremely awkward on land (Harrison 1990).

Shearwaters are extremely difficult to identify at sea, as the species are characterized by mostly dark plumage, long and thin wings, a slender bill with a pair of flat and wide nasal tubes at the base, and dark legs and feet. Like the albatross, the nasal tubes at the base of the bill enhance the bird's sense of smell, assisting them to locate food while foraging. The wedge-tailed shearwater may be more distinct from the other species of shearwaters as it is slightly larger with flesh-colored legs and feet and has a long wedge-shaped tail (Harrison 1990). The wedge-tailed shearwater is also polymorphic, meaning that there are dark, light and intermediate plumage forms (Whittow 1997).

3.6.1.2.1 Newell's Shearwater (*Puffinus auricularis newelli*)

The Newell's shearwater was listed as a threatened species under the ESA on September 25, 1975 (40 FR 44149). The Newell's shearwater breeds only in colonies on the main Hawaiian Islands, such as on Molokai, Hawaii, and mainly on Kauai (Pratt et al. 1987, Harrison 1990, Reynolds et al. 1997a, b). The Newell's shearwater (*Puffinus auricularis newelli*) was once widespread in the MHI, but is reduced to a few remnant breeding colonies because of urbanization and predation by introduced mammals.

The species was thought to be extinct in the Hawaiian Islands by 1908, but was found to be breeding on Kauai in 1967 (King and Gould 1967, Sincock and Swedberg 1969). Historically, the bird was collected for food by the Polynesians who colonized the Hawaiian Islands. Since then much of the breeding habitat for the species has been converted to agricultural, military, commercial or residential land (Cuddily and Stone 1990). The loss of nesting habitat for the species is considered one of the primary causes for the present decline of its populations (Ainley et al. 1997). Predation of adults and chicks by introduced predators, such as mongooses (*Herpestes auropunctatus*), rats (*Rattus* spp.), feral cats and barn owls (*Tyto alba*) (Byrd and Telfer 1980, Harrison 1990), is another factor in the species' decline.

The Newell's shearwater is highly pelagic, occurring year-round in the tropical and subtropical waters mostly to the east and south of the Hawaiian Islands (Ainley et al. 1997). The bird especially frequents the Equatorial Countercurrent, from near the portion of the equator lying south of the Hawaiian Islands east to about 120°W and north to and around the MHI (22°N). Isolated sightings of Newell's shearwater are recorded from the central and South Pacific Ocean, west to the Northern Mariana Islands and Guam, Wake Island, and Johnston Atoll (King and Gould 1967, Pratt et al. 1987), and south to the Marquesas Islands and Samoa (Pratt et al. 1987, Grant et al. 1994, Spear et al. 1995a).

Newell's shearwaters breed in burrows or deep rock crevices between 160 and 1,200 m elevation (Reynolds and Ritchotte 1997). Breeding pairs form in the years before mating. Mating usually begins at six years of age (Brooke 1990). One smooth, white egg is laid by the female in a breeding season. Both parents attend to a chick which is irregularly fed until it fledges in October (Telfer et al. 1987). For unknown reasons, fledglings are attracted to lights which can lead to mortality in urban settings (Reed et al. 1985). The annual adult survivorship of a Newell's shearwater is estimated to be about 90% (Ainley et al. 1997).

3.6.1.2.2 Wedge-tailed Shearwater (*Puffinus pacificus*)

The wedge-tailed shearwater is one of the largest of the tropical shearwaters with an overall length of 43 cm, and body mass of 390 g (Whittow 1997). The bird has grayish brown plumage on its back and white on its belly and underparts except for dark edge to the wings and dark undertail coverts. The sexes are indistinguishable and there are a light and a dark morph to this species.

The wedge-tailed shearwater has migratory behaviors. From September to November, large flocks of the species gather offshore before migrating near the Hawaiian Islands (King 1974). Often during this period there may be rafts of birds with up to 700 individuals. The wedge-tailed shearwater breeds between February and November in the Northern Hemisphere.

The wedge-tailed shearwater breeds from Kure Island in the NWHI to Maui Island in the MHI (Ainley et al. 1997). The wedge-tailed shearwater also breeds on other islands spread throughout the Northeast and South Pacific Ocean, including Johnston Atoll and Christmas, Bonin, Volcano, Marshall, and Caroline Islands, and the Indian Ocean where it is known to breed as far west as Madagascar (Whittow 1997).

A female wedge-tailed shearwater lays a single white egg in a burrow at sea level. The bird may use ledges and rock piles on rocky islands such as Necker in the NWHI (Harrison 1990), or use shell debris or crevices under coral ledges (Gallagher 1960). Both adults share in the excavation of the burrow, incubation of the egg, and feeding of the young (Shallenberger 1973, Shallenberger 1984). First breeding is at four years of age (Floyd and Swanson 1983), and a wedge-tailed shearwater may live as long as 29 years (E. Flint in Whittow 1997).

3.6.1.2.3 Christmas Shearwater (*Puffinus nativitatis*)

Christmas shearwaters are slender-bodied with a length of 35-38 cm and body mass of 354 g (Harrison et al. 1983). Their plumage is dark brown with their under parts being lighter than their upper parts. The sexes are indistinguishable.

The Christmas shearwater breeds primarily in the tropical Pacific Ocean ranging as far north as the Hawaiian Islands to as far south as Easter Island (Harrison 1996). The species usually breeds on remote, small, flat and sandy islands under dense vegetation such as naupaka (*Scaevola sericea*). Christmas shearwaters also breed on a steep grass covered slope on Motu Nui (Johnson et al. 1970).

Breeding adults return to the NWHI from early to late February (Naughton 1982). A breeding pair will occupy a nest site in early to late March (Seto 2001). The nest is a shallow scrape or depression in the ground, and usually located under vegetation. The female lays a single white egg each breeding season, and both parents share incubation of the egg and feeding of the chick (Seto 2001). Chicks fledge between September and October on Midway Atoll. The oldest record of a banded Christmas shearwater was 17 years on Laysan Island (K. Swift in Seto 2001).

3.6.1.3 Boobies (Order Pelecaniformes, Family Sulidae)

Three species of boobies breed in the NWHI and forage in the North Pacific Ocean: the masked booby (*Sula dactylatra*), the brown booby (*Sula leucogaster*) and the red-footed booby *(Sula sula*). Currently, the World Conservation Union classifies boobies as “not globally threatened.” Like the albatrosses, the boobies are also long-lived and have a delayed maturity. Unlike the albatrosses, which are primarily surface feeders, the boobies are plunge divers and also tend to take flying fish (*Cypselurus* spp.) just above or at the surface of the water.

To date, there have been no reports of lethal interactions between boobies and the Hawaii-based longline fishery, but boobies are reported to sit on vessel decks and watch the baited hooks as they are being set or hauled back. NOAA Fishery observers report boobies hovering over baited hooks and some birds may actually attempt a dive; however, no boobies have been reported hooked. Although the foraging behavior of boobies may differ from that of the albatrosses, such that they do not interact with longline fishing vessels or gear in the same manner, boobies are present during fishing operations and the potential for fatal interactions does exist.

Boobies breed throughout the Hawaiian Archipelago, and three localities have been routinely monitored by the USFWS in Honolulu (Table 3.6.1-4).

Table 3.6.1-4 NWHI Booby Counts at Johnston Atoll, Midway Atoll and Tern Island, French Frigate Shoals, Between 1979 and 1996.

Year	Johnston Atoll			Midway Atoll	Tern Island	
	Red-footed	Masked	Brown	Red-footed Booby	Red-footed	Masked
1979	--	--	--	--	385	--
1980	--	--	--	--	441	--
1981	40	--	92	--	394	--
1982	--	--	80	--	341	--
1983	35	--	56	--	500	--
1984	40	--	150	--	605	--
1985	57	--	135	178	727	--
1986	86	--	123	--	691	--
1987	84	1	169	--	735	--
1988	102	3	200	282	932	--
1989	116	3	189	410	1133	--
1990	119	9	217	427	888	--
1991	189	5	204	--	1267	--
1992	230	11	287	555	1348	18
1993	312	13	401	--	1579	23
1994	309	14	369	--	1040	29
1995	320	18	361	--	1561	32
1996	--	--	--	563	2194	35

Source: USFWS Refuges Office, Honolulu, Hawaii, unpubl. data.

Harrison (1990) reported breeding pair numbers from surveys of booby colonies completed between 1981 and 1988. From the surveys completed in the 1980s, it was estimated that there were about 14,000 masked boobies, 1,500 brown boobies and 11,000 red-footed boobies (Harrison 1990).

The age at first breeding for boobies is usually four years (Woodward 1972). Boobies tend to lay between one and two eggs each breeding season. Red-footed boobies only lay one egg each season, while brown boobies lay one or two eggs (Nelson 1978). Masked boobies lay two eggs and when both eggs hatch, the oldest hatchling ejects its sibling from the nest (Anderson 1990). The ejected chick is not protected by the parents and dies (Anderson 1990). Adult boobies are known to live at least 22 years, if not longer (Clapp et al. 1982, Anderson 1993).

3.6.1.4 Fishery Seabird Interactions

3.6.1.4.1 Worldwide Longline Albatross Interactions

Albatrosses forage around longline fishing vessels because they often provide the birds ample food in the form of bait, discarded bait and offal (unwanted body parts of fish catch) (Harrison et al. 1983). Brothers (1991) first quantified the magnitude of the incidental catch of albatrosses for the Japanese longline fishery in the Southern Ocean and found that by conservative calculation 44,000 albatrosses were killed annually when they attempt to take bait from baited hooks and are hooked in the process. In many instances albatrosses successfully remove a bait or part thereof from a hook without being hooked. The incidental catch of albatrosses has since been estimated in a number of other fisheries (Murray et al. 1993, Moloney et al. 1994, Ashford et al. 1995, Klaer and Polacheck 1995, Alexander et al. 1997, Klaer and Polacheck 1997, Brothers et al. 1999a), including the Hawaii-based pelagic longline fishery.

Researchers began documenting declines in wandering albatross (*P. exulans*) populations on islands in the Southern Ocean in 1979 (Croxall 1979, Tomkins 1985, Weimerskirch et al. 1987, Weimerskirch and Jouventin 1987, Croxall et al. 1990). The declines were attributed to the incidental catch of these birds by the tuna longline industry in the region (Gales 1993, CCAMLR 1994, Birdlife International 1995, Kalmer et al. 1996, Gales et al. 1998, Klaer and Polacheck, 1995). By the early 1990s, at least six of the world’s albatross species were known to have experienced recent declines in population size (Gales 1993), and it was determined that the single greatest anthropogenic threat to these seabirds was the longline fishing industry (Birdlife International 1995, Brothers et al. 1999a, Gales 1998, Cousins and Cooper 2000). The Australian Government formally recognized this threat in 1995, when it listed the incidental catch of seabirds during oceanic longline fishing operations as a key threatening process on Schedule 3 of the *Endangered Species Protection Act 1992.* The United Nations Food and Agriculture Organization Committee on Fisheries formulated an initiative calling for longlining nations experiencing incidental seabird catch to voluntarily employ proven incidental seabird catch mitigation methods in their fisheries.

The current worldwide albatross incidental catch-rate by longline vessels is believed to average 0.4 albatrosses per 1,000 hooks set (Alexander et al. 1997, Bergin 1997) although there is variation around this number. For instance, Brothers (1991) reports a catch rate of 1-1.6 albatrosses per 1,000 hooks near New Zealand, while Klaer and Polacheck (1997) estimate an incidental catch rate of 0.15 albatrosses per 1,000 hooks for Japanese longline vessels fishing in the Australian Fishing Zone. In comparison, between 1994 and 1998, before implementation of seabird interaction avoidance measures in the fleet, the USFWS estimated 0.10 Laysan albatrosses and 0.12 black-footed albatrosses were caught per 1,000 hooks in the Hawaii longline fishery (USFWS 2000).

The U.S. National Plan of Action (NPOA) to reduce the incidental catch of seabirds in U.S. fisheries was published in February 2001 (DOC 2001). The goal of the NPOA is to reduce the incidental catch of seabirds in U.S. longline fisheries where it is determined by a regional fishery management council to be a problem. It recommends that NMFS assess its longline fisheries for seabird bycatch, and if a problem is found to exist, implement measures to reduce seabird bycatch within two years. Annual reports on the status of seabird mortality in each longline fishery are required. The plan recognizes that each longline fishery has unique characteristics, and that the solution to seabird bycatch issues will likely require a multi-faceted approach requiring different fishing techniques, the use of mitigating equipment, and education within the affected fisheries. Specific mitigation measures for each fishery are not prescribed in the plan, but the seabird action assessed in this EIS supports the NPOA's objectives.

3.6.1.4.2 Hawaii Longline Seabird Interactions

Data sources considered in this EIS primarily focus on the findings and observations made onboard Hawaii-based pelagic longline vessels and the seabird populations nesting in the NWHI. The Hawaii-based longline fleet encounters seabirds because the fleet operates in known foraging grounds for the seabirds that nest in the NWHI. At present, this fishery is the only fishery operating under the Pelagics FMP known to interact with seabirds. At-sea seabird observations for vessels operating in Guam and Northern Mariana Islands are absent and limited NMFS observations of the American Samoa longline operations did not detect seabird interactions there.

Hawaii-based pelagic longline fishing operations hook, entangle and kill black-footed albatrosses and Laysan albatrosses that nest in the NWHI. The birds follow the longline vessels and dive on the baited longline hooks during setting or hauling of the longline, become hooked and subsequently drown. Besides the direct mortality to adult birds, fishing-related deaths may also have a negative influence on chick survival if one or both parent birds are killed. On rare occasions wedge-tailed and sooty shearwaters are also incidentally caught by these vessels. Although the endangered short-tailed albatross is seen in the areas where the fishery operates and is known to visit the NWHI, there are no reports of interactions between the fishery and the seabird. In the Hawaii-based longline fishery, the problem of incidental seabird catch occurs mainly among those fishing vessels targeting broadbill swordfish (*Xiphias gladius*) or a mixture of swordfish and bigeye tuna (*Thunnus obesus*), and fishing near known seabird foraging areas.

Although seabird interactions were known to occur in the Hawaii longline fishery prior to the inception of the NMFS longline observer program, the deployment of observers by the NMFS on longliners from 1994 onwards provided data to quantify seabird interaction rates. Still, management initiatives generated by the Western Pacific Fishery Management Council (WPFMC) in the early 1990s to regulate the Hawaii-based longline fishery may have inadvertently mitigated some of the incidental seabird catch. These initiatives included the limited entry program, the cap on fishing capacity (number and size of vessels), and the implementation of a 50 nautical mile protected species closed area around the NWHI. Data collected by NMFS observers showed that vessels with a line-shooter targeting principally tunas had seabird catch rates about an order of magnitude less than vessels employing no line-shooter and targeting swordfish.

3.6.1.4.3 Previous Actions to Reduce Seabird Interactions in the Hawaii-based Longline Fishery

Measures taken by the Council in the early 1990s to manage the Hawaii-based longline fishery indirectly reduced the incidental catch of seabirds by the fleet. These measures included limiting the size of the longline fleet to 162 permits, and prohibiting longline fishing in a 50 nautical mile area (Protected Species Zone) around the NWHI. Specific actions by the Council to reduce the incidental catch of seabirds began in 1996, when the Council and the USFWS conducted a workshop in Honolulu to inform longline fishermen of the problem and introduce to them various methods they could employ to reduce seabird interactions. The book *Catching Fish, Not Birds* by Nigel Brothers (1995) was translated into Vietnamese and Korean, and copies were sent to all holders of a NMFS Hawaii longline limited entry permit. A second workshop informing fishermen of the problem was held in January 1997. At that time, the USFWS also distributed a laminated card showing various species of albatross and describing possible interaction avoidance methods. The card was issued in both English and Vietnamese.

Assessments of the level of voluntarily adoption of interaction avoidance methods by Hawaii longline fishermen indicated that the education program described above was only partially successful. Two dockside visits by Council and USFWS staff in mid-1997 to examine what interaction avoidance methods, if any, were being employed revealed that, of the 12 longline vessels surveyed, five used weighted hooks, one used bait dyed blue to camouflage it in the water, three towed a trash bag or buoy, one scared birds with a horn, one distracted the birds by strategically discarding offal and two vessels employed no interaction avoidance methods. A mail survey of 128 Hawaii-based longline vessels was conducted by the Environmental Defense Fund during the same period. Ten of the 18 fishermen that responded to a question regarding interaction avoidance methods employed indicated that they were actively using some type of measure, such as reducing the use of deck lights at night, adding weights to increase the sink rate of the fishing line during setting, strategically discarding offal to distract birds, using a line-setting machine or setting the line underwater.

In October 1997, NMFS observers deployed on Hawaii-based longline vessels began recording which interaction avoidance methods, if any, were being used voluntarily by fishermen. Information from the observer program for 1998 showed that nearly all vessels used some measure, the most common being to avoid setting the line in the vessel's wake. About 55% of the vessels thawed the bait before baiting hooks, 29% of the vessels set at night and 11% avoided discarding unused bait while setting the fishing line. Only two percent of the vessels used a towed deterrent or blue-dyed bait.

A Biological Assessment (BA) by the NMFS, Pacific Islands Area Office (now the Pacific Islands Regional Office) and incorporated into the 2000 BiOp estimated that 15 short-tailed albatross have visited the NWHI over the past 60 years (NMFS 1999). The assessment noted that the historical range of the short-tailed albatross was known to include the waters and coastlines near China, Japan, Korea, Russia, the West Coast of the U.S. and British Columbia, Canada. There is no evidence to indicate that short-tailed albatross once bred in the NWHI. Many mariners and a few naturalists (i.e., H. Palmer and G. Munro) visited Midway Atoll between 1859 and 1891 (i.e., prior to the species being harvested to near extinction by Japanese settlers between 1880 and 1932) with no reports of short-tailed albatross. It is possible that the bird did breed in the NWHI, but in recent years very few short-tailed albatross have returned to Midway or other islands in the NWHI each breeding season. The BA concluded that the chance of an interaction between a longline vessel and a short-tailed albatross was extremely low, but it would be reduced further if interaction avoidance methods were employed by longline vessels in areas where the bird might be present. The BA also noted that the risk of interactions with fisheries could increase if the short-tailed albatross population grows and the range of the species expands to include its historical range along the west coast of North America.

In October 1998, a seabird population biology workshop was convened at the Council office in Honolulu to make a preliminary assessment of the impact of fishing by the Hawaii-based longline fleet on the black-footed albatross population in the NWHI (WPRFMC 2000d). The incidental catch of seabirds by fishing vessels was identified as a source of chronic or long-term mortality. It was noted that the impact of the interactions would be more serious if the albatrosses killed were predominantly adult birds because this would result not only in the consequent loss of chicks they were caring for, but also the loss of many breeding seasons for the surviving mate while it finds another mate and establishes a pair bond. However, banding data analyzed at the workshop suggested that it was predominantly immature juvenile birds that were interacting with longline boats. This finding is consistent with that of Brothers (1991), who observed that about four times as many juvenile as adult albatrosses are caught in the Southern Bluefin tuna (*Thunnus maccoyii*) longline fishery.

In anticipation that regulatory measures would be required to further reduce the incidental catch of seabirds in the Hawaii longline fishery, in 1998 the Council funded a study to assess which interaction avoidance methods would be most effective for local vessels under actual commercial fishing conditions. As reported in McNamara et al. (1999), the study assessed the effectiveness of various interaction avoidance methods aboard Hawaii-based longline vessels under actual fishing conditions. The interaction avoidance techniques evaluated included several of those identified by Alexander et al. (1997) as being effective in other fisheries, such as night-setting, towed deterrents, modified offal discharge practices and thawed bait. In addition, the study evaluated blue-dyed squid bait, the effectiveness of which appeared promising based on limited use by Hawaii-based longline vessels, but which previously had not been scientifically assessed. Because data collected by NMFS observers showed that Hawaii-based longline vessels targeting swordfish had higher incidental catches of seabirds than did vessels targeting tuna, the study tested the effectiveness of interaction avoidance methods primarily during swordfish trips. The criteria used to evaluate the effectiveness of interaction avoidance methods included the number of attempts on (chases, landings and dives) and interactions (physical contact) with fishing gear as well as actual hookings and mortalities.

In early 1999, NMFS' Honolulu Laboratory assessed the effectiveness of several seabird interaction avoidance methods during a cruise on a NOAA research vessel in the waters around the NWHI (Boggs 2001). This study was designed to supplement the field test of towed deterrents and blue-dyed bait conducted in the Council-funded study, and to evaluate an additional measure: weighted branch lines. The advantage of using a research vessel to test the effectiveness of interaction avoidance methods was that fishing operations could be controlled to improve the opportunities for observation, comparison and statistical analysis. For example, by setting gear in daylight, researchers greatly increased the number of bird interactions with the gear in the presence and absence of each interaction avoidance method. Easily regurgitated net pins were substituted for hooks in the research to avoid injuring seabirds. Based on observer records from 1994 to 1998, the Honolulu Laboratory also assessed the mitigative effectiveness of a line-setting machine used in combination with weighted branch lines.

In October 1999, the Council recommended three measures to mitigate the harmful effects of fishing by vessels registered under Hawaii longline limited entry permits on seabirds. The first measure required vessel operators fishing with longline gear north of 25°N to employ two or more of the following seabird interaction avoidance techniques: 1) maintain adequate quantities of blue dye on board and use only completely thawed, blue-dyed bait; 2) discard offal while setting and hauling the line in a manner that distracts seabirds from hooks; 3) tow a NMFS-approved deterrent (such as a tori line or a buoy) while setting and hauling the line; 4) deploy line with a line-setting machine so that the line is set faster than the vessel's speed , promoting rapid sinking of the bait; 5) attach weights equal to or greater than 45 g to branch lines within one meter of each hook; and 6) begin setting the longline at least one hour after local sunset and complete the setting process no later than local sunrise, using only the minimum vessel's lights necessary for safety. The second measure directed vessel operators to make every reasonable effort to ensure that birds brought onboard alive are handled and released in a manner that maximizes the probability their long-term survival. The final measure required all vessel owners and operators to annually complete a protected species educational workshop conducted by NMFS.

NMFS published a proposed rule for the Hawaii-based longline fishery based on the Council's recommended measures (65 FR 41424, July 5, 2000). However, the agency did not proceed with the publication of a final rule, as the USFWS was in the process of developing a BiOp under section 7 of the ESA for the effects of the fishery on the short-tailed albatross.

The USFWS BiOp, published on November 28, 2000 (USFWS 2000), concluded that the Hawaii-based longline fishery was not likely to jeopardize its continued existence. The BiOp was based on the operations of the Hawaii-based longline fishery prior to December 1999, and anticipated that the fishery would take 15 short-tailed albatross during the seven-year period addressed in the consultation (2.2 short-tailed albatross annually from 2000-2006). The BiOp considered a "take" to include not only injury or mortality to a short-tailed albatross caused by longline gear, but also any short-tailed albatross striking at the baited hooks or mainline gear during longline-setting or haulback.[23]

The 2000 USFWS BiOp included several non-discretionary measures to be employed by the Hawaii-based longline fishery and implemented by NMFS. In contrast to the Council's recommendation requiring the use of any two of the six approved measures when fishing north of 25°N, the 2000 USFWS BiOp required that all Hawaii-based vessels operating with longline gear north of 23°N latitude use thawed, blue-dyed bait and discard offal strategically to distract birds during setting and hauling of longline gear. In addition, when making deep-sets (targeting

[23]The 2002 BiOp (USFWS 2002) states "Because the Service defines take of short-tailed albatrosses to include injury or mortality resulting from physical interaction with longline gear, it is not necessary to have a dead bird in hand to document take. The record of a short-tailed albatross physically interacting with gear and being hooked and/or obviously killed is sufficient."

tuna) north of 23°N latitude, Hawaii-based vessel operators were required to employ a line-setting machine with weighted branch lines (minimum weight: 45 g). Under the Terms and Conditions of the BiOp, all longline vessel operators and crew were also required to follow certain handling techniques to ensure that short-tailed albatross would be handled and released in a manner that maximizes the probability of their long-term survival, and vessel operators were required to annually complete a protected species educational workshop conducted by NMFS. It was recommended that these guidelines be followed for all seabirds hooked but still alive. Optional interaction avoidance methods included towed deterrents, or the use of weighted branch lines without a line-setting machine (in the case of swordfish or mixed target sets).[24] In addition, operators of vessels making shallow-sets (targeting swordfish) north of 23°N latitude were required to begin the setting process at least one hour after sunset and complete the setting process by sunrise.

The emergency and final regulations implementing the above seabird mitigation measures for the Hawaii-based longline fishery were promulgated on June 12, 2001 and May 14, 2004, respectively. However, the 2000 USFWS BiOp requirements regarding shallow-set longlining north of 23°N latitude were not implemented by NMFS. Instead, for the purpose of minimizing effects of the fishery on threatened and endangered sea turtle species, on March 31, 2001, by order of the court, NMFS prohibited all shallow-set pelagic longline fishing north of the equator by Hawaii-based longline vessels. Implementation of seabird interaction avoidance measures for the shallow-set sector of the fleet was thus rendered moot.

The March 31, 2001 closure of the shallow-set longline component of the fishery led NMFS on August 15, 2001, to reinitiate consultation with the USFWS under the ESA to examine the impacts of the reduced (deep-set only) fishery on short-tailed albatross. The subsequent 2002 BiOp was released November 18, 2002, and again concluded that the Hawaii-based longline fishery was not likely to jeopardize the continued existence of the short-tailed albatross. The 2002 USFWS BiOp estimated that one short-tailed albatross per year may be taken in the reduced Hawaii-based longline fishery, or a total of four over the remaining four-year duration of that consultation (USFWS 2002).

In the meantime, in 2001, the Council, NMFS, the HLA, USFWS and the Blue Ocean Institute continued a collaborative research effort on seabird interaction avoidance techniques using tuna gear. Of particular interest was the development of an underwater setting chute in New Zealand and Australia, and the potential for adapting this technology for Hawaii-based longline vessels.

A series of research trials with new interaction avoidance methods were conducted between 2002 and 2003 using Hawaii-based longline vessels. The trials found that underwater setting chutes and side-setting in conjunction with a bird curtain, where the longline is deployed laterally from amidships rather than directly over the stern, were also effective in minimizing interactions with seabirds.

In a ruling on August 31, 2003, the District Court vacated the 2002 sea turtle BiOp prepared by NMFS and the fishery regulations promulgated on June 12, 2002. This had the effect of

[24] On October 18, 2001, the USFWS revised the 2000 BiOp to include traditional basket-style, tarred mainline gear as an alternative to monofilament gear set with a line-setting machine and weighted branch lines.

removing the ban on shallow-setting by the Hawaii-based longline fishery, but also removed the protection afforded fishermen from prosecution under the ESA by the Incidental Take Statement for listed sea turtles contained in the invalidated BiOp. This situation, combined with new information, experimental results and technological advances in longline gear design applicable to interactions between the fishery and sea turtles, prompted the Council to recommend new turtle interaction mitigation methods for the Hawaii-based fishery. As a result, current regulations allow a limited amount of shallow-set longline effort (2,120 sets annually) by Hawaii-based vessels using circle hooks with mackerel-type bait. Because this action allowed limited shallow-setting, it also implemented the 2000 USFWS BiOp requirements for shallow-setting north of 23°N latitude (i.e., thawed, blue-dyed bait, strategic offal discard, night setting, line shooter with weighted branch lines, seabird handling techniques and protected species workshop attendance). Final regulations implementing these recommendations were promulgated on April 2, 2004 (69 FR 17329).

A recent Biological Assessment (BA) concluded that the seasonal southern time/area closure during April and May (from the equator to 15°N and 145°W to 180°) poses a low likelihood of increased seabird interaction rates and that the fishery would not likely jeopardize the short-tailed albatross (HLA and WPRFMC 2004). The BA also acknowledged that the greatest likelihood of interaction with seabirds may exist with the reopening of the swordfish component of the fishery, even though this component of the fishery will be markedly different than the historical fishery, such that vessels will employ all required seabird interaction avoidance measures as well as use circle hooks and mackerel bait (HLA and WPRFMC 2004).

3.6.1.4.4 Monitoring Seabird Interactions

The two major sources of information on albatross interactions with Hawaii-based longline vessels are the mandatory logbook and observer data collection programs administered by NMFS. The longline logbook program requires operators of longline vessels to complete and submit to NMFS a data form containing detailed catch and effort data on each set (50 CFR 660.14). Although the information is extensive, it does not compare to the completeness of the data collected by NMFS observers. Furthermore, preliminary comparisons between logbook and observer data indicate under-reporting of protected species interactions by vessel operators in the logbooks (NMFS 1996).

The Observer Program administered by NMFS was implemented in February, 1994 to collect data on protected species interactions (marine turtles have highest priority) which include: all sea turtles, especially green, leatherback, and loggerhead turtles; Hawaiian monk seals; selected whale and dolphin species; and seabirds, including the albatross species and the brown booby. The NMFS Observer Program achieved 5.3% coverage of all trips in the first year it was implemented, but then did not exceed 5% coverage over the next five years (Table 3.6.1-5). The selection of trips to observe was based on a sampling design by DiNardo (1993) to monitor sea turtle interactions. Because most interactions with sea turtles tended to occur on vessels setting shallow and targeting swordfish, most trips observed tended to be those that fished above 23°N latitude and targeted swordfish or a mixture of swordfish and tuna. As a consequence of regulatory changes, and with the prohibition of shallow-setting, a new sampling program was designed by M. McCracken where observers are randomly placed on vessels.

Although monitoring protected species interactions is the primary purpose of the Observer Program, the observers also collect catch data on the fishery and, in total, record five different sets of data as follows: 1) incidental sea turtle take events; 2) fishing effort; 3) interactions with other protected species; 4) fishes kept and discarded, by species; and, 5) life history information, including biological specimens in some instances. The data from this program cover observed trips from February 25, 1994 to the present, and provide the primary source of statistical information on seabird interaction rates for the Hawaii longline fishery.

Table 3.6.1-5 NMFS Observer Program Coverage of Hawaii-based Longline Fishing Vessels Between 1994 and 2003.

Year	Number of Trips	Observed Number of Trips	Average % Coverage
1994	1031	55	5.3
1995	937	42	4.5
1996	1062	52	4.9
1997	1123	40	3.6
1998	1180	48	4.1
1999	1136	38	3.3
2000[1]	1134	118	10.4
2001[2]	1035	233	22.5
2002	1193	294	24.6
2003	1120	266	22.2

[1] Year 2000 was calculated as the time period between August 25, 2000 and March 31 2001.
[2] Year 2001 was calculated as the time period between July 1, 2001 and June 30, 2002.

NOAA observers record seabird interaction data from three main types of events that include approaches, contacts and sightings. At-sea seabird abundance around Hawaii longline fishing vessels is also collected (Figure 3.6.1-4). Sighting events are descriptions of seabird activity or behavior that do not involve approach or contact. An approach event is when a seabird is observed coming closer to the vessel or the gear and in some cases attempting to make contact. A contact event is when the seabird is observed to touch the gear. Any seabirds that become entangled or hooked in the gear are considered incidental catch. A mortality is usually recorded by a NOAA observer when a seabird is retrieved during the haul. Dead seabirds retrieved on the haul-back are assumed to have been hooked during the set. Infrequently, albatrosses are incidentally caught during the haul, and although they are usually alive when landed, their subsequent mortality rates are unknown.

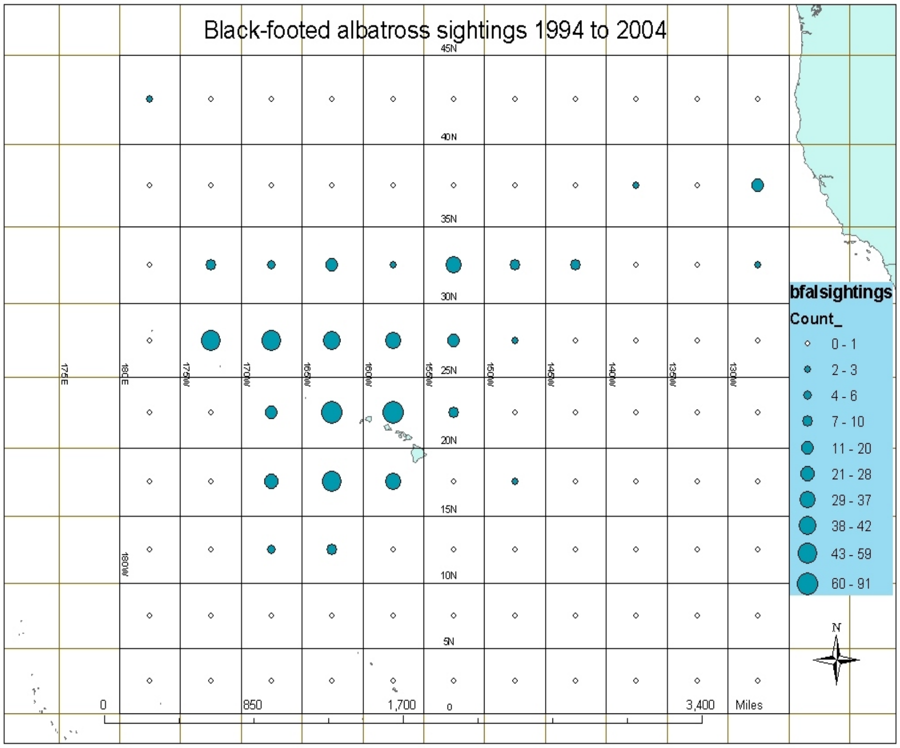
The recording of approach and contact events are important in that these data could be used to estimate seabird incidental catch. For instance, seabird interaction avoidance measure data collected on Hawaii longline fishing vessels during 1998 (McNamara et al. 1999) suggested that approach and contact events by albatrosses are correlated with hooking events. Further, contact events also appear to be linearly correlated with the number of seabirds present. Because seabird mortalities are statistically rare events (Brothers 1991, Perkins and Edwards 1996), gathering enough mortality data to show a statistically significant difference between interaction avoidance methods may be difficult given that the seabird interaction rates for the Hawaii longline fishery are very low (Section 3.6.1.4.5). The gathering of more abundant data such as approaches and contacts may be one way to estimate possible seabird incidental catches in the fishery.

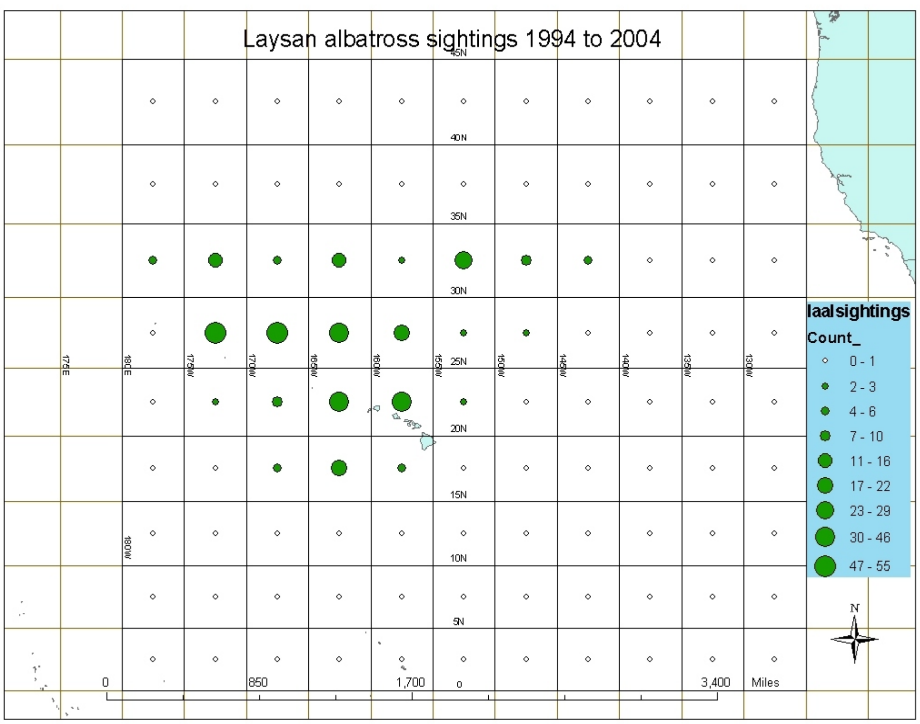
The relationship described in the second assumption supposes that albatross behavior is density independent, such that as bird abundance increases the number of approaches (or attempts to contact the gear) and contact events increase linearly. Because albatross abundance varies at sea, the data could be biased by inequalities in their abundance during the application of various interaction avoidance methods. Albatross abundance data could be taken so that results could be presented in units of behaviors/mortality per bird (Grabowsky et al. in prep.). This correction is successful only if the number of behaviors show a linear correlation with changes in abundance. The data from the McNamara et al. (1999) study and that of Gilman et al. (2003) suggest that the assumption that albatross attempt and contact events are correlated with a catch event, is valid.

3.6.1.4.5 Estimating the Incidental Catch of Seabirds by the Hawaii-based Longline Fishery

The NMFS, Southwest Fisheries Science Center, Honolulu Laboratory (NMFS, SWFSC Honolulu Laboratory [now PIFSC]) used data from observer reports and the Western Pacific Daily Longline Fishing Log to estimate the annual incidental catch of seabirds in the Hawaii longline fishery, and to describe the spatial distribution of the catch.

Figure 3.6.1-4 Abundance of Black-footed Albatrosses (top map) and Laysan Albatrosses (bottom map) Around Hawaii Longline Vessels During Fishing Operations (Source: NMFS Observer Program, unpubl. info.).





Fleet-wide incidental catch estimates prior to 1998, were computed using a regression tree technique and bootstrap procedure (Skillman and Kleiber 1998). The regression tree technique revealed structure in observer data sets and was applied to an array of independent variables (e.g., month, latitude, longitude, target species, gear type, sea surface temperature and distance to seabird nesting colonies). The model was "pruned" by cross validation, meaning that only the statistically significant predictors of seabird catches were kept in the analysis. Interestingly, this analysis showed that catches of black-footed albatrosses were found to be significantly related only to proximity to nesting colonies and longitude, while catches of Laysan albatrosses were significantly related only to proximity to nesting colonies and year (Klieber 1999). In 1999, McCracken (2000) developed a new prediction model to estimate the number of black-footed and Laysan albatrosses captured by the Hawaii longline fishery during 1999, and then re-estimated captures for earlier years, 1994-1998 (Table 3.6.1-6).

For each albatross species, a prediction model was developed that related the number of captures documented by an observer to ancillary variables recorded in the vessel's logbook or derived from such variables. The model was then used to predict the number of albatrosses captured on each unobserved trip on the basis of the predictor variables recorded in the logbooks for those trips. The total annual number of albatrosses captured by the fleet was estimated by adding the sum of predicted captures for the unobserved trips to the sum of recorded captures for the observed trips. After exploring several alternative statistical models for capture estimation, a negative binomial generalized linear model was adopted. Variables well represented in the logbooks and transformations of them were considered as candidate predictors. A bootstrapping procedure that takes into account the uncertainty of the prediction model parameter estimates, and also the random variation of actual unobserved captures about the expected predicted values, was used to construct approximate "prediction intervals" for captures. The bootstrap analysis also produced estimates of the estimation bias; the latter was used to adjust the point estimates. Point estimates adjusted for estimation bias and approximate prediction intervals for captures are given in Table 3.6.1-6. Estimates of captures for the years 1994-1998 differ from values computed and reported by P. Kleiber in 1999. The revised estimates are based on a larger accumulation of observer statistics and different prediction models.

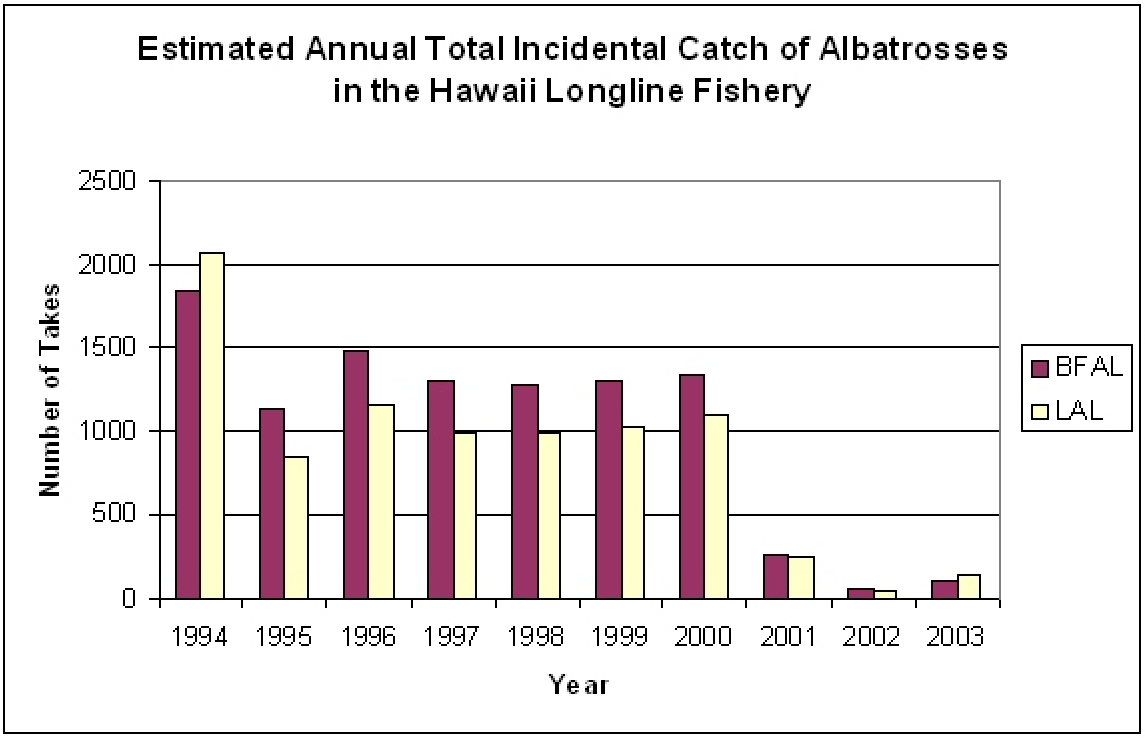
It was estimated that between 1994 and 1999, an average of 1,175 Laysan albatrosses and 1,388 black-footed albatrosses were killed in the Hawaii longline fishery each year (Table 3.6.1-6). These average annual incidental catches represent about 0.46% and 0.05% of the estimated 1998 worldwide black-footed and Laysan albatross populations, respectively. Albatross behavior, coupled with their numbers, may explain why more black-footed albatrosses interact with Hawaii longline fishery than Laysan albatrosses. The world breeding population of the Laysan albatross (558,415 birds) was estimated to be roughly ten times that of the black-footed albatross (61,866 birds), yet more black-footed albatrosses were recorded to interact with the Hawaii-based longline fishery, suggesting that the latter species was more seriously affected (Cousins and Cooper 2000). Satellite telemetry studies have shown that in general the Laysan albatrosses tend to fly to Alaska to forage whereas the black-footed albatrosses fly to the west coast continental U.S. (Anderson and Fernandez 1998). More recent data show the dramatic decline (Table 3.6.1-6, Figure 3.6.1-5) in seabird catch by the Hawaii longline fishery with closure of the shallow-set sector of the fishery and imposition of mandatory interaction avoidance measures above 23°N latitude.

Table 3.6.1-6 Estimated Annual Total Incidental Catch of Albatrosses in the Hawaii Longline Fishery.

Black-footed Albatross				
Year	Estimated Seabird Catch	95% Prediction Interval		Previous Estimate (Kleiber 1999)
		Lower Bound	Upper Bound	
1994	1,830	1,457	2,239	1,994
1995	1,134	899	1,376	1,979
1996	1,472	1,199	1,811	1,568
1997	1,305	1,077	1,592	1,653
1998	1,283	1,028	1,601	1,963
1999	1,301	1,021	1,600	—
2000	1,339	—	—	—
2001	258	—	—	—
2002	65	—	—	—
2003	111	43	211	—
Laysan Albatross				
Year	Estimated Seabird Catch	95% Prediction Interval		Previous Estimate (Kleiber 1999)
		Lower Bound	Upper Bound	
1994	2,067	1,422	2,948	1,828
1995	844	617	1,131	1,457
1996	1,154	835	1,600	1,047
1997	985	715	1,364	1,150
1998	981	679	1,360	1,479
1999	1,019	688	1,435	—
2000	1,094	—	—	—
2001	252	—	—	—
2002	51	—	—	—
2003	146	77	247	—

Sources: 1994-1999, NMFS, SWFSC Honolulu Laboratory (McCracken 2000). 2000-2003, NMFS PIRO Annual Reports on Seabird Interactions in the Hawaii Longline Fishery.

Figure 3.6.1-5 Estimated Annual Total Incidental Catch of Albatrosses in the Hawaii Longline Fishery (1994-2003) (Sources as for Table 3.6.1-6).

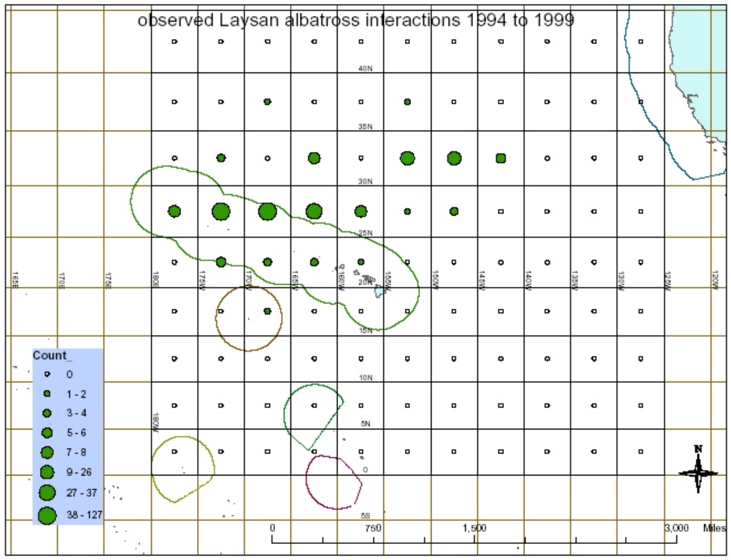


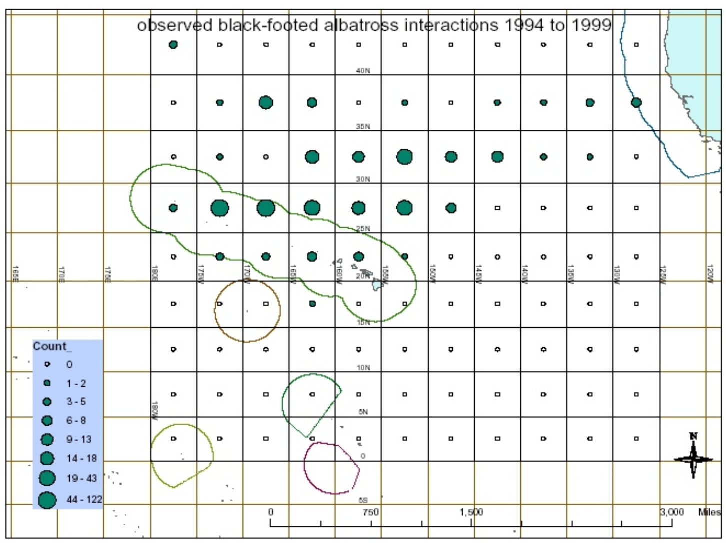
Based on NMFS' extrapolations from observer data during 1999, the fleet is estimated to have retrieved 2,320 hooked albatrosses (1,301 black-footed and 1,019 Laysan), while in 2002 the fleet is estimated to have retrieved 113 hooked albatrosses (65 black-footed and 51 Laysan), and 257 albatrosses (111 black-footed and 146 Laysan) in 2003. The closure of the swordfish fishery (which previously operated without seabird interaction avoidance measures) and imposition of interaction avoidance measures on the tuna fishery reduced population impacts on black-footed and Laysan albatrosses by approximately an order of magnitude.

The USFWS has reported that worldwide populations of short-tailed albatrosses are increasing at more than 7% per year. Even though no short-tailed albatross has been reported interacting with a Hawaii-based longline vessel or its gear, a BA (NMFS 1999) was completed to assess the range of maximum annual interactions in the Hawaii longline fishery. The assessment concluded that between one and three short-tailed albatross may be in the area where the fishery operated, based on the at-sea sighting from aboard the NOAA FRS *Townsend Cromwell* and visitations to the NWHI. The continued sighting of the lone female short-tailed albatross on Sand Island, Midway Atoll, suggests that if the bird interacts with a Hawaii longline vessel and its gear, the interaction is not lethal. Interactions could occur with no injuries to the bird, but hooking and entanglement interactions often lead to a death. Given the historical levels of fishing effort and lack of interactions of short-tailed albatross with the Hawaii longline fishery, the probability of a single interaction was assessed to be extremely low; and this probability would be reduced if seabird interaction avoidance techniques were employed. Based on a random distribution of the short-tailed albatross in the North Pacific Ocean, and the area fished by the Hawaii longline fishery, the USFWS in their 2000 BiOp estimated that 334 short-tailed albatross are in the area where the fishery operates and that up to 2.2 birds would be incidentally caught each year. Then on November 18, 2002, the USFWS revised the short-tailed albatross BiOp to reflect the changes in the fishery (no shallow-sets) due to the final sea turtle rules. They amended the Incidental Take Statement for the Hawaii-based longline fishery from 2.2 short-tailed albatross per year to one bird per year. The 2004 BiOp (USFWS 2004a) concerning the effects of the shallow-set sector of the fishery on the short-tailed albatross also contains an Incidental Take Statement limiting the potential take in that sector of the fishery to one bird.

Data collected by the NOAA Observer Program show that when Hawaii-based longline vessels targeted swordfish without using seabird interaction avoidance measures the incidental catch of seabirds was far higher than when vessels target tuna (Table 3.6.1-7). One reason for this is that vessels targeting swordfish are more likely to operate within the foraging range of the seabirds. Black-footed and Laysan albatrosses nesting in the NWHI forage predominantly to the north and northeast of the Hawaiian Archipelago, flying as far as Alaska or the western coast of the contiguous U.S. (Anderson and Fernandez 1998). The region of greatest interaction between seabirds and the longline fishery as it operated in 1998 is a latitudinal band between 25°N and 40°N stretching from the international dateline to about 150°W (Figure 3.6.1-6). This band, referred to as the North Pacific Transition Zone, contains a broad, weak, eastward flowing surface current composed of a series of fronts situated between the Subtropical Gyre to the south and Subarctic Gyre to the north (Roden 1980, Polovina et al. 2000, Seki et al. 2002). The convergent fronts are zones of enhanced trophic transfer with high concentrations of phytoplankton, zooplankton, jellyfish and squid (Bakun 1996, Olson et al. 1994).

Figure 3.6.1-6 Observed Interactions of Black-footed Albatrosses (top) and Laysan Albatrosses (bottom) Between 1994-1999 in the Hawaii Longline Fishery (Source: NMFS Observer Program, unpubl. info.).





The increased level of biological productivity in these zones attracts, in turn, higher trophic level predators such as swordfish, sea turtles and seabirds. Hawaii longline vessels that targeted swordfish set their lines where the fish are believed to be moving south through the fronts following squid, the primary prey of swordfish (Seki et al. 2002). Squid is also the primary prey item for the albatrosses (Harrison et al. 1983). Hence, the albatrosses and the longline vessels targeting swordfish are often present at the same time in the same northern front of high biological productivity.

A second reason that longline vessels targeting swordfish incidentally caught a larger number of seabirds than vessels targeting tuna relates to differences in gear configuration and the depth and time of gear deployment. Longline gear targeting swordfish generally consists of fewer hooks between floats (3-5), branch line (gangion) weights attached further from the hooks, and buoyant chemical light sticks. During swordfish fishing, the longline is set at a shallow depth (5-60 m), and the line and baited hooks sink comparatively slowly. Consequently, albatrosses following behind a vessel targeting swordfish have a greater opportunity to dive on hooks and become caught. In addition, before current regulations mandating night-setting, vessels targeting swordfish often set their lines in the late afternoon or at dusk when the foraging activity of seabirds may be especially high.

Vessels targeting tuna differ from those targeting swordfish in that they generally operate in warm waters further south and set their lines at a relatively deep depth (15-180 m or greater). To facilitate the deployment of fishing gear at these depths vessels usually increase the longline sink rate by employing a hydraulic line-setting machine (line-shooter or line-setter) to set the mainline with slack to promote rapid sinking and branch lines with 40-80 g weights attached close (20-90 cm) to the hooks. The use of a line-setting machine and weighted branch lines to increase the longline sink rate also reduces the incidental catch of seabirds by decreasing the time that baited hooks are near the surface and accessible to feeding seabirds.

Since December 1999, the Hawaii longline fishery has been subject to a range of measures arising from litigation concerning sea turtle interactions in this fishery. These methods included time-area closures, fishing effort limits, and a ban on shallow longline sets, and were designed to minimize interactions between the longline fishery and sea turtles. A consequence of these various methods to reduce sea turtle takes also affected the level of seabird incidental catch by the Hawaii longline fishery. In particular, the ban on the use of shallow longline sets greatly reduced the incidental catch of black-footed and Laysan albatrosses.

In 2000, the Hawaii-based longline fishery operated under two different management regimes: 1) between January 1 - August 24, 2000, the Hawaii-based longline fleet was prohibited from fishing within a box (termed “Area A”) which was bounded by 28°N, 44°N, 150°W and 168°W; between August 25 - December 31, 2000, the fleet continued to be prohibited from fishing within Area A, but was also limited to no more than 154 sets (with 100% observer coverage) within the area on either side of Area A and bounded by 28°N and 44°N and between 173°E and 168°W (“Area B”). Further, targeting of swordfish (shallow-setting) was prohibited in waters between the equator and 28°N, from 173°E to 137°W (“Area C” Figure 3.6.1-7).

Total fleet wide incidental catches of seabirds during the two time periods in 2000 were estimated using a prediction model that related observer recorded catch to ancillary (predictor) variables recorded in logbooks (McCracken 2001). The incidental seabird catch for unobserved trips was predicted by applying the model to the predictor variables recorded in the logbooks for those trips. The catch rates were then calculated as the bird catch per set (fleet wide catches/fleet wide effort).

A comparison of seabird incidental catch rates between 1999 (Table 3.6.1-6), and the two management regimes in 2000 (Table 3.6.1-7), reveals that area closures and a prohibition on shallow-setting greatly reduced the incidental seabird catch rates. The area closure alone may not have been effective at reducing the incidental catch of seabirds by the Hawaii longline fleet because the result of the closure (implemented to afford protection to sea turtles) tended to push fishing effort towards the breeding colonies on the NWHI. Earlier analysis of NMFS observer data showed that catches of black-footed and Laysan albatrosses were found to be significantly related to the proximity to nesting colonies (Skillman and Kleiber 1998).

Table 3.6.1-7 Estimated Fleet-wide Albatross Catch Rates During Two Time Periods in 2000 for the Hawaii-based Longline Fishery Based on NMFS Observer Records.

Period	Observer Coverage (% of trips)	Total Fleet Wide Effort (# of sets)	Estimated Fleet Wide Seabird Catch Rate (bird catch/set)	
			Black-footed	Laysan
January 1, 2000 to August 24, 2000	4.4	9156	0.13	0.12
August 25, 2000 to December 31, 2000	21.3	3827	0.02	0

Further regulatory changes were made on June 12, 2001. Of most relevance to seabird catch was the continued prohibition on shallow-setting for all Hawaii-based longline vessels fishing north of the equator, as well as requirements that all bait be dyed blue and that strategic offal discards be used to mitigate seabird interactions. The low numbers of observed seabirds caught by the Hawaii longline fleet during 2001 (Figure 3.6.1-7), suggests that the prohibition on shallow-setting continued to maintain the fleet's reduced seabird incidental catch (Table 3.6.1-8).

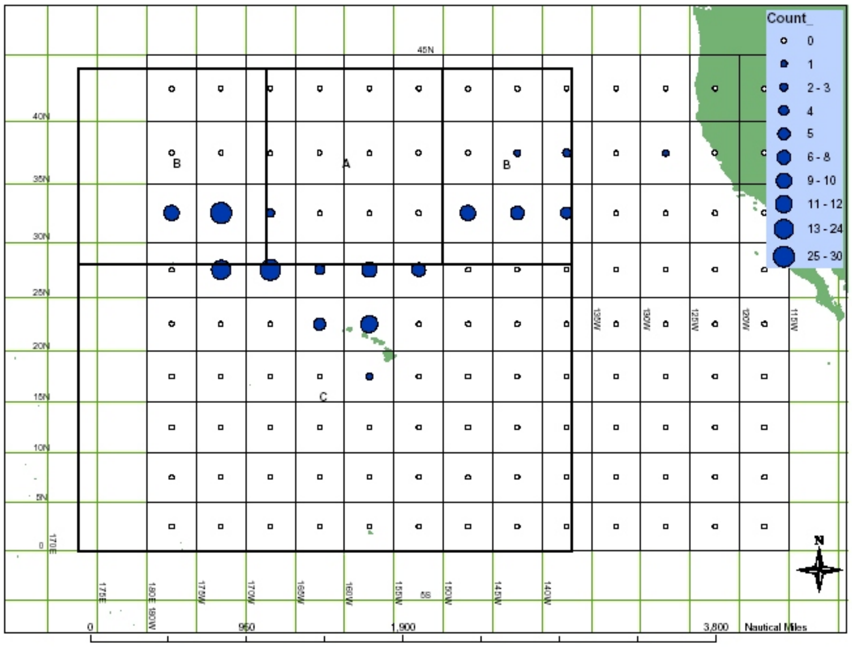
Table 3.6.1-8 Observed Numbers of Seabirds Caught by Hawaii-based Longline Vessels Between 2001 and 2003.

Seabird Species	2001			2002			2003		
	Released Alive	Returned Dead	Total	Released Alive	Returned Dead	Total	Released Alive	Returned Dead	Total
Black-footed Albatross	6	76	82	1	17	18	1	23	24
Laysan Albatross	13	63	76	3	13	16	0	44	44
Sooty Shearwater	0	2	2	0	0	0	0	0	0
Unidentified Shearwater	0	1	1	0	0	0	0	0	0
Total	19	142	161	4	30	34	1	67	68

Source: NMFS Observer Program, unpubl. info.

Figure 3.6.1-7 Observed Interactions of Black-footed Albatrosses (top) and Laysan Albatrosses (bottom) Between August 25, 2000 and March 31, 2001, in the Hawaii Longline Fishery (Source: NMFS Observer Program, unpubl. info.)

observed black-footed albatross interactions 2000



observed Laysan albatross interactions 2000

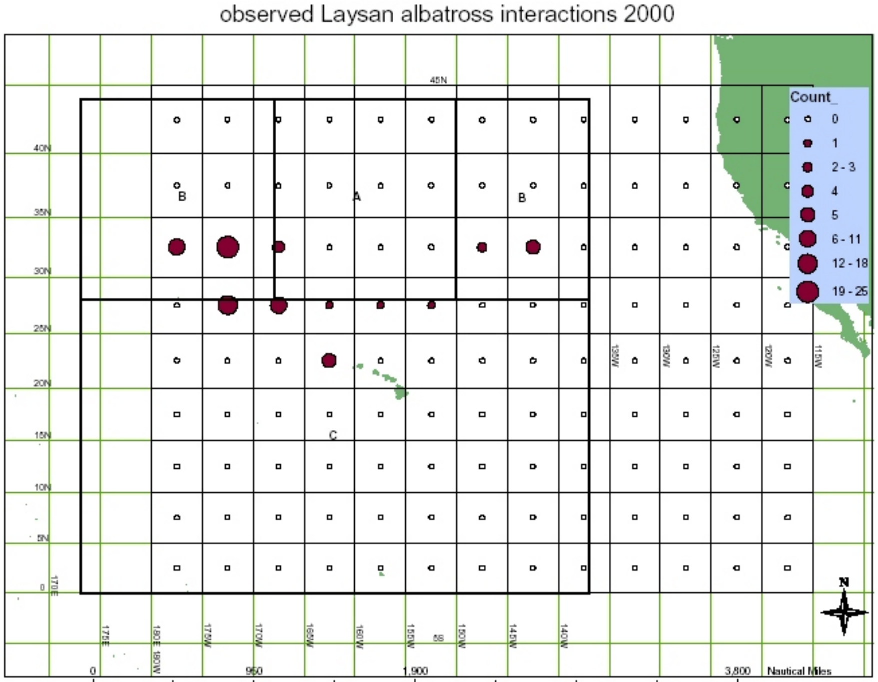
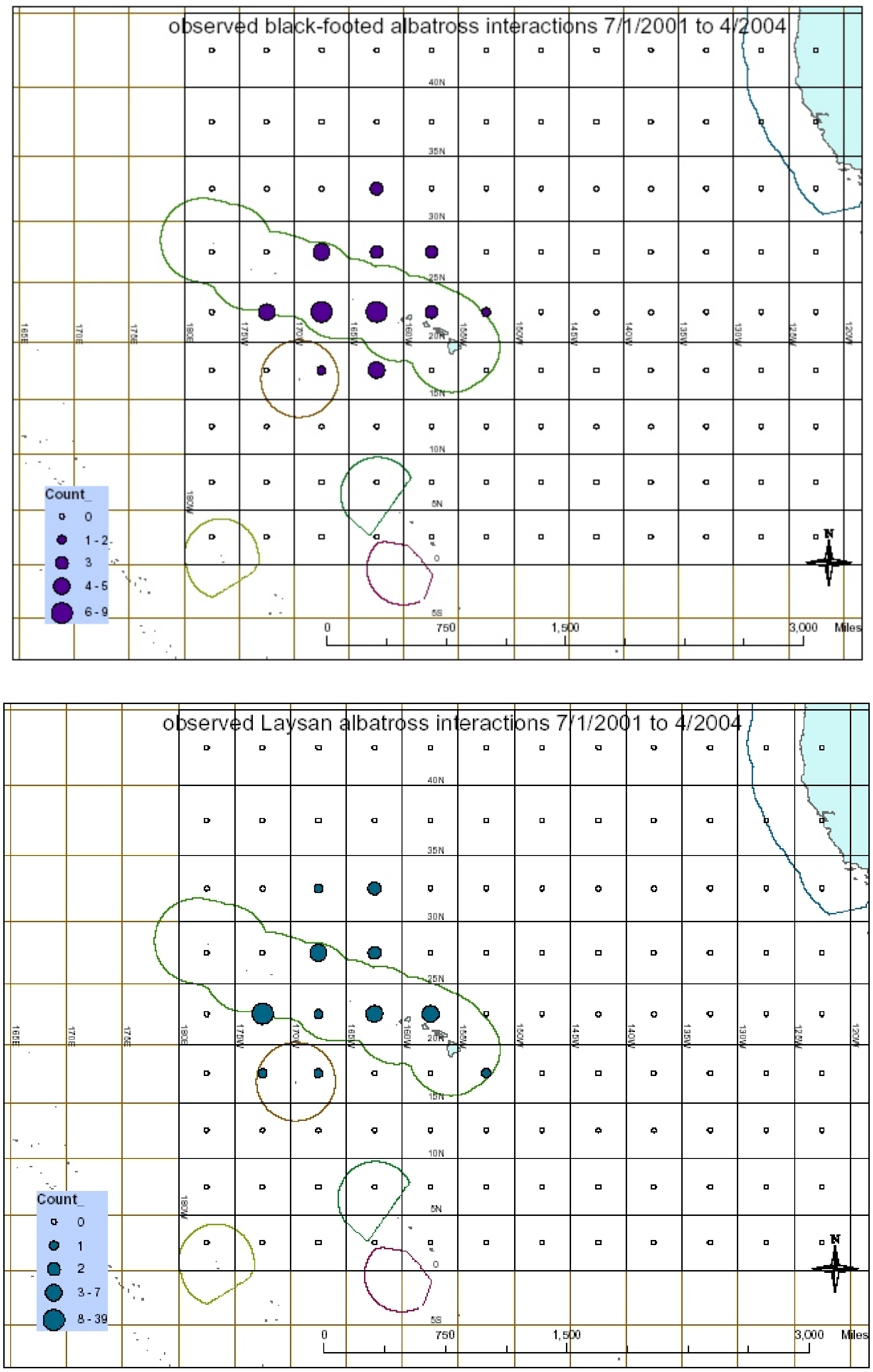


Figure 3.6.1-8 Observed Interactions of Black-footed Albatrosses (top) and Laysan albatrosses (bottom) From July 1, 2001 to July 4, 2004 in the Hawaii Longline Fishery (Source: NMFS Observer Program, unpubl. info.)



3.6.2 Sea Turtles

The Pelagics SEIS (WPRFMC 2004b) described sea turtle species present in the region in some detail. Much of that and other current information on these species is contained in Appendix C. The following sections briefly describe the current status of these species.

3.6.2.1 Leatherback Turtle (*Dermochelys coriacea)*

Leatherback turtles are widely distributed throughout the oceans of the world, however, populations have been severely reduced. In 1980, the leatherback population was estimated at approximately 115,000 (adult females) globally (Pritchard 1982a). A 1996 publication estimated the global population of nesting female leatherbacks at 26,200 to 42,900 (Spotila et al. 1996).

The leatherback turtle is listed as endangered under the ESA throughout its global range. Furthermore, the Red List 2000 of the IUCN has classified the leatherback as "critically endangered"[25] due to "an observed, estimated, inferred or suspected reduction of at least 80% over three generations" based on: (a) direct observation; (b) an index of abundance appropriate for the taxon; and (c) actual or potential levels of exploitation.

Leatherback turtles are the largest of the marine turtles, with a curved carapace length (CCL) often exceeding 150 cm and sometimes spanning 270 cm in an adult (NMFS and USFWS 1998c). Befitting its unusual ecology, the leatherback is morphologically and physiologically distinct from other sea turtles. Its streamlined body, with a smooth, dermis-sheathed carapace and dorso-longitudinal ridges may improve laminar flow of this highly pelagic species. Its front flippers are proportionately larger than in other sea turtles.

Primary threats to the species are the incidental killing of turtles by coastal and high seas fishing and to a lesser extent the killing of nesting females, collection of eggs at the nesting beaches (Eckert and Sarti 1997, NMFS and USFWS 1998d, Spotila et al. 2000, Wetherall et al. 1993) and degradation of habitat. On some beaches, nearly 100% of the eggs are harvested.

There are no nesting populations of the leatherback turtle in areas under U.S. jurisdiction in the Pacific Ocean; however, there are important foraging areas off the west coast of the continental U.S. and on the high seas near the Hawaiian islands.

The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment (for a review see Bjorndal 1997). Surface jellyfish feeding is reported in waters under U.S. jurisdiction, especially off the western coast of the continental U.S. (Eisenberg and Frazier 1983, Starbird et al. 1993). While Monterey Bay and the Farallon islands in California (Starbird et al. 1993) and the southwest Pacific Ocean off Chile and Peru (Eckert 1999a, Eckert, unpub. data) appear to be important seasonal foraging areas for the leatherback, there has been no systematic study of leatherback turtle foraging grounds in the Pacific Ocean (NMFS and USFWS 1998a).

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[25]Taxa are categorized as critically endangered when they are facing an extremely high risk of extinction in the wild in the immediate future.

3.6.2.2 Loggerhead Turtle (*Caretta caretta*)

The loggerhead turtle is listed as threatened under the ESA throughout its range, primarily due to direct take, incidental capture in various fisheries, and the alteration and destruction of its habitat. The loggerhead is categorized as endangered by the IUCN, where taxa so classified are considered to be facing a very high risk of extinction in the wild in the near future. Loggerhead turtles are a cosmopolitan species inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters.

The loggerhead is characterized by a reddish brown, bony carapace, with a comparatively large head, up to 25 cm wide in some adults. Adults typically weigh between 80 and 150 kg, with average CCL measurements for adult females worldwide between 95-100 cm (in Dodd 1988) and adult males in Australia averaging around 97 cm (Limpus 1985 in Eckert 1993). Juveniles found off California and Mexico measured between 20 and 80 cm (average 60 cm) in length (Bartlett 1989, in Eckert 1993).

There are no records of nesting loggerhead turtles in the Hawaiian Islands (Balazs 1982a), or in any of the islands of Guam, Palau, Northern Mariana Islands, Marshall Islands (Thomas 1989), the FSM (Pritchard 1982a), or American Samoa (Tuato'o-Bartley et al. 1993). There are very few records of loggerheads nesting on any of the many islands of the central Pacific Ocean, and the species is considered rare or vagrant on islands in this region (NMFS and USFWS 1998d). Pacific populations of loggerhead turtles found in U.S. jurisdictions are thought to originate from Japanese nesting areas (NMFS and USFWS 1998d).

For their first years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish, and algae. The large aggregations of juveniles off Baja California have been observed foraging on dense concentrations of the pelagic red crab, *Pleuronocodes planipes* (Pitman 1990, Nichols et al. 2000).

The transition from hatchling to young juvenile occurs in the open sea, and evidence is accumulating that this part of the loggerhead life cycle may involve trans-Pacific developmental migration (Bowen et al. 1995).

3.6.2.3 Green Turtle (*Chelonia mydas*)

Green turtles are listed as threatened under the ESA, except for breeding populations found in Florida and the Pacific coast of Mexico, which are listed as endangered. The IUCN has classified the green turtle as endangered due to an "observed, estimated, inferred or suspected reduction of at least 50% over the last 10 years or three generations, whichever is longer," based on: (a) direct observation; (b) an index of abundance appropriate for the species; and (c) actual or potential levels of exploitation. Using a conservative approach, Seminoff (2002) estimates that the global green turtle population has declined by 34% to 58% over the last three generations (approximately 150 years) although actual declines may be closer to 70% to 80%. Causes for this decline include harvest of eggs, subadults and adults, incidental capture by fisheries, loss of habitat, and disease.

Green turtles are distinguished from other sea turtles by their smooth carapace with four pairs of lateral scutes, a single pair of prefrontal scutes, and a lower jaw-edge that is coarsely serrated. Adult green turtles have a light to dark brown carapace, sometimes shaded with olive, and can exceed one meter in carapace length and 100 kg in body mass.

Green turtles are found throughout the world, occurring primarily in tropical, and to a lesser extent, subtropical waters. The species is considered to consist of five main populations: those in the Pacific Ocean, Atlantic Ocean, Indian Ocean, Carribean Sea, and Mediterranean Sea.

The genus *Chelonia* is composed of two taxonomic units at the population level, the eastern Pacific green turtle (referred to by some as "black turtle," *C. mydas agassizii*), which ranges (including nesting) from Baja California south to Peru and west to the Galapagos Islands, and the nominate *C. m. mydas* in the rest of the range (insular tropical Pacific, including Hawaii). Green turtles in Hawaii are considered genetically distinct and geographically isolated, although recently a nesting population at Islas Revillagigedos in Mexico has been discovered to have some animals with the same mtDNA haplotype that commonly occurs in Hawaii.

Green turtles are thought to be declining throughout the Pacific Ocean, with the exception of Hawaii, as a direct consequence of a historical combination of overexploitation and habitat loss (Eckert 1993, Seminoff 2002).

Based on limited data, green turtle populations in the Pacific islands have declined dramatically, due foremost to harvest of eggs and adults by humans. In the green turtle recovery plan (NMFS and USFWS 1998a), directed take of eggs and turtles was identified as a "major problem" in American Samoa, Guam, Palau, Northern Mariana Islands, FSM, Republic of the Marshall Islands, Wake, Jarvis, Howland, Baker, and Midway Islands, Kingman Reef, Johnston and Palmyra Atoll. Severe over harvests have resulted in modern times from a number of factors: 1) the loss of traditional restrictions limiting the number of turtles taken by island residents; 2) modernized hunting gear; 3) easier boat access to remote islands; 4) extensive commercial exploitation for turtle products in both domestic markets and international trade; 5) loss of the spiritual significance of turtles; 6) inadequate regulations; and 7) lack of enforcement (NMFS and USFWS 1998a).

In Hawaii, green turtles nest on six small sand islands at French Frigate Shoals, a crescent-shaped atoll situated in the middle of the Hawaiian Archipelago (Balazs 1995). Ninety percent of the nesting and breeding activity of the Hawaiian green turtle occurs there, where 200-700 females are estimated to nest annually (NMFS and USFWS 1998a). Important resident areas have been identified and are being monitored along the coastlines of Oahu, Molokai, Maui, Lanai, Hawaii, and at large nesting areas in the reefs surrounding French Frigate Shoals, Lisianski Island, and Pearl and Hermes Reef (Balazs 1982a, Balazs et al. 1987). Since the establishment of the ESA in 1973, and following years of exploitation, the nesting population of Hawaiian green turtles has shown a gradual, but definite increase (Balazs 1996). For example, the number of green turtles nesting at an index study site at East Island has tripled since systematic monitoring began in 1973 (NMFS and USFWS 1998a).

Most green turtles appear to have a nearly exclusive herbivorous diet, consisting primarily of sea grass and algae (Wetherall et al. 1993, Hirth 1997), those along the east Pacific coast seem to have a more carnivorous diet.

The nonbreeding range of green turtles is generally tropical, and can extend thousands of miles from shore in certain regions. Hawaiian green turtles monitored through satellite transmitters were found to travel more than 1,100 km from their nesting beach at French Frigate Shoals, south and southwest against prevailing currents to numerous distant foraging grounds within the 2,400 km span of the archipelago (Balazs 1994, Balazs et al. 1994, Balazs and Ellis 1996). Three green turtles outfitted with satellite tags on Rose Atoll (the easternmost island of the Samoan Archipelago) traveled on a southwesterly course to Fiji, approximately 1,500 km distance (Balazs et al. 1994).

3.6.2.4 Olive Ridley Turtle (*Lepidochelys olivacea*)

The olive ridley is listed as threatened under the ESA throughout the Pacific Ocean, except for the Mexican nesting population, which is listed as endangered, primarily because of over-harvesting of females and eggs. The olive ridley is categorized as endangered by the IUCN, where taxa so classified are considered to be facing a very high risk of extinction in the wild in the near future (IUCN Red List 2000).

The olive ridley is one of the smallest living sea turtles (carapace length usually between 60 and 70 cm and rarely weighing over 50 kg) and is regarded as the most abundant sea turtle in the world. They are olive or grayish green, with a greenish white underpart, and adults are moderately sexually dimorphic (NMFS and USFWS 1998e).

Olive ridley turtles occur throughout the world, primarily in tropical and sub-tropical waters. The species is divided into three main populations in the Pacific Ocean, Indian Ocean, and Atlantic Ocean. In the western Pacific Ocean, olive ridleys are not as well documented as in the eastern Pacific Ocean, nor do they appear to be recovering as well.

The olive ridley turtle is omnivorous and identified prey include a variety of benthic and pelagic prey items such as shrimp, jellyfish, crabs, snails, and fish, as well as algae and sea grass (Marquez 1990).

Olive ridley turtles lead a primarily pelagic existence (Plotkin et al. 1993), migrating throughout the Pacific Ocean, from their nesting grounds in Mexico and Central America to the north Pacific Ocean. While olive ridleys generally have a tropical range, with a distribution from Baja California, Mexico to Chile (Silva-Batiz et al. 1996), individuals do occasionally venture north, some as far as the Gulf of Alaska (Hodge and Wing 2000). Surprisingly little is known of their oceanic distribution and critical foraging areas, despite being the most populous of north Pacific sea turtles.

3.6.2.5 Hawksbill Turtle (*Eretmochelys imbricata)*

The hawksbill turtle is listed as endangered under the ESA and in the IUCN Red List. Under Appendix I of the CITES, the hawksbill is identified as “most endangered.” Anecdotal reports from throughout the Pacific Ocean indicate that the current population is well below historical levels. In the Pacific Ocean, this species is rapidly approaching extinction primarily due to the harvesting of the species for its meat, eggs, and shell, as well as the destruction of nesting habitat by human occupation and disruption (Meylan and Donnelly 1999, NMFS 2001b).

Hawksbill turtles are circumtropical in distribution, generally occurring from latitudes 30°N to 30°S within the Atlantic, Pacific and Indian Oceans and associated bodies of water (NMFS and USFWS 1998b). In the U.S. Pacific Ocean, there have been no hawksbill sightings off the west coast (Meylan and Donnelly 1999). Hawksbills have been observed in the Gulf of California as far as 29°N, throughout the northwestern states of Mexico, and south along the Central and South American coasts to Columbia and Ecuador (Meylan and Donnelly 1999). In the Hawaiian Islands, hawksbill turtles nest in the main islands, primarily on several small sand beaches on the Islands of Hawaii and Molokai. Two of these sites are at a remote location in the Hawaii Volcanos National Park. There are no reports of interactions between this species and the Hawaii-based longline fishery, although the potential for interaction exists.

Hawksbills are recognized by their relatively small size (carapace length less than 95 cm), narrow head with tapering “beak,” overlapping scutes, and strongly serrated posterior margin of the carapace.

Hawksbills appear to be declining throughout their range. By far the most serious problem hawksbill turtles face is harvest by humans, but loss of habitat due to expansion of resident human populations and/or increased tourism development is also a serious problem.

There is limited information on the biology of hawksbills, probably because they are sparsely distributed throughout their range and they nest in very isolated locations (Eckert 1993). Hawksbills have a relatively unique diet of sponges (Meylan 1985, 1988). While data are somewhat limited on diet in the Pacific Ocean, it is well documented in the Caribbean where hawksbill turtles are selective spongivores, preferring particular sponge species over others (Dam and Diez 1997b).

3.6.2.6 Interactions of the Hawaii-based Longline Fleet with Sea Turtles

The 2004 SEIS (WPRFMC 2004b) summarizes estimated turtle takes in the Hawaii-based longline fleet from 1994 through mid-2002, and that discussion is incorporated herein by reference. Table 3.6.2-1 summarizes that information. The annual average estimated take from 1994-1999 represents impacts of the fishery on turtles prior to the 2001 ban on shallow setting. The 2002 estimated take represents the impacts of the fishery on turtles after the ban on shallow setting.

Table 3.6.2-1 Estimated Annual Averages of Turtles Captured and Killed in the Hawaii-based Longline Fishery Under Two Management Regimes.

Turtle Species	1994-1999		2002	
	Takes	Kills	Takes	Kills
Loggerhead	418 (273-527)[1]	73	14 (na)	8
Olive Ridley	146 (99-203)	49	26 (12-47)	24
Leatherback	112 (75-157)	9	8 (2-21)	3
Green	40 (18-71)	5	8 (2-21)	7
Total	716 (465-958)	136	56 (na)	42

[1] 95% prediction intervals shown in parentheses.
Source: WPRFMC 2004b.

The measures implemented between the two time periods highlighted in Table 3.6.2-1 included a ban on the use of shallow-set swordfish longline fishing north of the equator and a seasonal area closure from 15°N to the equator and from 145°W to 180° during April and May for any longline vessel fishing under the authority of the Pelagics FMP.

3.6.3 Marine Mammals

Stock assessment information presented below for both listed and non-listed marine mammal species comes primarily from NOAA's *U.S. Pacific Marine Mammal Stock Assessments: 2002* (Carretta et al. 2002) and the draft 2003 updates (Carretta et al. 2003) available on NMFS' Office of Protected Resources web site.

The most recent information on cetacean abundance in Hawaiian waters is the report by Barlow 2003) that summarizes the results of a NOAA survey conducted in August-November 2002. Two NOAA research vessels surveyed the entire EEZ around the Hawaiian Islands along parallel transects spaced 85 km apart (outer EEZ stratum) and 42.5 km apart within 140 km of the MHI (main island stratum). Both visual observations and acoustic detections were employed. Twenty-four species of cetaceans were seen, including two species (Fraser's dolphin and sei whale) that previously had not been documented to occur in Hawaiian waters. The most abundant large whales were sperm whales and Bryde's whales. The most abundant delphinids were rough-toothed dolphins and Fraser's dolphins. Dwarf and pygmy sperm whales and Cuvier's beaked whales were estimated to be quite abundant. Accurate estimates of abundance for migrating whales were not possible as the survey did not take place during periods of their highest abundance in Hawaiian waters. Nevertheless, abundance estimates were possible for 21 other species. The overall density of cetaceans was low, especially for delphinids. The precision of density and abundance estimates was generally low for all species due to the small number of sightings. Table 3.6.3-1 summarizes the sightings data, calculated abundances and densities, and the coefficients of variation (CV) from Barlow (2003).

Table 3.6.3-1 Sightings and Estimated Abundances of Cetaceans in the Hawaii EEZ from Research Cruises in 2002.

Species	Main Island Stratum		Outer EEZ Stratum		Overall		
	#Sightings	Abundance	#Sightings	Abundance	Abundance	Individuals/ km^2	CV
offshore spotted dolphin	6	4931	2	5329	10260	0.0042	0.41
striped dolphin	1	508	10	9877	10385	0.0042	0.48
rough-toothed dolphin	7	3860	7	16044	19904	0.0081	0.52
bottlenose dolphin	5	525	4	2738	3263	0.0013	0.6
Risso's dolphin	2	594	3	1757	2351	0.001	0.65
Fraser's dolphin	0	0	1	16836	16836	0.0069	1.11
melon-headed whale	0	0	1	2947	2947	0.0012	1.1
pygmy killer whale	1	817	0	0	817	0.0003	1.12
false killer whale	0	0	1	268	268	0.0001	1.08
short-finned pilot whale	7	3131	7	5715	8846	0.0036	0.49
killer whale	0	0	2	430	430	0.0002	0.72
sperm whale	2	56	16	7026	7082	0.0029	0.3
pygmy sperm whale	0	0	2	7251	7251	0.003	0.77
dwarf sperm whale	0	0	3	19172	19172	0.0078	0.66
unidentified beaked whale	1	330	0	0	330	0.0001	1.05
Blaineville's beaked whale	0	0	1	2138	2138	0.0009	0.77
Cuvier's beaked whale	0	0	2	12728	12728	0.0052	0.83
Longman's beaked whale	0	0	1	766	766	0.0003	1.05
Bryde's whale	0	0	8	493	493	0.0002	0.34
sei whale	1	77	0	0	77	0	1.06
fin whale	0	0	2	174	174	0.0001	0.72
spinner dolphin	3	2036	1	768	2804	0.0011	0.66
DELPHINIDS	32	16403	39	62709	79112	0.0323	
BEAKED WHALES	1	330	4	15632	15962	0.0065	

Source: Barlow 2003.

3.6.3.1 Endangered Marine Mammals

Endangered marine mammals in the Pacific Ocean include six cetaceans, two pinnipeds and the dugong (*Dugon dugon*). The cetaceans are the humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), northern right whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*) and sei whale (*B. borealis*). The pinnipeds are the Hawaiian monk seal (*Monachus schauinslandi*), and the Steller sea lion (*Eumetopias jubatus*).

Although blue whales, fin whales, right whales, sei whales and Steller sea lions are found within the region and could potentially interact with the Pelagics FMP fisheries, there have been no reported or observed incidental takes of these species in these fisheries and therefore potential impacts to these species are not discussed further in this document. No blue whales or right whales were seen in the 2002 NOAA surveys (Barlow 2003).

Dugongs are seagrass specialists and frequent coastal waters including shallow protected bays, mangrove channels, the lee sides of large inshore islands, and deeper water farther offshore in areas where the continental shelf is wide, shallow and protected. Most of the world's population of dugongs is now found in northern Australian waters (Leatherwood et al. 1992). Interactions with Pelagics FMP fisheries are extremely unlikely and potential impacts to dugongs will not be considered further in this EIS.

Based on research, observer, and logbook data on population densities and historic interaction rates, the listed marine mammals most likely to be affected by the fisheries managed under the Pelagics FMP include the humpback whale (*Megaptera novaeangliae*), the sperm whale (*Physeter macrocephalus*) and the Hawaiian monk seal (*Monachus schauinslandi*). The sections below summarize available information on the biology and population status of these three species.

3.6.3.1.1 Humpback Whale (*Megaptera novaeangliae*)

The International Whaling Commission (IWC) first protected humpback whales in the North Pacific Ocean in 1965. Humpback whales were listed as endangered under the ESA in 1973, and consequently are also automatically considered "depleted" and "strategic" under the MMPA. They are also protected by the CITES. Critical habitat has not been designated for this species, but some protections are afforded by the Humpback Whale National Marine Sanctuary while the whales are on their winter grounds in Hawaii.

Humpback whales typically migrate between tropical/sub-tropical and temperate/polar latitudes. The whales occupy tropical areas favoring shallow nearshore waters of usually 100 fathoms (fm) or less during winter months when they are breeding and calving, and polar areas during the spring, summer, and fall, when they are feeding. It is believed that minimal feeding occurs in wintering grounds, such as the Hawaiian Islands (Balcomb 1987, Salden 1987). Humpback whales can attain lengths of 16 m.

Genetic and photo identification studies indicate that within the U.S. EEZ in the North Pacific Ocean there are at least three relatively separate populations of humpback whales (Hill and DeMaster 1999). The Central North Pacific stock of humpback whales winters in the waters of the Hawaiian Islands (Hill et al. 1997). Humpback whales occur off all eight MHI, but particularly within the shallow waters of the "four-island" region (Kahoolawe, Molokai, Lanai, Maui), the northwestern coast of the island of Hawaii (Big Island), and the waters around Niihau, Kauai and Oahu (Wolman and Jurasz 1977, Herman et al. 1980, Baker and Herman 1981). The whales are generally found in shallow water shoreward of the 182 m (600-ft) depth contour (Herman and Antinoja 1977), although Frankel et al. (1989) reported some vocalizing individuals up to 20 km (10.8 nm) off South Kohala on the west coast of the Big Island, over bottom depths of 1400 m (4593 ft). Cow and calf pairs appear to prefer very shallow water less than 18 m deep (10 fm [60 ft]) (Glockner and Venus 1983).

There is no precise estimate of the worldwide humpback whale population. The Central North Pacific stock appears to have increased in abundance between the early 1980s and early 1990s; however, the status of this stock relative to its optimum sustainable population size is unknown (Hill and DeMaster 1999). The humpback whale population in the North Pacific Ocean basin is estimated to contain 6,000 to 8,000 individuals (Calambokidis et al. 1997, Cerchio 1998, Mobley et al. 1999b).

Humpback whales exhibit a wide range of foraging behaviors, and feed primarily on small schooling fish and krill (Caldwell and Caldwell 1983).

3.6.3.1.2 Sperm Whale (*Physeter macrocephalus*)

Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific Ocean until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973, and consequently the Hawaiian stock of sperm whales is automatically considered "depleted" and "strategic" under the MMPA. They are also protected by the CITES. Critical habitat has not been designated for sperm whales.

The sperm whale is the most easily recognizable whale with a darkish gray brown body and a wrinkled appearance. The head of the sperm whale is very large, comprising up to 40 percent of its total body length. The current average size for male sperm whales is about 15 m, with females reaching up to 12 m.

Sperm whales are found in tropical to polar waters throughout the world (Rice 1989). They are among the most abundant large cetaceans in the western Pacific region. They were the most abundant large whale in the Hawaii EEZ in the 2002 NOAA surveys (Barlow 2003).

Sperm whales have been sighted around several of the NWHI (Rice 1960) and off the MHI (Lee 1993). The sounds of sperm whales have been recorded throughout the year off Oahu (Thompson and Freidl 1982). Sperm whales have been sighted in the Kauai Channel, the Alenuihaha Channel between Maui and the island of Hawaii, and off the island of Hawaii (Lee 1993, Mobley, et al. 1999a). Twenty-one sperm whales were sighted during aerial surveys conducted in nearshore Hawaiian waters conducted from 1993 through 1998. Sperm whales sighted during the survey tended to be on the outer edge of a 50 - 70 km distance from the Hawaiian Islands, indicating that presence may increase with distance from shore (Mobley, pers. comm. 2000). However, from the results of these surveys, NMFS has calculated a minimum abundance of 66 sperm whales within 25 nm of the MHI (Mobley et al. 2000).

Sperm whales feed primarily on mesopelagic squid, but also consume octopus, other invertebrates, and fish (Tomilin 1967, Tarasevich 1968, Berzin 1971).

3.6.3.1.3 Hawaiian Monk Seal (*Monachus schauinslandi*)

Hawaiian monk seals comprise one of the two remaining species of the genus *Monachus*, one of the most primitive genera of seals. The species was listed as endangered under the ESA in 1976, and it is one of the most endangered marine mammal species in the U.S.. The Hawaiian monk seal is endemic to the Hawaiian Archipelago and Johnston Atoll, and is the only endangered marine mammal that exists wholly within the jurisdiction of the United States.

Hawaiian monk seals are brown or silver in color, depending upon age and molt status, and can weight up to 270 kg. Adult females are slightly larger than adult males. It is thought that monk seals can live to 30 years. Monk seals stay on land for about two weeks during their annual molts. Monk seals are nonmigratory, but recent studies show that their home ranges may be extensive (Abernathy and Siniff 1998). Counts of individuals on shore compared with enumerated sub-populations at some of the NWHI indicate that monk seals spend about one-third of their time on land and about two thirds in the water (Forney et al. 2000).

The six major reproductive sites are French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Atoll and Kure Atoll. Small populations at Necker Island and Nihoa Island are maintained by immigration, and a few but growing number of seals are found throughout the MHI, where preliminary surveys have counted more than 50 individuals. NMFS researchers have also observed monk seals at Gardner Pinnacles and Maro Reef. Additional sightings and at least one birth have occurred at Johnston Atoll, excluding eleven adult males that were translocated to Johnston Atoll (nine from Laysan Island and two from French Frigate Shoals) over the past 30 years.

In 2001, the minimum population estimate for monk seals was 1,378 individuals (based on enumeration of individuals of all age classes at each of the subpopulations in the NWHI, derived estimates based on beach counts for Nihoa and Necker, and aerial survey estimates for the MHI) (Carretta et al. 2003). The best estimate of the total population size was 1,409.

Population trends for monk seals are determined by the highly variable dynamics of the six main reproductive sub-populations. The sub-population of monk seals on French Frigate Shoals has shown the most change in population size, increasing dramatically in the 1960s-1970s and declining in the late 1980s-1990s. In the 1960s-1970s, the other five sub-populations experienced declines. However, during the last decade the number of monk seals increased at Kure Atoll, Midway Atoll and Pearl and Hermes Reef while the sub-populations at Laysan Island and Lisianski Island remained relatively stable. At the species level, however, demographic trends over the past decade have been driven primarily by the dynamics of the French Frigate Shoals subpopulation, where the largest monk seal population is experiencing an increasingly unstable age distribution resulting in an inverted age structure. This age structure indicates that recruitment of females and pup production may soon decrease. In the near future, total population trends for the species will likely depend on the balance between continued losses at French Frigate Shoals and gains at other breeding locations including the MHI. The recent sub-population decline at French Frigate Shoals is thought to have been caused by male aggression, shark attack, entanglement in marine debris, loss of habitat and decreased prey availability. The Hawaiian monk seal is assumed to be well below its optimum sustainable population, and, since 1993, the overall population has declined approximately 0.7% per year (Carretta et al. 2003). The Hawaiian monk seal is characterized as a strategic stock under the MMPA.

Monk seals feed on a wide variety of teleosts, cephalopods and crustaceans, indicating that they are highly opportunistic feeders (Rice 1964, MacDonald 1982, Goodman-Lowe 1999).

3.6.3.2 Non-ESA-Listed Marine Mammals

Marine mammals not listed as threatened or endangered under the ESA that have been observed in areas where fisheries in the western Pacific region operate are listed in Table 3.6.3-2. The Pacific white-sided dolphin and Dall's porpoise were not seen in the 2002 NOAA surveys (Barlow 2003).

Table 3.6.3-2 Marine Mammals Not Listed as Threatened or Endangered Under the ESA but Observed in Areas Where Fisheries in the Western Pacific Region Operate.

Common Name	Scientific Name
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Rough-toothed dolphin	*Steno bredanensis*
Risso's dolphin	*Grampus griseus*
Bottlenose dolphin	*Tursiops truncatus*
Pantropical spotted dolphin	*Stenella attenuata*
Spinner dolphin	*Stenella longirostris*
Striped dolphin	*Stenella coeruleoalba*
Melon-headed whale	*Peponocephala electra*
Pygmy killer whale	*Feresa attenuata*
False killer whale	*Pseudorca crassidens*
Killer whale	*Orcinus orca*
Pilot whale, short-finned	*Globicephala macrorhynchus*
Blainsville's beaked whale	*Mesoplodon densirostris*
Cuvier's beaked whale	*Ziphius cavirostris*
Bryde's whale	*Balaenoptera edeni*
Pygmy sperm whale	*Kogia breviceps*
Dwarf sperm whale	*Kogia simus*

Common Name	Scientific Name
Minke whale	*Balaenoptera acutorostrata*
Dall's porpoise	*Phocoenoides dalli*
Fraser's dolphin	*Lagenodelphis hosei*
Longman's beaked whale	*Indopacetus pacificus*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursinus*

One stock of non-endangered marine mammals, the Hawaii stock of the false killer whale, is classified as "strategic" under the MMPA, owing to serious injuries documented in the Hawaii-based longline fishery (Carretta et al. 2003). Strategic stocks are those that have a level of human-induced mortality that exceeds the number of animals that can be safely removed from the stock without interfering with that stock's ability to reach or maintain its optimum sustainable population level.

3.6.3.3 Interactions of the Hawaii-based Longline Fleet with Marine Mammals

Observed interactions of the Hawaii-based longline fishery with marine mammals are summarized in Table 3.6.3-3

Table 3.6.3-3 Observed Interactions of the Hawaii-based Longline Fishery with Marine Mammals, 1994-2004.

Species	1994-1999 (3.3%-5.3%)[1]	2000 (10.4%)	2001 (22.5%)	2002 (24.6%)	2003 (22.2%)	Jan.-Sep. 2004 (22.4%-25.3%)
Humpback whale	0	0	1 released injured	1 released injured	0	1 released injured
Short-finned pilot whale	1 released alive	1 released alive 1 released dead	2 released injured	0	0	1 released injured
False killer whale	2 released alive	0	3 released injured	5 released injured	2 released injured	4 released injured 1 released dead
Sperm whale	1 released injured	0	0	0	0	0
Blainsville beaked whale	0	0	0	1 released dead	0	0
Unidentified whale	4 released alive	1 released alive	0	0	1 released injured	0

Species	1994-1999 (3.3%-5.3%)[1]	2000 (10.4%)	2001 (22.5%)	2002 (24.6%)	2003 (22.2%)	Jan.-Sep. 2004 (22.4%-25.3%)
Risso's dolphin	7 released alive	1 released alive	1 released injured	0	0	1 released injured
Spinner dolphin	1 released alive	1 released alive	0	0	0	0
Bottlenose dolphin	2 released alive	0	0	0	1 released dead	0
Common dolphin	0	1 released alive	0	0	0	0
Spotted dolphin	0	0	1 released dead	0	0	0
Unidentified cetacean	1 released, condition unknown	2 released alive	2 released injured	2 released injured	1 released injured	0
TOTAL	19	8	10	9	5	8

[1] Numbers in parentheses are the percent of total trips that were observed.
Source: NMFS observer reports 1994-2004.

Each commercial fishery is annually placed into Category I, II or III. Category I includes commercial fisheries determined by the Assistant Administrator to have frequent incidental mortality and serious injury of marine mammals. Category II includes commercial fisheries determined by the Assistant Administrator to have occasional incidental mortality and serious injury of marine mammals. Category III includes commercial fisheries determined by the Assistant Administrator to have a remote likelihood of, or no known incidental mortality and serious injury of marine mammals. The List of Fisheries for 2004 places the Hawaii longline fishery into Category I (69 FR 48407, August 10, 2004) because of the number of false killer whale takes. The proposed list for 2005 (69 FR 70094, December 2, 2004) does not change that status.

3.7 Features of the Economic Environment

The description of the economic environment provided here focuses on pelagic fisheries that could be potentially affected by the proposed actions. These fisheries include the Hawaii pelagic longline fishery and the ika shibi component of the Hawaii pelagic handline fishery—two fisheries managed under the Pelagic Fisheries FMP—and the distant-water and Hawaii near-shore squid fisheries, which are currently not managed under the Pelagics Fisheries FMP. The affected environment description concentrates on important issues that have shaped the existing economic conditions within these fisheries. Where possible, trends in the economic condition of the fisheries are identified.

Comprehensive descriptions of the Hawaii longline and ika shibi fisheries are provided in Chapter 3 of the Pelagics FEIS (NMFS 2001a). The descriptions of these fisheries presented in the current document summarize the discussion in the Pelagics FEIS and incorporate new economic information that has become available since the Pelagics FEIS was released. The Pelagics FEIS also provided economic profiles of the pelagic fisheries in Guam, American Samoa and Northern Mariana Islands. The current EIS does not summarize or update that information because the proposed actions are not expected to have major economic impacts in those areas of the western Pacific region.

Following the data requirements set forth in section 303(a)(2) of the MSA, the descriptions of the Hawaii near-shore squid fishery and incipient distant-water squid fishery include the number of vessels involved, the type and quantity of fishing gear used, the species of squid involved and their location, actual and potential revenues from the fishery, any recreational interest in the fishery, and the nature and extent of foreign fishing and Indian treaty fishing rights, if any. These descriptions of the near-shore and distant-water squid fisheries of interest are prefaced by a general description of squid fisheries world-wide.

3.7.1 Overview of Hawaii's Pelagic Fisheries

This section examines the relative importance of Hawaii's pelagic fisheries in terms of catch, ex-vessel value and participation. The state's pelagic fisheries are unique and diverse. Hawaii-based longline vessels are capable of traveling long distances to high-seas fishing grounds, while the smaller handline and troll fisheries—which may be commercial, charter, recreational or subsistence—generally occur within 25 miles of land, with trips lasting only one day. All of Hawaii's pelagic fisheries are small in comparison with other Pacific Ocean pelagic fisheries such as distant-water purse seine fisheries and other foreign pelagic longline fisheries, but they comprise the largest fishery sector in the State of Hawaii. Tuna, billfish and other tropical pelagic species supply most of the fresh pelagic fish consumed by Hawaii residents and support popular recreational fisheries.

In recent years, Hawaii's commercial pelagic fisheries have been greatly affected by a series of court decisions that resulted in federal regulatory measures. In 2001, total catch and ex-vessel value decreased by about 7.8 million lb and $20.1 million, respectively, primarily as a result of the implementation of court-ordered measures that eliminated the swordfish portion of the Hawaii longline fishery (Table 3.7-1). Swordfish, the largest component of the catch by volume in 2000, has been a negligible component since that year (Table 3.7-2). In recent years, bigeye tuna has been the most important pelagic species by both volume and value, followed by yellowfin tuna and albacore. As a result of an increase in the catch of bigeye tuna the ex-vessel value of landings in Hawaii's pelagic fisheries increased to about $45.3 million in 2002.

Table 3.7-1 Volume and Ex-vessel Value of Landings in Hawaii's Commercial Pelagic Fisheries by Major Gear Type, 1999-2003.

Year	Volume (1000 lb)				Ex-Vessel Value ($1000)			
	Aku (Pole-and-Line)	Longline	Troll-Handline	Total	Aku (Pole-and-Line)	Longline	Troll-Handline	Total
1999	1,310	28,350	6,310	36,058	1,740	49,300	10,650	61,690
2000	710	23,810	4,970	29,600	1,120	51,300	10170	62,590
2001	990	15,550	5,220	21,760	1,380	33,400	7,720	42,500
2002	530	17,160	3,710	21,400	750	37500	5,650	43,900
2003[1]	1,020	17,640	3,700	22,360	1,000	37,500	82,10	46,710

[1] Preliminary data.
Source: WPRFMC 2004a.

Table 3.7-2 Volume and Ex-vessel Value of Landings in Hawaii's Commercial Pelagic Fisheries by Species, 1999-2002.

Species	1999		2000		2001		2002	
	Volume (1000 lb)	Ex-Vessel Value ($1000)	Volume (1000 lb)	Ex-Vessel Value ($1000)	Volume (1000 lb)	Ex-Vessel Value ($1000)	Volume (1000 lb)	Ex-Vessel Value ($1000)
Bigeye Tuna	6,200	20,400	6,240	21,611	5,873	19,675	10,266	27,513
Yellowfin Tuna	4,000	8,100	4,833	12,343	4,145	9,492	2,462	5,589
Albacore Tuna	4,000	4400	2,282	3,336	3,229	3,584	1,522	1,781
Skipjack Tuna	1,900	2,300	1,111	1,471	1,696	1,900	986	1,252
Blue Marlin	1,400	1,400	1,125	1,252	1,494	1,061	1,001	1,171
Striped Marlin	900	1,200	473	832	73	925	558	893
Swordfish	6,900	13,000	6,520	12,789	500	1,155	461	904
Mahimahi	1,300	2,800	1,543	2,987	1,191	1,918	1,164	2,223
Ono	1,000	1,700	673	1,549	922	1,558	620	1,364
Moonfish	1,200	1,400	693	1,109	756	930	915	1,226
Sharks	6,300	1,600	3,400	863	327	131	388	163
Other	920	1150	808	1,186	749	866	1,049	1,275
Total	36,020	59,450	29,528	61,283	21,755	43,194	21,392	45,354

Source: WPRFMC 2004a.

The longline fishery is the largest commercial fishery in Hawaii. In 2002, longline catch was 17.2 million lb worth $37.5 million (Table 3.7-1). Catch in the commercial troll and handline fisheries has been relatively stable in recent years, while catch in the skipjack tuna or aku fishery continues to show a declining trend. An estimate of the level of participation in Hawaii's commercial pelagic fisheries can be derived from data collected by the HDAR commercial marine license system, which asks fishermen to identify their primary fishing gear or method at the time of licensing. This does not preclude fishermen from using other gears or methods, but does indicate the primary fishing method. A total of 3,195 fishermen were licensed in 2002, including 2,025 who indicated that their primary fishing method would use fishing gear intended to catch pelagic fish (Table 3.7-3). Most licenses that indicated pelagic fishing as their primary method were issued to trollers (72%) and longline fishermen (18%). The remainder were issued to ika shibi and palu ahi (handline) (8%) and aku (pole-and-line) boat fishers (2%). The total number of licenses issued and licenses indicating pelagic fishing as the primary method decreased six percent from the previous year.

Table 3.7-3 Primary Fishing Method Reported on HDAR Commercial Marine Licenses, 1999-2002.

Fishing Method	1999	2000	2001	2002
Longline	546	553	465	367
Trolling	1572	1,464	1,449	1451
Ika shibi and palu ahi (handline)	199	190	163	164
Aku boat (pole-and-line)	62	41	44	43
Total pelagic	2379	2,248	2,121	2025
Total all methods	3876	3,609	3401	3195

Source: WPRFMC 2004a.

The pelagic fish resources in the EEZ around Hawaii also support important charter and recreational fisheries. Participants in Hawaii's charter boat fishery primarily troll for billfish. In 2002, blue marlin formed about half of the total annual charter vessel catch by weight (Table 3.7-4). Big game sportfishing rods and reels are used, with four to six lines trolled at any time with outriggers. Both artificial and natural baits are used. In addition to lures, trollers occasionally use freshly caught skipjack tuna and small yellowfin tuna as live bait to attract marlin, the favored landings for charter vessels, as well as yellowfin tuna. Charter fishing in Hawaii and elsewhere in the western Pacific region has elements of both recreational and commercial fishing. The primary motivation for charter patrons is recreation, while the charter vessel skipper and crew receive compensation in the form of patron fees and fish sales in local markets.

Table 3.7-4 Species Composition of Landings Made by Hawaii Charter Vessels, 2002.

Species Caught	Landings (lb)	Percent
Mahi mahi	71,741	17.3
Skipjack tuna	18,712	4.5
Wahoo	31,115	7.5
Blue marlin	196,084	47.4
Yellowfin tuna	57,633	13.9
Other	38,069	9.3
Total	413,893	100

Source: WPRFMC 2004a.

Hawaii's recreational fleet also primarily employs troll gear to target pelagic species. Although their motivation for fishing is recreational, some of these vessel operators sell a portion of their landings to cover fishing expenses and have been termed "expense" fishermen (Hamilton 1999). While some of the fishing methods and other characteristics of this fleet are similar to those described for the commercial troll fleet, a survey of recreational and expense fishermen showed substantial differences in equipment, avidity and catch rates compared to commercial operations. Vessel operators engaged in subsistence fishing are included in this recreational category. An estimate of catch in Hawaii's recreational pelagic fishery is available from the NMFS Marine Recreational Fisheries Statistical Survey, which was reinitiated in 2001 following a 20 year gap. The survey indicated that boat-based recreational fishing resulted in the harvest of 11.2 million lb of pelagic species in 2002 (WPRFMC 2004a). The contributions by the six major pelagic species caught by boat-based recreational fishing are shown in Figures 3.7-1and 3.7-2. Skipjack is the most commonly caught pelagic species taken by recreational fishermen in terms of numbers, but it is only a minor fraction of the catch by weight. Yellowfin tuna and blue marlin are the most important species in terms of weight.

Figure 3.7-1 Estimated Hawaii Recreational Private Boat Catch of Pelagic Species by Number of Fish, 2002 (Source: WPRFMC 2004a).

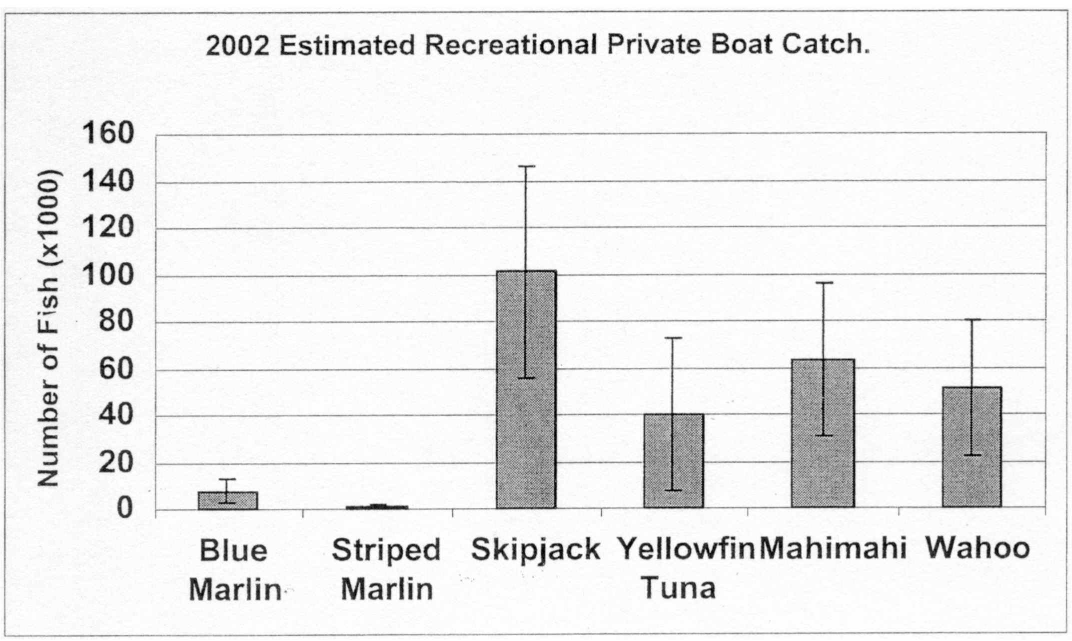
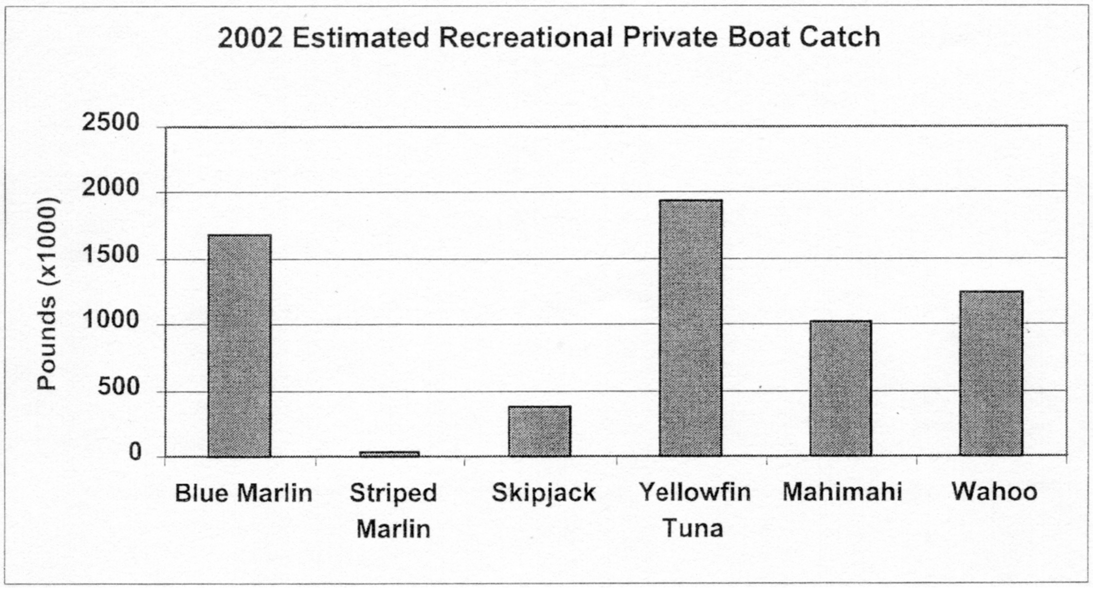


Figure 3.7-2 Estimated Hawaii Recreational Private Boat Catch of Pelagic Species by Weight of Fish, 2002 (Source: WPRFMC 2004a).



3.7.2 Hawaii Longline Fishery

3.7.2.1 Overview

The Hawaii longline fishery operates under a limited entry regime with a total of 164 transferable permits and a maximum vessel length of 101 ft. The longline fleet has historically operated in two distinct modes based on gear deployment: deep-set longlines by vessels that target primarily tuna and shallow-set longlines by those that target swordfish or have mixed target (swordfish-tuna) trips including albacore and yellowfin tuna. Swordfish and mixed swordfish-tuna target sets are buoyed to the surface, have few hooks (<15) between floats, and are relatively shallow (5-60 m). These sets use a large number of light sticks, as swordfish are primarily targeted at night.

Vessels targeting tuna differ from those targeting swordfish in that they generally operate in warm waters further south and set their lines at relatively deep depths (15-180 m or greater). To facilitate the deployment of fishing gear at these depths vessels usually increase the longline sink rate by employing a hydraulic line-setting machine (line-shooter or line-setter) and branch lines with 40-80 g weights attached close (20-90 cm) to the hooks.

Total landings in the Hawaii longline fishery decreased by 8.2 million lb (34%) in 2001 (Table 3.7-5). Dramatically lower catches of swordfish and shark following the closure of the swordfish-targeting segment of the fishery and the restriction on shark finning, respectively, were the primary reasons for the overall decline. Ex-vessel value in the Hawaii longline fishery dropped from $51.3 million in 2000 to $33.4 million in 2001. The primary reason for the decrease was the cessation of swordfish-targeted fishing, but weak economic conditions in the

U.S. and Japan also contributed to the decline. The recovery of Hawaii's tourist industry and increased demand for Hawaii's fresh fish in 2000 was short-lived as the U.S. economy slowed in 2001. A downturn in the economy in Japan resulted in lower prices for high grade bigeye tuna. Average prices for all species except swordfish declined in 2001.

Table 3.7-5 Hawaii Pelagic Longline Fishery Activity, 1999-2003.

Category	1999	2000	2001	2002	2003 [1]
Total landings (million lb)	28.3	23.8	15.6	17.2	17.6
Catch composition (1000 lb)					
Bigeye tuna	5,995	5,788	5,217	9,669	7,768
Albacore tuna	3,250	2,026	2,802	1,156	1,157
Yellowfin tuna	1,042	2,506	2,233	1,257	1,820
Swordfish	6,835	6,520	485	450	301
Miscellaneous	4,712	3,462	4,022	3,960	NA
Sharks	6,272	3,297	327	388	NA
Active vessels	119	125	101	100	110
Total trips	1,137	1,034	1,034	1,164	1,216
Number of hooks set (millions)	19.1	20.3	22.3	27.2	29.3
Total ex-vessel value (adjusted for inflation) ($million)	49.3	51.3	33.4	37.5	37.5

[1] Preliminary data
Source: WPRFMC 2004a.

The total number of longline trips remained fairly constant between 1997 and 2002, although effort patterns changed considerably. The longline fishery shifted its effort from swordfish to tuna throughout the 1990s, with the number of tuna-directed trips more than doubling between 1992 and 2001. The closure of the swordfish portion of the longline fishery in 2001 led to especially high tuna catches. The Hawaii longline fleet now targets primarily bigeye tuna, for which catch nearly doubled between 2001 (5.2 million lb) and 2002 (9.7 million lb), and more than doubled from the 16-year average (4.8 million lb). The increasing number of hooks set is attributed to the increase in tuna-targeted sets, which typically set a higher number of hooks per day fished in comparison to swordfish-targeted sets.

The number of active Hawaii-based longline vessels grew from 37 vessels in 1987 to 141 in 1991, but then decreased to 103 in 1996 as some vessels left for the U.S. mainland (15-20) and Fiji (2-4) (WPRFMC 2003a). In addition, some Hawaii-based swordfish vessels began to routinely fish outside the EEZ off of California and make landings in that state during part of each year, typically from October through February. Apparently, swordfish catch rates in the eastern Pacific Ocean are higher than those in the central Pacific Ocean during these months, possibly because of a seasonal eastward migration of the fish stock. Longline vessels operating out of California also retain marketable non-target species such as bigeye tuna, albacore tuna, and thresher shark. In the latter part of 1997, 15 Hawaii-based longline vessels migrated to California. The number of vessels migrating to California increased to 18 in 1998 (Ito and Machado 1999). By 1999, over 30 Hawaii-based longliners fished out of California during part of the year. In 2000, the size of the Hawaii longline fleet gradually increased to 125 with the return of a few boats that had migrated to the U.S. mainland, along with a few new participants from the West Coast and Alaska. However, the number of Hawaii-based longline vessels fell to

101 in 2001. Many of the longline vessels that targeted swordfish moved to California. Twenty-one California-based longline vessels submitted federal high seas longline logbook data in 2002. All but one of them fished out of Hawaii before 2000. Almost all the longline vessels participating in the California-based longline fishery continued to target swordfish, and some fished in the same areas of the North Pacific Ocean that they had previously fished in under a Hawaii longline limited entry permit. However, in April 2004, NMFS issued a rule that prohibited shallow-set longlining targeting swordfish on the high seas in the Pacific Ocean east of 150°W and north of the equator (69 FR 11540, March 11, 2004).

A survey conducted by O'Malley and Pooley (2003) provides estimates of average income for various vessel classes in the Hawaii-based longline fleet in 2000 (Table 3.7-6). Only vessels that were interviewed in the survey are included in the final income statements, which include fixed costs, variable costs, labor costs, and gross and net revenue. These tables were calculated by including zero costs in the calculated averages for each vessel target and classification. Swordfish and tuna vessels earned a net return of $27,484 and $55,058, respectively. Among the tuna vessels, the small vessels were the most profitable. These vessels had higher gross revenues and, consequently, higher labor costs but lower fixed and variable costs. On average, swordfish vessels were larger than tuna vessels and had higher levels of capitalization and greater operating expenses (NMFS 2001a).[26] Large swordfish vessels were generally more profitable than smaller swordfish vessels due to higher gross revenues.

Table 3.7-6 Reported Average Annual Revenue and Costs for the Hawaii-based Longline Fleet, 2000[1].

Category	Swordfish Average	Tuna Average	Small Tuna Average	Medium Tuna Average	Large Tuna Average	Medium Swordfish Average	Large Swordfish Average
Gross revenue ($)	490,301	495,456	502,740	496,578	485,286	459,465	526,277
Fixed costs total ($)	93,207	90,597	66,409	93,056	84,433	81,520	105,633
Variable costs total ($)	230,232	184,986	147,503	182,868	239,749	239928	221,449
Labor costs ($)	139,379	164,815	187,685	167,378	142,896	114,422	160,619
Total costs ($)	462,818	440,398	401,597	443,302	467,078	435,870	487,701
Net revenue ($)	27,483	55,058	101,143	53,276	18,208	23,595	385,776

[1] Vessels are classified by size (small <56 ft, medium 56.1 ft to 73.9 ft, large >74 ft) and target (tuna or swordfish).
Source: O'Malley and Pooley 2003.

<u>3.7.2.2 Description of Impacts of Recent Regulatory Changes</u>

The focus of this section is recent federal fishery management regulations that have played an important role in the cumulative economic stress on the Hawaii-based longline fleet. To the extent possible, important cause-and-effect relationships between regulatory changes and the economic performance of the Hawaii longline fishery are described. The regulations that have been identified for discussion pertain to sea turtle and seabird interactions in the Hawaii longline fishery and the practice of shark finning.

[26] Swordfish vessels were typically larger than tuna vessels because they generally operated in the rougher sea and weather conditions of more northerly waters (NMFS 2001). In addition, the fishing grounds for swordfish are more distant. Between 1991 and1998, the average distance traveled to first set by swordfish vessels was 570 miles, whereas the average distance traveled by tuna vessels was 275 miles.

3.7.2.2.1 Sea Turtle Interaction Measures

In late 1999, a series of federal closures and fishing restrictions began when vessels registered for use under Hawaii longline limited entry permits were prohibited from engaging in fishing in certain accustomed areas and with certain gear. The management measures were initially the result of injunctions issued by the U.S. District Court for the District of Hawaii to reduce the number of sea turtles injured and killed incidental to fishing operations. In 2001, after completion of a BiOp that assessed the Hawaii longline fishery's impacts on sea turtles, NMFS implemented by emergency rule measures that prohibited Hawaii-based longline vessels from deploying shallow-longline gear (swordfish-target longline gear) and from fishing in an area south of 15°N to the equator and from 145°W to 180° from April 1 through May 31. In 2002, NMFS published an emergency regulation setting a limit of 10 swordfish per trip for any longline vessel arriving in Honolulu because some vessels were suspected of targeting swordfish.

The implementation of regulations designed to reduce interactions between the longline fishery and sea turtles resulted in a dramatic change in the size and composition of the Hawaii longline fleet. Vessels targeting swordfish were forced to either convert to targeting tuna or leave Hawaii and fish elsewhere. Since 2001, of the estimated 45 Hawaii-based longline vessels that were not equipped with line-shooters (and therefore restricted to targeting swordfish or a mixture of swordfish and tuna), about 20 dropped their Hawaii longline limited entry permits and relocated to southern California.[27]

The swordfish vessels that stayed in Hawaii after the gear restrictions were forced to target tuna, which entailed converting their gear. O'Malley and Pooley (2003) note that because bigeye and yellowfin tuna are fished deeper than swordfish, tuna gear is considerably heavier; hence most of the swordfish gear was rendered useless. O'Malley and Pooley estimated the cost to purchase new gear to be approximately $35,925 per vessel (Table 3.7-7). This cost estimate does not include the 20 person-days of labor required to install the line-shooter and rig the tuna gear; nor does it include the economic loss that swordfish vessels that switched to targeting tuna experienced while learning to fish for tuna (NMFS 2001a).

Table 3.7-7 List of Items and Their Costs Associated with Converting Gear from Targeting Swordfish to Tuna.

Item	Quantity	Cost per Unit ($)	Total Cost/Item ($)
Line-shooter	1 + hydraulics	7,000	7,000
Mainline	40 miles	320	12,800
Buoys	110	35	3,850
Floatline	-	-	1,500
Branchline	-	-	1,720
Wire leader	-	400	400
Snap swivels	1,500	1	1,500
Weights	2,500	0 .70	1,750

[27] Federal regulations effectively prevent Hawaii-based longline vessels from periodically fishing for swordfish outside the jurisdiction of the Pelagics FMP during part of the year. In order for a vessel "coupled" with a Hawaii longline limited entry permit to fish for swordfish outside the EEZ off of California (or anywhere else) the vessel has to be "decoupled" from the permit because of gear restrictions.

Item	Quantity	Cost per Unit ($)	Total Cost/Item ($)
Hooks	2,500	1	2,500
Sleeves	35 bags	35	1,225
Vinyl tubes	4 bags	20	80
Side roller	1	1,600	1,600
Total cost			35,925

Source: O'Malley and Pooley 2003.

As noted above, those displaced fishermen who elected to target tuna or shift to the California-based swordfish fishery recovered some portion of the revenue previously generated from the swordfish-targeting segment of the Hawaii longline fishery. In addition, owners of Hawaii-based longline vessels received financial assistance from a federal direct economic assistance program because of the unanticipated and serious business impairment and disruption participants experienced as a result of the series of restrictive management actions that began in late 1999 (66 FR 58440, November 21, 2001).[28] Owners of tuna vessels received $16,000, while owners of swordfish vessels received $32,000.

Although tuna-targeting longline fishing expanded, it was constrained to some extent by the annual seasonal (April-May) longline closure of about one million square nm (nm) of ocean bounded by 15°N to the equator and from 145°W to 180°W. The Pelagic Fisheries FMP FEIS (NMFS 2001a) noted that the closure denied the fleet access to yellowfin and bigeye tuna catches at a time when these stocks are known to be especially productive in equatorial regions, particularly in the U.S. EEZ around Palmyra Atoll and Kingman Reef (NMFS 2001a). Moreover, the closure occured during or immediately preceding periods when the demand for tuna is relatively high (e.g., Lent, Mothers Day, Fathers Day, and school graduation and wedding celebrations). Consequently, the seasonal closure would result in a substantial reduction in the income of some vessels. The FEIS (NMFS 2001a) concluded that the financial situation of many tuna longline vessels is sufficiently marginal that the effects of a seasonal closure may drive some fishing enterprises into insolvency. In addition, the FEIS noted that it is likely fish dealers in the state would increase their purchases of imported fish to offset the loss of Hawaii-produced pelagic fish during the seasonal closure. As imports establish a greater foothold in the Hawaii market they may depress the prices that Hawaii-based vessels receive for tuna during the open season.

However, annual tuna catches in the EEZ surrounding the U.S. possessions, which mainly consists of the waters around Palmyra Atoll and Kingman Reef, do not show an appreciable decrease since the closure was implemented in 2001 (Table 3.7-8). It is also important to note that average prices for the longline fishery have been increasing, from $1.67/lb in 1999 to $2.19/lb in 2002. However, the average price of bigeye tuna decreased in 2002, probably due to the record catch of this species.

[28] The Consolidated Appropriations Act of 2001 made $3.0 million available to NMFS to provide economic assistance to fishermen and fishing communities affected by federal closures and fishing restrictions in the Hawaii longline fishery. Vessel owners that fished under a Hawaii longline limited entry permit and harvested pelagic species in the Hawaii longline fishery between January 1, 1999, and November 29, 1999 were eligible to participate in the program. This eligibility period directed financial assistance to owners of vessels engaged in harvesting activity under a Hawaii longline limited entry permit in the months immediately preceding the implementation of restrictive management actions.

Table 3.7-8 Hawaii-based Longline Catch in the U.S. Possessions, 1991-2002.

Year	Bigeye Tuna (no.)	Yellowfin Tuna (no.)	Albacore Tuna (no.)	Total (no.)
1991	374	439	30	843
1992	70	42	0	112
1993	_	_	_	_
1994	1,127	1,649	151	2,927
1995	460	583	296	1,339
1996	766	1,184	1,612	3,562
1997	2,070	1,932	4,052	8,054
1998	17,666	6,313	3784	27,763
1999	4514	5737	4514	14765
2000	7483	21788	8766	38037
2001	5563	20777	9493	35833
2002	18110	12826	6342	37278

Source: WPRFMC 2004a.

In April 2004, NMFS reopened the swordfish-targeting segment of the Hawaii longline fishery under new federal rules. Instead of the more typically used J-hooks and squid bait, boats targeting swordfish are required to use circle hooks sized 18/0 or larger with a 10-degree offset and mackerel-type bait. Research conducted in the Atlantic longline fishery demonstrated that circle hooks and mackerel-type bait greatly reduced accidental hooking of sea turtles. A maximum of 2,120 swordfish sets are allowed per calender year, or about half of the average annual number of longline sets targeting swordfish prior to the 2001 ban. NMFS also eliminated the April-May tuna fishing area closures (15°N to the equator and from 145°W to 180°W).

The annual effort limit of 2,120 swordfish sets is divided and distributed each calendar year in equal portions (in the form of transferable single-set certificates valid for a single calendar year) to all holders of Hawaii longline limited entry permits (according to the number of permits held) who provide written notice to NMFS no later than November 1 prior to the start of the calendar year of their interest in receiving such certificates (for the 2004 fishing year the deadline was May 1, 2004). Hawaii-based longline vessels are prohibited from making more shallow-sets north of the equator during a trip than the number of valid shallow-set certificates on board the vessel, and operators of these vessels must submit to NMFS within 72 hours of each landing of pelagic management unit species, with the logbooks, one valid shallow-set certificate for every shallow-set made north of the equator during the trip.

Every boat intending to make a shallow-setting trip is required to carry a NMFS-certified observer (operators of Hawaii-based longline vessels are required to notify NMFS before leaving port of their trip type—either deep-setting or shallow-setting). NMFS is bearing the costs of the increased observer coverage. If a total of either 16 leatherback turtles or 17 loggerhead turtles are hooked, no swordfish fishing is allowed for the remainder of the year.

The relaxation of the restrictions on longlining is expected to have positive overall economic impacts on participants in the Hawaii longline fishery. Holders of Hawaii longline limited entry permits that choose not to engage in shallow-setting are likely to benefit each year by being able to sell their share of shallow-set certificates to other permit holders. Holders of Hawaii longline limited entry permits that choose to engage in shallow-setting are likely to benefit from the required hook-and-bait combination, as it has been found in experiments in the Atlantic Ocean to result in higher catch rates of swordfish relative to conventionally used hook and bait types (WPRFMC 2004b). These permit holders would also be subject to new costs, which would partly offset the new benefits available from shallow-setting. These include the costs of acquiring an adequate number of shallow-set certificates each year and acquiring and using circle hooks of the required size. The cost to rig over from tuna fishing to swordfish fishing is reported to be about $15,000. There are also very minor new costs associated with the requirement to notify NMFS each year if they are interested in receiving shallow-set certificates and with the requirement to submit shallow-set certificates to NMFS after each trip. There may also be new costs (relative to the costs associated with conventional practices) associated with the need to use only mackerel-type bait.

Currently, shallow-set certificates are divided equally among interested permit holders at the beginning of each season. While this allocation method, recommended by the Council and approved by NMFS, maintains administrative flexibility for unforeseen eventualities that may oblige changes in the distribution of effort shares, it precludes creating a stable set of privileges with a long time horizon that, in turn, would promote the efficiency and stability of the fishery. In addition, the “hard limit” on hookings of leatherback and loggerhead turtles may create an incentive for each holder of shallow-set certificates to do as much shallow-setting as possible before the fishery is closed, thereby encouraging fishermen to shallow-set under what would otherwise be sub-optimal conditions (in terms of both economic performance and safety).

About two-thirds of the 164 Hawaii longline limited entry permit holders requested shallow-set certificates for 2004. Among those requesting certificates were permit holders who have no historical participation in the swordfish portion of the Hawaii longline fishery and permit holders who do not currently own a longline vessel. The large number of requests suggests that certificates are perceived by permit holders as having substantial cash value in the “created market” for fishing effort. It is also possible that speculation in future allocations based on swordfish catch or effort history may lead some fishermen to increase their amount of swordfish fishing activity (the phenomenon of increasing catch history in anticipation of a quota allocation is commonly referred to as “fishing for quota”).

3.7.2.2.2 Seabird Interaction Mitigation Methods

Owners and operators of vessels registered for use under Hawaii limited entry longline permits are currently required to comply with several measures intended to reduce interactions between seabirds and the Hawaii longline fishery. When making deep-sets north of 23°N latitude, these vessels must employ a line-setting machine (line-shooter) with at least 45 g of weight attached within 1 m of each hook. When making shallow-sets north of 23°N latitude, these vessels are required to begin setting longline gear at least one hour after local sunset and complete the setting process by local sunrise, using only the minimum vessel lights necessary. In addition, all Hawaii-based vessels operating north of 23°N latitude must use thawed, blue-dyed bait and strategic offal discards to distract birds during the setting and hauling of longline gear. Regardless of the area fished, longline vessel operators and crew must follow certain handling techniques to ensure that hooked seabirds are handled and released in a manner that maximizes the probability of their long-term survival, and vessel owners and operators are required to annually complete a protected species educational workshop conducted by NMFS.

The compliance costs of the seabird interaction mitigation measures implemented in the Hawaii longline fishery are minimal. Vessels targeting tuna (i.e., making deep-sets) routinely use a line-shooter and weighted branch lines. Although vessels targeting swordfish (i.e., making shallow-sets) routinely set at night, the requirement to begin setting the longline gear at least one hour after local sunset and complete the setting process by local sunrise could potentially have a negative effect on catch rates. Some fishermen claim that hooks set before dusk are more effective. In addition, the night-setting requirement may provide less setting time for vessels fishing at high latitudes during summer months. While there is insufficient information to quantify these effects on catch rates, the impact on the overall economic performance of individual fishing enterprises is likely to be low. The investment and operational costs of dyeing bait are small, although some preparation time is required. The cost of dyeing bait blue using a dye such as Virginia Dare FDC No. 1 Blue Food Additive is about $14 per set (Gilman et al. 2003). Assuming a typical longline vessel makes 100 sets per year, the total annual cost of dyeing bait is about $1,400. Dyeing bait requires that crew spend considerable extra time preparing the bait in lieu of personal time. In addition, blue-dyed bait is messy, staining the crew's hands and clothes and the vessel deck. Despite these difficulties, some participants in the Hawaii longline fishery routinely dye a portion of their bait blue in order to increase its allure to target fish species. There are no costs associated with strategic offal discards other than the need to purchase containers to store offal for discarding on the set; the container costs are estimated to be about $150 per year (McNamara et al. 1999).

The addition of weight near the hook can be a danger to fishermen if hooks are suddenly pulled loose from the weight of a captive fish. Night-setting is another interaction avoidance method that could be dangerous if vessels are not equipped for this type of operation. As noted above, however, vessel operators that target swordfish often set at night, and vessel operators targeting tuna often use line-setting machines and weights of up to 60 g. It is expected that vessel operators employing these interaction avoidance methods are not compromising the safety of human life at sea, as they are already familiar with these techniques.

The cost-earnings study by O'Malley and Pooley (2003) described in Section 3.7.2.1 reports that the average annual total costs of operating a swordfish vessel and tuna vessel are about $462,000 and $441,000, respectively. Assuming the costs of dyeing bait and strategically discarding offal are about $1,550 per year, the additional costs of employing current seabird interaction avoidance methods represent a small fraction (less than 0.5%) of a typical vessel's expenses.

The compliance costs of current measures to mitigate seabird interactions are not evenly distributed across the fleet. As presented in Appendix D, in 2003, fishing grounds north of 23°N latitude accounted for 19% of the fishing effort (sets) of small vessels (<56 ft), 25% of the effort of medium vessels (56.1 ft-73.9 ft), and 30% of the effort of large vessels (>74 ft).Consequently, small vessels bear the lowest proportion of the fleet-wide compliance costs, and large vessels bear the highest share.

Up until April 2004, the only Hawaii limited entry longline permit holders affected by the seabird interaction avoidance measures were those making deep-sets, as shallow "swordfish-style" setting was prohibited to protect sea turtles. With the reopening of the swordfish-targeting segment of the Hawaii longline fishery under new regulations, it is anticipated that the impacts of employing the current methods to reduce seabird interactions will affect all vessels targeting swordfish. As shown in Appendix D, the fishing effort of swordfish vessels has historically been concentrated above 23°N latitude.

During 2002 and 2003, additional seabird interaction avoidance research field tests were conducted aboard Hawaii-based longline vessels with underwater setting chutes, blue-dyed bait and side-setting (see, for example, Gilman et al. 2003). Side-setting, as the term implies, means setting the longline from the side, rather than from the stern of the vessel. The results of these tests suggested that there may be a wider array of cost-effective methods to reduce seabird interactions in the Hawaii longline fishery.

Table 3.7-9 summarizes the socioeconomic characteristics of the various interaction avoidance methods that the Hawaii longline fleet is currently required to employ or that have been examined as additional or alternative methods. These characteristics include the direct costs to fishery participants of employing the interaction avoidance methods, the potential impact of measures on fishing efficiency (an increase in which is assumed to result in a higher target fish CPUE), the effect of the interaction avoidance methods on fishing vessel safety, and the operational difficulty of using the interaction avoidance methods. Also summarized are possible ancillary effects of seabird interaction avoidance methods, one of the most important being the impact of a method on the incidental catch of sea turtles. Under the new regulations for the swordfish-targeting segment of the Hawaii longline fishery, no swordfish fishing is allowed for the remainder of the year if a total of either 16 leatherback turtles or 17 loggerhead turtles are hooked. Thus, those fishermen targeting swordfish may be less negatively affected overall by a higher cost seabird interaction avoidance method if it helps them avoid attaining the “hard limit”on hookings of leatherback and loggerhead turtles (alternatively, fishermen targeting swordfish may be more negatively affected overall by a lower cost seabird interaction avoidance method if it increases hookings of sea turtles).

Table 3.7-9 Estimated Economic Effects of Various Mitigation Methods that May Reduce Seabird Interactions in the Hawaii-based Longline Fishery.

Method	Direct Compliance Costs		Fishing Efficiency [1]			Other Factors			
	Mitigation Method Installation/ Set-up Costs	Mitigation Method Annual Costs [2]	Bait Retention [3]	Hook Setting Rate	Fish Attraction	Safety of Human Life at Sea	Risk of Entanglement	Crew Convenience	Ancillary Effects
Current Mitigation Methods									
Thawed, blue-dyed bait	None.	$1,400 for dye (estimated to cost $14 per set).	Expected to increase but effect may be reduced if birds are able to more easily remove thawed bait and if thawed fish bait tends to fall apart when baiting the hook through the fish head. In addition, birds may become habituated to blue-dyed bait.	No effect.	May increase for some species.[4]	No effect.	No effect.	Requires preparation time and is messy.	
Strategic offal discard	None.	$150 for replacement containers to store offal.	Expected to increase but effect may be reduced if offal discards attract birds to the vessel.	No effect.	No effect.	No effect.	No effect.	Requires the preparation of offal for use during the longline set, especially when catches are low.	Requires the storage of offal for use during the longline set, especially when catches are low. Piles of offal floating at the surface may attract sea turtles and increase the incidental catch.

Method	Direct Compliance Costs		Fishing Efficiency [1]			Other Factors			
	Mitigation Method Installation/ Set-up Costs	Mitigation Method Annual Costs [2]	Bait Retention [3]	Hook Setting Rate	Fish Attraction	Safety of Human Life at Sea	Risk of Entanglement	Crew Convenience	Ancillary Effects
Night-setting	Small cost may be incurred to make vessel lighting appropriate.	None.	Expected to increase but effect may be reduced during a full moon.	No effect.	May decrease for some species (some fishermen claim that hooks set before dusk are more effective than those set after). In addition, setting time during the summer at high latitudes would be shorter because the night-time period is shorter.	May be dangerous if vessels are not equipped for night-setting.	No effect.	No effect.	
Line-shooter	$5,700 for line-shooter installation.	$1,200 for depreciation and maintenance.	Expected to increase if weighted branch lines are also used.	No effect.	May increase for deep-swimming species; may decrease for shallow-swimming species.	No effect.	No effect.	No effect.	May reduce turtle interactions by decreasing the time that baited hooks are near the surface and accessible to feeding turtles.
Weighted branch lines	No effect.	$1,200 year for replacement swivels and crimps.	Expected to increase.	No effect.	No effect.	Adding weight to hooks may increase the danger to fishermen of being hit by flying hooks that pull loose from fish as branch lines are hauled.	No effect.	No effect.	May reduce turtle interactions by decreasing the time that baited hooks are near the surface and accessible to feeding turtles.
Seabird handling techniques	No effect.	Replacement cost of equipment is approx. $100.	No effect.	No effect.	No effect.	No effect.	No effect.	No effect.	
Protected species educational workshop	No effect.	Costs of the participants' time spent at the meetings.	No effect.	No effect.	No effect.	No effect.	No effect.	No effect.	

Method	Direct Compliance Costs		Fishing Efficiency [1]			Other Factors			
	Mitigation Method Installation/ Set-up Costs	Mitigation Method Annual Costs [2]	Bait Retention [3]	Hook Setting Rate	Fish Attraction	Safety of Human Life at Sea	Risk of Entanglement	Crew Convenience	Ancillary Effects
Other Mitigation Methods That Have Been Evaluated									
Side-setting	$1,500 for deck modifications. These expenses could be substantially higher if reconfiguration of the entire deck is required. In addition, some vessels would have to replace 45 g swivels with 60 g swivels (about $2,500 for new swivels and crimps).	Replacement cost of a bird curtain is approx. $50.	Expected to increase.	May increase hook setting rate.	No effect.	Increases risk of injury from hooks when there are tote tangles. May decrease safety when swells come onto the side where setting is occurring.	May decrease gear tangles.	May increase discomfort when swells come onto the side where setting is occurring.	May provide an opportunity for more efficient use of deck space.
Underwater setting chute	$5,000 for purchase. $1,000 for chute installation.	$125- $250 for depreciation. In addition, there may be maintenance costs.	Expected to increase.	Decreases hook setting rate.	No effect.	Safety hazard when tangles cause hooks to come up prong first during hauling.	Tangles occur around chute if main line is slack during setting.	Reduces bait splatter during setting.	Requires substantial deck space to stow.
Tori lines	$1,000 for tori pole installation.	$4,600 for replacement poles and streamer lines (two each).	Expected to increase but effect may be reduced in rough weather or if seabirds become habituated.	No effect.	No effect.	Entangle-ment risk and constant attention needed to ensure proper functioning may increase risk of accidents during setting operations.	May become entangled with fishing gear or vessel's propeller if not closely monitored.	Requires frequent adjustment	

[1]An increase in a fishing efficiency factor is assumed to result in a higher target fish CPUE.
[2]The straight-line method of calculating depreciation is used. The life expectancy of an underwater setting chute and line-shooter is assumed to be 20 years and 25 years, respectively (pers. comm., Eric Gilman, Blue Ocean Institute, 6/13/04). Assets were assumed to have a salvage value of zero.
[3] Incidence of loss of bait due to seabird interactions and to the mechanical process of setting baited hooks.
[4] A research study conducted aboard Hawaii-based longline vessels found that the catch rate of swordfish and other commercially valuable fish was higher when blue-dyed bait was tested than when natural bait was used, but the difference was not statistically significantly (McNamara et al. 1999).
Sources: Gilman et al. 2003, pers. comm., Eric Gilman, Blue Ocean Institute, 6/13/04, McNamara et al. 1999, McNamara et al. 1999, WPRFMC 2004c.

3.7.2.2.3 Shark Finning Measures

Prior to 2000, swordfish and tuna longline vessels were actively taking shark fins. The longline fleet suffered an economic setback from a state statute enacted in 2000 that prohibits landing of shark fins without the corresponding carcass. Later that year the Shark Finning Prohibition Act was passed by the U.S. Congress. Federal regulations implementing the Act prohibit any person under U.S. jurisdiction from engaging in shark finning, i.e., possessing shark fins harvested on board a U.S. fishing vessel without corresponding shark carcasses or landing shark fins harvested without corresponding shark carcasses (67 FR 30346 May 6, 2002). Shark catch by longline vessels, which was predominantly blue sharks retained for their fins only, decreased by 6 million lb in the two years after the restriction on shark finning. Longline caught mako and thresher sharks continue to be landed and sold, as the meat for these species has a market value.

O'Malley and Pooley (2003) note that the shark finning measure resulted in a financial loss primarily to crew members because, in most cases, the revenue generated from the sales went directly to the crew, not the vessel owner. The approximate annual loss of revenue per tuna vessel was $10,652 (Table 3.7-10). This equates to approximately ten percent of the annual pay to tuna crews, which is similar to the percentages estimated by McCoy and Ishihara (1999). The approximate annual loss of revenue per swordfish vessel was $20,435, and this equaled one-fifth of the annual pay to swordfish crew. Although there was no direct economic impact on longline vessel owners or captains, the lost supplement to crew income may have increased the difficulty of hiring crew.

Table 3.7-10 Reported Average Vessel Annual Loss of Revenue to the Hawaii-based Longline Fleet Because of the 2000 Shark Finning Regulations[1].

Vessel Classification	Average ($)	Standard Deviation ($)	Number
Swordfish	20,435	14,618	7
Tuna	10,947	5,660	29
Small tuna	7,656	4,050	8
Medium tuna	11,684	4,343	16
Large tuna	13,850	9,513	5
Medium swordfish	20,663	18,285	4
Large swordfish	20,133	11,801	3

[1]Vessels are classified by size (small <56 ft, medium 56.1 ft to 73.9 ft, large >74 ft) and target (tuna or swordfish).
Source: O'Malley and Pooley 2003.

3.7.2.3 Changes in Net Revenue and Regional Impacts

To evaluate the overall economic effects of recent regulatory changes in the Hawaii longline fishery it is necessary to estimate changes in net revenues and induced and indirect impacts on the local economy.

3.7.2.3.1 Changes in Net Revenue

Estimating changes in net revenue requires the collection of cost data from vessel owners and operators. While the study by O'Malley and Pooley (2003) provides baseline economic information associated with operating a pelagic longline vessel in Hawaii in 2000, it does not provide the time series information necessary to fully assess the economic effects of the management measures implemented during 2000 and after. Nevertheless, it is possible to examine the initial effects of these regulatory changes by comparing the 1993 cost-earning study of the Hawaii-based longline fleet (Hamilton et al. 1996) with the more recent study by O'Malley and Pooley (Table 3.7-11). O'Malley and Pooley state that a striking difference between the two studies is the amount of gross revenue generated by the tuna fleet, with the 2000 fleet having substantially higher gross returns and therefore higher net revenue. The researchers note that to a certain extent this may reflect the transition of some larger swordfish and mixed target vessels that began targeting tuna in the late 1990s. The curtailing of the swordfish fleet in late 2000 may be responsible for the decrease in the swordfish vessels' gross revenue and variable costs compared to 1993. In addition, many of the most expensive swordfish vessels left the fishery in the mid-1990s.

Table 3.7-11 Comparison of the Average Annual Revenue and Costs in Costs-Earning Studies of the Hawaii-based Longline Fleet, 1993 and 2000.

Category	Swordfish		Tuna	
	1993 avg. ($1000)	2000 avg. ($1000)	1993 avg. ($1000)	2000 avg. ($1000)
Gross revenue ($)	633	490	355	495
Fixed costs total ($)	127	93	89	91
Variable costs total ($)	356	230	133	185
Labor costs ($)	139	139	113	165
Total costs ($)	622	462	335	441
Net revenue ($)	11	27	20	55

Source: O'Malley and Pooley 2003.

In April 2004, NMFS reopened the swordfish-targeting segment of the Hawaii longline fishery under new federal rules. While it is uncertain at this early stage of the reopening what the impacts will be on the economic performance of the Hawaii longline fleet, the effects are likely to be positive and significant. Moreover, should the measures to mitigate sea turtle interaction prove successful, the potential for having a higher amount of swordfish fishing effort increases, potentially resulting in additional economic benefits for Hawaii-based longline fishery participants.

3.7.2.3.2 Regional Impacts

Changes in the economic performance of the longline fleet do not take into account impacts to the overall economy. Additional revenue, employment and income are generated in the Hawaii economy by businesses whose goods and services are purchased by longline fishery participants and by businesses that use products from the fishery as inputs for production of goods and services.[29] People earning incomes directly or indirectly from the fishery also generate additional employment and income by making expenditures within the economy. A more complete assessment of the effects of changes in economic conditions in the pelagic longline fishery on the

[29] Included are individuals or firms that process, distribute and sell fishery products and enterprises that provide goods and services to the fish harvesting sector in Hawaii such as chandlers, gear manufacturers, boatyards, and insurance brokers.

state's economy can be obtained by combining input/output model multipliers with estimates of total sales from this fishing sector.

Leung and Pooley (2002) used a supply-driven approach to estimate the potential economy-wide impacts to Hawaii on output, employment, and income resulting from a 100 percent reduction in longline fishery output of $43.88 million (the 1992 output or gross revenue). Such a reduction would create a potential decrease of $106.2 million in output, 1,600 jobs and $47.21 million in household income. The corresponding output supply-driven multiplier is 2.42, the employment multiplier is 2.46, and the income multiplier is 2.22. Linear interpolations can be used to estimate the impacts with a less than 100 percent reduction in longline fishery output. For example, the $17.9 million reduction in gross revenue that occurred in the longline sector in 2001 is estimated to have created a potential decrease of $43.3 million in output, 653 jobs and $19.2 million in household income.

In addition, the fishery has an impact on businesses that use fishery products as inputs for their own production of goods and services. Firms that buy, process or distribute fishery products include seafood wholesale and retail dealers, restaurants, hotels and retail markets. Leung and Pooley estimated an input supply-driven multiplier of 1.6540 for the longline sector. A reduction of $17.9 million in gross revenue in this sector will cause a total economy-wide output reduction of $29.5 million from a forward linkage point of view.

Leung and Pooley state that the backward linkage effects cannot be added to the forward linkage effects to arrive at some "total" economy-wide impacts because that would amount to double counting the effects of the same exogenous change under two different configurations of the same input-output model. Furthermore, Leung and Pooley note that while the backward linkage effect is relatively straightforward, the same cannot be said about the forward linkage effect. For example, one can assume the reduction in output of the longline sector would certainly reduce the outputs of other sectors in the economy that sell to the longline sector, as well as the subsequent indirect and induced effects. However, the forward linkage impact is generally less well defined. For instance, most seafood buyers, restaurants and other businesses that lost access to a local supply of swordfish simply replaced the local catch with imports from abroad.[30] Fish quality and wholesale price do not appear to have been affected; hence, the price of swordfish at restaurants and thus final demand did not change.

It is also important to note that the contribution of the pelagic longline fishery to overall economic activity in Hawaii is small. The downturn in the fishery in 2001 had a negligible effect

[30] The U.S. is the world's largest swordfish market, and prior to the closure of the swordfish portion of the Hawaii longline fishery in 2001 Hawaii was a major supplier for this market—Hawaii swordfish represented between 37.3 percent and 47.8 percent of the total domestic production between 1997 and 2000 (Bartram and Kaneko 2004). However, the closure of the fishery had little effect on the domestic market. This is because swordfish is a global commodity (Ward 2000), and U.S. fresh fish marketers were able to replace Hawaii-caught swordfish with foreign imports (Bartram and Kaneko 2004). Marketers who were formerly major dealers in Hawaii swordfish products identified the primary sources of fresh swordfish replacing Hawaii products as eastern Pacific suppliers—California (as a consequence of the relocation of Hawaii-based swordfish longline boats), Mexico, Panama, Costa Rica—and South Africa. In general, the U.S. fresh swordfish supply is becoming increasingly dependent on imported products (Bartram and Kaneko 2004). Fresh swordfish imports to the U.S. market began to increase in the mid-1990s. By 2002, swordfish imports accounted for about 71 percent of the total domestic supply.

on total state output, income and employment.[31] Moreover, the negative regional impacts gradually lessened as fishermen recovered some portion of the revenue previously generated from swordfish fishing by outfitting their vessels to participate in fisheries on other stocks (most notably tuna) or by finding other jobs in Hawaii that may or may not be fishing-related.

Although in April, 2004 NMFS reopened the swordfish-targeting segment of the Hawaii longline fishery under new federal rules, it is uncertain at this early stage of the reopening what the regional impacts will be. The effects are likely to be positive. Moreover, should the measures to mitigate sea turtle interaction prove successful, there is greater potential for increasing effort in the fishery, potentially resulting in additional regional economic benefits.

3.7.3 Squid Fisheries

The domestic fisheries potentially affected by the proposed action can be separated into two distinct categories based on the location of the fisheries and target species. One category consists of the incipient domestic distant-water squid jigging fishery occurring in various areas of the Pacific Ocean. This fishery typically occurs outside the U.S. EEZ, and the major target species include the neon flying squid. A description of the distant-water fishery is presented in Section 3.7.3.2. The second category of fisheries potentially affected by the proposed action includes the long-established ika shibi component of the Hawaii pelagic handline fishery, in which squid are caught and used as tuna bait, and a small artisanal fishery in Hawaii that mainly captures squid for human consumption. These fisheries occur in the U.S. EEZ or state waters around the MHI and mainly target the purpleback flying squid. A description of the ika shibi portion of the Hawaii pelagic handline fishery is provided in Section 3.7.3.3, while the artisanal directed squid fishery is described in Section 3.7.3.4.

There are no directed commercial squid fisheries in any sub-region of the western Pacific region other than Hawaii (although small amounts of squid may occasionally be sold in local markets in Guam, American Samoa and Northern Mariana Islands). It is possible that squid are sometimes caught for personal consumption in Guam, American Samoa and Northern Mariana Islands, but no data on the subsistence catch in these islands are available. The only sub-region in the western Pacific region in which the ika shibi style of fishing is widely practiced is Hawaii. While early experiments with ika shibi fishing in Guam showed promise (Amesbury and Meyers 1982), it is a rarely used method of catching pelagic species in the Territory (Meyers 1993). Similarly, exploratory ika shibi fishing was conducted in Northern Mariana Islands (Palacios 1989), but no commercial fishery developed, A survey of the literature revealed no reports of ika shibi fishing in American Samoa or the U.S. Pacific remote island areas.

Squid is an international commodity produced and sold in many areas around the world. Consequently, the economic aspects of squid fisheries, particularly those involving distant-water fleets producing squid products for export, can only be fully understood by examining trends in squid fisheries worldwide. To provide this global perspective, the descriptions of the near-shore and distant-water squid fisheries of interest are prefaced by an overview of: 1) landings trends in

[31] Hawaii's agricultural and fishery production sectors combined account for only about 1.8% of total state output, 1.8% of labor income and 3.0% of employment (Sharma et al. 1999).

the major squid fisheries in the U.S. EEZ and elsewhere in the world; 2) squid capture methods; 3) squid handling and processing techniques; and 4) market trends for squid products.

3.7.3.1 Overview of Global Squid Fishery[32]

3.7.3.1.1 Harvesting Sector

3.7.3.1.1.1 Production

Squid fisheries are among the fastest growing fisheries in the world (Sonu 1993). World squid production nearly doubled during the past two decades in order to keep pace with the rise in demand and appears to be still growing. Currently, more than 2 million mt of squid are landed throughout the world (FAO 2000). From landing trends it seems that squid and other cephalopods are one of the few remaining marine groups of resources where some species in some areas are still experiencing increases in landings, in a world fishery marked by overfishing and decline of many finfish (FAO 1992 1994, cited in Caddy and Rodhouse 1998). The fast pace of growth in squid fisheries is generally attributed to the development of squid fisheries in several regions around the world. In addition, it has been hypothesized that fishing-related reductions in predatory fish biomass and declines of other cephalopod predators such as marine mammals (e.g., toothed whales (Odontocetidae) have, in fact, positively affected oceanic squid and other cephalopod populations (Caddy and Rodhouse, 1998). Just as fast growing weeds can quickly colonize an area of ground that has been denuded of vegetation, it has been suggested that the rapid growth of squid and their short life cycles may have enabled them to move into regions that have been heavily overfished (Jackson 2001). An increase in water temperature due to global warming could also favor population expansion of squids over fish (Christie 2002, Jackson 2001).

What is remarkable is that as recently as three decades ago squid fisheries were concentrated in the Northwest Pacific Ocean and virtually dominated by one nation, Japan, and one species, Japanese flying squid (*Todarodes pacificus*) (Sonu 1993) (Figure 3.7-3). For instance, the 1968 catch of *T. pacificus* which totaled 668,000 mt, an historical high for this species, comprised 73 percent of the total world landings of squid for that year. Japan's share of the world catch for 1968 was nearly 83 percent (Sonu 1993).

[32] This section depends heavily on reported landings provided by FISHSTAT Plus (FAO 2000). Caddy (1989) notes that the quality of the information available to the FAO depends greatly on national reporting by governments. He suggests that the quality of government reporting may be decreasing as evidenced by a growing proportion of squid catch remaining unidentified to species group in official statistics.

Figure 3.7-3 Annual Squid Catch in the Southwest Atlantic and Northwest Pacific Ocean, 1950-2000 (Source: FAO 2000).

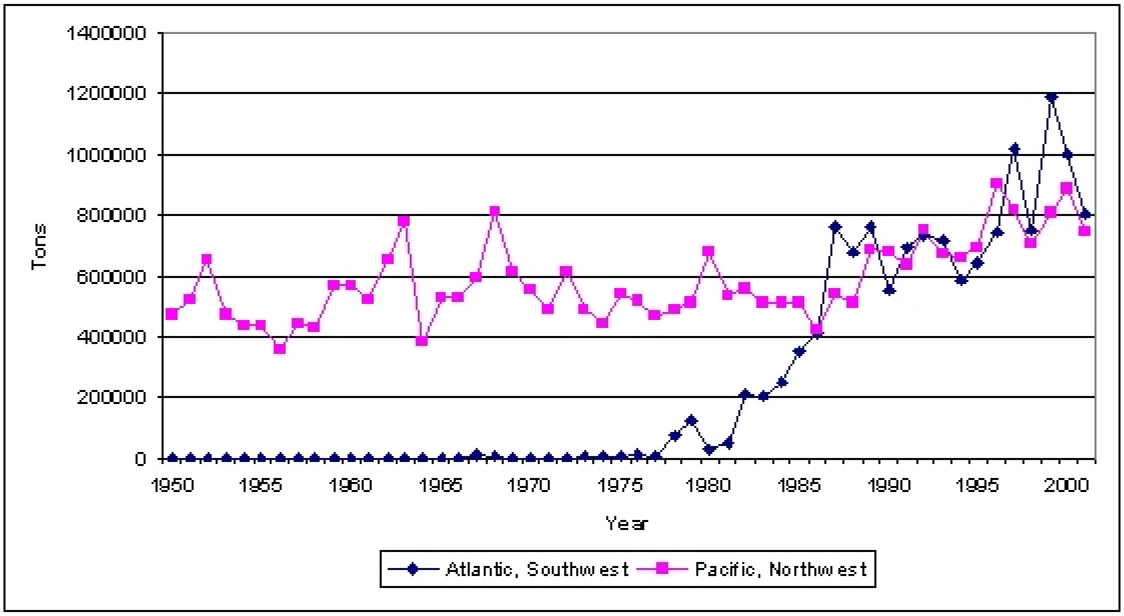
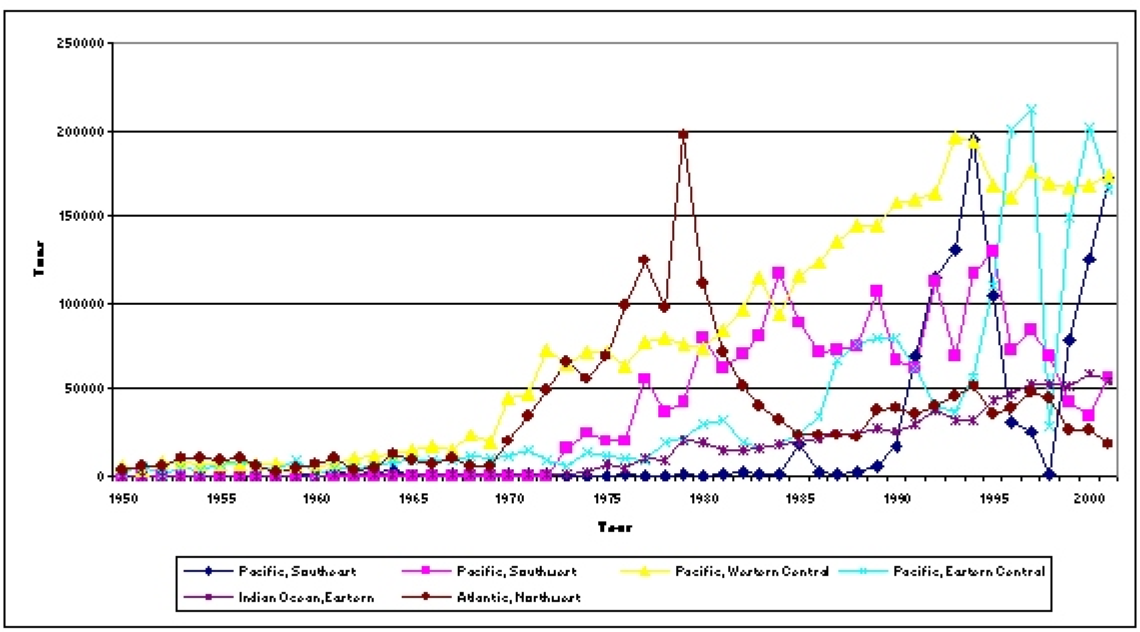


Figure 3.7-4 Annual Squid Catch in the Southeast Pacific Ocean, Southwest Pacific Ocean, Western Central Pacific Ocean, Eastern Central Pacific Ocean, Eastern Indian Ocean and Northwest Atlantic, 1950-2000 (Source: FAO 2000).



The catch of *T. pacificus* in the waters near Japan dropped precipitously between 1969 and 1974 as a result of environmental factors and increasingly intense fishing pressure. However, by that time Japanese squid jigging vessels had increased in size and were using more sophisticated navigational and fishing equipment. These changes improved the ability of vessels to locate seasonally migrating schools of oceanic squid species over considerable distances and to select those areas of densest squid concentration to carry out their fishing operations (Murata 1989). Beginning in the 1970s, there was an expansion of the WCPO fisheries by Japan using jigging and driftnet techniques and a development of fisheries outside the North Pacific Ocean targeting several different species (Sonu 1993) (Figure 3.7-4). The diversification of squid fisheries in terms of regions and target species was accompanied by an increase in the number of nations actively engaged in squid fisheries, as countries sought to increase export earnings as well as domestic food supplies (Japan External Trade Organization 1993, cited in Sonu 1993). The number of nations with more than 20,000 mt in annual squid catch rose from two in 1966 to 12 in 1990 (Sonu 1993). Between 1975 and 1989, the world squid catch more than doubled, from 929 thousand mt to about 2.2 million mt.

One region in which an especially major expansion occurred was the Southwest Atlantic around the Falkland Islands and off Argentina (Figure 3.7-3). Japanese fishermen began to increase the harvest of Argentine shortfin squid (*Illex argentinus)* off Argentina in 1978 (Kohrin Sha 1989, cited in Sonu 1993). Typically, Japanese squid jiggers would fish for Wellington flying squid (*Nototodarus sloanii*) off of New Zealand for a short time before continuing on to the Southwest Atlantic. Eventually, Eastern European countries also began participating in this fishery and through this participation became important suppliers of squid to the world market. By the late 1980s, vessels from Japan, the Republic of Korea, Russia, Spain, Argentina, Poland, Germany, the United Kingdom and the Ukraine were fishing for squid in the region. During the late 1990s, the Southwest Atlantic fishery accounted for about one-third of world squid landings and was worth up to $1 billion (Bostano 2002, FAO 2000). The proceeds from the sale of squid fishing licenses in the EEZ around the Falkland Islands dramatically improved the economy of that country (Thomas 2002). However, *Illex* catches in the Southwest Atlantic declined sharply in 2002. Some researchers are of the opinion that overfishing did not cause the fishery to collapse; rather, they believe that temperature-driven ocean currents swept squid larvae into the open ocean (Bostano 2002). Catches in the Southwest Atlantic rebounded in 2003, but another drastic decrease in 2004 resulted in an early closure of the fishery by the Falkland Islands and Argentina.

Large fluctuations in abundance and availability are a feature of squid fisheries worldwide. They are short-lived animals, and catches of most species fluctuate widely from year to year, depending on water temperature and many other factors (SeaFood Business 2000). It is difficult to count on, with any degree of confidence, a guaranteed supply from any one source. For example, Canada was the major supplier of frozen squid to Japan until 1982, when squid catches by Canadian vessels decreased sharply and exports to Japan from that country dwindled to zero (Sonu 1993). From 1982 to 1990, Poland was the main squid supplier to Japan, but its exports declined in half in 1991 due to poor catches off the Falkland Islands.

Although individual squid fisheries tend to be very irregular, there is rarely a shortage because squid are now fished around the world. Generally, squid are always readily available from somewhere. Moreover, because squid reproduce rapidly, they tend to recover quickly from environmental factors or fishing effort. For example, stock abundance of *O. bartrami* in the

WCPO was extremely low in 1993, probably due to high fishing rates derived from the driftnet fishery (Yatsu et al. 1999). After the driftnet fishery ended in 1992 as a result of an United Nations global moratorium on all large-scale driftnet fisheries, the *O. bartrami* stock seemed to quickly recover and abundance was high during 1994-96. Stock abundance was again depressed in 1997, the most prominent El Niño year in this century, but was high in 1998.

There is also the possibility that some squid species are considerably underutilized. Although almost a hundred species of squid are fished commercially, two species, the *T. pacificus* and *I. argentinus*, account for over half the world harvest (Pacific Seafood Group 2001-2002). Fewer than a dozen species of squid account for almost 90 percent of the world production (SeaFood Business 2000). Results from experimental fisheries suggest that there are squid species existing in substantial quantities that have yet to be effectively exploited. For example, one likely candidate for expanded harvests is the seven star flying squid (*Martialia hyadesi*), a Subantarctic, oceanic species (Rodhouse 1994).

<u>Major U.S. Squid Fisheries</u>

Squid are harvested by U.S. vessels along both the East and West Coasts. Three species of squid are commercially important in U.S. waters, market squid (*Loligo opalescens*) on the Pacific coast, and long-finned squid *(L. pealei)* and short-finned squid (*I. illecebrosus*) on the Atlantic coast. Vessels based in California and Rhode Island produced 92 percent of the total national harvest in 2001 (USDA 2003). Annual landings of the U.S. squid fishery averaged approximately 69 thousand mt from 1980 through 2001 (FAO 2000). However, the U.S. squid supply is characterized by cyclical periods of relative scarcity and abundance. The El Niño periods of 1983-1985 and 1997-1998 on the West Coast had an especially dramatic negative effect on domestic production.

A large portion of the U.S. catch is exported to markets in Europe and Asia/Southeast Asia (Pacific Seafood Group 2001-2002). Despite the wide fluctuations in harvest, squid exports are an important component of U.S. seafood trade, increasing steadily from $25.5 million in 1990 to $91.5 million in 1997, a 258 percent increase (USDA 2003). U.S. squid exports fell sharply in 1998 but averaged around $72.2 million from 1999 through 2002. China has generally been the largest single destination for U.S. squid exports since the mid-1990s, receiving $24.5 million, or about 40 percent of the total U.S. exports in 2002 (USDA 2003).

California

As noted above, much of the variability in U.S. squid landings during the past decade is accounted for by periodic increases and declines in the catch of market squid in the California fishery. In general, this harvest involves luring the animals to the surface with high wattage lamps, encircling them with purse seine nets and pumping and/or using brail nets to remove the squid from the water. The California fishery has a long history, dating back to the mid-nineteenth century, although catches were usually less than 10,000 tons until the 1960s (CDFG 2003). During the early 1990s, the waters of California saw a rapid squid fishery expansion due to the exploitation of a previously “underutilized” population of squid off of southern California and an increased market demand fueled by the emergence of international markets (notably China). In the 1996-1997 season, California fishermen caught a record 124,309 tons of market squid, with an estimated dockside value of $33.3 million. Market squid was the most valuable commercial fishery product to the state in terms of volume and revenue, and became one of the most highly sought after fisheries in California (Lutz and Pendleton 2000). However, landings plummeted to less than 12,000 tons during the El Niño of 1997-1998. The fishery bounced back during the 1999-2000 season, surpassing the previous record with a catch of 126,772 tons, worth nearly $35 million. This catch was followed by another good year in which 119,000 tons were caught with a value of $22.8 million. However, the 173 licensed purse seiners and 39 light boats brought in only 39,000 tons during 2003.

The market squid resource is managed by the California Department of Fish and Game and California Fish and Game Commission. Prior to 1997, the market squid fishery was largely an unregulated, open access fishery. In that year, California legislators placed a moratorium on the number of vessels in the fishery as a result of the increasing market interest and rising squid landings. There is currently no quota on squid; however, the Department of Fish and Game is preparing a management plan for this species.

New England

Long-finned squid, *L. pealei,* is an important U.S. commercial squid species because of its comparatively high value (Rathjen 1983, cited in Sonu 1993). This species is preferred in the European markets for its excellent taste and texture qualities compared to short-finned squid, *I. illecebrosus*, and larger size compared to market squid and brings a considerably higher price on foreign markets than the other two species.[33] Both long-finned squid and short-finned squid inhabit deep waters of the continental shelf through most of the year, moving into shallow waters in spring and summer at which time they become available to fishermen employing bottom trawl gear (Rathjen 1973). While foreign vessels had been catching these species since the mid-1960s, heavy fishing by U.S. fishermen only began after 1983. During the early 1980s, NMFS and the Mid-Atlantic Fishery Management Council initiated a policy of associating foreign fishing allocations to agreements by foreign interests to purchase squid from U.S. fishermen. As a result, foreign allocations and catches declined, while the U.S. domestic catches increased. Between 1981 and 1990, the domestic catches of long-finned squid and short-finned squid rose from 2,947 mt to 26,509 mt, while foreign catches dropped from about 35,000 mt to zero. In 2001, about 14,211 mt of long-finned squid and 4,009 mt of short-finned squid were landed in the East Coast fishery, accounting for around 14 percent and 4 percent of the domestic squid catch, respectively.

The U.S. East Coast squid fisheries are managed by the Mid-Atlantic Fishery Management Council under provisions of the *Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan*. The fisheries are managed under separate limited entry programs. Every year the Mid-Atlantic Council establishes the maximum allowable biological catch for each species. The commercial quota for long-finned squid is allocated into quarterly periods. With some exemptions, otter trawl vessels possessing this squid are subject to a mesh size restriction.

[33] In general, the loligo species, which account for about 20 percent of the world catch, are generally preferred because they are considered more tender (SeaFood Business 2000). As a rule, squid belonging to the Ommastrephidae family are larger and have a tougher membrane, which gives them a more coarse texture.

Difficult economic conditions for New England's commercial fishing fleet have led to a search for new fishery resources, and alternative species of squid are among the potential resources of interest (Vecchione and Galbraith 2001). Moreover, there is interest in adopting alternatives to bottom trawl gear in order to reduce bycatch, interactions with marine mammals, gear conflicts with other types of fishing operations, and disturbance of bottom habitat. To further these combined goals, an experimental jig fishery was conducted by a private firm in 1996 under a federal Saltonstall-Kennedy grant. The fishery tested the feasibility of a commercial fishery for squid using jigging gear and assessing the availability and distribution of oceanic squid resources along the edge and off the margins of the continental shelf in the New England and the Mid-Atlantic regions. While there were hopes to find an abundance of orangeback squid (*Sthenoteuthis pteropus*) and other squid species, the neon flying squid was the only species that showed any potential for future expanded exploitation.

3.7.3.1.1.2 Types of Fishing Gear Used

Squid are caught in a variety of ways, but on a worldwide basis jigging has historically been the most important single fishing method employed (Rathjen 1991). This technique is especially favored for harvest of pelagic species of squid, including *O. bartrami*. Jigging also accounts for the bulk of production of *I. argentinus* taken from the southwest Atlantic (Rathjen 1991). The fishing gear description presented here centers upon that method of fishing, but a number of squid netting techniques are briefly described and contrasted in various ways with jig gear.

<u>Jigging</u>

Squid jigging is carried out on very specialized boats. Almost all aspects of the jigging fishery have undergone rapid changes within the past few decades (Saharuddin et al. 1990). Automatic squid jigging machines have been widely used since around 1965. Computer operated automatic jigging machines were developed in the late 1980s (Lee et al. 1997). These changes were related to boat size and reflected the increase in fishing intensity as squid fisheries changed from coastal to distant-water fisheries (Saharuddin et al. 1990).

Japanese researchers are responsible for many, if not most, of the advancements in squid jigging techniques. While these researchers have published numerous articles on squid fishing technology in trade journals and scientific publications, a major portion of this literature is written in Japanese and thus is difficult for non-Japanese to utilize (Rathjen 1991). The description of squid jigging gear provided here represents a précis of the more accessible literature.

Many automatic jigging machines are available on the world markets today for both hydraulic and electric power (Bjarnason 1992). A modern 50-70 m vessel will be equipped with 50-70 jigging machines (Rathjen 1991).[34] These machines work on the same principle as jigging by hand but are made less labor intensive by the use of electric or hydraulic motors which automatically move the line up and down in a jigging motion and retrieve the line when squid are

[34] The number of jigging machines that can be placed on a vessel depends on the vessel's deck configuration as well as its size.

hooked. The adoption of this technology led to a marked reduction in the number of crew employed on each vessel (Murata 1990).

The jigging machines wind a line over an elliptical or oval shaped reel. Normally a single squid jigging machine drives two reels. Two reels are mounted on each side of a shaft and one sinker-weighted line is attached to each drum (Court 1978). Most machines are equipped with a line-laying device. Earlier machines had an externally mounted sliding-train device, while on later machines the whole shaft moves slowly back and forth, causing the line to wind onto the reel at intervals along its axis. A mesh-covered frame extending the full width of the machine is hinged outboard, and when lowered during fishing, projects about one meter over the water. Lures or jigs equipped with sharp, barbless hooks are attached to each line at short (e.g.,70 to 90 cm) intervals, and the lines are passed over rollers mounted on the outboard edge of the mesh-covered frame.

The lines are lowered to a 30 to 100 m depth depending on the strength of the lights used (Bjarnason 1992). The turning of the reels causes the lure to move upwards through the water in a rhythmic jerking movement which attracts the squid and helps ensure that they remain on the hooks (Black et al 1987).[35] As the lures are recovered over the front rollers this pressure is released, and the squid drop onto the mesh-covered frame between the two rollers. The screen is sloped so that the squid will drop onto the deck or into a flume which carries them below deck for processing. The jigging machines are designed to fish continuously, and when everything is operating properly, a minimal amount of labor is needed (Lemon and Rycroft 1982). Most machines will stop automatically when they malfunction. Because a machine continuously reels many jigs, it functions best in dense concentrations of squid (Court 1978). The machines are operated so that adjacent lines move in opposite directions; thus, no matter when a school of squid passes under the boat, half the lines are apt to be productive. A vessel fishing a large school of squid will often deploy a sea anchor in order to maintain position (Lemon and Rycroft 1982).

Most automatic jigging machines have an easily operated control board which can be adjusted to suit most fishing conditions. Variables that can be controlled include: hauling power and speed; jigging speed and span or length; jigging timing in relation to span or length; depth or distance from bottom; and sensitivity when hauling to prevent slackening or overloading of the line even when the boat rolls. These variables can be adjusted using a computer console to increase fishing efficiency and catch rates (Lee et al. 1997).

A typical lure is about 70-mm long and consists of one or more rings of hooks with an ellipsoid lure above. However, the lures are manufactured in various sizes, shapes and colors, and new types are continually being developed. For example, Guo et al. (1997) describe two new kinds of jigs that have been devised, the impeller-jig and the roller-jig, which attract the squid and hold them firmly with the visual stimulation of the rotating parts. In addition, some fishermen attach lights to the lines to increase catch rates (Flores 1982).

[35] The hooks may penetrate the skin of the tentacles as a squid grasps the lure, but they generally leave only barely perceptible marks on the animal (pers. comm., Mike Seki, NMFS Pacific Islands Fisheries Science Center, 10/21/03).

Jigging uses the squid's natural behavioral characteristics to make catching easier. The boats have powerful lights strung above the deck that illuminate the water and attract small fish. The squid group in the boat's shadow and then dart into the light to feed on the fish. The knowledge that squid can be attracted to light has been utilized as an aid in harvesting squid for centuries (Flores 1982). Torches were replaced by the electrified fishing lamp around 1950, and since then, the invention of the high intensity discharge lamp and other types of lamps have improved the performance of jigging operations. The optimal light intensity is the most important item in jigging activity and has been the subject of intense study in Japan (Flores 1982).

The light arrangement on a squid jigging vessel basically consists of a row of lamps along the fore-and-aft line of the vessel which are hung to a pole or a line stretched horizontally between the fore mast and the mizzen mast (Flores 1982). Large vessels may have two such rows with 25 - 50 2,000-4,000 watt lamps per row. This specific arrangement of the lamps over the vessel rather than over the water is due to the peculiar reaction of the squid, which prefer to aggregate in the boundary area between the shadow of the vessel and the lighted area. The position of the lines in relation to the location of the boundary area is therefore of great importance. The location of the boundary area can be adjusted by the height of the lamp and by its distance from the centerline of the vessel. The position of the lines can be adjusted by the length of the roller arm. Ogura (1981 cited in Flores 1982) reports that if the lines are set in the boundary area the catch is best. Further investigations showed that the relationship between the lamp light beam, water line, and fishing lines influences the catch considerably. Results showed that the catch is better when the so called triangle falls below the waterline. This is achieved by adjusting the length of the roller arm and position of the fishing lamp. Catches of some species of squid may be affected by the phases of the moon, with lower catches during the full moon period (Flores 1982).

Sometimes underwater lights are used on large boats. They are sunk as deep as possible and then slowly hauled back to the boat (Bjarnason 1992). This is done to try to lure the squid from deep water into the light or shade from the above deck lights. In addition to experimenting with different lighting arrangements, researchers have investigated other ways to increase catch rates, such as using artificial sound (Choo and An 1998).

Jigging can be a very productive form of fishing. For example, near New Zealand one jigging machine reportedly caught 1,491 kg of squid in six hours (Wolfe 1973, cited in Court 1978), and Voss (1973 cited in Court 1978) notes similar catch rates for boats that had 20 to 24 machines. A representative of the Hawaii-based distant-water squid jigging operation reports that the catch of that operation reaches 16,000-18,000 kg per night when fishing in the waters off New Zealand; while the catch on North Pacific fishing grounds can reach 8,000 kg per night (pers. comm., Bob Endreson, 10/8/03). The representative notes that the squid caught in New Zealand are substantially smaller than those caught in the North Pacific Ocean.

Moreover, the quality of the squid caught with jigging tends to be comparatively high — the squid arrive on deck still alive and with little or no mechanical damage. The time lag between being caught and frozen is low with jigging, as this fishing method tends to assure steady and controlled catches (Court 1982, Leta 1982). Furthermore, jigging has the benefit of being a "clean" fishing method with little incidental catch of non-targeted species and no destructive interference with benthic fauna or habitat (Rathjen 1991). A representative of the Hawaii-based distant-water squid jigging operation reports that operation brings no bycatch species on-board, but it loses a large quantity of fishing gear due to interactions with blue sharks (pers. comm., Bob Endreson, 10/8/03). The operation uses fishing lines that are 30-60 lb test, and the lines quickly break when sharks attack the hooked squid.

Bower (2004) cites Japanese studies indicating that large squid often drop from jigs as they break the surface due to their weak tentacles. Surveys of *O. bartrami* fisheries in the North Pacific Ocean reported drop-off rates of 36 to 52 percent (JAMARC 2003a 2003b, cited in Bower 2004). Guo et al. (1997) note that the long, thin arms of *O. bartrami* make this species susceptible to drop-off when pulled up by jigs. Japanese researchers have developed new jig designs in an effort to reduce the number of drop-offs (Guo et al. 1997, Yada et al. 1997).

<u>Netting</u>

The use of various types of nets is the method often used for harvesting loliginids, which generally occur in shallow, nearshore waters. The most productive netting technique is trawl fishing. At present, trawling tends to be the most important squid harvesting technique in the North Atlantic, probably due to the intensive use of trawling gear in the fisheries of this region (Rathjen 1991). The principal fishing gear used in the U.S. *L. pealei* and *I. illecebrosus* fisheries is the squid otter trawl. This gear type is also commonly used to catch squid and cuttlefish in the Gulf of Thailand. In all types of otter trawls, the diverting ("paravaning") effect of otter boards or doors keeps the otter trawl spread open horizontally. A weighted groundrope and floats on the headrope keep the net open vertically as the nets are towed over the seabed.

While trawling can be an economically efficient method of catching squid, catch quality may be more difficult to control in comparison to jigging. A major deteriorative reaction bringing about a loss in quality in squid has been identified as enzymatic proteolysis that results in the formation of free protein degradation products such as peptides and amino acids (Rathjen and Stanley 1982). The enzymes responsible for this reaction are present in squid in levels much higher than other marine species. This reaction leads to a softer texture and probably enhanced bacterial action with concomitant off odors and flavors. Trawling exposes the susceptible squid tissue to high levels of physical forces including squeezing and compression that could initiate liberation of proteolytic enzymes and the ensuing loss of quality.

Moreover, unlike jigging, trawls may produce large amounts of species that are not targeted. For example, the directed fisheries for *L. pealeii* in the Northwest Atlantic frequently catch large amounts of butterfish (*Peprilus triacanthus*) (Kolator and Long 1979, Rathjen 1991). This finfish is itself commercially valuable, but the small individuals caught in the squid fishery are unmarketable and therefore discarded. In October 2001, a Northeast Fisheries Center observer documented the take of a leatherback sea turtle in a bottom otter trawl fishing for *L. pealeii* off of Delaware. The mainland squid trawl fishery in New Zealand has generated opposition from environmental advocacy groups because of incidental catches of sea lions, fur seals, basking sharks, and seabirds (Weeber 2004).

Seine and lift nets of various forms are also employed to harvest squid (Rathjen 1991). Although seining is for the most part a comparatively little used technique, the purse seine is important in the California market squid fishery (Lutz and Pendleton 2000, Rathjen 1991). Purse seine gear functions by encircling squid in a netted bag. When deploying the net (making a set), a motor skiff is used to position the net around a school of squid. A typical seine net used in the California fishery is 185 fm long and 22 fm deep. A crew of four or five is commonly needed to handle typical seine gear although fewer are needed if a drum seine is used, which rewinds the net onto a large reel. After the net has been set and closed, the squid are typically sucked into the hold by centrifugal wet pump machinery lowered into the drawn net. In a seining operation, spotter planes and satellite and sonar technology assist fishermen in locating and tracking schools of squid. Additionally, at night, "light boats" equipped with generators and a large array of high-powered electrical lights are employed to attract and maintain schools of squid.

The incidental catch of non-target species is minimal in the commercial market squid fishery, although it cannot be avoided entirely (CDFG 2003). Most of the incidental catch is other coastal pelagic species, including Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*) and jack mackerel (*Trachurus symmetricus*). Smaller vessels in the California fishery use power-assisted lift nets (brail nets) in conjunction with attracting lights (CDFG 2003). A similar fishing method is used in Southeast Asia, especially in the Gulf of Thailand and Philippines squid fisheries (Rathjen 1989, SEAFDEC 2002-2003).

The now largely defunct high-seas driftnet squid fishery targeting *O. bartrami* was prosecuted in the waters of the central North Pacific Ocean by fleets from Japan, Korea and Taiwan. Squid driftnets were made of transparent, monofilament nylon and manufactured in panels (tans or poks) approximately 9 m wide and 50 m long (Gong et al. 1993, Yatsu et al. 1993). The mesh size that was employed varied with the fleet and with the time of year. Mesh sizes increased as the squid grew during the fishing season. Individual net panels were attached together to form sections a few km long. A lead line was attached to the bottom of the driftnet to stretch it out. Larger buoys, flashing lights and radio beacons were usually attached to help locate the driftnet for retrieval. Most of the larger vessels deployed 810 sections per night or between 40 and 60 km of netting (Wetherall 1989). The sections were strung along a float line with 100 to 1000 m between sections. Sometimes sections were set parallel to one another and/or a fleet of vessels would form an array of nets.

During the 1980s, between 200,000 and 300,000 mt of squid were caught annually by driftnets in the North Pacific Ocean, with a landed value exceeding $250 million (Gong et al. 1993, Wetherall 1989). Lee et al. (1997) report that the fishing efficiency of driftnets was higher than that of jigging when targeting *O. bartrami*. This species has long, thin arms which may break off when pulled up by jigs (Guo et al. 1997). In addition, the shape of their fins, which form an angle at the point of attachment to the mantle, is conducive to entanglement at certain combinations of body size/mesh size (Rathjen 1991). The catch per boat per fishing day using driftnets was 1.5-3.8 times greater than that of jigging in the same fishing grounds (Murata 1990). In addition, operating costs were less with driftnet fishing, as no lights were used to attract the squid, resulting in lower fuel consumption (Yeh and Tung 1993). Driftnet fishing was also attractive because capital costs were comparatively low. Many different types of vessels could easily shift to this fishing method with the purchase of relatively cheap, second-hand nets.

Although driftnets were deemed more effective in catching squid than jigs, the non-selective nature of this gear and the impacts of the fishery on marine mammals, seabirds and other marine life led to United Nations General Assembly Resolution 46-215 which mandated a global moratorium on all large-scale driftnet fisheries by December 31, 1992. However, despite the actions taken by the international community to implement the UN moratorium, sporadic large-scale high seas driftnet fishing activity persists in the North Pacific Ocean. For example, the U.S. Coast Guard received two unconfirmed reports of illegal high seas driftnet activity in the North Pacific Ocean in July and August 2002 (NMFS 2002a). On 25 July 2002, Japanese squid jigging vessels reported three driftnet vessels operating at 41°25'N, 169°06'E. One of the vessels was identified as a vessel from the Peoples' Republic of China. Approximately two weeks later, U.S. and Canadian commercial tuna fishermen observed two vessels tending driftnets near 42°06'N, 166°12'E. It is possible that the sightings may have involved the same vessel or vessels.

3.7.3.1.2 Processing Sector

3.7.3.1.2.1 On-Board Processing

In addition to being highly perishable, squid are more susceptible to damage than gutted finfish if not handled carefully; crushing, scuffing or tearing of the skin, and burst ink sacs are indicative of rough handling (Stroud 2001). An important factor in maintaining good quality is speed and workmanship (Kreuzer 1984). Furthermore, in today's highly competitive markets, generating top quality seafood often means freezing products at sea at very low temperatures (20 degrees below zero or colder). By freezing a fishery product at sea, the natural deterioration of fish products is halted. In addition, preservation of the skin color of fresh squid (an important quality criterion in the demanding Japanese market) entails freezing the squid as soon as they are brought on board in order to prevent drying (Sugiyama et al. 1980). On-board freezing of squid increased in importance with the development of distant-water fishing in the 1960s (Kreuzer 1984). Today, freezing is the most important method of preservation in squid fisheries, and frozen at-sea squid is of considerable importance in international trade. In order to produce a high quality product, the squid are blast frozen within 20 minutes of being caught.

On a typical industrial-scale squid jigging vessel, squid which have been caught are transmitted directly to the below-deck working area by trough, slipway, conveyor, etc. (Lemon and Rycroft 1982). Water washing and drainage occurs at the working area, although some vessels are equipped to carry out water washing during transit. Squid in poor condition are culled out and thrown overboard. The squid are hand sorted into different size classes and carefully packed in two or three layers, laid out evenly tail by tail with tentacles folded under and along the outside of the block. The traditional block size is 8.5 kg.[36] Each block carries a tag indicating the number of squid per block. This is an important marketing consideration, for in the market, all things being equal, larger squid command a higher price (Lemon and Rycroft 1982).

The blocks of squid are quickly frozen in a freezing chamber using the contact-freezer or semi-air blast method. At the completion of freezing, the squid are removed and a glaze is applied by immersing the frozen blocks in fresh water for five to six seconds. The glazed squid are then placed in a corrugated board box for sheathing and are stored in the fish hold at -25°C to -35°C. Glazing and packing the frozen blocks are essential in order to prevent dessication during cold storage (Kreuzer 1984). In addition, stowage in boxes is generally better than bulk stowage

[36] Sorted squid may be packed in containers of different sizes. For example, large squid such as *O. bartrami* are packed in containers of 10 kg or larger (Sugiyama et al. 1980).

because there is less risk of crushing and bursting the ink sac. Whole squid keep in good condition in cold storage at -30°C for nine months or more.

Squid are not normally gutted at sea because many markets prefer them whole; the ink and the tentacles are often used along with the flesh of the mantle when preparing squid for eating. The form in which squid is frozen at sea is changing. While in the past they were all frozen whole, now some vessels freeze their catch as skin-on uncleaned tubes (Kreuzer 1984). The fins and head and tentacles are removed and packed onto separate freezing trays. Next, the mantles are butterflied, the viscera are removed and discarded, and the product is placed on a third set of trays. Alternatively, the squid are headed and eviscerated and only the tubes are frozen.

Vessels that supply markets for squid in which product color is not an important quality criterion may forego investments in on-board freezing capacity. No difference in taste is apparent between squid that are frozen immediately or after having been properly chilled or iced for 1-2 days or so, provided optimal handling procedures are followed on board the vessels from the time the squid are caught (Kreuzer 1984). For example, in the California market squid fishery none of the vessels have on-board flash freezing capability. However, the fishery occurs in shallow waters (generally within a mile of shore), and usually the squid are landed within hours of capture (Lutz and Pendleton 2000). After being offloaded, the squid are trucked to processing facilities where most of the squid is frozen whole in blocks or individually quick frozen.

3.7.3.1.2.2 Shoreside Processing

Land processing methods vary according to type of fishery, kind of raw material and specific products produced (Kreuzer 1984). However, after being transported frozen to a processor, the edible parts of squid are generally prepared in the following manner. First, the whole squid are thawed by hot water and washed. The tentacles are cut off just in front of the eyes and retained, as they can be eaten once the suckers have been removed. The head is twisted and the mantle is squeezed while the head, pen and viscera are gently pulled out. The mantle can be left whole, with the gut cavity washed out, or it can be split and opened so that any remaining guts can be scraped or washed away. The skin on the mantle can be peeled or scraped off; blanching in hot water at 25-30°C for about 15 seconds makes the skin easier to remove. Machinery for the entire process of heading, gutting, skinning and cutting is available.

The yield of edible meat from squid depends on various factors such as species, size, season, processing methods, etc. (Kreuzer 1984). Although squid have a much higher yield than finfish, at least 30 percent of the animal may be inedible when processing products for human consumption. However, most inedible parts can be transformed into potentially valuable products. The skin can be used to produce a high protein solution that is added to animal feed (Learson et al. 1982). The viscera can also be used as animal feed. The eyes can be used in the paint industry for their high luminosity, and certain parts of the gut wall may be used in the cosmetics industry. The lipid and fatty acid compositions of the integument of *O. bartrami* is being assessed as a possible new source of phospholipids containing docosahexaenoic acid (DHA) (Deng et al. 1999). Omega-3 fatty acids, specifically DHA, are widely touted for their health benefits. Its high chitin content (90 percent) also makes the internal shell useful for many other medical and health-related applications (Learson et al. 1982). For example, it is currently used for bandages and burn dressings, as it reduces scars and infection and improves healing. At one time the integument was also investigated for its use in the manufacture of contact lenses (Learson et al. 1982). Finally, the squid beak is prized in Japan for its purported aphrodisiacal attributes (Learson et al. 1982).

As a result of the extensive international trade of frozen squid, costs largely dictate the level of processing that occurs in various countries. For example, due to lower labor costs overseas, many U.S. processors freeze whole squid into blocks and export the blocks to China and other countries for secondary processing into tubes, tentacles, rings, breaded or canned seafood products for re-export. Relatively small quantities of U.S.-caught squid receive additional domestic processing.

In addition to being processed for human consumption, squid are frozen for bait and supplied to domestic commercial and recreational anglers. Squid is an especially desirable bait in longline fisheries because it holds up well in the water and will not easily tear off the hook (Sonu, 1993). The market for *I. illecebrosus* has primarily been for bait. This species is preferred over *L. pealei* because it is larger, has a thicker and tougher mantle, and also because it is considerably less expensive. In addition to providing bait to domestic fishermen, East Coast producers provide *I. illecebrosus* to export bait markets in Canada, Iceland and other countries. The *L. opalescens* fishery is an important source of both frozen bait and live bait for the California recreational fishing industry (CDFG 2003).

3.7.3.1.3 Market Trends for Squid Products

The volume and value of international trade in squid products have increased dramatically over the past two decades. World imports of squid in all forms (frozen, fresh or chilled, seasoned, dried, salted or pickled) rose from about 89,000 mt (valued at approximately $138 million) in 1980 to just over 506,000 mt ($849 million) in 2001 (FAO 2000). Squid have a well-defined group of consumers concentrated in relatively few markets, the principal ones being Japan and countries of southern Europe (primarily Spain). In these markets, squid products have a definite segment of the food market and compete with meat or other fish products to a limited extent only. There is, however, considerable competition within the global squid market. For the most part squid products are commodities that face strong international competition for access to export markets. For example, California market squid competes with squid from the New Zealand and Falkland Islands fisheries for the Chinese market. Because of the international competition, prices tend to move in parallel over the medium to long term, with Japanese demand setting the trend (ITC 1989).

In some markets, particularly Japan, there is also competition between domestic and imported products (Sonu 1993). To supplement its domestic catch Japan imports around 50,000 mt of squid each year. These imports make up about 10 percent of the Japanese market. Before Japanese landings of *T. pacificus* dropped sharply in 1971, Japan prohibited imports of squid. In 1971, imports were allowed, but import quotas are maintained on seven product forms of squid and cuttlefish: live, fresh, chilled, frozen, salted, brine-soaked and dried. Product forms which are exempt from import regulations include processed squid which has been flavored, such as smoked and prepared or preserved products (i.e., canned, boiled, seasoned or fermented products). Import quotas are set every six months. Because imports represent a small percentage of total domestic consumption of squid, they are too small to influence domestic prices.

Japan’s quota system sets not only the amount of annual imports but also decrees recipients of import quotas (Sonu 1993). Quota allocations can be purchased for a fee, which varies according to prevailing squid prices. The transferred import quota is, however, credited to the original holder. Since the import quota allocation is based mainly on previous import records, the system guarantees that the same holders will continue to be given allocations even if they have no intention of buying squid themselves. There is a great deal of variation in the amount of quota held by individual importers, who are reported to number more than 200. In Japan (and other countries such as China) a major share of squid imports has been handled by trading companies, which usually have one or more seafood import departments (ITC 1989). In recent years, however, the numerous supermarkets under large national chains have also become a major factor in Japan’s seafood industry.

Because of the limited import quotas, importers seek items which bring high profitability, usually those that fill special niches in the Japanese market (Sonu 1993). Even with import quotas it appears that the volume of imports is affected by prices of domestic squid. When prices are low, importers have little incentive to use their allotted quotas.

Imports of squid into Japan are also subject to tariffs (Sonu 1993). As Japan and the U.S. are signatories to the General Agreement on Tariffs and Trade, lower tariffs apply to U.S. exports of squid products: five percent for fresh or frozen products, and 15 percent for salted, dried, prepared or preserved products (including products in airtight containers). Tariff rates are calculated as a percentage of cost, insurance, freight value.

Squid prices have a seasonal cycle, being lower in July-September owing to Japanese landings during that period (Food Market Exchange.com). Another important element influencing squid prices are catches in the Southwest Atlantic. Eastern European countries have tended to sell at low prices when catches in the area are high, often depressing world market prices for other varieties of squid as well. In general, Japanese importers pay higher prices than Europeans, and most of the world supply goes to Japan for as long as the national import quota remains unfilled.

With respect to the prospect of market expansion, some of the traditional markets, including Japan and Spain, are expected to show little or no growth (Anon. 2001). Squid and cuttlefish combined remains the leading seafood consumed in Japan due to the wide range of utilization of these seafoods such as sashimi, family cooking use, institutional and restaurant use, and many kinds of processed food. The market for these cephalopods in Japan has returned to normal following the financial crisis in the late-1990s. However, the long-term demand is uncertain because of the switch of younger Japanese to a more western-style diet (Anon. 2001).

On the other hand, squid consumption is expanding in Northern Europe and the U.S., which are areas traditionally having low consumption figures. Americans generally prefer to call squid “calamari,” the Italian name for squid, and the average U.S. consumer has a strong aversion to buying whole, wet squid (although that may not be true of some ethnic groups in the U.S., such as those with an Asian or Mediterranean background). Nevertheless, imports of squid into the U.S. are increasing and this trend is expected to continue. Since 1990, U.S. squid imports have grown from 13,000 to 47,600 mt in 2001 (SeaFood Business 2000). Dozens of countries are now exporting squid to the U.S.. The biggest supplier is Asia, where squid from all over the world is reprocessed into a variety of products, including steaks, rings, cleaned tubes and tentacles. China, the single largest supplier of squid, accounts for about one-quarter of all U.S. squid imports, followed by Taiwan, India, South Korea, and Thailand. Almost all of the squid imported from China is reprocessed product, including large volumes of California market squid.

The domestic consumption of squid is spreading among the non-ethnic as well as the ethnic U.S. population (Sonu 1989). New products catering to the non-ethnic groups, such as battered, breaded squid rings and steak strips are being successfully marketed. Other favorable factors include the so-called "grazing" trend — the tendency for restaurant patrons to forgo a full meal and be satisfied with an appetizer only — and the fact that squid products are easy to prepare at restaurants. Brown (2002:116) notes the mass-appeal of squid to restaurant patrons:

> *Fried calamari may be the most popular restaurant appetizer in all of Christendom. I'm amazed that McSquid hasn't started popping out of drive-thrus worldwide.*

SeaFood Business (2000) describes the attraction of squid as a menu item in the U.S. food service industry. They note that the world-wide abundance of squid maintains a downward pressure on prices. Recently, cleaned tubes and tentacles may be purchased from importers for \$1.10 to \$1.85 a lb. The cheapest squid are small (3- to 5-in) product from China, while large (8- to 12-in) tubes from Thailand are at the high end. Squid steaks may sell to distributors for \$2.45 to \$2.65 a lb. Restaurants can take 3 oz of squid, costing less than 50 cents, and charge \$6.95 or \$7.95 for it breaded or battered as an appetizer.

3.7.3.2 Domestic Distant-Water Squid Fishery in the Pacific

The domestic distant-water squid jigging fishery in the Pacific Ocean is currently being conducted by a single operation and is a very small contributor to the Pacific squid harvest. The vessels of this one operation occasionally call into Honolulu and Dutch Harbor, but the operation may be relying mostly on at-sea transshipment to deliver product to buyers. The level of on-board processing depends on the size of the squid caught and the preferences of buyers (pers. comm., Bob Endreson, 10/8/03). All of the product of the operation is currently destined for the Japanese market (pers. comm., Bob Endreson, 10/8/03).

3.7.3.2.1 Number of Vessels Involved

According to a representative of the U.S. distant-water squid harvesting operation, the operation consists of four catcher vessels (pers. comm., Bob Endreson, 10/8/03). The mothership is 47 m long and holds 1 million lb of squid. It is a Japanese-built vessel that was seized by the U.S. Coast Guard (USCG) for illegal driftnet fishing, bought at auction, and given a U.S. fisheries endorsement. It has 38 jigging machines on board and cost \$1.5 million to convert. The other three catcher boats are converted crab boats from Alaska. They range from 32 m to 34 m in length, and each holds between 450,000 lb and 850,000 lb of squid (Table 3.7-12). Fitting out the vessels for squid fishing was costly (the least expensive boat was \$1.2 million) because of the need to install blast freezers aboard each boat (pers. comm., Bob Endreson, 10/8/03). The total investment of the operation is about \$20 million.

Table 3.7-12 Characteristics of the Vessels Participating in the Domestic Distant-Water Squid Fishery in the Pacific Ocean.

Vessel Name	HSFCA Permit Issue Date	Length (m)	Gross Tonnage	Hold Capacity (m^3)	Crew No.
Pacific Wind	April 22, 2002	47.1	642	443.77	18
Pacific Ballad	September 3, 2001	32.5	327	438.27	12
Pacific Star	September 4, 2001	33.3	277	208.19	12
Pacific Venture	September 4, 2001	34.2	335	527.05	12

Source: NMFS PIRO.

Honolulu is listed on the HSFCA fishing permit and application as the hailing port of all the vessels. Each vessel is incorporated under a different name.

3.7.3.2.2 Type and Quantity of Fishing Gear Used

The U.S. distant-water operation relies solely on the jigging method of harvesting squid. The four catcher boats each carry 21-38 jigging machines (pers. comm., Bob Endreson, 10/8/03).

3.7.3.2.3 Species of Fish Involved and Their Location

According to the HSFCA fishing permit and application, the vessels participating in the U.S. distant-water operation are licensed to fish in the following six FAO fishing areas:

61. Northwest Pacific;
67. Northeast Pacific;
71. Western Central Pacific;
77. Eastern Central Pacific;
81. Southwest Pacific; and
87. Southeast Pacific.

The U.S. distant-water operation competes directly with international fleets in oceanic squid fisheries outside the U.S. EEZ. The operation fishes to the north of the Hawaiian Archipelago (at around 45°N) in zones of enhanced biological productivity. The primary species targeted in the North Pacific fishery is *O. bartrami* (commonly referred to as the neon flying squid or red flying squid). This fishery is seasonal, usually occurring during the summer months of the Northern Hemisphere.

In addition, the U.S. distant-water operation fishes in the New Zealand EEZ where it operates under charter to a New Zealand-owned company. The New Zealand fishery is managed by an individual transferable quota system (Easton 1989). The target species in the fishery is *Nototodarus sloanii* (Wellington flying squid). Participation by the U.S. distant-water operation in this fishery generally occurs between October and February.

3.7.3.2.4 Actual and Potential Revenue from the Fishery

A representative of the U.S. distant-water operation reports that the squid catch can be as high as 35,000 to 40,000 lb per night when fishing in the waters off New Zealand; while the catch on the North Pacific fishing grounds can reach 18,000 lb per night (pers. comm., Bob Endreson, 10/8/03). At an assumed ex-vessel price of $1,000 per ton, these catches would generate gross revenues ranging from $9,000 to $20,000 per night of fishing. However, average catches and revenues may be much lower. During fishing trips made in the 2003 fishing season, the combined squid catch of three of the vessels participating in the U.S. distant-water operation was only 44,596 lb after about 22 days of fishing on the North Pacific grounds (these fishery statistics are based on 2003 North Pacific high seas squid jig logbook data).

3.7.3.2.5 Recreational Interest in the Fishery

Access to the *O. bartrami* resource by the general public is limited. There is likely no recreational fishing for this species in the western Pacific region.

3.7.3.2.6 Nature and Extent of Foreign Fishing and Indian Treaty Fishing Rights, If Any

There are no foreign fishing or Indian treaty fishing rights associated with the distant-water squid jigging fishery.

3.7.3.3 Ika Shibi Component of the Hawaii Pelagic Handline Fishery

Handline fishing is an ancient technique used to catch yellowfin and bigeye tunas with simple gear and small boats. Handline gear is set below the surface to catch relatively small quantities of large, deep-swimming tuna that are suitable for sashimi markets. This fishery continues in isolated areas of the Pacific Ocean and is the basis of an important commercial fishery in Hawaii. Three methods of pelagic handline fishing are practiced in Hawaii, the ika shibi (nighttime) method, the palu-ahi (daytime) method and seamount fishing (which combines both handline and troll methods).

The ika shibi method of catching tuna developed from a squid fishery that was started in the early 1900s by early immigrants to Hawaii from Okinawa (Yuen 1979). The incidental tuna caught in the squid fishery were known as “ika-shibi” (squid-tuna in Japanese). After World War II, participants in the fishery who owned boats equipped with iceboxes began to target tuna using the squid as bait (Yuen 1979). Assisted by increased demand for sashimi grade tuna, the ika shibi fishery became a well established component of the Hawaii pelagic fishery (Itano 2004).

3.7.3.3.1 Number of Vessels Involved

In the late 1970s and early 1980s, participation in the ika shibi component of the Hawaii pelagic handline fishery increased as a result of the introduction of fuel-efficient small-scale vessels and the expansion of the restaurant market in Honolulu (Pooley 1993). The rising price for fresh tuna and reduced shipping costs made air shipment to Honolulu economically feasible (Boggs and Ito 1993, Yuen 1979). In 1977, about 40 boats (many of them part-timers) were involved in the fishery from Hilo and about 10 or so boats were fishing from Kona on the west side of the island

(Yuen, 1979). By 1980, at least 230 boats were participating in the fishery (Ikehara 1982). However, during the early 1990s, some of the larger handline boats began to shift their fishing effort to the seamount and weather buoy fishery 100-200 nm from the coast (Boggs and Ito, 1993). More recently, some handline fishermen have focused their effort on home-made private fish aggregating devices (PFADs) anchored offshore.[37] The first of these private buoys appears to have been set in 1999. With the shift of many pelagic handline vessels to fishing around FADs there has been a considerable decrease in the size of the ika shibi fleet. Currently, the ika shibi fleet based in Hilo consists of only one to three boats that fish regularly (pers. comm., Craig Severance, University of Hawaii-Hilo, 7/2/04).

3.7.3.3.2 Type and Quantity of Fishing Gear Used

A wide assortment of boats have adopted the ika shibi method of harvesting tuna. The fishery generally employs small boats, between 18 and 30 feet in length. In a 1995-1996 survey the average length of an ika shibi boat was eight m (26.65 ft) (Hamilton and Huffman 1997). Many of the smaller boats are trailered to launching ramps such as those located on the Wailuku River in Hilo and at Pohoiki, southeast of Hilo and south of Cape Kumukahi (Itano 2004). Some of the larger boats tie up at wharves and slips on either side of the lower Wailuku River.

The average trip length in the ika shibi fishery during 1995-1996 was one day. The boats are usually manned by two people, but fishermen will often go out alone (Yuen 1979). Typically, participants in the fishery leave port to get to the grounds at sundown (Yuen 1979). Upon arrival, the engine is turned off and a parachute sea anchor is attached to the bow and lowered into the water. The sea anchor reduces the drift of the vessel allowing it to stay fishing over a congregation of squid and/or tuna longer. It also reduces the pitch and roll of the vessel to produce a more stable working platform. Surface and underwater lights powered by storage batteries are turned on to attract the squid. Above surface lights are usually 25-watt incandescent bulb with polished metal reflectors. Often two of these are used. The single underwater light is a 50-watt incandescent bulb that has been waterproofed and weighted. Brighter bulbs are sometimes used for moonlit nights.

Yuen (1979) reports that the squid are caught by angling and gaffing. In angling for the squid, hooks are baited with mackerel scad by cutting off the tail so that the body of the scad is the proper length to fit on the shank of the hook and inserting the shank of the hook through the length of the fish starting with the cut end and ending at the mouth. A light line or wire attached to the proximal tip of the shank is wound around the fish to keep it from falling apart. This makes it possible to use the same piece of bait repeatedly despite the squid bites that are inflicted upon it. The baited hook is tossed out about 5 m and slowly pulled back to the boat. In this manner the hook is used not only to hook squid but also to lure the school of squid to within gaffing range of the boat. A few fishermen prefer to gaff the squid exclusively. In this case the squid are lured to the boat by tossing out a whole scad hooked through the head with a fish hook and retrieving it in the same manner applied to the squid hook.

[37] The State of Hawaii also constructs and deploys FADs. To date, there are 55 state-funded FADs: 18 are in the waters surrounding the Big Island, 14 are around Oahu, 14 are around Maui County (which includes Lanai, Molokai, and Kahoolawe) and 9 are around Kauai.

Itano (2004) reports that some ika shibi fishermen also employ a variety of jigs to capture squid. All of the jigs are locally made and most are relatively small, thin and dense in comparison to many commercially available squid jigs. Typically, the jigs are constructed of or painted with a green luminescent material. Squid jigs are usually fished with a light fishing rod with a spinning reel equipped with 8 - 15 lb test monofilament. The jig is allowed to sink and retrieved with a steady or jerky motion. Fiberglass rods with a short, fixed length of monofilament line are also used with the smaller jigs. These rods are swung in a rapid "figure-8" motion to entice squid to strike near the surface.

In the past, fishing for tuna began after five to 10 squid had been caught. Today most fishermen bait their tuna lines with mackerel scad and proceed with fishing while catching squid for bait. The tuna bait is typically fished at a 30 m depth (Nitta and Henderson 1993).

3.7.3.3.3 Species of Fish Involved and Their Location

In the ika shibi component of the Hawaii pelagic handline fishery, squid are caught and used as bait to capture yellowfin tuna and to a lesser extent bigeye tuna and albacore tuna. The squid species primarily caught is *Sthenoteuthis oualaniensis* (purpleback flying squid).

The ika shibi fleet is based largely on the island of Hawaii (Big Island), but this style of fishing is also occasionally employed by fishermen on the other MHI (Ikehara 1989, Nitta and Henderson 1993). The Big Island ika shibi fishery occurs predominantly south of the island from Hilo to around the town of Captain Cook. Fishing effort is generally focused at the edge of the island shelf near the 600 to 1,000 fm contour from 2 to 20 km from shore (Ikehara 1989, Nitta and Henderson 1993). The ika shibi season may start as early as April and continue through December (Rizzuto 1987). Peak fishing activity usually occurs in the summer months. The west side of the Big Island may also have a winter "run" of large tuna near the South Point area. Specific ika shibi fishing locations and seasons on the Big Island are provided in Table 3.7-13.

Table 3.7-13 Ika Shibi Fishing Locations and Seasons in the Waters Around the Island of Hawaii.

Region	Area/Season
East Hawaii	Pohoiki - March-June. 92.50
	Hilo/Pepeekeo - July-September
	North Pepeekeo - October-November
	South Point - December-January
West Hawaii	Keauhou - June-August
	Milolii - September-December

Source: Ikehara 1989.

The effectiveness of the fishing lights to attract squid is influenced by the phase of the moon, with the new moon producing higher catches of squid. During the full moon phase fewer squid are attracted to the lights. Brighter bulbs are sometimes used for moonlit nights (Yuen 1979). Some ika shibi fishermen believe the highest tuna catches occur when the moon is in the first or third quarter (Ikehara 1989). However, other fishermen indicate that the tuna catch is unaffected by the moon phase.

3.7.3.3.4 Actual and Potential Revenue from the Fishery

Some of the ika-shibi catch of yellowfin tuna is marketed through the Honolulu fish auction. However, the majority of the catch is sold through the fish auction in Hilo and through intermediary buyers on the island of Hawaii. Most of the catch is sold fresh, but surpluses caught during the peak summer season are sometimes dried and smoked.

Output of the pelagic commercial handline fishery was estimated at $9.35 million in 1995-1996. This total was composed of $0.36 million in sales for palu ahi vessels, $2.82 million for ika shibi vessels, and $6.17 million for seamount vessels (Hamilton and Huffman 1997). In more recent years, however, tuna landings by the ika shibi fleet have reportedly declined sharply. While the reasons for the collapse of the fishery are uncertain, questions have been raised concerning whether or not the PFADs deployed off the Big Island in recent years are intercepting fish that would otherwise be available to the ika shibi boats and other small handline vessels (Tummons 2001, WPRFMC 2003a). There is also concern that the increasing effort on FADs may be resulting in unsustainable harvests of small, pre-reproductive yellowfin and bigeye tuna.

A 1995-1996 survey of Big Island full-time ika shibi vessels indicated that ika shibi fishermen earned 92 percent of their personal income from fishing (Table 3.7-14).

Table 3.7-14 The 1995-1996 Average Characteristics of Island of Hawaii Full-Time Ika Shibi Vessels.

Respondent Characteristic	Value
Percent of Personal Income from Fishing	92.5
Total Household Income	$46,111
Age	42.10 yrs.

Source: Hamilton and Huffman 1997.

Average pro forma cost and earnings estimates for Big Island full-time ika shibi vessels for 1995-1996 are shown in Table 3.7-15. The average full-time ika-shibi handline vessel generated $70,813 in gross revenues from the sale of pelagic species in 1995-1996. After fixed costs and variable costs for the average of 99 pelagic trips during the year are subtracted, the vessel has a net operating income of about $38,948. After one-third of net operating income for crew share is subtracted, income to the owner and/or the captain of the vessel is $25,706. Sales of tuna account for nearly all of this income; although ika shibi fishermen may occasionally sell surplus catches of squid, the revenue earned from these sales is probably negligible. Although no recent economic data are available, the aforementioned recent decline in the catch of the ika shibi fleet has likely had an adverse effect on the economic performance of this fleet, although some of these vessels have presumably switched to more lucrative pelagic handline fisheries.

Table 3.7-15 The 1995-1996 Average Annual Revenue and Costs for Full-time Ika Shibi Vessels

Statement	Value ($)
Gross revenue	70,813
Fixed costs total	11,233
Variable costs total	20,632
Total costs	31,865
Net revenue	38,948

Source: Adapted from Hamilton and Huffman 1997.

3.7.3.3.5 Recreational Interest in the Fishery

Charter boats occasionally engage in ika shibi fishing, as described in the following excerpt from the Web page of a Kauai-based charter boat operation:

> *There is a fishery called IKA/SHIBI, or Squid/Tuna. It is a very productive method to fish for Tuna.*
>
> *Basically, we head out before sunset to deeper waters, find our spot where we deploy a parachute (sea anchor) off our bow. This will slow our drift. We then submerge a light off the side and start chumming. Soon you will be catching Squid on light spinning tackle using Squid lures (good fun). Those same Squid will then be used to bait the big Yellow Fin Tuna or AHI. If you're lucky and the AHI find the boat, watch out because you are in for the battle of your angler's life. This type of fishing is seasonal and the conditions have to be favorable* (True Blue Fishing Tours).

No information is available on the amount of squid harvested in the charter or recreational ika shibi component of the Hawaii pelagic handline fishery.

Some ika shibi fishermen occasionally hook squid for home consumption, provide gifts for friends and family or to supply a specific banquet or large social gathering with fresh squid (Itano 2004). The amount of this recreational or subsistence catch is unknown.

3.7.3.3.6 Nature and Extent of Foreign Fishing and Indian Treaty Fishing Rights, If Any

There are no foreign fishing or Indian treaty fishing rights associated with the ika shibi component of the Hawaii pelagic handline fishery.

<u>3.7.3.4 Kauai-based Directed Squid Fishery</u>

A small directed squid fishery exists in Hawaii, primarily on Kauai. In addition, a few Hilo-based fishermen may occasionally make directed fishing trips for squid, mainly for personal consumption.

3.7.3.4.1 Number of Vessels Involved

It is estimated that there are currently 20 to 30 participants in the Kauai-based fishery (Itano 2004).

3.7.3.4.2 Type and Quantity of Fishing Gear Used

The Kauai-based squid fishery is primarily conducted from trailered boats ranging in size from around 16 to 22 ft and powered by single or twin gasoline powered outboard engines of 30 to 70 hp (Itano 2004). Due to the small size of the vessels, two or more boats may fish in the same general area for safety, but fishermen indicate that catches may suffer if vessels fish too close to one another. Vessels are usually manned with two or three fishermen equipped with a single baited handline rig.

Fishery participants use a standardized style of fishing with little apparent variation (Itano 2004). The common luminous squid jigs are generally not used in favor of bait covered steel rods armed with two "baskets" of barbless hooks set at one end. Fishermen typically make their own rigs by soldering hooks to a short section of 3/16-in diameter stainless steel rod. A three-foot section of fine stainless steel wire is attached close to the hooks for wrapping the bait. Each lure is wrapped with a thin section of squid mantle and secured in place with the attached wire.

Most fishermen prefer to fish the baited rigs with a small monofilament handline spooled on a wooden handreel (Itano 2004). The handreels are fished from drifting vessels, while fishing rods and reels are sometimes preferred when fishing for bait squid from slower moving vessels that are drifting on a parachute anchor. A 12-volt, 25-watt above water light is used to attract the squid or to attract the small fish and crustaceans that attract squid. The above water lights are believed to be more efficient than submersible lights. In addition, they create a shadow under the hull where the squid often wait to ambush prey. Sometimes only a very small light or no light at all may be used.

An essential piece of gear is a round scoop net to land the squid caught on the baited rigs (Itano 2004). Wood handled nets with 14- to 18-in diameter circular hoops are typical. Hooked squid are hauled quickly to the surface and netted or lifted from the water and stored in 5-gal buckets or small ice chests.

3.7.3.4.3 Species of Fish Involved and Their Location

The small-scale jig fishery targets *Sthenoteuthis oualaniensis* (purpleback flying squid) (Itano 2004). A small amount of *Thysanoteuthis rhombus* (diamondback squid) is also caught. The primary fishing grounds lie along the south and southwest coasts of Kauai between Makahuena Point (Koloa) and Kekaha. Fishermen indicate that the squid on the windward coast are larger but much less abundant. Boats typically launch from Port Allen or the Kikiaola small boat harbor in Kekaha. These launch sites are preferred due to their location in relation to prevailing winds and currents that transport boats along the shore or slightly offshore. A small amount of squid fishing effort may also be based in Nawiliwili and Hanalei Bay. However, Nawiliwili Harbor is not commonly used by the squid fleet, as the drift is strongly onshore, requiring vessels to run several miles south of the harbor to set up for a safe longshore or offshore drift.

The fishing grounds are close to shore, often only two to four miles from the southern harbors (Itano 2004). Vessels normally do not attempt to slow their drift with a sea anchor or parachute drogue as is typical in the ika shibi fishery. Once a drift is set up, an above water light is activated to attract squid or squid prey and the vessel allowed to drift freely with the wind. On the southeast coast of Kauai, the prevailing wind will transport a vessel in an east-northeast to west-southwest direction parallel to the shoreline and depth contours. This provides the fisherman a considerable advantage as he can maintain a near constant depth over productive grounds and be confident that he will not be taken toward the reef or too far out to sea.

Squid fishing is a seasonal activity (Itano 2004). Participants may also engage in the ika shibi fishery, pelagic troll fishery or handline fishery for akule, squirrelfish or bonefish. Fishermen noted that as a rule of thumb the season for squid jigging roughly coincides with the months when humpback whales are not found in local waters, i.e., April to November, although there is no apparent link between the species. The main squid jigging time occurs from the beginning of May to October. Larger, egg bearing females were reported as being more common early in the season, with small squid being more common during July and August.

In order to take advantage of the maximum period of dark in the early evening hours (most of the fishing occurs from sunset to about 10 pm), squid jigging generally begins two days after the full moon, continues through the dark new moon period, and ends between the quarter to half moon period (Itano 2004). This strategy equates to a maximum of 18 to 20 fishing nights per lunar month.

3.7.3.4.4 Actual and Potential Revenue from the Fishery

Catches of purpleback squid generally remain within the community for home consumption; however, some of the squid caught are sold. No cost-earnings studies have been conducted for the Kauai-based fishery; however, a rough estimate of gross revenues can be derived from the data available. Fishery participants measure catch in terms of how many 5-gal buckets are filled in an evening of fishing (Itano 2004). It is estimated that one bucket contains approximately 130 to 200 squid. Roughly speaking, two buckets of squid is considered a good catch, while a half bucket represents a poor catch. Itano (2004) reports that seafood buyers on the Big Island purchase fresh squid from handline fishermen at $1.00 - $1.25/lb.[38] Assuming that a typical daily catch is one 5-gal bucket of squid weighing 45 lb, a fisherman could gross about $50 per fishing trip. If a fisherman made 114 trips per year, his total income from squid fishing would be about $5,700. This estimate is consistent with Itano's (2004) finding that revenues in the directed squid fishery are modest.

3.7.3.4.5 Recreational Interest in the Fishery

As noted above, catches of purpleback squid in the Kauai-based fishery generally remain within the community for home consumption. Another important function of the fishery is to provide a special food item for banquets, outdoor barbecues and large social gatherings (Itano 2004). The squid is favored as a local delicacy, and fishermen sometimes fish to fulfill social obligations.

[38] Some fishermen may earn more by selling their squid directly to grocery outlets, thus eliminating the wholesalers and gaining a slightly higher price (Itano 2004).

Occasionally, surplus catch may be sold to local grocery stores or markets. The small catches of diamondback squid reportedly are never sold, as this particular delicacy is used for personal consumption or shared among friends (Itano 2004).

3.7.3.4.6 Nature and Extent of Foreign Fishing and Indian Treaty Fishing Rights, If Any

There are no foreign fishing or Indian treaty fishing rights associated with the Kauai-based fishery squid fishery.

3.8 Sociocultural Setting and Fishing Communities

The description of the sociocultural environment focuses on the pelagic fisheries that could be potentially affected by the proposed actions. These fisheries include the Hawaii longline fishery and the ika shibi component of the Hawaii pelagic handline fishery—two fisheries managed under the Pelagics FMP—and the distant-water and Hawaii near-shore squid fisheries, which are currently not managed under the Pelagics FMP. This description of the affected environment records the present social context of the affected fisheries, including socioeconomic problems, opportunities and conflicts created in the fisheries and communities by recent federal fishery management regulations.

Comprehensive descriptions of the sociocultural settings of the Hawaii longline and ika shibi fisheries are provided in Chapter 3 of the Pelagics FEIS (NMFS 2001a). The sociocultural descriptions of these fisheries presented in the current document summarize the discussion in the Pelagics FEIS and incorporate new information that has become available since the Pelagics FEIS was released. That EIS also described the sociocultural settings of the pelagic fisheries in Guam, American Samoa and The Northern Mariana Islands. The current EIS does not summarize or update that information because the proposed actions are not expected to cause social or cultural impacts in those areas of the western Pacific region.

The sociocultural analysis provided in this section is driven by requirements of NEPA, EO 12898 and the MSA. Under NEPA, "social" and "cultural" effects are specific environmental consequences of the proposed action to be examined (40 CFR 1508.8).

Beyond NEPA requirements, this section takes into account EO 12898 (59 FR 7629 February 16, 1994), which requires federal agencies to address environmental justice concerns by identifying disproportionately high and adverse human health and environmental effects on minority and low-income populations. Consistent with these requirements, the sociocultural analysis presented here includes data on affected minority and low-income populations. Although other minority group participants in the affected fisheries are discussed, the analysis focuses on Vietnamese Americans because vessel owners and crew members belonging to this minority group were especially adversely affected by the management measures that eliminated the swordfish portion of the Hawaii longline fishery in 2001. The discussion highlights ways in which these fishery participants have adapted to various stress factors.

This section is also guided, in part, by National Standard 8 under the MSA. National Standard 8 is part of a set of standards that apply to all FMPs and regulations promulgated to implement such plans. Specifically, National Standard 8 states that:

> *Conservation and management measures shall, consistent with the conservation requirements of this [Magnuson-Stevens] Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities and (B) to the extent practicable, minimize adverse economic impacts on such communities (Sec. 301(a)(8)).*

The MSA defines a "fishing community" as "...a community that is substantially dependent upon or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and fish processors that are based in such communities" (Sec. 3 (16)). NMFS further specifies in the National Standard guidelines that a fishing community is "...a social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational, or subsistence fishing or on directly related fisheries dependent services and industries (for example, boatyards, ice suppliers, tackle shops)" (63 FR 24235, May 1, 1998). "Sustained participation" is defined by NMFS as "...continued access to the fishery within the constraints of the condition of the resource" (63 FR 24235, May 1, 1998). Consistent with National Standard 8, this section first identifies sub-regions and communities and then describes and assesses the nature and magnitude of their dependence on and engagement in the affected pelagic fisheries.

3.8.1 Hawaii Sociocultural Setting

3.8.1.1 Longline Fishery

As noted in the Pelagics FEIS (NMFS 2001a), the sociocultural context of fishing in Hawaii has been shaped by the multi-ethnicity of local fisheries. The Hawaii longline fishery is an example of a fishery that experienced rapid development as a result of the participation of new groups of fishers of various ethnic backgrounds. The contemporary longline fishery is ethnically complex, and the ethnic composition of its participants differs markedly from that of the state population as a whole.

Prior to the 2001 prohibition on deployment of swordfish-target longline gear, differences in the ethnicity of participants in the longline fishery were linked to differences within the fleet in terms of a number of related factors, including target species, fishing grounds, and vessel operating characteristics. Nearly all of the swordfish/mixed vessels were owned and crewed by Vietnamese Americans. In contrast, this ethnic group operated only about four or five longline vessels targeting tuna. Demographic data on vessel owners and operators collected in a 2000 survey of the Hawaii-based longline fleet conducted by O'Malley and Pooley (2002) showed this ethnic differentiation within the longline fleet (Table 3.8-1).

Table 3.8-1 Ethnicity of Hawaii Longline Vessel Owners in 2000[1].

Vessel Classification	Caucasian (%)	Korean-American (%)	Vietnamese American (%)	Number
Fleet	27	30	43	120
Swordfish	6	0	94	70
Tuna	41	53	6	50
Small tuna	31	64	6	16
Medium tuna	31	64	6	36
Large tuna	72	22	6	18
Medium swordfish	11	0	89	18
Large swordfish	3	0	97	32

[1]Vessels are classified by size (small <56 ft, medium 56.1 ft to 73.9 ft, large >74 ft) and target (tuna or swordfish). Source: O'Malley and Pooley 2003.

This ethnic differentiation within the longline fleet based on target species largely disappeared after the 2001 prohibition on deployment of swordfish-target longline gear. Twenty to 30 of the longline vessels owned by Vietnamese Americans dropped their Hawaii longline limited entry permit and relocated to southern California where they continued to target swordfish. Three swordfish vessels relocated to American Samoa and changed ownership (O'Malley and Pooley 2002). The remainder of the Vietnamese American vessel owners elected to stay in Hawaii and switch to targeting tuna.

The Pelagics FEIS stated that Vietnamese American vessel owners nearly exclusively hired other individuals of Vietnamese ancestry (NMFS 2001a). Boat owners of Korean descent reportedly hired predominately crews from FSM, while the crews of longline vessels owned by Caucasians were reported to generally be a mixture of Micronesians and established Hawaii residents of various ethnicities. However, the aforementioned survey conducted by O'Malley and Pooley (2002) indicated that a recent trend among Hawaii-based longline vessels is the hiring of foreign crew, primarily from the Philippines. In 2000, only six interviewed vessels employed foreign crews. By 2001, over 54 percent of the vessels employed foreign crew. Currently, about 75 percent of crew members are Filipinos who commit to a one-year contract, working and living on the vessel while their families remain in the Philippines (Allen and Gough 2004). The survey questionnaire administered by O'Malley and Pooley asked vessel owners who changed from hiring local to foreign crews what motivated them to switch. Three answers were given, corresponding to the ethnicity of the vessels' owners. Korean Americans stated the foreign crew members were easy to work with; Caucasian Americans found foreign crew to be cheaper than local crew; and Vietnamese Americans switched because they could not find Vietnamese American crew who wanted to fish for tuna.

Vietnamese American vessel owners in particular have become increasingly dependent on Filipino crews (pers. comm., Stewart Allen, NMFS Pacific Islands Fisheries Science Center, ½0/04). With this increased reliance on foreign crews, some Vietnamese American vessel owners have become concerned that new U.S. immigration policies may make it difficult to hire and retain a sufficient number of crew members (pers. comm., Stewart Allen, NMFS Pacific Islands Fisheries Science Center, ½0/04).

The majority of the Filipino crew are from fishing families or communities in the Philippines (Allen and Gough 2003). About half have education or training in a marine related field, and the majority have considerable experience as fishermen outside of the Philippines. For example, individuals have worked in Guam, South Africa, Taiwan, Latin America, and California in a variety of fishing fleets. They are hired through a recruitment agency and brought to Hawaii utilizing a C-1 transit visa. Their transit status does not allow them to leave the pier, which increases their desirability as workers as they tend to the vessels while in port. Most 2003 arrivals came to Hawaii via California, as the latter state offers easier access to the U.S. With respect to job satisfaction, the majority of Filipino crew would rather work on a cargo vessel than on a Hawaii-based longline boat. However, Hawaii-based longline vessels are generally preferred over boats in other fleets (e.g., the Japanese fleet based in Guam). Those with larger families or more education are less satisfied with the pay.

The increasing dependence on Filipino crews has been accompanied by a change in the way in which crew members are paid in the Hawaii-based longline fleet. In 2000, the majority of the interviewed vessel owners were paying the captain and crew using the share method (O'Malley and Pooley 2002). First, specific expenditures such as fuel, oil, ice, bait, provisions, gear, and auction fees were deducted from the gross revenue. The remaining revenue was then split in half, 50 percent for crew and 50 percent for the vessel owner. However, Filipino crew members are paid a monthly salary and in some cases a tonnage or captain's bonus depending on the catch. Salaries start at $385 per month and are arranged between the vessel owner, manning agency and individual (Allen and Gough 2004). The average monthly salary of these foreign workers is $475. Local and Micronesian crew continue to be paid a percentage of the earnings rather than a set salary.

O'Malley and Pooley (2002) noted that the type of crew remuneration used can have a marked effect on the cost of operating a longline vessel. The researchers compared the annual costs to pay crew using the share method and those that paid a fixed salary. The 2000 fleet average annual cost using the crew shares method was $152,097, and the annual cost to pay the crew a monthly salary was $44,333 (this figure does not include the agency and immigration fees associated with the hiring of foreign crew).

The Pelagics FEIS predicted that the closure of the swordfish-targeting segment of the Hawaii longline fishery would disproportionately and negatively affect Vietnamese American fishermen (NMFS 2001a). The FEIS described the predicted effects on vessel owners as "immediate and substantial," as well as imposing "severe economic hardship" on crew members of Vietnamese descent. The FEIS cited a study of workers laid off from the sugar industry on the island of Hawaii to describe the range of possible effects, including sustained unemployment and loss of income and the resulting social and psychological impacts. These included heightened feelings of anxiety, depression, illness, and increased problems in relationships among laid-off employees and family members.

A subsequent exploratory study of the impacts to Vietnamese American vessel owners and captains conducted by Allen and Kleiber (2003) revealed that many of the effects predicted by the FEIS were present, as well as some additional impacts that had not been anticipated. Many Vietnamese Americans had already been regulated out of other U.S. fisheries; several mentioned that they have dealt with hardships and challenges in the industry before but the closure of the swordfish portion of the Hawaii longline fishery was the toughest situation they had faced. Swordfish fishing is a lucrative business, and the loss of income that Vietnamese American fishermen experienced after the closure of the Hawaii fishery had many direct and indirect negative socioeconomic effects on individuals, families and households, and the Vietnamese community. The passage below excerpted from Allen and Kleiber (2003) summarizes some of the effects:

> *Many [Vietnamese Americans] mentioned having to cut back on educational expenses at all levels, such as not being able to afford private schools or having to borrow for college expenses, accumulating additional debt. Nearly all spoke about wanting their children to have quality educations so they would not have to fish for a living.*
>
> *Interviewees reported a range of effects on the closeness and cohesion of their families. Family solidarity suffers when a family member is not present for extended time periods. Fishing families are accustomed to their husband or father being gone on long fishing trips, which is especially the case with swordfishing in Hawaii, which typically required longer trips than tuna fishing. Although family members may not like this, they adapted because of the financial benefits. Fishermen and family members also mentioned that the time between trips allowed for high-quality family time, including vacations. People who moved boats to California had many additional expenses aside from moving the boat there. Wives who travel to Los Angeles to meet boats between swordfish trips and assist with many aspects of the business incur direct costs are such as airfare, car rental, and hotels. In addition, being gone 7-10 days a month makes it more difficult to obtain a job to supplement income. Disruption of normal behavior, coupled with financial stress, can cause friction among family members, reflected by increased arguments and conflicts.*
>
> *Interviewees expressed a range of emotions including bewilderment at the closure and its reported justification; loss of confidence that the family would be adequately cared for; shame at not being able to help family members here or elsewhere; sadness at the decrease in the quality of life, which many suggested was quite high before the ban; anger at the federal government for closing the fishery; frustration at being unable to thwart the ban legally or politically, at having to rely on others, and that the international fleet is not regulated; blame on entities both inside and outside the industry for their inability to prevent or lessen the ban despite rallies and financial support.*
>
> *When the ban was first introduced, fishermen pulled together to fight it but that enthusiasm and solidarity waned as time dragged on and the ban became permanent. Several interviewees mentioned existence of a Vietnamese Fishing Association that previously existed and dissolved following the ban. Such associations are an important source and indicator of cohesion and support among the fishing community.*

Owners of Hawaii-based longline vessels that fished during 2001 received economic assistance from the federal direct economic assistance program because of the sudden impact of the regulations. Owners of tuna vessels received $16,000, while owners of swordfish vessels received $32,000 because the new regulations had a greater impact on their operations. O'Malley and Pooley (2003) note that the amount given to the swordfish vessels covered about 89 percent of the estimated cost to convert to tuna fishing (not including the labor to assemble the gear and the time spent learning to fish for tuna). However, the need for many of the owners of swordfish vessels to repay large bank loans acquired to purchase their vessels forced some to relocate to California or switch to tuna fishing before the economic assistance was disbursed (pers. comm., Stewart Allen, NMFS Pacific Islands Fisheries Science Center, 1/20/04). The economic assistance program did not benefit the crew members of swordfish or tuna longline vessels.

During fishing experiments conducted by NMFS to test fishing methods and gears that may reduce turtle interactions in the Hawaii longline fishery, five vessels (all owned by Vietnamese Americans) were contracted to participate in the experiments. The vessel owners received a total of $311,147 for conducting a total of 194 sets (pers. comm., Stewart Allen, NMFS Pacific Islands Fisheries Science Center, 1/20/04). While this was a short-term source of income, it was a substantial amount to a vessel owner making payments on a vessel as well as supporting a family. The contribution of the pelagic longline fishery to overall economic activity in Hawaii is small. Moreover, the economic impacts of the closure of the swordfish portion of the Hawaii longline fishery on fishermen and their families gradually lessened as fishermen outfitted their vessels to participate in fisheries on other stocks (most notably tuna), relocated to California and continued to fish for swordfish in areas that remained open (e.g., the high seas in the Pacific Ocean east of 150°W), or found other jobs that may or may not be fishing-related.

The relaxation of the restrictions on longlining is expected to have positive overall economic impacts on participants in the Hawaii longline fishery. Holders of Hawaii longline limited entry permits that choose to engage in shallow-setting are likely to benefit from catches of swordfish, a high value pelagic species. Holders of Hawaii longline limited entry permits that choose not to engage in shallow-setting are likely to benefit each year by being able to sell their share of shallow-set certificates to other permit holders.

One hundred and twenty (73%) of the 164 Hawaii longline limited entry permit holders requested shallow-set certificates for 2004. As shown in Table 3.8-2, about 80 percent of the permit holders who currently own vessels categorized as swordfish boats in 1999 requested certificates. Four of these vessel owners relocated in California after the swordfish component of the longline fishery was closed in 2001.[39] Also among those who requested certificates were

[39] One other vessel owner who relocated in California requested certificates, but that person's vessel was not categorized. In addition, between April 30 and mid-July, 2004, at least seven vessels owners who shifted to California applied to have their vessels registered for use under Hawaii longline limited entry permits. Some of these vessels owners may also have requested certificates.

Table 3.8-2 Allocation of Shallow-set Certificates Among Hawaii Longline Limited Entry Permit Holders.

Category	Permit Holders as of May 1, 2004		
	Requested 2004 Certificates	Did Not Request 2004 Certificates	Total
Permit holders who owned vessels categorized as tuna vessels in 1999[1]	30	15	45
Permit holders who owned vessels categorized as swordfish vessels in 1999[1]	20	5	25
Permit holders who owned vessels that can not be linked to 1999 vessel categorizations[2]	41	19	60
Permit holders who did not own vessels in 2004	29	5	34
Total	120	44	164

[1] Vessel categorizations are based on an analysis conducted by NMFS to identify vessels qualifying for the 2001 Direct Economic Assistance Program.
[2] Vessel names rather than permit numbers or permit holders were used to establish linkages between the permits in 2004 and 1999. Consequently, a given vessel categorized in 1999 may have been under different ownership in 2004. If a vessel name change occurred between 1999 and 2004, no link between the permits in 2004 and 1999 could be identified. For seven of the 118 vessels categorized in 1999 the vessel name could not be identified.
Source: NMFS PIRO.

permit holders who currently own vessels categorized as tuna boats in 1999 and permit holders who do not currently own a longline vessel. The majority of individuals who own vessels categorized as tuna boats in 1999 are of European or Korean descent (Table 3.8-1).

A number of factors may make it difficult for Vietnamese Americans to regain a dominant position in the swordfish portion of the Hawaii longline fishery. Under the effort quota allocation scheme developed for the reopened fishery vessel owners must bear the costs of acquiring an adequate number of shallow-set certificates each year, and those owners that switched to tuna fishing in 2001 would incur the costs to rig over from tuna fishing to swordfish fishing—these latter costs are reported to be about $15,000 (WPRFMC 2004b). In addition, Vietnamese American vessel owners that have hired Filipino crews may find these crew members unwilling to endure the longer fishing trips that swordfish fishing entails (pers. comm., Stewart Allen, NMFS Pacific Islands Fisheries Science Center, 1/20/04).[40]

3.8.1.2 Squid Fisheries

The squid species occurring around the MHI were known as *muhe'e* by the early Hawaiians (Titcomb 1978). Although squid were eaten, they were not as popular as octopus (*he'e*).[41] Squid also had mythological significance for early Hawaiians. The god Kanaloa was represented in the deep ocean depths by squid, octopus and certain kinds of seashells. A reference book on ancient Hawaiian myths by Beckwith (1970), which was published in 1940, stated that Hawaiian fishermen "still solicit [Kanaloa's] protection, but on the whole the squid is today looked upon

[40] According to the Pelagics FEIS, longline trips typically last between 14 and 21 days when yellowfin and bigeye tuna are targeted, and 30 to 45 days when swordfish are targeted (NMFS 2001a).
[41] In contemporary Hawaii the term "squid" is used indiscriminately to signify both squid and octopus (Titcomb 1978).

with distrust as an aumakua." (p. 60).[42] Beckwith noted that, "This attitude is reflected in a tendency by Hawaiian antiquarians to equate Kanaloa with the Christian devil" (p. 60). The contemporary spiritual significance of Kanaloa is uncertain; however, the creation of a Web site (http://www.bluecoast.org/kanaloa.html) dedicated to the study of Kanaloa suggests a continuing interest in the deity.

As discussed in Section 3.7.3.3, commercial squid fishing in Hawaii was initiated in the 1920s by Japanese immigrants who brought squid fishing techniques from their native islands of Okinawa. The directed squid fishery has since largely disappeared, although a remnant continues as a small, artisanal fishery on Kauai. A description of this fishery is provided in Section 3.7.3.4. Although the Kauai-based directed squid fishery has been in existence since at least the immediate post-World War II era, only a few communities and social networks on Kauai are familiar with it (Itano 2004). The squid caught in the fishery that are sold are typically marketed in local grocery stores.

Presently, there are 20 to 30 participants in the Kauai-based fishery (Itano 2004). Many of the participants are elderly, with some individuals being 80 years of age or older. Itano (2004) estimated that about 50 percent of the participants have a Japanese ethnic background, 22 percent are of Filipino ancestry, 18 percent are of mixed Portuguese descent and 10 percent have a mixed Hawaiian ancestry. Catches of purpleback squid in the fishery generally remain within the community for home consumption (Itano 2004). Another important function of the fishery is to provide a special food item for banquets, outdoor barbecues and large social gatherings. Squid is favored as a local delicacy, and fishermen sometimes fish to fulfill social obligations.

Squid also continues to be caught in the waters around the Big Island for bait in the ika shibi component of the pelagic handline fishery. The ika shibi method of fishing for tuna evolved from the directed squid fishery and is currently employed by a few small-boat owner-operators targeting yellowfin tuna. A detailed description of the fishery is provided in Section 3.7.3.3.

The domestic distant-water squid jigging fishery in the Pacific Ocean is currently being prosecuted by a single operation. Honolulu is listed on the HSFCA fishing permit as the hailing port of the four vessels involved in this operation, and the vessels occasionally call into Honolulu. However, the operation may be relying mostly on at-sea transshipment to deliver product to the Japanese market. The ethnic composition of the vessels' crews is unknown.

3.8.2 Hawaii Fishing Communities

In 1998, the the islands of American Samoa, The Northern Mariana Islands and Guam were identified as fishing communities for the purposes of assessing the effects of fishery conservation and management measures on fishing communities, providing for the sustained participation of such communities, minimizing adverse economic impacts on such communities, and for other purposes under the MSA (submitted in September 1998; approved April 19,1999; 64 FR 19067). In 2002, the islands of Kauai, Niihau, Oahu, Maui, Molokai, Lanai and Hawaii were identified as a fishing community (submitted by the Council in December 2002; approved and implemented by NMFS in August 5, 2003; 68 FR 46112).

[42] *'Aumākua* are family or personal deities that can be called upon for protection, comfort, and spiritual support. An *'aumākua* can manifest itself in varying forms, including an animal, plant, or rock.

The Pelagics FEIS noted that the City of Honolulu on the island of Oahu is the base of the longline and other industrial-scale fleets and the center of the state’s fish marketing/distribution network (NMFS 2001a). However, the total number of pelagic fisheries-related jobs in the Honolulu metropolitan area compared to the overall number of jobs in the area is very small. Oahu contains approximately three-quarters of the state’s total population, and over one-half of Oahu’s residents live in the “primary urban center,” which includes greater Honolulu. Thus, although Oahu has a high level of engagement in fishing and especially longline fishing relative to the other islands in Hawaii, the island’s level of dependence on it is lower due to the size and scope of Oahu’s population and economy.

As described in Section 3.7, during the past few years the Hawaii longline fishery has been affected by a series of legal decisions that resulted in changes in the federal management regime for the fishery. In 2001, total catch and ex-vessel value in the fishery decreased by about 34 percent, primarily as a result of the implementation of litigation-driven management measures that eliminated the swordfish portion of the Hawaii longline fishery. Swordfish, the largest component of the longline catch in 2000, became a negligible component in 2001.

Although the closure of the swordfish portion of the Hawaii longline fishery had a negative economic impact on some local businesses, the closure did not affect the sustained participation of any fishing community in Hawaii’s pelagic fisheries. Many of the fishermen that formerly targeted swordfish outfitted their vessels to target other pelagic species, most notably tuna. In recent years, bigeye tuna has been the largest component of the pelagic catch, followed by yellowfin tuna, and albacore. As a result of an increase in the catch of bigeye tuna the ex-vessel value of landings in Hawaii’s pelagic fisheries increased to about $45.3 million in 2002.

In April 2004, the swordfish-targeting segment of the Hawaii longline fishery was reopened under new federal rules. While it is uncertain at this early stage of the reopening what the regional impacts will be, the effects are likely to be positive. Moreover, should the measures to mitigate sea turtle interactions prove successful, it is likely that the amount of swordfish fishing effort allowed will be increased, resulting in additional regional economic benefits.

The nature and magnitude of Hawaii communities’ dependence on and engagement in pelagic fisheries have also been affected by the overall condition of the state’s economy. As described in the Pelagics FEIS (NMFS 2001a), tourism is by far the leading industry in Hawaii in terms of generating jobs and contributing to gross state product. In the first years of the new century Hawaii's tourism industry suffered major external shocks, including the September 11 terrorist attacks and severe acute respiratory syndrome (SARS) epidemic (Brewbaker 2003). The market for tuna weakened due to the decline in tourists arriving from Japan and elsewhere and due to a weak export demand. More recently, the decline in the value of the U.S. dollar compared with other currencies such as the Euro and the Japanese yen has made it more expensive for Americans to travel overseas and cheaper for foreign visitors to visit Hawaii. The weak U.S. dollar, combined with moderate growth in the national economy, is expected to help boost the state's tourism industry. Both domestic and international visitor counts have shown a general increasing trend (Brewbaker 2003). These improvements in Hawaii’s tourist industry will likely have a positive economic effect on local businesses engaged in the harvesting, processing and marketing of pelagic fishery resources.

3.9 Administration and Enforcement

3.9.1 Permitting, Data Collection and Enforcement under the Pelagics FMP

3.9.1.1 Permitting

Permitting and data collection under the Pelagics FMP are accomplished by the Sustainable Fisheries Division of the PIRO. Under the Pelagic FMP, two fishewries are regulated by Federal permits: pelagic troll/handline fisheries in Federal waters of the Pacific remote island areas (\Howland Lsland, Baker Island, Javis Island, Johnston Atoll, Kigman Reef, Palmyra Atoll, wake Island, Midway Atoll) and the western Pacific region longline fisheries. The Hawaii-based longline fishery is a limited entry fishery with a maximum of 164 permits. Longline fisheries elsewhere in the region operate under a currently unlimited number of general longline permits. During 2002 (WPRFMC 2004a), all 164 of the Hawaii-based permits were maintained, although 46 of these were held without vessels. In 2003, all 164 permits were maintained, 123 with vessels registered to them (NMFS PIRO, unpub. data).

There were also 88 active general longline permits, all for vessels based in American Samoa. In 2003, 66 General Longline Permits were issued, 64 for vessels in American Samoa, one in Guam and one in the Northern Mariana Islands (NMFS PIRO, unpub. data)

A U.S. fishing vessel must be registered for use under a general longline permit if that vessel is used: (1) to fish for PMUS using longline gear in the EEZ around American Samoa, Guam, Northern Mariana Islands, or other U.S. island possessions in the Pacific Ocean; or (2) to land or transship, shoreward of the outer boundary of the EEZ around American Samoa, Guam, Northern Mariana Islands or other U.S. island possessions in the Pacific Ocean, PMUS that were harvested with longline gear. In addition, a U.S. fishing vessel of the U.S. must be registered for use under a Hawaii longline limited entry permit if that vessel is used: (1) to fish for PMUS using longline gear in the EEZ around Hawaii; or (2) to land or transship, shoreward of the outer boundary of the EEZ around Hawaii, PMUS that were harvested with longline gear. A receiving vessel must be registered for use with a receiving vessel permit if that vessel is used to land or transship, shoreward of the outer boundary of the fishery management area, PMUS that were harvested with longline gear.

In 2002, the Council approved Amendment 11 to the Pelagics FMP, which is intended to create a limit entry permit system for American Samoa. NMFS published a request for comments on the proposed rule (69 FR 43789, July 22, 2004). The intent of this action is to avoid gear conflicts in the American Samoa EEZ outside of the 50 nm area closed to large longline vessels and to avoid overcapitalization in the fleet. The estimated maximum number of permits will be 138. To qualify for a permit an individual must have owned a vessel used to legally harvest PMUS in the EEZ around American Samoa prior to March 22, 2002. Permits would be established for four categories based on vessel length (less than 40 ft, 40-50 feet, 50-70 feet, and over 70 feet). "Upgrade permits" (26) will be available to permit holders in the smallest vessel size class. Vessels greater than 40 feet in length will be required to carry observers, if requested by NMFS.

3.9.1.2 Observer Program

The NMFS, Pacific Islands Region Office, Hawaii Longline Observer Program implements field aspects of the MMPA, ESA, and the MSA. NMFS observers have been deployed in the Hawaii-based longline fishery since February 1994. Due to court decisions in recent years, observer coverage of the fleet has increased considerably. The docks are surveyed daily and vessels absent from the harbor are assumed to be fishing.

The mission of the program is to observe and document all species caught, including sea turtles, seabirds, marine mammals, swordfish, tunas, sharks, and other non-target fishes and to collect selected biological specimens. The observer program, therefore, collects data on interactions between the pelagic longline fleet and protected sea turtles, marine mammals, and seabirds. In addition to protected species catch rates, the program has also gathered data on sea turtle life history. The program provides deoxyribonucleic acid (DNA) samples, turtle morphometrics, and a means for gathering satellite telemetry data. Secondarily, data and tissue samples from target species (swordfish, tuna) are also collected.

More specifically, among other tasks, observers:

- Identify protected species, target, and bycatch species by number and location;
- Record incidental mortality and injury of sea turtles, and tally all sea turtle observations during fishing activity;
- Dissect post-mortem marine species as instructed (gonads, stomachs, otoliths);
- Record sea turtle life history data, and tag all live sea turtles without existing tags;
- Record life history data on other selected marine species;
- Collect data on vessel activity and fishing operations;
- Review and enter all data into a computer data base when on-shore; and
- Collect seabird/fishing vessel interaction data including observations of deployed deterrents.

The PIFSC analyzes the data in conjunction with logbook data (from PIRO) to estimate total sea turtle takes and mortalities. Data are used to prepare annual reviews of BiOps, quarterly reports to the Western Pacific Fishery Management Council, and estimates of bird mortality to the USFWS.

3.9.1.3 Enforcement

The USCG patrols the region with C-130 aircraft and surface vessels; however, since the terrorist attacks of September 11, 2001, the Homeland Security mission has taken precedence over fisheries surveillance and enforcement activities. In FY02, the USCG flew approximately 800 hours of fisheries patrols, including 520 hours in the MHI, 8 hours in the NWHI, 105 hours in Guam and the Northern Mariana Islands, 56 hours in American Samoa, 15 hours in Palmyra Atoll/Kingman Reef, 49 hours in Jarvis Island, and 41 hours in Howland/Baker Islands. Over 1300 cutter hours of fisheries patrols were conducted in the region with almost 200 vessel boardings (133 U.S. and 63 foreign vessels).

Enforcement for the Hawaii-based longline fishery is facilitated by use of a Honolulu-based VMS operated by NMFS and USCG. A VMS is an automated real-time, satellite-based tracking system that obtains accurate and near-continuous position reports from vessels at sea. The VMS in Hawaii was established in 1994 to help enforce area closures around the Hawaiian Islands in which fishing with longline gear is prohibited. NMFS certifies the VMS system hardware and software aboard each vessel and assigns each VMS unit a unique identification number.

The VMS, monitored in the 14^{th} District Command Center by NMFS and USCG personnel, has proven to be an effective, cost-saving technology for the monitoring and enforcement of restricted areas over great distances. In 2002, there were three major enforcement cases cued by information obtained from VMS. Using "signature analysis," USCG and NMFS identify possible incursions into the main Hawaiian Island longline closure area and the NWHI Protected Species Zone. This information is passed to patrolling cutters for investigation during at-sea enforcement boarding. In addition to enhancing government enforcement capability, VMS has yielded benefits for the fishers on equipped vessels, such as increased navigational capacity and secure, low-cost communications. The equipment also allows domestic fishers to transmit catch and effort data to NMFS and accurately report the position of illegal foreign fishing activity in the EEZ.

Special Agents of NOAA's Office of Law Enforcement (OLE) conduct investigations of alleged violations of NOAA statutes and regulations, including the MSA, the Lacey Act, the Shark Finning Prohibition Act, the MMPA and the ESA based on case packages forwarded from the Coast Guard.

3.9.1.4 Data Collection

Non-longline vessels targeting pelagic species around the PRIA are required to get permits and submit logbooks. There are no federal reporting and recordkeeping requirements for any other pelagic fishery occurring in the western Pacific region other than the longline fishery. The Pelagics FMP requires federal logbooks be kept by participants in longline fisheries. The implementing regulations require participants in pelagic fisheries in the region other than longline to comply with the data collection programs maintained by the respective state or territory.

The Western Pacific Fishery Information Network (WPacFIN) is a federal and state partnership for collecting, processing, analyzing, sharing and managing fisheries data from the western Pacific region. Through the cooperative efforts of the member agencies, WPacFIN provides fisheries data and information when, where, and in the quality needed by NMFS and the WPRFMC and its various support groups to develop, implement, evaluate and amend FMPs for the region. WPacFIN assists island agencies in designing and implementing appropriate local fisheries data collecting, monitoring, analyzing and reporting programs, complete with associated microcomputer-based data processing systems, and helps promote data standards to facilitate information analyses and reports. WPacFIN manages the data used by the Pelagics Plan Team to produce the annual report for the Pelagics FMP.

Brief descriptions of the fisheries data collection systems for the pelagic fisheries in each island area are provided below.

3.9.1.4.1 Hawaii

State of Hawaii regulations require any person who takes marine life for commercial purposes, whether within or outside of the state, to first obtain a commercial marine license from the HDAR. Every holder of a commercial marine license must furnish to HDAR a monthly catch report[43]. Any commercial albacore troll vessel that lands its catch in Hawaii is required to complete the HDAR Albacore Trolling Trip Report. Pole-and-line vessels in Hawaii are required to record their catches on the HDAR Aku Catch Report. Longline vessels are required to complete the NMFS Western Pacific Daily Longline Fishing Log, which requires recording of protected species interactions, and the HDAR Longline Trip Report. The requirement for completion of an HSFCA logbook when fishing on the high seas is satisfied by the Western Pacific Daily Longline Fishing Log.

Every commercial marine dealer must furnish to HDAR a monthly report detailing the weight, number and value of each species of marine life purchased, transferred, exchanged or sold and the name and current license number of the commercial marine licensee from whom the marine life was obtained.

NMFS formerly administered a fish market sampling program in Honolulu. In cooperation with the state, staff from both NMFS and HDAR visited the fish auction managed by the United Fishing Agency and obtained size frequency and economic data on pelagic fish and bottomfish sold. These data are now submitted electronically to HDAR by the auction as part of the commercial marine dealer reporting system.

3.9.1.4.2 American Samoa

Longline vessels are required to complete the NMFS Western Pacific Daily Longline Fishing Log. Catch data for other fishing methods are collected through the Offshore Creel Survey administered by the Department of Marine and Wildlife Resources (DMWR) of the American Samoa Government. Since 1985, the Offshore Creel Survey conducted on the island of Tutuila has examined both commercial and recreational boat trip catches at five designated sites. For two weekdays and one weekend day per week, DMWR data collectors sample offshore fishers between 0500 and 2100 hours. Two DMWR data collectors also collect fishing data on the islands of Tau and Ofu in the Manua Group.

Data on fish sold to outlets on non-sampling days or caught during trips missed by data collectors on sampling days are accounted for in a Commercial Purchase System (receipt book) or in the Cannery Sampling Form. A Daily Effort Census is used to monitor the activity of the longline fleet. A vessel inventory conducted twice a year provides data on other vessel numbers and fishing effort.

3.9.1.4.3 Guam

An Offshore Creel Survey program administered by the Division of Aquatic and Wildlife Resources (DAWR) of the Government of Guam provides estimates of island-wide catch and

[43]Licenses can be "non-reporting" for crew, if one person reports for the vessel.

effort for all the major fishing methods used in commercial and recreational fishing. In 1982, WPacFIN began working with the Guam Fishermen's Cooperative Association to improve their invoicing system and obtain data on all fish purchases on a voluntary basis. Another major fish wholesaler and several retailers who make purchases directly from fishers also voluntarily provide data to WPacFIN using the Commercial Fish Receipt Book Program. That program, however, is not yet mandatory for local fish vendors. Under a CDPP grant, Guam has recently started a Voluntary Data Collection Program to collect additional information from fishery participants. The Guam Department of Commerce also maintains a mandatory data submission program to monitor landings from foreign longliners transshipping their catch through Guam.

3.9.1.4.4 Northern Mariana Islands

The Division of Fish and Wildlife (DFW) of the CNMI monitors the commercial fishery by summarizing sales ticket receipts from commercial establishments (commercial purchase database collection system). DFW staff routinely distribute and collect invoice books from 80 participating local fish purchasers on the island of Saipan, including fish markets, stores, restaurants, government agencies and roadside vendors. Similar systems are being developed for Tinian and Rota.

3.9.2 Permitting, Data Collection and Enforcement under the High Seas Fishing Compliance Act

The High Seas Fishing Compliance Act of 1995 (HSFCA) (16 U.S.C. 5501 et seq.) establishes a system of permitting, reporting and regulation for all U.S. fishing vessels operating on the high seas. Applications for high seas permits are issued by NMFS Regional Offices. With the creation of the new Pacific Islands Region in late 2004, this function was transferred from the Southwest Region, headquartered in Long Beach, California to Honolulu. Permits are valid for five years. Permitted vessels must be marked, and operators must submit reports of fishing operations and catch.

The Act is enforced by the Secretary of Commerce and Homeland Security Department in which the Coast Guard is operating, using personnel and facilities of other federal or state agencies by agreement. Enforcement officers have enumerated powers, including searches, inspections, arrests and seizures of high seas fishing vessels used in violation of the Act and living marine resources taken unlawfully. Violators of the Act are liable for costs of storage, care and maintenance of living marine resources or other property seized in connection with the violation. Violations of the Act are subject to civil penalties of up to $100,000, with each day of a continuing violation a separate offense, and are also subject to criminal penalties. The Secretary of Commerce may suspend, revoke, deny or impose additional conditions on a permit as a sanction for violation. High seas fishing vessels used, and living marine resources taken, in connection with a violation are subject to forfeiture to the U.S.

3.9.3 Permitting, Data Collection and Enforcement under the South Pacific Tuna Treaty

The SPTT, entered into in 1988, is an international agreement between the U.S. and sixteen members of the South Pacific Forum. The current agreement allows annual access for up to 50 U.S. purse seiners (with an option for 5 more if agreed to by all Parties) to the EEZs of various

Pacific island countries. U.S. operational, administrative, and enforcement commitments under the SPTT are carried out by NMFS on behalf of the Secretary of Commerce. The NMFS maintains a field station in American Samoa to monitor and administer the U.S. purse seine fleet operating under the SPTT. The office's responsibilities include collection and transmission of fishing data, placement of observers, and sampling of landings. Data on the U.S. and other pelagic fishing fleets in the WCPO is collected and reported by the Secretariat of the Pacific Community's OFP, which provides the secretarial support for the annual SCTB meeting. Licensed vessels are required to submit various reports detailing, among other things, catch, port schedules, and national zone entry and exit.

The Secretary of Commerce, in cooperation with the Secretary of State, is charged with enforcing the South Pacific Tuna Act, which implements the SPTT. The Act directs the Secretary to investigate, at the request of a Pacific Island Party, alleged Treaty infringements involving a U.S. vessel and report to the Party on corrective action taken or proposed. After conducting an investigation, the Secretary, with the concurrence of the Secretary of State, and on the request of the Pacific Island Party concerned, may, based on specified findings, order a fishing vessel that has not submitted to the jurisdiction of that Party immediately to leave the area. Authorized Officers may make arrests, board, and search or inspect vessels subject to the Act, and seize samples of fish or other items for evidence related to a violation.

The Act mandates that vessel operators and crew members allow individuals named by Pacific Island Parties as observers under the Treaty to board vessels for scientific, compliance, monitoring and other functions and engage in other specified activities.