# CHAPTER 3: AFFECTED ENVIRONMENT

This description of the affected environment focuses on how the existing conditions of key resources, ecosystems and human communities have been altered by human activities. Where possible, trends in the condition of resources, ecosystems and human communities have been identified. This information provides the baseline and historical context needed to evaluate, in Chapter 4, the potential environmental consequences of each of the alternatives considered herein.

## 3.1 TARGET SPECIES

### 3.1.1 Life History Overviews

#### 3.1.1.1 Bottomfish

The bottomfish fisheries in the region target an assemblage of species from the taxonomic groups Lutjanidae (Snappers), Serranidae (Groupers), Carangidae (Jacks), and Lethrinidae (Emperors). The seamount groundfish fishery when extant targeted the armorhead *(Pseudopentaceros richardsoni)* and the alfonsin (*Beryx splendens*). Bottomfish management unit species (BMUS) are listed in Section 2.3.2.

Commercially important deepwater bottomfish inhabit the deep slopes of island coasts and banks at depths of 100 to 400 m.[1] Throughout their spatial and depth range, deepwater snappers are typically distributed in a clumped pattern, and are often associated with underwater headlands and areas of high relief. Although deepwater snappers are generally thought of as top level carnivores, several snapper species in the Pacific are known to incorporate significant amounts of zooplankton in their diets (Haight et al. 1993a).

Relatively little is known about the reproduction and early life history of deepwater bottomfish in the region. Spawning occurs over a protracted period, and peaks from July to September (Haight et al. 1993b). The eggs are released directly into the water column. The eggs hatch in 3 to 4 days, and the planktonic larval phase is thought to last at least 25 days (Leis 1987). For some species this phase may be considerably longer. For example, the pelagic stage for *'ōpakapaka* is thought to be as long as six months (Moffit and Parrish 1996). Larval advection simulation research suggests that larval exchange may occur throughout the Hawaiian archipelago and that the amount of larval exchange between the NWHI and the MHI is correlated with the duration of the larval phase, with the highest larval exchange occurring with the longest larval phase durations (Kobayashi 1998).

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[1] *Uku* is a targeted BMUS, often caught at shallower depths than deepwater snappers using trolling methods rather than bottomfish fishing gear.

The Hawaiian archipelago's position in the Pacific Ocean lies within the clockwise rotating North Pacific Subtropical Gyre, extending from the northern portion of the North Equatorial Current into the region south of the Subtropical High, where the water moves eastward in the North Pacific Current. At the pass between the MHI and the NWHI there is often a westward flow from the region of Kauai along the lee side of the lower NWHI. This flow, the North Hawaiian Ridge Current (NHRC), is extremely variable and can also be absent at times. The analysis of 10 years of shipboard acoustic Doppler current profiler data collected by the NOAA Ship Townsend Cromwell shows mean flow through the ridge between Oahu and Nihoa, and extending to 200 m. While the high variability of the NHRC certainly allows for the possibility of direct larval transport toward the MHI, the mean currents indicate that direct larval recruitment is more likely from the MHI to the NWHI (J. Firing, 2005, pers. comm.). Data on actual exchange rates, however, are lacking. Preliminary genetic work corroborates the notion of single archipelago-wide stocks of bottomfish.

Little is known of the life history of the juvenile fish after settling out of the plankton, but research on *P. filamentosus* indicates the juveniles utilize nursery grounds well away from the adult habitat (Parrish 1989). Most of the target species have a relatively high age at maturity, long life span, and slow growth rate. These factors, combined with considerable variation in larval recruitment, make these species highly susceptible to overfishing (Haight et al. 1993b).

#### 3.1.1.2 Seamount Groundfish

Three species of seamount groundfish are included as BMUS in the FMP. These deepwater species primarily occur at depths of 275 - 500 m at Hancock Seamount, which is located 2,800 km northwest of Honolulu. The seamount species generally occur at higher latitudes, and below the depth range of the snapper-grouper bottomfish species complex. The armorhead and alfonsin spawn free-floating eggs which are dispersed by the North-equatorial and Kuroshio currents. Juvenile fish remain in the pelagic environment for up to a year, and then descend to seamount summits and begin a demersal existence. These species feed on species associated with the deep-scattering layer (euphausids, copepods, shrimps, myctophids, etc.) and make vertical migrations at night to follow their prey.

### 3.1.2 Status of the Stocks

#### 3.1.2.1 Bottomfish

##### *3.1.2.1.1 Maximum Sustainable Yield*

The maximum sustainable yield (MSY) of BMUS from the NWHI as a whole was estimated by

Kobayashi (1996) at 586,000 pounds. This is the greatest quantity of bottomfish that could be harvested annually on a sustainable basis by average NWHI bottomfish fishing vessels. Using average operational characteristics for these vessels, Pooley (1996) partitioned the MSY into 131,000 pounds for the Mau Zone and 455,000 pounds for the Hoʻomalu Zone. In the most recent year for which data are available (2002) 108,000 pounds of bottomfish were harvested from the Mau Zone and 120,000 pounds of bottomfish were harvested from the Hoʻomalu Zone. These landings represent 82 and 26 percent, respectively, of the Mau and Hoʻomalu Zone's MSYs. During the same year, total landings from the MHI were 361,774 pounds, but the MHI MSY is not known. Bottomfish landings, participation in the fisheries, and economic performance of the participants are discussed in greater detail in Section 3.6.

*3.1.2.1.2 Spawning Potential Ratio*

Amendment 3 to the Bottomfish FMP defines recruitment overfishing as a condition in which the ratio of the spawning stock biomass per recruit at the current level of fishing to the spawning stock biomass per recruit that would occur in the absence of fishing (termed spawning potential ratio, or SPR) is equal to or less than 20 percent. SPR has been used by the Council as a proxy for MSY. The 1996 re-authorization of the MSA by the Sustainable Fisheries Act (SFA) resulted in new requirements for monitoring for potential overfishing, among other things. In 1998, the Council submitted to NMFS for approval Amendment 6 to the FMP, which was intended to bring the FMP into compliance with the new provisions of the SFA concerning overfishing, bycatch, fishing sectors, essential fish habitat, and fishing communities. The portion of the amendment dealing with overfishing initially was disapproved as not providing a measure of stock biomass as required. The next section (3.1.2.1.3) describes the portion of the Council's supplement to Amendment 6 (WPRFMC 2002c) that rectified that problem. The methods presented there will allow calculation of MSY and other reference parameters, however, those calculations have not yet been completed. In the meantime, however, the Council has amassed 17 years of SPR data for Hawaiʻi's bottomfish fisheries, and the values are illustrative of the status of the bottomfish stocks in the three Hawaiʻi management zones.

The SFA requires preparation of an annual Stock Assessment and Fishery Evaluation (SAFE) report for every managed fishery. The Council's "Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region 2002 Annual Report" (WPRFMC 2004) compiles and interprets the most recent data available, that for 2002. That report is the source of most of the data reported below.

In 2002, none of the five BMUS species for which SPR values can be calculated have SPR values below the 20% critical threshold that defines recruitment overfishing under the FMP. Estimates range from a low of 26% for *onaga* to a high of 47% for *ʻōpakapaka* when viewed on an archipelagic basis. However, *onaga* and *ehu* stocks are severely depleted on a localized basis in the MHI. The SPR values for these species are at or below 20% (3% for *onaga* and 11% for *ehu* using targeted CPUE figures. (The Bottomfish Plan Team feels that targeted CPUE better represents the condition of bottomfish stocks in the MHI than aggregated CPUE. Using this measure, neither *'Ōpakapaka* nor *uku* SPRs indicate critically depleted conditions.)

To address this issue of localized depletion of bottomfish stocks in the MHI, in 1998 the State of Hawai'i implemented Hawai'i Administrative Rules (HAR) Chapter 13-94. This rule establishes, for the deep-sea bottomfish fishery managed by the state, gear restrictions, non-commercial bag limits, 19 areas closed to bottomfish fishing, fishing registration and identification of bottomfish fishing vessels, and a control date for possible future implementation of a limited access management regime. The State is currently evaluating the results from the first five years of this program.

As indicated above, evidence from larval drift simulation and genetic studies however, supports the conclusion that bottomfish stocks are archipelago-wide with substantial larval transport between zones. Consequently, despite the evidence of localized overfishing in the MHI, archipelago-wide SPR estimates are the best method available to assess the status of Hawai'i's bottomfish stocks (WPRFMC 2003). Table 3-1 summarizes the archipelago-wide SPR values for the most important BMUS.

**TABLE 3-1: Historical Annual Archipelago-wide SPRs by BMUS Stock**

| YEAR | *Ehu* | *Hāpu'upu'u* | *Onaga* | *'Ōpakapaka* | *Uku* |
|---|---|---|---|---|---|
| 1986 | 41 | 55 | 53 | 51 | 58 |
| 1987 | 61 | 71 | 61 | 69 | 65 |
| 1988 | 37 | 56 | 42 | 49 | 62 |
| 1989 | 51 | 70 | 38 | 69 | 68 |
| 1990 | 44 | 57 | 36 | 57 | 52 |
| 1991 | 44 | 58 | 42 | 57 | 53 |
| 1992 | 51 | 67 | 41 | 68 | 61 |
| 1993 | 54 | 65 | 53 | 67 | 73 |
| 1994 | 38 | 51 | 39 | 53 | 52 |
| 1995 | 41 | 48 | 33 | 54 | 56 |
| 1996 | 43 | 49 | 39 | 52 | 57 |

| YEAR | *Ehu* | *Hāpu'upu'u* | *Onaga* | *'Ōpakapaka* | *Uku* |
|---|---|---|---|---|---|
| 1997 | 42 | 49 | 25 | 52 | 51 |
| 1998 | 38 | 44 | 22 | 47 | 50 |
| 1999 | 37 | 47 | 34 | 46 | 55 |
| 2000 | 39 | 49 | 27 | 52 | 52 |
| 2001 | 40 | 51 | 26 | 51 | 48 |
| 2002 | 37 | 45 | 26 | 47 | 45 |
| mean | 43.41 | 54.82 | 37.47 | 55.35 | 56.35 |
| s.d. | 6.91 | 8.71 | 10.89 | 7.98 | 7.42 |

Source: WPRFMC 2004

According to the Bottomfish Plan Team (WPRFMC 2004) the archipelago-wide SPR estimates are the best method available to assess the Hawai'i bottomfish resources and should be the only values used to evaluate overfishing.

*3.1.2.1.3 Overfishing Criteria*

Re-authorization of the MSA brought with it new requirements for the quantification of fish stock status with respect to numerical overfishing criteria. The MSA seeks to ensure long-term fishery sustainability by halting or preventing overfishing, and by rebuilding any overfished stocks. Overfishing occurs when fishing mortality (F) is higher than the level at which fishing produces maximum sustainable yield (MSY). MSY is the maximum long term average yield that can be produced by a stock on a continuing basis. A stock is overfished when stock biomass (B) has fallen to a level substantially below what is necessary to produce MSY. So there are two aspects that managers must monitor to determine the status of a fishery: the level of F in relation to F at MSY ($F_{MSY}$), and the level of B in relation to B at MSY ($B_{MSY}$).

The National Standard Guidelines (50 CFR §600.305 et. seq.) for National Standard 1 call for the development of control rules identifying "good" versus "bad" fishing conditions in the fishery and the stock and describing how a variable such as F will be controlled as a function of some stock size variable such as B in order to achieve good fishing conditions. Because fisheries must be managed to achieve optimum yield, not MSY, the MSY control rule is useful for specifying the required "objective and measurable criteria for identifying when the fishery is overfished." The National Standard Guidelines (50 CFR 600.310) refer to these criteria as "status determination criteria" and state that they must include two limit reference points or thresholds: one for F that identifies when overfishing is occurring and a second for B or its proxy that indicates when the stock is overfished. The status determination criterion for F is the maximum fishing mortality threshold (MFMT). Minimum stock size threshold (MSST) is the criterion for B. If fishing mortality exceeds the MFMT for a period of one year or more, overfishing is occurring. If stock biomass falls below MSST in a given year, the stock or stock complex is overfished. A Council must take remedial action in the form of a new FMP, an FMP amendment, or proposed regulations when it has been determined by the Secretary of Commerce that overfishing is occurring, a stock or stock complex is overfished, either of the two thresholds is being approached, or existing remedial action to end previously identified overfishing has not resulted in adequate progress.

The National Standard Guidelines state that the MFMT may be expressed as a single number or as a function of some measure of the stock's productive capacity, and that it "must not exceed the fishing mortality rate or level associated with the relevant MSY control rule" (50 CFR 600.310(d)(2)(i)). The Guidelines further state that "to the extent possible, the stock size threshold (MSST) should equal whichever of the following is greater: one-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the maximum fishing mortality threshold" (50 CFR 600.310(d)(2)(ii)). Although not required, warning reference points (e.g., $B_{FLAG}$) may be specified in advance of B or F approaching or reaching their respective thresholds. When such a reference point is reached, the Council may begin preparations for action to control F.

A target control rule specifies the relationship of F to B for a harvest policy aimed at achieving a given target. Optimum yield (OY) is one such target, and National Standard 1 requires that conservation and management measures both prevent overfishing and achieve OY on a continuing basis. OY is the yield that will provide the greatest overall benefits to the nation, and is prescribed on the basis of MSY, as reduced by any relevant economic, social, or ecological factor. MSY is therefore an upper limit for OY. A target control rule can be specified using reference points similar to those used in the MSY control rule, such as $F_{TARGET}$ and $B_{TARGET}$. While MSST and MFMT are limits, the target reference points are guidelines for management action, not constraints. The technical guidance for National Standard 1 states that "Target reference points should not be exceeded more than 50% of the time, nor on average" (Restrepo et al. 1998).

An additional set of control rules must be developed and applied if it is determined that overfishing is occurring, a stock or stock complex is overfished, either of the two thresholds is being approached, or existing remedial action to end previously identified overfishing has not resulted in adequate progress. These rules may be established in advance of a stock becoming overfished.

The Council completed a supplement to Amendment 6 (WPRFMC 2002c) specifying how it intends to comply with the new requirements and this supplement has been approved (68 FR 46112). Because of the paucity of data for all species and island areas managed under the Bottomfish FMP, the Council's control rules and overfishing thresholds are specified for multi-species complexes. No indicator species are used for the four bottomfish multi-species stock complexes (American Samoa, CNMI, Guam and Hawai'i). Instead, the control rules are applied to each of the four stock complexes as a whole. Standardized values of catch per unit effort and fishing effort are used as proxies for biomass and fishing mortality, respectively. The stock status determination criteria are specified for those proxies using defaults recommended in the NMFS technical guidance for implementing National Standard 1.

The MSY control rule is specified as the MFMT. The MFMT and MSST are dependent on the natural mortality rate (M), an estimate of which will be published annually in the SAFE report and occasionally re-estimated using the best available information.

In addition to the thresholds MFMT and MSST, a warning reference point, $B_{FLAG}$, is also specified at some point above the MSST to provide a trigger for consideration of management action prior to B reaching the threshold.

MFMT, MSST and $B_{FLAG}$ are specified as follows:

MFMT: $F(B) = F_{MSY}B/cB_{MSY}$ for $B \leq cB_{MSY}$
$F(B) = FMSY$ for $B > cB_{MSY}$

MSST: $cB_{MSY}$

$B_{FLAG}$: $B_{MSY}$

Where c = max(1-M, 0.5)

Standardized values of fishing effort (E) and catch-per-unit-effort- (CPUE) are used as proxies for F and B, respectively, so $E_{MSY}$, $CPUE_{MSY}$, and $CPUE_{FLAG}$ are used as proxies for $F_{MSY}$, $B_{MSY}$, and $B_{FLAG}$, respectively. In cases where reliable estimates of $CPUE_{MSY}$ and $E_{MSY}$ are not available, they are estimated from catch and effort time series, standardized for all identifiable biases. In Hawai'i, archipelago-wide estimates of the reference points are calculated as the weighted averages of estimates for each of the three management zones.

Because the above MSY control rule applies to multi-species complexes, it is important to ensure that no particular species within the complex has a mortality rate that leads it to required protection under the ESA. In order to accomplish this, a secondary set of reference points are specified to evaluate stock status with respect to recruitment overfishing. A secondary "recruitment overfishing" control rule is specified to control fishing mortality with respect to that status. The rule can be applied only to those component stocks (species) for which adequate data are available. The ratio of a current spawning stock biomass proxy ($SSBP_t$) to a given reference level ($SSBP_{REF}$) is used to determine if individual stocks are experiencing recruitment overfishing. SSBP is CPUE scaled by percent mature fish in the catch. When the ratio $SSBP_t/SSBP_{REF}$, or the "SSBP ratio" (SSBPR) for any species drops below a certain limit ($SSBPR_{MIN}$), that species would be considered to be recruitment overfished and management measures would be implemented to reduce fishing mortality on that species, regardless of the effects on other species within the stock complex. The rule would apply only when the SSBP ratio drops below the $SSBPR_{MIN}$, but it would continue until the ratio achieves the "SSBP ratio recovery target" ($SSBPR_{TARGET}$), which would be set at a level no less thatn $SSBPR_{MIN}$. These two reference points and their associated recruitment overfishing control rule, which prescribes a target fishing mortality rate ($F_{RO\text{-}REBUILD}$) as a function of the SSBP ratio, are as specified below, with $E_{MSY}$ again used as a proxy for $F_{MSY}$.

| | | |
|---|---|---|
| $F_{RO\text{-}REBUILD}$: | $F(SSBPR) = 0$ | for $SSBPR \leq 0.01$ |
| | $F(SSBPR) = 0.2F_{MSY}$ | for $0.10 < SSBPR \leq SSBPR_{MIN}$ |
| | $F(SSBPR) = 0.4F_{MSY}$ | for $SSBPR_{MIN} < SSBPR \leq SSBPR_{TARGET}$ |

$SSBPR_{MIN}$: 0.02

$SSBPR_{TARGET}$: 0.30

### 3.1.2.2 Seamount Groundfish

Southeast Hancock Seamount, 1,400 nm northwest of Honolulu, is the only area in the U.S. EEZ that has supported a seamount groundfish fishery. The Russians and Japanese began this trawl fishery in the late 1960s and made large catches for about 10 years until the stocks of the target species, alfonsin and armorhead, collapsed. The Bottomfish FMP, approved in 1986, placed a moratorium on this fishery. The status of the groundfish stocks at Southeast Hancock Seamount was evaluated using as an indicator the catch-per-unit-effort (CPUE) and SPR estimates from NMFS research longline catches by PIFSC personnel aboard the NOAA ship R/V *Townsend Cromwell.* Data were collected from 1985 through 1991, and in 1993. SPR values from these cruises were always around 2.5, indicating no recovery of the stocks. Monitoring of the stocks ceased in 1993. Because of its similarity in size and depth, values at the Colahan Seamount, outside the U.S. EEZ, currently are used as a proxy for the status of the Hancock Seamount groundfish. The most recent available SPR values for the Colahan Seamount were 0.2 (2001 and 2002) (WPRFMC 2004), indicating seriously depressed stock levels. There was a sharp peak in CPUE and SPR in the 1992 data indicating that episodic pulses of recruitment may be the product of environmental factors rather than a typical stock-recruitment relationship.

The current fishing moratorium on seamount groundfish at the Hancock Seamount expired on August 31, 2004. NMFS has implemented another six-year extension of the moratorium until August 31, 2010.

## 3.2 BYCATCH

Most fisheries have both non-target species (not the target of fishing, but kept for consumption or sale) and bycatch (discards). If the fish, or any part of it, is used or sold, it is incidental catch of non-target species, not bycatch. Thus, for example, in years past, when there was no prohibition on finning sharks, the discarded shark carcass was not bycatch. It is also important to note that the MSA includes turtles as bycatch, but not marine mammals or seabirds. The discussion below focuses on bycatch of fish species. Turtles are discussed later, in the protected species section.

### 3.2.1 MSA Definitions and Requirements

Bycatch is defined as follows in the MSA (§3(2, 12, 9, and 33)):

> *The term "bycatch" means fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch and release fishery management program.*
>
> *The term "fish" means finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds.*
>
> *The term "economic discards" means fish which are the target of a fishery, but which are not retained because they are of an undesirable size, sex, or quality, or for other economic reasons.*
>
> *The term "regulatory discards" means fish harvested in a fishery which fishermen are required by regulation to discard whenever caught, or are required by regulation to retain but not sell.*

The National Standard Guidelines (50 CFR 600.350(c)) extend the definition of bycatch to include:

> *fishing mortality due to an encounter with fishing gear that does not result in capture of fish (i.e., unobserved fishing mortality).*

The 1996 SFA amendments to the MSA added two key requirements of FMPs regarding bycatch. First, the new National Standard 9 (MSA §301(a)(9)) requires that:

> *Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.*

Second, MSA §303(a)(11) requires that FMPs:

> *establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable and in the following priority -*
>
> > *(A) minimize bycatch; and*
> >
> > *(B) minimize the mortality of bycatch which cannot be avoided.*

### 3.2.2 Available Estimates of Catch and Mortality

With the moratorium on the seamount groundfish fishery there is no bycatch or bycatch mortality in that fishery. Bottomfish fisheries exist throughout the management area, but with the exception of the Hawai‘i fisheries, these are shallow-water fisheries that take place almost exclusively in state and territorial waters, and consequently are not subject to federal management. Nevertheless, the 2002 SAFE report for the Bottomfish FMP (WPRFMC 2004) summarizes data for these fisheries. For 2002, no bycatch was reported in American Samoa. For Guam, bycatch information was gathered through interviews. Historically, most fish landed there are kept, regardless or size or species. However, the charter fishing sector commonly practices catch-and-release fishing, which technically results in released fish being classified as bycatch. Consequently, this sector of the fishery had a very high bycatch percentage of nearly 75%. The non-charter bottomfish sector, on the other hand, had a bycatch rate of over 41% (211 of 518 fish landed), with fish in the families carcharhinidae, lethrinidae and balistidae commonly discarded alive. The fishery in the CNMI also consists of both a charter sector and a non-charter sector, with very different bycatch rates for the same reason as Guam. 2002 bycatch rates were investigated using interviews. The non-charter interviewees (27) reported no bycatch. Of the charter interviewees (12), two reported bycatch consisting of 7.7% of their catch (all triggerfish).

In Hawai‘i, there are two separately managed bottomfish fisheries: a strictly commercial fishery in the NWHI, and a mixed commercial, recreational and subsistence fishery in the MHI. While these fisheries use the same gear and operational methods, the motivation of the fishermen is different between the commercial operators and recreational or subsistence fishermen. This results in different bycatch characteristics. The NWHI commercial fishermen seek the highest economic return on their catch and therefore may discard lower valued species, especially early in a trip, thereby conserving both ice and hold space. Recreational or subsistence fishermen, on the other hand, are more inclined to retain a greater variety of species for home consumption or distribution to relatives and friends. For this reason, the bycatch of the NWHI commercial fleet is likely the largest and most diverse of the Region's bottomfish fisheries, and will be used to conservatively characterize bottomfish bycatch. In addition, because Hawai'i has no permit, logbook, or catch reporting system for non-commercial marine fishermen, there are no data on bycatch by this sector. Data on bycatch in the NWHI commercial fishery is available from the logbook program, from limited observer data, and from NMFS research cruises in the NWHI.

Bottomfish gear types and fishing strategies are highly selective for desired species and sizes. Measures that serve to further reduce bycatch in the botomfish fishery include prohibitions on the use of bottom trawls, bottom gillnets, explosives and poisons.

Logbook data (State of Hawai'i), and observer programs conducted by NMFS indicate that total discards (including damaged target species) account for approximately 8 to 23% of the total catch in bottomfish fisheries in the Hawaiian archipelago (Nitta 1999, WPRFMC 1998a). Carangids, sharks, and miscellaneous reef fish (pufferfish, moray eels, etc.) are the most numerous discard species. Two species in particular, *kāhala* (*Seriola dumerili*) and *butaguchi* (*Pseudocaranx dentex*), make up the majority of the bycatch. Most species are not kept by vessels because of their unpalatability, however some carangids (large jacks and amberjacks) are also discarded because of concerns of ciguatera poisoning[2]. *Butaguchi*, which commands a low price in the Hawai'i market, may be discarded in the early days of a fishing trip to avoid reducing vessel hold space for more valuable bottomfish and because this species has a poor on-board "shelf-life." The major discard species in the NWHI bottomfish fishery are given in Table 3-2. It should be noted that a large percentage of the snappers and the grouper listed there are included as bycatch because of damage from sharks.

In bottomfish fishing operations the largest proportion of lost fish and gear is attributable to interactions with sharks (Nitta 1999). Some fishing areas are so plagued with sharks that a majority of hooked fish are either stolen or damaged. The estimated economic losses experienced by fishermen as a result of shark interference with fishing operations are substantial (Kobayashi and Kawamoto 1995). In the NWHI the gray reef shark (*Carcharhinus amblyrhnchos*) is the worst offender. When shark interactions become a problem, some fishermen will attempt to kill sharks by catching and/or shooting them. During the late 1990s, an increase in the market

[2]Ciguatera fish poisoning results from eating a fish containing a neurological toxin produced by a microscopic dinoflagellate algae. The algae grow epiphytically on benthic macroalgae (seaweeds) and are ingested by herbivorous fish which in turn are eaten by larger carnivorous fish, with each step concentrating the toxin. In humans, ciguatera poisoning may cause severe illness or even death.

demand for shark fins resulted in some bottomfish vessels "finning"[3] the sharks that were killed. In 2000 however, both the State of Hawai'i and the federal government implemented legislation that required the entire shark carcass to be landed along with the fins (HRS § 188.40.5 and CFR 600.1023, respectively). This legislation has curtailed shark-finning in the bottomfish fishery. Limitations in hold space and limited marketability preclude most bottomfish vessels from retaining shark carcasses.

**TABLE 3-2: Percent Discards from Bottomfish Fishing Trips with NMFS Observers, 1990-1993**

| SPECIES | NO. CAUGHT | NO. DISCARDED | % DISCARDED |
|---|---|---|---|
| *Kāhala* | 2438 | 2266 | 92.9 |
| *Kalekale* (yellowtail) | 40 | 22 | 55 |
| Sharks | 176 | 92 | 52.3 |
| Misc. fish | 115 | 59 | 51.3 |
| *Ulua* (white) | 127 | 62 | 48.8 |
| Misc. snapper/jack | 189 | 91 | 48.1 |
| *Butāguchi* | 3430 | 1624 | 47.3 |
| *Ulua* (black) | 23 | 10 | 43.5 |
| *Ta'ape* | 110 | 40 | 36.4 |
| Misc. fish unidentified | 174 | 26 | 14.9 |
| *Kalekale* | 874 | 52 | 6 |
| *'ōpakapaka* | 5092 | 107 | 2.1 |
| *Ehu* | 1185 | 20 | 1.7 |
| *Uku* | 2209 | 28 | 1.3 |
| *Hāpu'upu'u* | 1593 | 19 | 1.2 |
| *Gindai* | 459 | 3 | 0.7 |
| *Onaga* | 1141 | 8 | 0.7 |

[3]"Finning" is the practice of removing the fins from a shark and discarding the remainder of the carcass at sea.

| SPECIES | NO. CAUGHT | NO. DISCARDED | % DISCARDED |
|---|---|---|---|
| Alfonsin | 1 | 0 | 0 |
| Armorhead | 1 | 0 | 0 |
| *Lehi* | 3 | 0 | 0 |

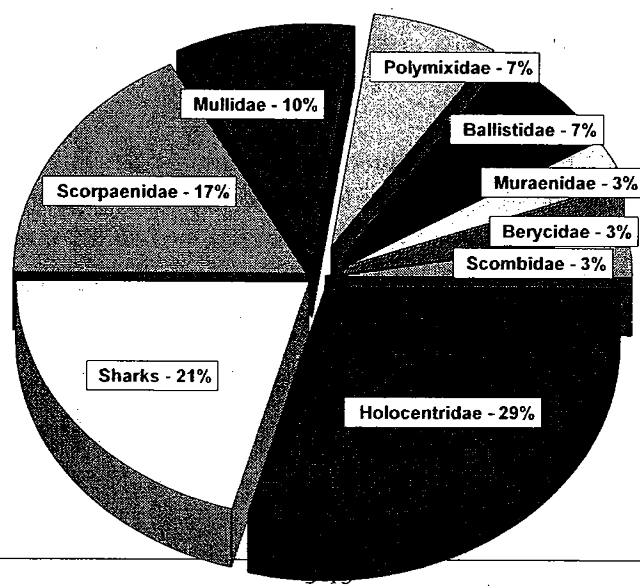
Source: Nitta 1999

Data collected by NMFS during research bottomfish fishing cruises indicate the potential species composition of bycatch in the NWHI bottomfish fishery (Figure 3-1). Research bottomfish fishing is less likely to exclusively successfully target commercial species, however Figure 3-1 indicates the other species that may be caught in association with bottomfish fishing operations.

The most recent data available (WPRFMC 2004) reinforce the trends described above, including the differences in strategy between Mau and Ho'omalu Zone operations. In both zones in 2002, 100% of the sharks and *kāhala* were discarded. In the Mau Zone, *butaguchi* was frequently discarded in 2002 (22%), unlike in 2001 when only 1% was discarded. The only other significant discard was *'ōmilu* (*Caranx melampygus*) at 9%, down from 38% in 2001.

In the Ho'omalu Zone, several lesser valued species were commonly discarded, including *kalekale* (48% in 2002, 24% in 2001), *butaguchi* (20% in 2002, 32% in 2001) and white *ulua* (*C. ignoblis*) (63% in 2002, 70% in 2001).

**FIGURE 3-1: NMFS Research Cruise Estimates of Composition of Bottomfish Bycatch in Hawai'i** (Percent of total number; Source: WPRFMC 1998a)



### 3.2.3 Anticipated Improvements to Management Measures

The Council's supplement to the bycatch provisons of Amendment 6 (WPRFMC 2002d) includes four types of non-regulatory measures aimed at further reducing bycatch and bycatch mortality and improving bycatch reporting: 1) outreach to fishermen and engagement of fishermen in management, including research and monitoring, in order to raise their awareness of bycatch issues and of options to reduce bycatch, 2) research into fishing gear and method modifications to reduce bycatch and bycatch mortality, 3) research into the development of markets for discarded fish species, and 4) improvement of data collection and analysis systems to better measure bycatch.

With the assistance of the WpacFIN program, bycatch data collection and analysis throughout the region, especially in areas outside Hawai'i, continues to improve. Education of fishermen regarding bycatch issues is ongoing. In American Samoa, Guam and the CNMI, this is done through the creel survey interviews. Bottomfish fishermen in the NWHI have been participating in the *ulua* tagging research program. In areas outside Hawai'i, bycatch is very small to non-existent, as almost all species are retained. In the Hawai'i fishery bycatch consists of mostly regulatory (sharks) and economic discards. There is little opportunity for market development for discarded species.

## 3.3 PROTECTED SPECIES

Protected species include those species listed as endangered or threatened under the ESA, all marine mammals, listed or not, as they are protected under the MMPA, and seabirds, listed or not, as they are protected under the MBTA. Each of these laws is described in Appendix F. Appropriate information on the species' life history, habitat and distribution, and other factors necessary to its survival, is included to provide background for analyses in other sections of this document. The Hawaiian monk seal (monk seal), the only listed species which may be adversely affected by the proposed activities, and its critical habitat are considered in detail in section 3.3.1.3.

In March 2002, NMFS completed a formal consultation under ESA Section 7 and released its Biological Opinion (BiOp) for the Bottomfish FMP. The BiOp concluded that the bottomfish fisheries of the Western Pacific Region are not likely to jeopardize the continued existence of any threatened or endangered species under NMFS' jurisdiction or destroy or adversely modify critical habitat that has been designated for them. The full text of the BiOp is included as Appendix H.

### 3.3.1 Marine Mammals

Protected marine mammals fall into two categories: species listed under the ESA and those species which are not listed, but otherwise protected under the MMPA. Cetaceans and pinnipeds are discussed separately in the sections below.

#### 3.3.1.1 Listed Cetaceans

There are six species of cetaceans listed under the ESA that occur within the area of operation of the bottomfish fishery of the Western Pacific Region. These species are the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), and right whale (*Eubalaena glacialis*).

Although these whales may be found within the action area and could interact with the U.S. fisheries of the Western Pacific Region, no reported or observed incidental takes of these species have occurred in the bottomfish fishery. Therefore, NMFS determined that there is no impact to these cetaceans from the bottomfish fishery.

#### 3.3.1.2 Other Cetaceans

Species of marine mammals that are not listed under the ESA but are protected under the MMPA and occur in the areas of the Western Pacific Region where bottomfish fisheries operate are as follows:

1. Blainsville beaked whale (*Mesoplodon densirostris*)
2. Bottlenose dolphin (*Tursiops truncatus*)
3. Bryde's whale (*Balaenoptera edeni*)
4. Cuvier's beaked whale (*Ziphius cavirostris*)
5. Dwarf sperm whale (*Kogia simus*)
6. False killer whale (*Pseudorca crassidens*)
7. Killer whale (*Orcinus orca*)
8. Melon-headed whale (*Peponocephala electra*)
9. Pygmy killer whale (*Feresa attenuata*)
10. Pygmy sperm whale (*Kogia breviceps*)
11. Risso's dolphin (*Grampus griseus*)
12. Rough-toothed dolphin (*Steno bredanensis*)
13. Short-finned pilot whale (*Globicephala macrorhynchus*)
14. Spinner dolphin (*Stenella longirostris*)
15. Spotted dolphin (*Stenella attenuata*)
16. Striped dolphin (*Stenella coeruleoalba*)
17. Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)
18. Minke whale (*Balaenoptera acutorostrata*)

19. Dall's porpoise (*Phocoenoides dalli*)
20. Fraser's dolphin (*Lagenodelphis hosei*)
21. Longman's beaked whale (*Indopacetus pacificus*)

Of the above species, the bottomfish fishery has been documented to interact with only one species, the bottlenose dolphin (*Tursiops trucatus*) (Nitta and Henderson 1993). Although the other species listed above may be found within the action area and could interact with bottomfish fisheries in the Western Pacific Region, no reported or observed incidental takes of these species have occurred in these fisheries. There is no current expectation of future interactions between these species and the bottomfish fisheries and therefore, they will not be considered further in this document.

Bottlenose dolphins are widely distributed throughout the world in tropical and warm-temperate waters (Reeves et al. 1999). Average size at birth is 0.9 to 1.2 m and 8 - 9 kg. Maximum size reported is 3.9 m and 275 kg. Males are sexually mature at 10 - 12 years of age, females between 5 and 12 years. Once reproductively active, females bear a single calf every second or third year. Gestation is about 12 months. Calves are nursed for a year or more. Maximum age appears to be 46 - 48 years, based on tooth growth analysis of both wild and captive dolphins.

The bottlenose dolphin is primarily coastal, but populations also occur in offshore waters. The species is common throughout the Hawaiian archipelago, usually within five miles of emergent land or shallow banks (Shallenberger 1981). School sizes range from single animals and small groups (3-10 individuals) to aggregations of more than 100 individuals. A combined aerial and vessel survey indicated at least 430 individuals in the shallow waters around the MHI (Nitta and Henderson 1993). Data suggest that the bottlenose dolphins in Hawai'i belong to a separate stock from those in the eastern tropical Pacific (Scott and Chivers 1990). The status of bottlenose dolphins in Hawaiian waters relative to their optimum sustainable population (OSP) is unknown, and there are insufficient data to evaluate trends in abundance or carrying capacity of the region (Forney et al. 2000). Although bottlenose dolphins have been observed stealing hooked fish off of bottomfish lines, the extent of such interactions are not known and are believed to be low. The impact of the bottomfish fishery on the behavior or foraging success of bottlenose dolphins is unknown.

### 3.3.1.3 Listed Pinniped: The Hawaiian Monk Seal

In 1976, the Hawaiian monk seal was listed as endangered under the ESA following a 50% decline in beach counts from the late 1950s to the mid-1970s (41 FR 33922). It was also designated a depleted species in 1976 under the MMPA, and its population status is considered to be below sustainable levels. The Hawaiian monk seal is the most endangered pinniped in U.S. waters and is second only to the northern right whale as the nation's most endangered marine mammal (Marine Mammal Commission 1999). The Hawaiian monk seal is also the only endangered marine mammal that exists wholly within the jurisdiction of the United States.

The first Hawaiian Monk Seal Recovery Team (HMSRT), appointed pursuant to the ESA in 1980, is a forum, supported by NMFS, in which issues involving recovery planning and implementation are discussed and recommendations for actions forwarded to NMFS. In 1982, the HMSRT completed the Hawaiian Monk Seal Recovery Plan. The highest priority activities identified by the HMSRT are those that support the following recovery-related objectives: 1) Determine the ultimate and proximate factors influencing population dynamics at each of the six major breeding locations; 2) Enhance survival of female Hawaiian monk seals and their pups to maximize reproductive potential and population growth; 3) Facilitate recovery of the depleted populations; and 4) Mitigate human impacts (HMSRT 1999).

Under the ESA, critical habitat may be designated to afford protection or special management consideration to physical or biological features essential to the conservation of a listed species. In May 1988, NMFS designated critical habitat for the Hawaiian monk seal out from shore to 20 fathoms in 10 areas of the Northwestern Hawaiian Islands. Critical habitat for this species includes "all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 20 fathoms around the following: Pearl and Hermes Reef, Kure Atoll, Midway Islands, except Sand Island and its harbor, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island" (53 FR 18990, May 26, 1988, 50 CFR § 226.201).

Critical habitat was designated in order to enhance the protection of habitat used by Hawaiian monk seals for pupping and nursing, areas where pups learn to swim and forage, and major haul-out areas where population growth occurs. The Bottomfish FMP manages areas included in the critical habitat for the Hawaiian monk seal (i.e., ocean waters out to 20 fathoms depth), although the fisheries operating pursuant to the Bottomfish FMP do not adversely affect the physical features identified as critical habitat, such as the substratum, waters, or nesting beaches.

*3.3.1.3.1 Biology and Distribution*

Monk seals are phocids, and are one of the most primitive genera of seals. They are brown to silver in color, depending upon age and molt status, and can weigh up to 270 kg. Adult females are slightly larger than adult males. Monk seals are solitary, and it is thought they can live up to 30 years. Females reach breeding age at about 5 to 10 years of age, depending on their condition, and can give birth about once every year. An estimated 40-80% of adult females give birth in a given year (NMFS unpub. data. 2001). After birth, pups nurse for 5-6 weeks, during which time the mother rarely, if at all, leaves the pup to feed. At weaning, the mother leaves and the pup must subsequently forage independently. Newly weaned pups tend to stay in the reef shallows, entering into more diverse and deeper waters to forage as they gain experience. Monk seals may stay on land up to about two weeks during their annual molt. Hawaiian monk seals are nonmigratory, but studies show their home ranges may be extensive (Abernathy and Siniff 1998). Counts of individuals on shore compared with enumerated subpopulations at some of the NWHI indicate that Hawaiian monk seals spend about one-third of their time on land and about two thirds in the water (Forney et al. 2000).

The Hawaiian monk seal breeds only in the Hawaiian Archipelago, with most monk seals inhabiting the remote, largely uninhabited atolls and surrounding waters of the NWHI. More than 90 percent of all pups are born at six major breeding colonies located at FFS, Laysan Island, Pearl and Hermes Reef, Lisianski Island, Kure Atoll and Midway Atoll. A few births also occur annually at Necker, Nihoa, and Ni'ihau Islands and in the main Hawaiian Islands. NMFS researchers have also observed Hawaiian monk seals at Gardner Pinnacles and Maro Reef. Although Hawaiian monk seals occasionally move between islands, females generally return to their natal colony to pup. Since 1990, there has been an apparent increase in the number of Hawaiian monk seal sightings and births in the main Hawaiian Islands (HMSRT 1999; Johanos 2000). A 2001 aerial survey determined a minimum abundance of 52 seals in the MHI (Baker and Johanos, in press). 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[4] and two from FFS) over the past 30 years.

Hawaiian 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 1998). Research to identify prey species is currently underway using several methods: collection of potential prey items and blubber samples for fatty acid analysis; Crittercam[5] recording of foraging behavior; correlation of dive/depth/location profiles with potential prey species habitat; and analysis of Hawaiian monk seal scat and spew samples for identifiable hard parts of prey. To date, completed studies indicate little or no overlap between Hawaiian monk seal prey items and the target and bycatch/incidental catch species of the bottomfish fishery. Table 3-3 identifies adult male Hawaiian monk seal prey families as indicated by Crittercam studies at FFS.

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[4]Nine adult male Hawaiian monk seals that had been identified as participating in mobbing behavior were translocated to Johnston Atoll by the NMFS in 1984. This was an attempt to reduce the frequency and/or severity of mobbing incidents involving injury or death of female seals, not to equalize the sex ratio at Laysan Island.

[5]A Crittercam is a self-contained video camera that has been mounted on a Hawaiian monk seal to record its foraging behavior.

**TABLE 3-3: Crittercam Study: Prey Items Eaten by Free Swimming Adult Male Hawaiian Monk Seals at FFS**

| FAMILY | NUMBER SEEN | BOTTOMFISH TARGET SPECIES: Y = Yes, ? = Maybe, N = No | BOTTOMFISH BYCATCH SPECIES: Y = Yes, ? = Maybe, N = No |
|---|---|---|---|
| Anthiinae | 2 | N | N |
| Balistidae | 1 | N | N |
| Bothidae | 1 | N | N |
| Cheilinninae | 2 | N | N |
| Congridae | 1 | N | ? |
| Pentacerotidae (groundfish) | 1 | N | N |
| Pomacentridae | 1 | N | N |
| Tetradontidae | 1 | N | N |
| Unidentified Eels | 2 | N | ? |
| Unidentified fish | 8 | ? | ? |
| Octopus | 2 | N | N |

(Source: Parrish et al. 2000; WPRFMC 2000a)

In a study at five of the principle breeding sites for the Hawaiian monk seal (FFS, Laysan Island, Lisianski Island, Pearl and Hermes Reef, and Kure Atoll) focused on identifying items eaten by Hawaiian monk seals, Goodman-Lowe (1998) analyzed scat and spew samples to identify prey, and to obtain size estimates of the more common cephalopod prey species.[6] This study also examined the temporal differences in diet among years. The frequency of occurrence (FO) was calculated as the number of samples in which an identified prey type was found. The percent frequency of occurrence (percent FO) was calculated as the FO divided by the total number of scat and spew samples analyzed (n=940)(Table 3-4).

[6]Scat and spew analysis is known to be biased due to differential digestion of various prey types. However, scat and spew analysis is, at this time, the best available scientific information for investigating Hawaiian monk seal diets.

**TABLE 3-4: Goodman-Lowe Results of Prey found in Scat and Spew samples Referenced to Bottomfish MUS and Bycatch Families**

| FAMILY | FO/%FO n=940 | BOTTOMFISH TARGET FAMILY: Y = Yes, ? = Maybe, N = No | BOTTOMFISH BYCATCH FAMILY: Y = Yes, ? = Maybe, N = No |
|---|---|---|---|
| Labridae | 194/20.6 | N | N |
| Balistidae | 123/13.1 | N | N |
| Scaridae | 99/10.5 | N | N |
| Acanthuridae | 71/7.6 | N | ? |
| Pomacentridae | 44/4.7 | N | N |
| Tetradontidae | 41/4.4 | N | N |
| Kyphosidae | 32/3.4 | N | N |
| Monacanthidae | 29/3.1 | N | N |
| Synodontidae | 25/2.7 | N | N |
| Pomocanthidae | 17/1.7 | N | N |
| Kuhliidae | 14/1.5 | N | N |
| Cirrhitidae | 12/1.3 | N | N |
| Chaetodontidae | 10/1.1 | N | N |
| Diodontidae | 10/1.1 | N | N |
| Bothidae | 9/0.9 | N | N |
| Cheilodactylidae | 6/0.6 | N | N |
| Scorpaenidae | 5/0.5 | N | N |
| Ostraciidae | 1/0.1 | N | N |
| Unidentified Eels | 207/22.0 | N | ? |
| Holocentridae | 135/14.4 | N | Y |
| Muraenidae | 53/5.6 | N | Y |
| Congridae | 52/5.5 | N | ? |

| FAMILY | FO/%FO n=940 | BOTTOMFISH TARGET FAMILY: Y = Yes, ? = Maybe, N = No | BOTTOMFISH BYCATCH FAMILY: Y = Yes, ? = Maybe, N = No |
|---|---|---|---|
| Priacanthidae | 40/4.3 | N | Y |
| Apogonidae | 9/0.9 | N | N |
| Opichthidae | 6/0.6 | N | N |
| Mullidae | 58/6.2 | N | Y |
| Lutjanidae | 24/2.6 | Y | Y |
| Carangidae | 11/1.1 | Y | Y |
| Polymixiidae | 9/1.0 | N seamount groundfish | ? |
| Serranidae | 5/0.5 | N | Y |
| Belonidae | 1/0.1 | N | N |
| Unidentified remains | 330 | ? | ? |

Source: Goodman-Lowe 1998

The results indicated that Hawaiian monk seals are opportunistic predators that feed on a wide variety of available prey as compared to the case of other seals in which the bulk of the diet is made up of only a few species (Goodman-Lowe 1998). The analysis revealed that teleosts (bony fish) were the most represented prey (78.6%) followed by cephalopods (15.7%) and crustaceans (5.7%). The most common teleost families found were marine eels (22.0%), Labridae (20.6%), Holocentridae (14.4%), Balistidae (13.1%) and Scaridae (10.5%). All teleost families found include common, shallow-water reef fishes, except for the beardfish family, Polymixiidae (1.0%), which is recognized to consist of deep-water benthic fish. The deep-water Polymixiidae are not caught in the bottomfish fishery either as target or bycatch species. Evidence of target species such as snapper and grouper appeared infrequently in fecal and regurgitate samples.

Both the Crittercam data and the scat and spew analyses indicate little overlap with the target and bycatch fish families of the bottomfish fishery. Moreover, overlap at the family level may not reflect an overlap at the species level because many species within families occur in both deep and shallow waters.

An ongoing study contracted by NMFS is using quantitative fatty acid signature analysis to identify which prey items are most important to the various age and sex components of the several island populations of Hawaiian monk seals (Iverson 2000). Initial estimates of diet suggest an array of prey species that are in some cases comparable to that found in the analysis of fecal and regurgitate samples. NMFS' NWHI bottomfish fishery observers are collecting bottomfish samples to extend this analysis to BMUS.

More information about the foraging activities of Hawaiian monk seals is available through the additional analysis of dive/depth/location profiles and the correlation with the habitat of potential prey families. Recent information suggests Hawaiian monk seals may forage in beds of precious corals, some of which are habitat for known Hawaiian monk seal prey items such as eels (Parrish et al. 2002).

The foraging and dive patterns of Hawaiian monk seals and the availability of prey items to Hawaiian monk seals are important to understand when determining the potential impact of the bottomfish fishery in terms of areas fished, potential for gear interactions, and prey competition. The foraging range of the Hawaiian monk seal extends to areas managed under the Bottomfish FMP. Various studies have been undertaken to determine the habitat use patterns of Hawaiian monk seals (Schlexer 1984; DeLong et al. 1984; Abernathy and Siniff 1998; Stewart 1998; Parrish et al. 2000). These studies used various technologies, including radio tags, dive depth recorders, Crittercams, and satellite telemetry, to study the foraging behavior of Hawaiian monk seals. The results of these studies vary by location.

DeLong et al. (1984) instrumented seven Hawaiian monk seals at Lisianski Island with radio transmitters and multiple depth of diving recorders and recorded movements for an aggregate of 94 days in which 4,817 dives were recorded. Most dives (59 percent) were in the 10-40 m depth range, and the remainder of dives were to deeper depths. Thirteen dives were recorded to depths of at least 121 m. The outer edge of the reef around Lisianski Island is generally delineated by the 40 m isobath. The study concluded that during breeding season at Lisianski Island males depend entirely upon the food resources on the coral reefs, sandy beach flats and deeper reef slopes around that island.

Schlexer (1984) also recorded diving patterns of Hawaiian monk seals at Lisianski Island. In that study, eight Hawaiian monk seals (five adult males, one juvenile male, one subadult female, and one juvenile female), tracked with radio transmitters and multiple depth of diving recorders, were recorded diving within the 0 - 70 m range. One subadult female and one juvenile female dove in the shallow range of 10 - 40 m, with some dives recorded from 150 - 180 m. None of the adult males instrumented dove to depths greater than 70 m.

Stewart (1998) investigated diving patterns of 24 Hawaiian monk seals at Pearl and Hermes Reef using satellite-linked radio transmitters to record dive depth and duration. That study concluded that the Hawaiian monk seals at Pearl and Hermes Reef foraged in relatively shallow waters, and that foraging activity was different for males and females and among age classes. At Pearl and

Hermes Reef, juveniles foraged almost exclusively within the fringing reef, adult males foraged mostly on the inside and outer edge of the fringing reef, and adult females foraged mostly within the center of the atoll and near the atoll's southwestern opening (Stewart 1998). Adult males generally dove within the 8 - 40 m range, with a secondary mode at 100 - 120 m. Male juveniles generally dove within the 8 - 40 m range. Adult females rarely dove deeper than 40 m, although one female made a number of dives to 60 - 140 m.

Abernathy and Siniff (1998) instrumented adult seals at FFS with satellite-linked time depth recorders. Data showed that instrumented adult male Hawaiian monk seals appeared to utilize the banks to the northwest, with a daytime diving range between 50 - 80 m and a nighttime range between 110 - 190 m. The study also suggested that seals that did not leave the vicinity of FFS rarely dove deeper than 80 m during the day, but made more dives closer to 80 m at night. The study also identified a few seals that were extremely deep divers. These seals' daytime dives reached depths > 300 m on a ridge to the east of the atoll. The researchers modeled the home range of individuals and concluded that the average home range was 6,467 $km^2$ (n=28, SE=3,055 $km^2$). For example, individuals were documented traveling between FFS and Gardner Pinnacles, St. Rogatien Bank, Brooks Bank, and Necker Island. The conclusion was that Hawaiian monk seals forage on benthic (bottom) and epibenthic (near bottom) species, in addition on other prey items in the fringing reef complex.

Parrish et al. (2000) provided further information that Hawaiian monk seal foraging behavior and range are extensive. Twenty-four Hawaiian monk seals were outfitted with Crittercams. The Crittercam recorded the habitat depth and bottom type at locations where Hawaiian monk seals were identified as successful in the capture of prey items. It was found that the diurnal pattern of foraging by male adults occurred mainly at the 60 m isobath. A few seals foraged at depths >300 m. Some of these areas were outside the critical habitat area and overlapped with areas fished by both lobster and bottomfish fisheries.

Since 1995, the abundance of shallow water (<20 m) reef fish has been surveyed at FFS and Midway. The data are checked as a potential indicator of changes in the abundance of Hawaiian monk seal prey. The surveys are conducted annually by NMFS and are designed to detect changes of 50 percent or greater in fish densities (Laurs 2000). So far, surveys have not indicated any statistically significant changes in prey abundance at either site (DeMartini et al. 1996; DeMartini et al. 1999).

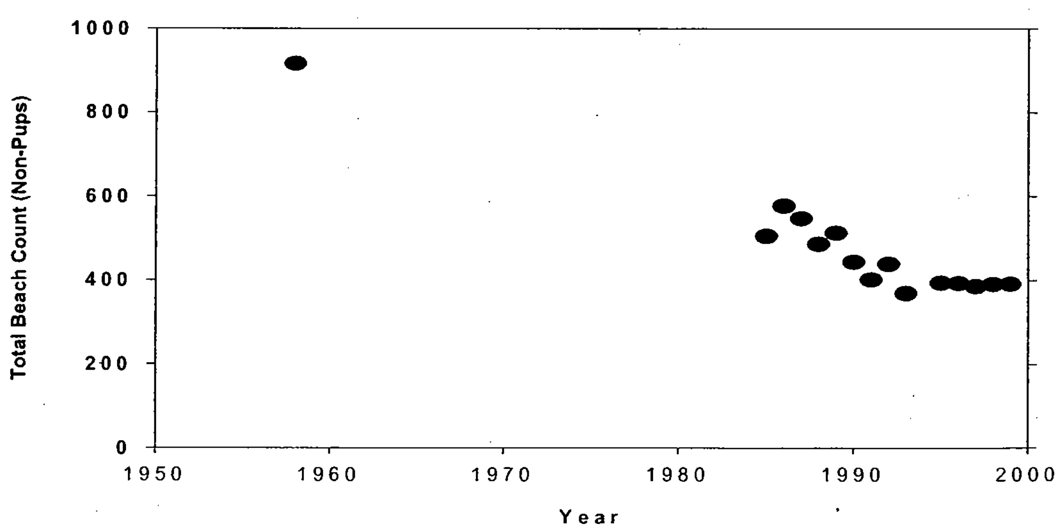
### *3.3.1.3.2 Population Status and Trends*

Little is known about Hawaiian monk seals or their population status before the 1950s. As a result of natural constraints, the species was probably never very abundant, presumably numbering, at most, in the thousands (as opposed to hundreds of thousands) (Ragen and Lavine

1999). The arrival of humans in the Hawaiian Islands may have reduced the range of the Hawaiian monk seal largely to the NWHI and contributed to its current endangered status. In historic times, human-related mortality appears to have caused two major declines of the Hawaiian monk seal (NMFS 1997; Marine Mammal Commission 2000). It generally is acknowledged that the species was heavily exploited in the 1800s during a short-lived sealing venture. Several island populations may have been completely eliminated during that period. The second major decline occurred after the late 1950s and appears to have been determined by the pattern of human disturbance from military activities at Kure Atoll, Midway Atoll and FFS. Such disturbance caused pregnant females to abandon prime pupping habitat and nursing females to abandon their pups. The result was a decrease in pup survival, which led to poor reproductive recruitment, low productivity and population decline (NMFS 1997; Marine Mammal Commission 2000).

When monk seal population measurements were taken in the 1950s, the population was already considered to be in a state of decline. The minimum population estimate ($N_{MIN}$) for monk seals is 1378 individuals (based on a 2001 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 estimates for the MHI) (Draft 2003 Stock Assessment Report). The PIFSC estimates the population to be 1300 to 1400 individuals (Laurs 2000). Figure 3-2 illustrates the long-term trend in total non-pup population size.

**FIGURE 3-2: Historical Trend in Beach Counts (non-pups) of the Six Main Reproductive Subpopulations of Hawaiian Monk Seals** (Source: Laurs 2000)



Various surveys of the islands and atolls in the NWHI that support the main monk seal breeding subpopulations indicate that the NWHI non-pup population (juveniles, sub-adults and adults) declined 60% between the years 1958 and 1999. Trends in subpopulations are measured by beach counts for each of these subpopulations. Trends vary within the NWHI. For example, from 1990 to 1998, the subpopulation at Lisianski Island decreased slightly, and the Laysan Island subpopulation increased slightly. The subpopulation at Kure Atoll increased at about 5% per year from1983 to 1998. The subpopulation at Pearl and Hermes Reef experienced the highest increase of 7% per year between 1983 and 1998. Researchers have been able to establish the minimum count of individuals in the main breeding subpopulations, and in 2001 the count of monk seals was 182 at Lisianski Island, 300 at Laysan Island, 122 at Kure Atoll, 322 at FFS, 259 at Pearl and Hermes Reef and 64 at Midway Atoll (NMFS, unpub. data). Figure 3-3 illustrates historical trends in beach counts (a relative measure of population size) of Hawaiian monk seals for each of the principle Hawaiian monk seal breeding areas in the NWHI. The overall population decline is primarily attributable to low reproductive recruitment and high juvenile mortality at the largest of the subpopulations at FFS. At this site, the average beach count of animals older than pups is now less than half the count in 1989. Poor survival of pups has resulted in a relative paucity of young seals, so that further decline is expected for this subpopulation as adults die and there are few immature seals to replace them. Also, survival from weaning to age 2 at FFS has declined to as low as 14% in 1997 from almost 90% in the mid-1980s (Laurs 2000) (Figure 3-4).

**FIGURE 3-3: Trends in Beach Counts of Hawaiian Monk Seals at the Major NWHI Breeding Areas** (Source: Laurs 2000)

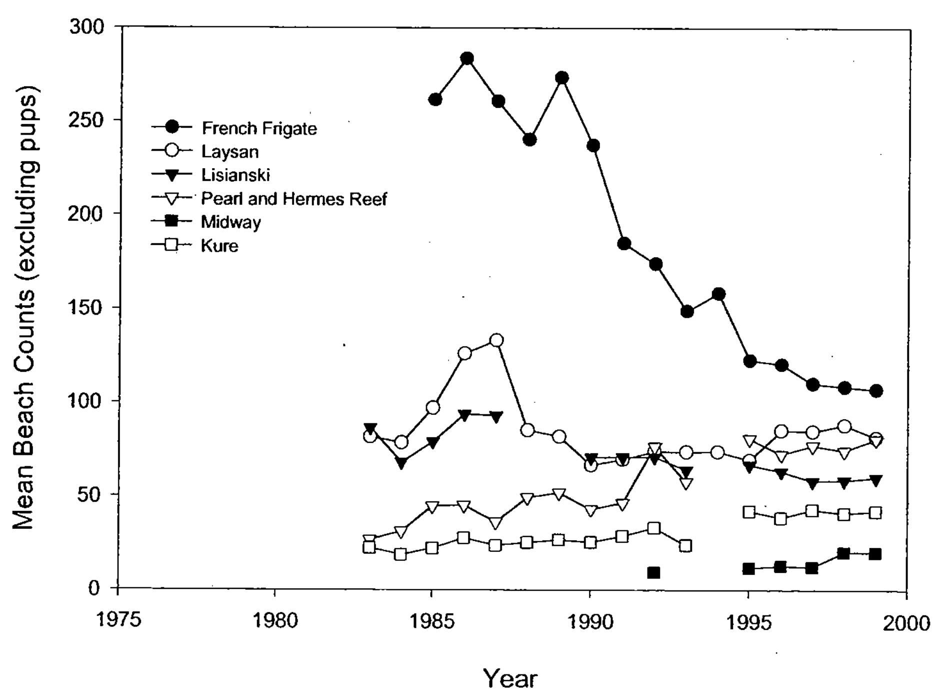
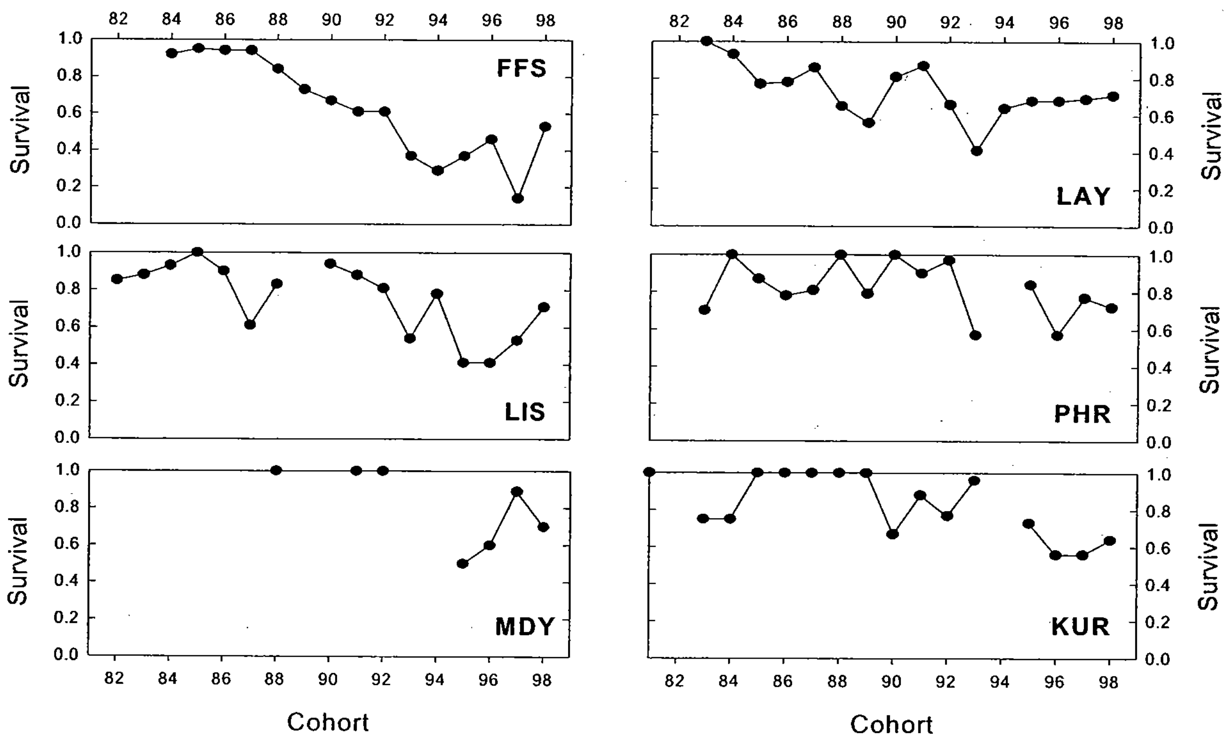
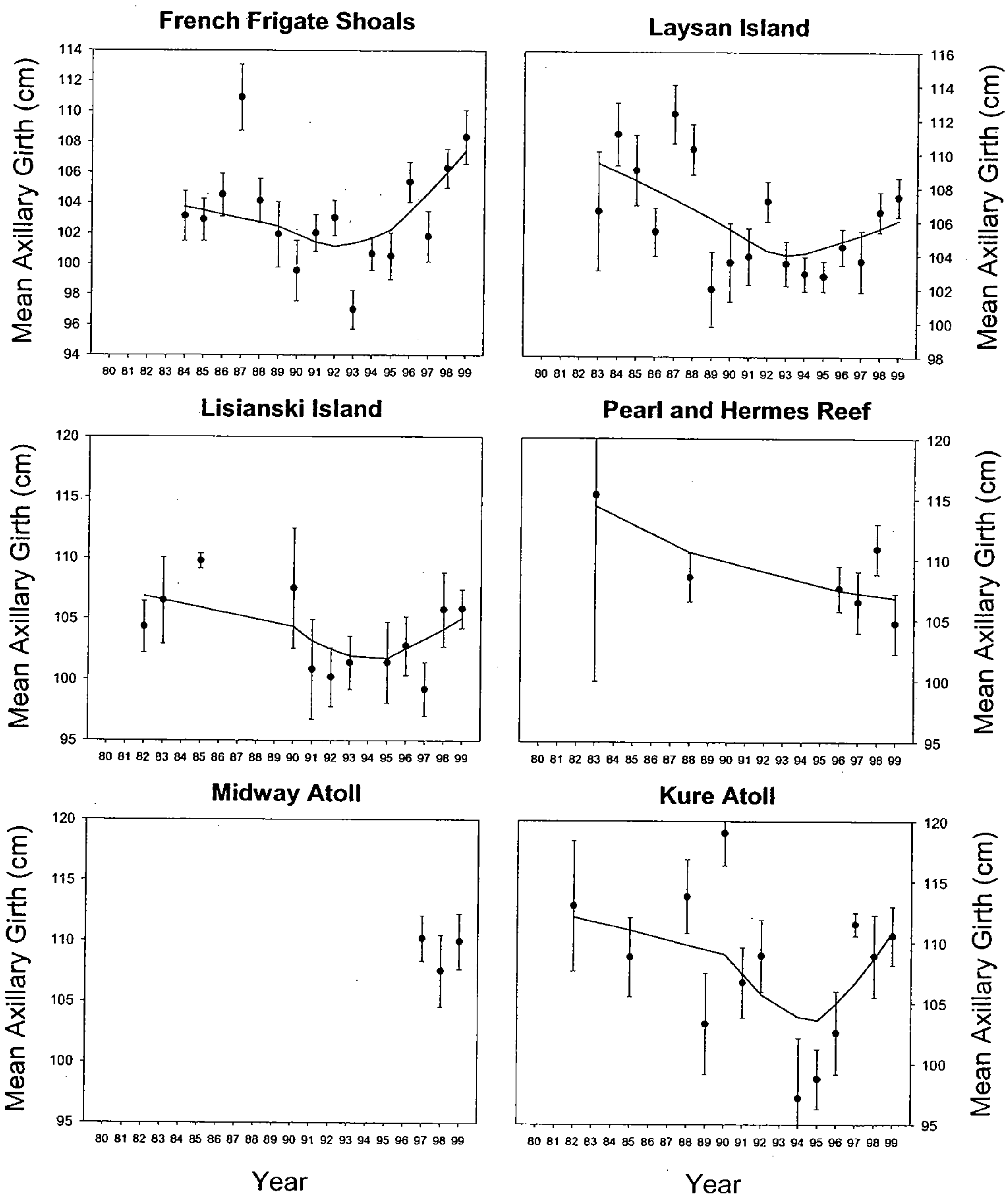


**FIGURE 3-4: Survival of Hawaiian Monk Seals from Weaning to Age 1 Year at the Major NWHI Breeding Areas** (Source: Laurs 2000)




Over the last decade, the causes of the poor survival for these age classes at FFS have been related to poor condition from starvation, shark predation, and male aggression. A decrease in prey availability may be the result of decadal scale fluctuations in productivity and corresponding or other changes in local carrying capacity for seals at FFS or a combination of factors (Craig and Ragen 1999; Polovina et al. 1994; Polovina and Haight 1999). While other subpopulations of monk seals in the Northwestern Hawaiian Islands are stable, increasing or declining slightly, the overall population status is being driven by the FFS population, which comprises about 25% of the total monk seal population. However, the girth of weaned pups at FFS (Figure 3-5), which may correlate with prey availability to females during gestation and resulting increased ability to nourish pups has increased (Laurs 2000).

**FIGURE 3-5: Trends in Axillary Girth of Hawaiian Monk Seal Pups Measured Within Two Weeks of Weaning at the Major NWHI Breeding Areas** (Source: Laurs 2000)



In sum, beach counts of monk seals have declined by 60% since the late 1950s, and current abundance is estimated at 1300 to 1400 seals. On the basis of systematic beach counts and analyses reported in the draft 2003 SAR, two population trends are evident. From 1985 to 1993 the population declined 4.3% per year. From 1994 to 2001 the population trend was - 0.7% per year (95% confidence bounds: - 2.1% to +0.8% per year). The 0.7% decline is not statistically different from stability. The trend results in large part from low beach counts in 2001.

Population trends for this species are determined by the highly variable dynamics of the six main reproductive subpopulations. At the species level, demographic trends over the past decade have been driven primarily by the dynamics of the FFS subpopulation. The subpopulation at FFS is likely to continue to decline for at least 5-8 years (Harting, 2002). In the near future, total population trends for the species will depend on the sum of continued losses at FFS and any gains at other breeding locations.

*3.3.1.3.3 Factors Influencing Population Size*

This section is a summary of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat) and ecosystem within the NWHI and the MHI, together with Johnston Atoll the only areas within the Western Pacific Region harboring Hawaiian monk seals. This section does not include the effects of the preferred and other alternatives considered in this analysis. Past effects and expected future effects of the activities conducted under the Bottomfish FMP are described in Chapter 4: Environmental Consequences.

During the past four decades the Hawaiian monk seal population has been affected by human and natural factors (Marine Mammal Commission 1999). Natural factors have included shark predation, disease, attacks by aggressive adult male Hawaiian monk seals on females and immature seals of both sexes (called "mobbing"), and reduced prey availability. Human factors have included various types of interactions with humans, their structures, contaminants and debris, fishing operations and vessel traffic. At each colony, differing combinations of these factors likely have contributed to local trends in abundance, with the relative importance of individual factors changing over time (Marine Mammal Commission 2000). The reported causes of changes in Hawaiian monk seal abundance are described in greater detail below.

**Mobbing:** Male aggression, including singular or multiple adult males attacking another seal (mobbing), can lead to Hawaiian monk seal injury and death. The deaths can be a direct result of injuries inflicted by the aggressive males or as a result of later shark attacks on wounded seals or pups chased into the water by aggressive males. Mobbing of females and immature seals by adult males is a source of mortality at FFS, Laysan Island and Lisianski Island. Evidence suggests that during the mid- to late-1990s, male Hawaiian monk seal aggression and shark predation contributed significantly to the mortality of weaned and pre-weaned pups at FFS (HMSRT 1999). At FFS, individual adult males have presented more of a problem than groups of males. Individuals which were directly observed injuring or killing pups were removed, either by translocation or euthanasia. At Laysan Island, injuries and deaths have tended to result from massed attacks, or mobbings, by large numbers of adult males. The primary cause of mobbing is thought to be an imbalance in the adult sex ratio, with males outnumbering females (NMFS 1998). Males that were removed from Laysan Island included seals which had been observed participating in mobbings, as well as other animals whose behavioral profile matched that of known "mobbers." Removal was effected either by translocation or by transfer into permanent captivity. Ten males were removed in 1984, 5 in 1987, and 22 in 1994.

Removal of individual male seals from FFS markedly decreased the number of injuries and deaths attributable to adult male aggression (Table 3-5). The results of removing adult males from Laysan Island are less clear. Injuries and deaths from adult male aggression at Laysan Island have diminished, but it is not known how much male removal has contributed to this decline.

**TABLE 3-5: Hawaiian Monk Seal Removals and Pre- and Post-Removal Mobbing Injuries and Mortalities**

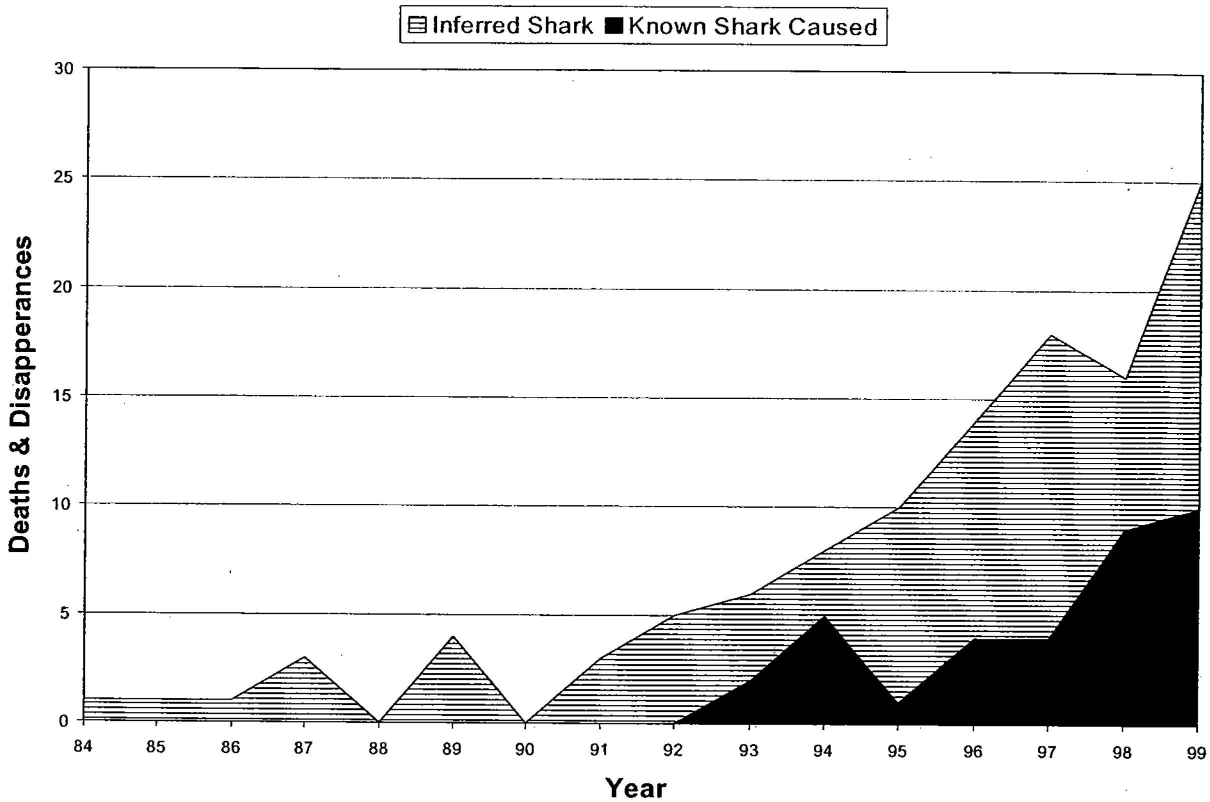
| LOCATION AND YEAR OF REMOVAL | NO. OF INJURIES/ MORTALITIES CAUSED BY ADULT MALE ATTACKS IN YEAR BEFORE REMOVAL | NO. OF MALES REMOVED | NO. OF INJURIES/ MORTALITIES CAUSED BY ADULT MALE ATTACKS IN YEAR AFTER REMOVAL |
|---|---|---|---|
| 1984 Laysan | 1983: 12 injuries; 3 mortalities | 10 removed (9 translocated to Johnston, 1 died) | 11 injuries; 5 mortalities |
| 1987 Laysan | 1986: 12 injuries; 5 mortalities | 5 removed (translocated to permanent captivity) | 1988: 25 injuries; 11 mortalities |
| 1991 FFS | 9 injuries; 4 mortalities (all mortalities attributable to single male) (as tallied from 1991, prior to male removal) | 1 (euthanized) | 5 injuries; 1 mortality |
| 1994 Laysan | 1993: 1 injury; 0 mortalities , plus an undetermined number of injuries before removal in 1994 for a total pre-removal: 6 injuries; 3 mortalities. | 22 (21 translocated to MHI, 1 died) | 1995: 3 injuries; 1 mortality |

| LOCATION AND YEAR OF REMOVAL | NO. OF INJURIES/ MORTALITIES CAUSED BY ADULT MALE ATTACKS IN YEAR BEFORE REMOVAL | NO. OF MALES REMOVED | NO. OF INJURIES/ MORTALITIES CAUSED BY ADULT MALE ATTACKS IN YEAR AFTER REMOVAL |
|---|---|---|---|
| 1998 FFS | 6 injuries; 11 mortalities | 2 (translocated to Johnston Atoll) | 2 injuries; 1 mortality |

Source: 2002 Biological Opinion

**Shark Predation:** Predation by Galapagos sharks (*Carcharhinus galapagensis*) and perhaps tiger sharks (*Galeocerdo cuvieri*) of Hawaiian monk seal pups seems to be increasing in occurrence, as 17 (18%), 16 (15%) and 25 (27%) pup mortalities or disappearances were believed to be associated with shark attacks at FFS in 1997, 1998 and 1999, respectively (HMSRT 1999). In 1999, shark predation may have accounted for the deaths of 51% (23 of 45) of the pups born at Trig Island in FFS (2002 Biological Opinion). Overall, 9.4 percent (25 out of 244) of pups born in the NWHI were inferred or known to be preyed upon by sharks in 1999 (Figure 3-6). The PIFSC infers shark related mortality whenever a newborn to approximately three week old pup disappears at FFS, especially during periods when large sharks are observed patrolling near pupping beaches. Shark predation is inferred to be the primary cause of disappearance of these pups because attacks by male adults (the other possible primary cause of mortality) are unlikely because nursing pups are defended by their mothers. However, sharks have been observed killing pups in this age category despite their mother's defense tactics against shark predation. According to the HMSRT (1999), a preliminary analysis of the impacts of shark predation on the recovery of the FFS population of Hawaiian monk seals indicates that the mitigation of this interaction is essential to the recovery of this population. The HMSRT recommended that NMFS undertake a program to remove Galapagos and/or tiger sharks observed patrolling beaches where Hawaiian monk seal pups are present within the FFS atoll. One shark was removed pursuant to a shark removal plan implemented by NMFS in 2000 to improve pup survival and possibly slow the FFS population decline.

**FIGURE 3-6: Trends in Number of Known and Inferred Shark-caused Deaths of Hawaiian Monk Seal Pups at FFS** (Source: Laurs 2000)




The dramatic increase in deaths and disappearances from shark attacks at FFS has been the result of an increased number of Galapagos sharks (*Carcharhinus galapagensis* ) in the immediate vicinity of Hawaiian monk seal pupping areas. The occurrence and escalation of Galapagos shark predation on pups may be related to an episode of adult male Hawaiian monk seal aggression against pups, which resulted in pup deaths and the presence of carcasses remaining in the waters surrounding the pupping area. These carcasses may have attracted sharks to the new prey resource of nursing seal pups. Also, the disappearance of Whale-Skate Island, which had been a large pupping site, may have resulted in more pups being born at Trig Island where sharks can easily approach the shoreline.

**Disease:** Although some information concerning medical conditions affecting the Hawaiian monk seal is available, the etiology and impact of disease on wild animals at the population level is far from clear. There are substantial data gaps regarding the prevalence of disease conditions in populations of Hawaiian monk seals in the wild, and thus their potential impact on population dynamics is unknown. In the wild, even massive epizootics in remote locations may pass undetected (Aguirre 2000).

There have been periods of unusually high mortalities in subpopulations located in the NWHI. A die-off occurred in 1978 at Laysan Island (Johnson and Johnson 1981). More than 50 seal carcasses were found in an advanced state of decomposition, and although the cause of the mortality was not identified, it may have been disease related. Also, survival of immature seals severely declined at FFS after 1987, and the reproductive potential of the species was being seriously compromised by the loss of young females. The cause has been attributed to emaciation/starvation; however, the role of endoparasites or disease is unknown. During 1992-93, undersized pup and juvenile seals from FFS were rehabilitated and released at Midway Atoll with poor success.

Health assessment and collection of baseline information on diseases is considered important to the recovery of the Hawaiian monk seal population (Gilmartin 1983; Aguirre et al. 1999). Banish and Gilmartin (1992) summarized pathological conditions found in 42 carcasses recovered from 1981 to 1985. Frequent findings included parasites, trauma, cardiovascular disease, and respiratory infections. Emaciation was a common condition. Banish and Gilmartin (1992) did not assess causes of death from any of their samples, but nonetheless concluded that there was no evidence of any disease phenomenon affecting the population in a manner which would significantly hinder recovery of the species. A series of examinations of 23 dead seals collected from 1989 to 1995 (Work unpubl. data) ascribed causes of death as follows: emaciation (7); emaciation compounded by senescence (1); trauma (2); foreign body aspiration (1); and euthanasia(1). Cause of death was not determined in 11 animals.

The relative significance of disease and related factors and their effect on population trends are poorly understood. Disease processes may be important determinants of population trends through long-term low levels of mortality, or through episodic die-offs. Table 3-6 describes the findings of health and disease studies on Hawaiian monk seals between 1925 and 1997.

**TABLE 3-6: Health and Disease Studies in Hawaiian Monk Seals**

| YEAR | HEALTH CONDITION AND REFERENCE |
|---|---|
| 1925 | Internal parasites were first reported (Chapin 1925). |
| 1952 | Diphyllobothriid cestodes were first reported (Markowski 1952). |
| 1959 | The Acanthocephalan *Corynosoma* sp. was first reported (Golvan 1959). |
| 1969 | Diphyllobothriid cestodes were reported (Rausch 1969). |

| YEAR | HEALTH CONDITION AND REFERENCE |
|---|---|
| 1978 | Known as the Laysan epizootic, ≥50 Hawaiian monk seals were found dead. Specimens from 19 dead and 18 live seals were collected. All carcasses found with stomach ulceration and heavy parasite burdens and in severe state of emaciation. Livers from two carcasses tested positive to ciguatoxin and maitotoxin. There was serologic evidence of caliciviruses but serum specimens were negative for *Leptospira*. *Salmonella sieburg* was isolated from a rectal swab. Many parasite ova and products in coprologic exams were identified. Diagnosis was inconclusive (Johnson and Johnson 1981; Gilmartin et al. 1980). |
| 1979 | *Contracecum* ulceration of a young seal was first reported (Whittow et al. 1979). |
| 1980 | Lung mites from the family Halarechnidae were first reported (Furman and Dailey 1980). |
| 1980 | The Hawaiian monk seal die-off response plan was developed with the support of the Marine Mammal Commission (Gilmartin 1987). |
| 1983 | The Recovery Plan for the Hawaiian Monk Seal addressed the importance of disease investigations (Gilmartin 1983). |
| 1988 | A coprologic survey for parasites was performed from field scats collected in 1985 (Dailey et al. 1988). |
| 1988 | The hematology and serum biochemistry of 12 weaned pups collected between 1984 and 1987 for their rehabilitation in Oahu were reported (Banish and Gilmartin 1988). |
| 1992 | Pathology of 42 seals collected between 1981-85 was summarized (Banish and Gilmartin 1992). |
| 1992 | The FFS relocation of 19 immature seals was initiated. Basic hematology, serum biochemistry, serology for leptospirosis and calicivirus infection, virus isolation, fecal culture for *Salmonella* and coproparasitoscopic examination were performed for their disease evaluation. Two of seven seals died of bacterial and aspiration pneumonia on Oahu, with positive titers to *Leptospira*. Detection of calicivirus by cDNA hybridization probe in 13 seals with viral particles seen by electron microscopy occurred in five seals. It was concluded that endemic disease agents identified in those seals were *Salmonella* and endoparasites (Gilmartin 1993a; Poet et al. 1993). |
| 1993 | Inoculation of four Hawaiian monk seals with a killed virus distemper vaccine was experimentally performed on three seals at the Waikiki Aquarium (Gilmartin 1993b; Osterhaus unpubl. data 1997). |
| 1995 | An eye disease of unknown etiology was first diagnosed in 12 female Hawaiian monk seal pups that were transported to Oahu for rehabilitation. To date the cause remains unknown (NMFS files 1995-97 unpubl. data). |
| 1996 | Histopathology of selected tissues collected from 23 seals between 1989 and 1995 was performed by personnel of the National Wildlife Health Research Center, Honolulu Station (Work unpubl. data 1996). |
| 1997 | Two captive seals died of causes unrelated to the eye disease. One seal was diagnosed with *Clostridium* septicemia and another seal with hepatic sarcocystosis (Yantis et al. 1998). |
| 1997 | The Monk Seal Captive Care Review Panel developed recommendations to evaluate the health assessment and future disposition of 10 captive seals and the future of captive care and release efforts to enhance the recovery of the species (NMFS unpubl. data 1997). |

Source: Aguirre et al. 1999

In April, 2001, an "Unusual Mortality Event[7]" was declared on the basis of four juvenile Hawaiian monk seal deaths within nine days at Laysan Island, a death of a yearling at Midway, discovery of three decomposed carcasses (one subadult, one pup, and two juveniles) and one fresh dead carcass at Lisianski Island, a death of a yearling at FFS, and lethargic, thin juvenile Hawaiian monk seals observed at Laysan and Midway Islands. The relationship of these deaths and observed conditions of the seals is not known at this time (NMFS unpub. data 2001). The Working Group on Unusual Mortality Events (WGUME) reviewed the available information and recommended on February 5, 2002, to close the event. Necropsies and sample analyses have revealed no unusual findings, and there have been no new reports of juveniles exhibiting abnormal behavior or thin body conditions. The WGUME also recommended that measures should be taken so that field teams are fully trained in proper sample collection techniques should any dead seals be found in 2002, to ensure that all possible information can be collected and preserved. The group also recommended performing as many necropsies as possible on fresh carcasses to collect essential data. A report summarizing the event and the results of the subsequent investigation are expected in the near future.

**Reduced Prey Availability:** One of the potential explanations of the poor juvenile survival at FFS from 1989 to the mid-1990s is limited prey availability and subsequent effects on both adults and juveniles. There are two factors related to food that influence weaned pup survival: 1) the amount of food (milk) pups acquire from their mothers prior to weaning and 2) the amount of food available to pups immediately after weaning (G. Antonelis pers. comm. 2000. NMFS-HL). The first factor is related to the mother's condition and ability to forage successfully prior to parturition and may be viewed as an indicator of prey availability during gestation. The second factor is related to the pup's ability to forage successfully after weaning. Evidence of limited prey availability at FFS included small and, in some cases, emaciated pups, juveniles that were smaller and thinner than those at other colonies and delayed sexual maturity of adult females (Craig and Ragen 1999; Marine Mammal Commission 2000).

Further evidence of limited prey availability at FFS has been provided by satellite-linked, time-depth recorders that have been used to track movements and record diving patterns of Hawaiian monk seals at various locations. All but one of the six juvenile and 18 adult Hawaiian monk seals tracked at Pearl and Hermes Reef foraged either within the fringing reef or just outside the reef (Stewart 1998). Most dives were to depths of 8 to 40 m, though there was a secondary mode at

[7]The MMPA defines an Unusual Mortality Event (UME) to be an occurrence which: 1) is unexpected; 2) involves a significant die-off of a marine mammal population; and 3) demands an immediate response. In addition to the above conditions, an immediate response is warranted under two other circumstances: 1) mass stranding of an unusual species of cetacean; and 2) small numbers of a severely endangered species of marine mammal are affected.

100 to 120 m. In contrast, Hawaiian monk seals studied at FFS, where the population of seals is considerably larger, exhibited more variation in their habitat use (Abernathy and Siniff 1998; Parrish et al. 2000; Parrish et al. 2002). Abernathy and Siniff (1998) recorded that the most prevalent pattern, particularly among males, was utilization of the banks to the northwest (some of which are more than 200 km from FFS), with daytime diving in the 50 to 80 m range and a nocturnal or crepuscular shift to the 110-190 m range. The next most common group included seals that did not leave the vicinity of FFS and rarely dived deeper than 80 m. Finally, a small number of seals made many dives greater than 300 m. Abernathy and Siniff (1998) suggested that reduced prey availability could account for the greater variety of foraging patterns at FFS as some individuals are forced to venture to new areas and alter their prey base.

The decrease in prey at FFS may have been the result of large-scale natural perturbations in ecosystem productivity and corresponding or other changes in local carrying capacity for seals at FFS or a combination of factors. From the mid-1970s to late 1980s, the central North Pacific experienced increased vertical mixing, with a deepening of the wind-stirred surface layer into nutrient-rich lower waters and probable increased injection of nutrients into the upper ocean. Resulting increased primary productivity likely provided a larger food base for fish and animals at higher trophic levels. In the NWHI changes of 60 to 100% over baseline levels in productivity for lobsters, seabirds, reef fish and Hawaiian monk seals were observed and attributed to deeper mixing during 1977-1988 (Polovina et al. 1994). The variation in the geographical position of this vertical mixing is in turn related to the position of the Aleutian low-pressure system.[8] As this system deviates from its long-term average position, productivity may be more or less affected in the waters around the NWHI.

Polovina et al. (1994) suggested that the average position of the Aleutian low-pressure system moved northward in the mid- to late-1980s. Thus, the "declines" in productivity observed at Midway and FFS after 1988 may actually represent returns to more "normal," lower levels of productivity (Mundy undated). Productivity may have been most affected at FFS, the southernmost reproductive colony of Hawaiian monk seals (Craig and Ragan 1999). Furthermore, the adverse impact of a return to less productive oceanographic conditions on Hawaiian monk seal reproduction and survival could presumably have been greater at FFS because that island's Hawaiian monk seal population was closer to carrying capacity (Ragen and Lavigne 1999).

Goodman-Lowe (1998) examined inter-island variation in the diet of mature and juvenile Hawaiian monk seals and concluded that Hawaiian monk seals are opportunistic foragers. The

[8]There are also considerable biological data showing higher fish and zooplankton densities in the Gulf of Alaska during the 1970s and 1980s compared to earlier decades, as well as correlations between biological indices and an index of the strength of the Aleutian low-pressure system (Polovina et al. 1995).

fact that seals at FFS were apparently unable to find sufficient prey during the late 1980s and early 1990s suggests the occurrence of a phenomenon capable of affecting the seals' entire prey base. For example, changes in the sizes of NWHI populations of reef fish, a known prey of Hawaiian monk seals (Goodman-Lowe 1998), may be linked to the interdecadal changes in ecosystem productivity in the central Pacific (DeMartini et al. 1996). In 1992-1993, there was a general decrease in reef fish abundance observed at Midway Atoll and FFS. In 1995, however, a dramatic increase in recruitment and availability of reef fish was detected at the two sites (DeMartini and Parrish 1996). No further increase in apparent abundance of reef fish since that time has been found (DeMartini and Parrish 1998), but from the mid- to late-1990s there was an improvement in the condition of Hawaiian monk seal pups at weaning and in pup births at FFS and other major island populations. Trends in pup girth measurements indicate that prey resources may have increased during the early 1990s, most notably at Laysan Island, Lisianski Island and FFS (HMSRT 1999).

Fisheries may also affect the forage base of Hawaiian monk seals. Hawaiian monk seals have the capability to dive to depths at which many species targeted by the bottomfish fishery occur. In addition, Hawaiian monk seals are known to remove hooked bottomfish from handlines and consume them (Nitta 1999). Seals appear to prefer *'ōpakapaka* but will also steal and eat *onaga*, *butaguchi* and *kāhala*. However, the results of dietary studies suggest that these species do not constitute a significant component of the natural diet of Hawaiian monk seals (see Section 3.3.1.3.1).

**Human Interactions:** Human interactions with Hawaiian monk seals range from unintentional disturbances at haul-out sites to inflicting intentional injuries on seals, and include a variety of interactions by scientists and resource managers. Human disturbance was probably the principal cause of Hawaiian monk seal population declines before the 1980s. Between 1958 and the mid-1970s, Hawaiian monk seal colonies at the western end of the archipelago between Kure Atoll and Laysan Island declined by at least 60 percent, and the colony at Midway Atoll all but disappeared (Marine Mammal Commission 1999). Most human activity was concentrated at the westernmost atolls of the chain during this period, suggesting that human disturbance contributed to the decline. The Navy undertook a major expansion of its air facility on Midway Atoll during the 1950s, and in 1960 the Coast Guard established a LORAN station at Kure Atoll that was occupied year-round. Ownership of Midway Atoll was transferred from the Navy to the U.S. Fish and Wildlife Service in 1996, and the atoll is now managed as the Midway Atoll National Wildlife Refuge. The Coast Guard closed the LORAN station at Kure Atoll in 1992 and removed most of the manmade structures by 1993.

The human population at Midway Atoll has decreased substantially in the last two decades, but year-round human habitation of the atoll has continued. From 1996 until 2001, there was limited eco-tourism and public use within the Midway Atoll National Wildlife Refuge in the form of charter boat and shore fishing, diving and wildlife observation. A privately-owned business was awarded a concession to develop and manage the tourist facilities in the refuge. The number of visitors allowed on the atoll at any one time was limited to reduce impacts to wildlife. A dispute between the contractor and the USFWS has suspended the visitor program. Nevertheless, the HMSRT (1999) indicated that it supports the efforts of the USFWS to provide compatible visitor opportunities and educational programs at the refuge. It is also important to note that the Midway Atoll Hawaiian monk seal population has increased since the atoll was transferred to the USFWS. However, some Hawaiian monk seal researchers have expressed concern about the possible long-term impacts of developing Midway Atoll as a tourist destination:

> *Such developments will of course yield benefits to the management bureaucracy, providing continued support for the Fish and Wildlife Service station on the island. It will also ease the logistical problems for scientists who wish to study the animals on the islands, and it will provide an opportunity for public education. But the conservation benefits of tourism for monk seals at Midway will not be measured by the numbers of visitors or their vacation experience, only its effects on the seals. Although these remain to be determined, one can only wonder what would happen if humans simply vacated Midway entirely* (Lavigne 1999:260).

Similarly, NMFS (1997) noted that as tourism ventures develop, so does a potential conflict of interest. The economic success of the venture may depend on the nature and variety of human activities permitted on the island. Importantly, those activities that are intended to enhance the Midway experience may be disruptive or detrimental to the refuge and its wildlife.

As Hawaiian monk seal haul-outs increase in the MHI, human interactions are becoming more frequent (Ragen 1999). Hawaiian monk seals hauled-out on beaches are viewed by tourists and residents who are often unfamiliar with the take prohibitions and/or the normal behavior of Hawaiian monk seals. NMFS receives at least two reports per week of "stranded" Hawaiian monk seals. Some people attempt to haze the animal back into the water. Most often, the animal reported is exhibiting normal haul-out behavior. Another common harassment is people approaching too closely to take photographs of the seal on land or in the water. One female Hawaiian monk seal was intentionally harassed when a resident threw coconuts at it (Henderson pers. comm. 2001). On Kauai, a Hawaiian monk seal was bitten by a pet dog (Honda pers. comm. 2001). Disturbance to Hawaiian monk seals may result in modified behavior making them more susceptible to predators when forced to enter the water or causing an unnecessary expenditure of energy required for thermal homeostasis or catching prey.

Hawaiian monk seal research activities have also inadvertently resulted in some seal mortality. Since 1982, Hawaiian monk seals have been removed from the wild or translocated between locations by the Marine Mammal Research Program (MMRP) of the NMFS-HL as part of research and management to facilitate recovery of the species.

Pups which wean prematurely from their mothers may be in poor condition, and are known to have a minimal probability of surviving their first year. Some of these animals, as well as emaciated juvenile Hawaiian monk seals, have been collected for rehabilitation and release back into the wild. A total of 104 seals (mostly females) have been so taken: 68 were successfully rehabilitated and released into the wild, 22 died during rehabilitation, and 14 were judged to be unsuitable for release and were placed into public aquaria and oceanaria for research. Of the 68 Hawaiian monk seals which were rehabilitated and released from 1984 through 1993, 19 were alive as of 1999. Some of the surviving 19, most of which are located at Kure Atoll, are pupping. However, the precise number of pups born to these released Hawaiian monk seals is unknown (NMFS unpub. data, 2001; Johanos and Baker 2001).

Of the remaining 49 Hawaiian monk seals that were rehabilitated and released, the following information has been gathered: 5 were found dead within one year of release, 29 disappeared within one year of release, and 15 disappeared from 2-11 years after release.

Adult male Hawaiian monk seals have been documented to injure and kill other Hawaiian monk seals, including adult females, immature Hawaiian monk seals of either sex, and weaned pups. Some of the attacks have been made by groups of adult males, while others were by individual males. To reduce injuries and mortalities, NMFS has removed aggressive adult males from some sites. A total of 40 adult male seals have been taken. Thirty-two were translocated to locations distant from the site where the attacks had occurred (21 were moved to the MHI in 1994 and 11 were moved to Johnston Atoll - 9 in 1984 and 2 in 1998). Five were placed into permanent captivity. Two died while being held in temporary pens for translocation. One was euthanized. Although there is no systematic sighting effort for the 21 adult males translocated to the MHI, one sighting was made on Kauai in April, 2001.[9] None of the adult Hawaiian monk seals translocated to Johnston Atoll have been resighted since the year in which they were translocated.

Hawaiian monk seals have been moved between populations for reasons other than mitigation of adult male attacks. A total of ten seals have been so taken; five healthy female weaned pups were translocated from FFS to Kure Atoll in an effort to bolster the population and increase the reproductive potential at Kure, and four healthy seals born in the MHI were translocated, after having weaned, to areas less utilized by humans to minimize the potential of human harassment.

[9]Salt Pond County Beach Park, Kauai. A Hawaiian monk seal with a red tag # 4A0 was reported acting aggressively toward another Hawaiian monk seal (Freeman pers. comm. 2001). That tag number was confirmed by NMFS to be the tag number of an adult Hawaiian monk seal relocated from Laysan in 1994 (Henderson pers. comm. 2001).

Of the five Hawaiian monk seals translocated from FFS to Kure Atoll in 1990, two were known to be alive at Kure as of 1999. Of the four Hawaiian monk seals relocated from sites in the MHI, one was observed alive at Kure Atoll in 1999, two were observed alive on Kauai in 2000, and one that was translocated to Niihau was reported to have been killed sometime after 1994 by a boat propellor, although this report is unconfirmed (Henderson, pers. comm., 2001).

In addition to using unsuccessfully rehabilitated Hawaiian monk seals or aggressive males as captive research animals, some Hawaiian monk seals have been collected from the wild and placed directly into captivity. From 1983 to 1991 a total of four animals were taken; two Hawaiian monk seals were collected from the NWHI, and two Hawaiian monk seals found badly injured in the MHI were treated and placed into permanent captivity (NMFS unpub. data 2001).

In 1995, twelve Hawaiian monk seal pups were taken into captivity by NMFS for the purposes of rehabilitation and eventual return to the wild population. At the time of capture, some of the pups exhibited clinical signs associated with conjunctivitis, red eyes, blepharism, blepharospasm, and photosensitivity. Of the twelve Hawaiian monk seals pups, nine later developed corneal opacities and subsequent cataracts, and one developed cataracts (with no corneal opacities), and two of these total of ten Hawaiian monk seals later died (due to causes unrelated to blindness) (NMFS unpub. data). The remaining 10 Hawaiian monk seals (eight blind and two sighted) were transferred to Sea World of Texas where they are research animals.

The MMRP handles Hawaiian monk seals in the wild as part NMFS' research to monitor the population and facilitate recovery. Takes have included tagging, instrumentation, and sampling for health assessment. The MMRP has handled seals 3,343 times as part of its research activities since 1981. Three seals died during research handling. All three individuals were adult males. Results of necropsies on these seals varied, but in general all three were older seals whose health had been compromised by chronic illness.

Some researchers have expressed concern that continuous human habitation of research field camps in the NWHI could have an adverse effect on Hawaiian monk seals if not carefully controlled (Spalding 2000). Currently, all Hawaiian monk seal research is monitored and regulated under several federal permit systems. An assessment of the possible impact of field research activities on Hawaiian monk seals evaluated 4,800 seals handled between 1982 and 1999 and found no significant deleterious effects on the seals' health or behavior (Baker and Johanos 2000).

There is no evidence of intentional injuries from acts such as clubbing or shooting of Hawaiian monk seals in the NWHI. The MMRP annually monitors all major breeding populations of Hawaiian monk seals, and collects data on any injuries or other events which could affect the survival of individual seals. The program has not documented any injuries or mortalities in the

NWHI that could be attributed to clubbing, shooting, or other intentional wounding of Hawaiian monk seals since the establishment of the Protected Species Zone in 1991 by Amendment 3 to the Pelagics FMP (Johanos and Ragen, 1996a, 1996b, 1997, 1999a, 1999b; Johanos and Baker 2000). Although a Court Order[10] found that intentional acts to Hawaiian monk seals have occurred in the NWHI, ongoing NMFS' monitoring of Hawaiian monk seal populations indicates that intentional acts in the NWHI have not occurred since the late 1980's.

**Tern Island Sea Wall Entrapment:** Hawaiian monk seals at Tern Island, FFS, have been entrapped behind a deteriorating sea wall. During World War II, the Navy enlarged Tern Island, one of several small islets at FFS, from its original 4.5 hectares (11 acres) to about 16.2 hectares (40 acres) to accommodate a landing strip (Marine Mammal Commission 1999). To do so, the Navy constructed a sheet metal bulkhead around most of the island and backfilled behind the structure with dredged spoil and coral rubble from the surrounding lagoon. The Coast Guard took over the island from 1952 to 1979 to operate a LORAN station. Since then, it has been used by the U.S. Fish and Wildlife Service as a field station for the Hawaiian Islands National Wildlife Refuge.

The continued existence of the runway and field station at Tern Island – in fact, the integrity of the entire island – is in doubt because the sheet metal bulkhead, now more than 50 years old, is badly deteriorated (Marine Mammal Commission 1999). If the bulkhead fails, the airstrip would be lost, the field station would have to be abandoned, most of the island would erode away, buried debris would be exposed and create entanglement hazards to wildlife, and erosion pockets behind the rusted-out seawall would become serious entrapment hazards for Hawaiian monk seals and other wildlife. Since recordkeeping began in 1988, a number of Hawaiian monk seals have been entrapped behind the seawall (Table 3-7). Most of these Hawaiian monk seals have been redirected to the water by FWS and NMFS personnel. Two subadult male Hawaiian monk seals have died as a result of becoming entrapped behind the sea wall.

**TABLE 3-7: Incidence of Hawaiian Monk Seal Entrapments and Deaths on Tern Island from 1988-2000**

| # | YEAR | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| E | 1 | 3 | 1 | 6 | 4 | 2 | 3 | 3 | 0 | 0 | 5 | 4 | 4 |

[10]The Order Granting in Part and Denying In Part Plaintiffs' Motion for Summary Judgement, Granting in Part and Denying in Part Defendants' Cross-Motion for Summary Judgement, and Granting in Part Plaintiffs' Motion for a Permanent Injunction Motion for Summary Judgement in Greenpeace Foundation, *et. al.*, v. Norman Mineta, *et. al.* Civil No. 00-00068SPKFIY. U.S. District Court of Hawaii, November 15, 2000, p. 30.

| # | YEAR | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| M | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Notes: E - entrapped; M - mortalities; Source: USFWS 2001

In 1999, the U.S. Fish and Wildlife Service received $1 million as an initial investment for sea wall construction at Tern Island. The total cost of the project is estimated to be about $15 million (Marine Mammal Commission 1999). At the 123rd Council meeting (June 21-24, 2004), the USFWS reported that the project began in March 2004 and is 35% complete, focused on the most damaged and vulnerable sections. NMFS has conducted an ESA Section 7 consultation on the project and, together with the FWS, has devised monitoring and other measures designed to avoid any take by harassment or otherwise of Hawaiian monk seals and other protected species during the construction activities. The completed restoration of the sea wall is expected to eliminate any future entrapment hazards to Hawaiian monk seals and turtles (USFWS 2001).

**Contaminants:** Contaminants in the marine and terrestrial environment also pose a potential but unknown risk to monk seal recovery and survival. Effects on monk seals are unknown at this time. The analysis of tissue samples from monk seals at FFS indicate that PCB levels and specific forms (congeners) known to be toxic are lower than other pinnipeds, and the values at FFS are below similar samples obtained from monk deals at Midway Islands (MNFS unpub. Preliminary data, 1999). The significance of these levels to monk seals health is unknown at this time. However, the ecological effects of contaminant clean-up operations at Tern Island (FFS), Johnston Atoll, and Midway Island may have short-term adverse effects on the surrounding corals, fish and invertebrates if an exposure event were to occur. Reductions in prey abundance due to clean-up efforts could reduce foraging success and survival rates of monk seals near these areas.

**Fisheries:** Several fisheries operate or have operated in the areas utilized by the Hawaiian monk seal. Some of the fisheries are federally managed. These are: the bottomfish fishery, the pelagic longline fishery (transit only), the crustacean fishery (currently suspended), and the deep water precious corals fishery (no participants currently). Other fisheries that operate in areas utilized by the Hawaiian monk seal include fisheries managed by the State of Hawai'i. These fisheries include the state-managed MHI bottomfish fishery, commercial and recreational nearshore fisheries (including gillnet fisheries), recreational *ulua* fishery, coastal *opelu* and *akule* fisheries, and collection for the aquarium trade.

The Hawai'i-based pelagic longline fishery targets pelagic species of tunas and swordfish. Under the Fishery Management Plan for the Pelagic Fisheries in the Western Pacific Region (Pelagics

FMP), NMFS permits up to 164 vessels, but only about 100 vessels have been active during the past two years.

There was some evidence in the early 1990s that longline operations were adversely affecting the Hawaiian monk seals, as indicated by the sighting of a few animals with hooks and other non-natural injuries. Amendment 2 to the Pelagics FMP required longline permit holders to notify NMFS if intending to fish within 50 miles of any NWHI and required all vessel operators to attend a training session. These measures were later deemed insufficient. In 1991, Amendment 3 established a permanent 50-mile Protected Species Zone around the NWHI that closed the area to longline fishing. Establishment of this zone appears to have eliminated Hawaiian monk seal interactions with the longline fleet. Since 1993, no interactions with Hawaiian monk seals in the pelagic longline fishery have been reported. Longline observers recorded only one sighting of a Hawaiian monk seal during transit through the Protected Species Zone near Nihoa Island in 1995 (NMFS unpubl. data).

The NWHI lobster fishery is managed under the Fishery Management Plan for the Crustacean Fisheries of the Western Pacific Region (Crustaceans FMP). The lobster fishery began in the 1970s and annual landings peaked at 1.92 million lobsters in 1985. Since then, landings have decreased. The number of vessels participating in the lobster fishery has ranged from 0 to 17, with only five and six vessels participating during 1998 and 1999, respectively (A. Katekaru pers. comm. 2001. NMFS-PIRO).

Historically, effort has been concentrated near the islands and atolls of the NWHI where Hawaiian monk seals occur. Observer reports[11] show no Hawaiian monk seal entanglements or other interactions. However, in 1986 near Necker Island, one Hawaiian monk seal died as a result of entanglement with a bridle rope from a lobster trap. In 1983 a precautionary measure was taken to redesign the entrance cone to ensure that Hawaiian monk seals could not get caught in lobster trap entrances.[12]

Lobster is a known prey item of the Hawaiian monk seal, but the importance of lobster in their diet has not been quantified. Ongoing foraging and prey identification studies will help understand the effect, if any, of the lobster fishery on Hawaiian monk seal populations in the NWHI.

[11]The lobster fishery was "observed" on a voluntary basis starting in 1997. NMFS scientific data collectors were dispatched on each of the lobster trips during 1997 through 1999. In 2000 and 2001 the lobster fishery was closed.

[12]Plastic dome-shaped single-chambered traps with two entrance funnels or cones located on opposite ends are employed in the lobster fishery. All traps are required to have escape vents (for smaller lobster). The traps are usually set in strings of about one hundred, with several strings fished at a time.

The lobster fishery was closed in 1993 based on the harvest quota set for the fishery under Amendment 7 of the Crustaceans FMP. The fishery re-opened in 1994 with five vessels participating in the fishery. In 1995 the fishery was again closed; however, one vessel was allowed to fish under an experimental fishing permit issued by NMFS to obtain scientific information on the lobster stock. From 1996 through 1999 the fishery had five, nine, five, and six vessels participating, respectively. Although the lobster fishery was not overfished, NMFS closed the fishery in 2000 through 2001 because of an increased level of uncertainty in the model assumptions used to estimate the lobster harvests (65 FR 39314). Harvest guidelines for the 2001 through 2004 fisheries were not issued by NMFS (66 FR 11156, Feb. 22, 2001; 67 FR 11678, March 15, 2002; 68 FR 8490, Feb. 21, 2003; 69 FR 12303, March 16, 2004).

Precious corals are harvested under the Fishery Management Plan for Precious Corals Fisheries of the Western Pacific Region (Precious Corals FMP). NMFS has determined that the harvest would not adversely affect the Hawaiian monk seal (NMFS 2000). Regulatory changes to the Precious Corals FMP recommended by the WPRFMC in 2000 are intended to, among other things, protect precious coral beds that provide foraging habitat for some Hawaiian monk seals in the NWHI (65 FR 53692).

The contribution of coral beds to prey aggregation and prey availability for Hawaiian monk seals remains unclear. As discussed previously, Hawaiian monk seal diet studies indicate that Hawaiian monk seals are opportunistic and feed on a wide variety of prey (Goodman-Lowe 1998). Research from Parrish et al. (in press) and Abernathy and Siniff (1998) indicate that some seals forage at depths where precious coral beds occur. However, the absence of deep diving activity at Pearl and Hermes Reef suggests that Hawaiian monk seals at FFS may vary their foraging behavior depending on the availability of prey resources.

Until recently, a U.S. Fish and Wildlife Service concessionaire operated an ecotourism station at Midway Island. Recreational fishing was allowed in the lagoon and waters around the island. No adverse interactions (e.g., entanglements or hookings) with Hawaiian monk seals in this recreational fishery have been reported. However, a study conducted in 1998 recorded Hawaiian monk seal interactions at six locations during fishing activities (Bonnet and Gilmartin 1998). Inquisitive, newly weaned pups sometimes approach fishing activities, presumably to investigate human activity (Shallenberger pers. comm. 2001. FWS). However, three Hawaiian monk seals were reported to have been hooked as a result of recreational fishing during the operation of the U.S. Coast Guard station at Kure Atoll, which closed in 1993 (Forney et al. 2000).

In the MHI, the state-regulated bottomfish fishery operates off-shore of shoreline areas where Hawaiian monk seals are sometimes observed. There have been no reported interactions between Hawaiian monk seals and this fishery. Some areas off-shore of regularly utilized Hawaiian monk seal haul-out areas have been closed to bottomfish fishing operations due to concerns about local depletion.

The fisheries for big game (*ulua*) and small game (*papio* and other smaller fish) are two of the largest components of the shore-based recreational fisheries in Hawaii. The term *ulua* mainly refers to two species: the white *ulua* (*Caranx ignobilis*) and the black *ulua* (*C. lugubris*). *Ulua* can also be used to refer to any larger *Caranx* (ten or more lbs). The term *papio* can refer to *Caranx ignoblis* and *C. lugubris* under 10 lbs as well as to six to eight other smaller Carangids commonly found in near-shore waters. The two fisheries differ more in the gear used than the target species. Any of the species can be and are taken in both fisheries. The two predominant fishing methods employed are the "slide-bait" and "shore casting" fisheries.

Big game shorefishing, primarily targeting large *ulua* (jacks), usually utilizes slide-baiting techniques. Slide bait rigs have a large hook tied or crimped to a short length of wire or heavy monofilament leader which is in turn tied or crimped to a "slide bait" swivel. The slide-bait fishery almost exclusively employs circle hooks of sizes corresponding to Mustad #14/0 and larger. This leader and hook set up is independent of the wired weight set up. These two independent sets of gear combine to make a whole slide bait rig. The weight is cast out and anchored before the slide bait hook rig is attached to the mainline and allowed to "slide" down and out to its final fishing position. The preferred baits are moray eels, "white eel" or "tohei" (conger eel), and octopus. Live reef fish of all kinds are also among the preferred baits.

The mainline (line on the fishing reel) used in slide baiting varies according to the individual, but is generally heavy line in the 80-100 lb plus test weight. The fishing weights generally have 4-5 inch soft wires extending from the terminal end. These wires are bent into a grapnel shape to snag onto rocks and coral to provide a solid anchoring point from which to suspend the large baits off the bottom and prevent the rig from moving with the current or swell. The limited movement prevents tangling with other rigs. The wires used are malleable enough to be straightened with pressure from the rod. The line connecting the weight to the swivel is of a lesser strength than the mainline and designed to break should the weight become inextricably stuck on the bottom.

Small game fishing uses a rig in which a hook(s) and lead is attached to a swivel and is cast as a single unit. It uses smaller hooks and lighter leaders. The major differences between big game fishing and small game fishing are the kind of rig used, the size of the gear, and the general kinds of areas that are preferred by each. The slide-bait fishery is generally associated with close proximity of deep water (20-100 ft) because the technique depends on gravity or the live bait to take the bait down the mainline to the strike zone. Shorecasting for small game is done anywhere along the shoreline.

The third shore based fishery is locally referred to as "whipping." Whipping involves standing on the shore, usually a rocky area, and casting and quickly retrieving an artificial lure into breaking waves headed towards shore. The lure usually has treble or double hooks attached. Fishing line in the 20-50 lb test weight range is commonly used in this fishery. Often the leader, the first few feet of line directly attached to the lure, is a thicker line for protection from chafing on the fish's teeth or the reef and rocks. Whipping is also successfully done from boats.

*Ulua* are also fished from boats. A variety of gear may be employed; typical are the trolling set-up, with down riggers or trolling planes, and surface plugs or casting jigs. Artificial lures, e.g., plugs and lead-head jigs, are used just outside the breaking surf.

The gear used in these recreational fisheries varies, but the most popular gear composition is a circle hook with a slide bait swivel on a wire leader. There is some overlap with the type of hook used (circle hooks) in the bottomfish fishery although the size of the *ulua* circle hook tends to be larger than that used in the bottomfish fishery. Some of the hooks embedded in Hawaiian monk seals have been identified as gear used in the state *ulua* fishery based on gear, size of hook, and location of the Hawaiian monk seal when discovered, while other hooks have been identified as bottomfish fishery hooks. Table 3-8 compiles all available information of Hawaiian monk seal hookings and net entanglements from all fisheries. Table 4-1 in Section 4.1.3.1.1 extracts those incidents that may be attributable to the bottomfish fishery. There is only one report of a hooking of a Hawaiian monk seal on bottomfish gear being actively fished.

## TABLE 3-8: Opportunistically Observed Hawaiian Monk Seal Entanglements in Fishing Gear

| DATE AND LOCATION | DESCRIPTION | OUTCOME |
|---|---|---|
| 1976 MHI - Kauaʻi | Seal drowned in nearshore gillnet | Mortality |
| 1982 FFS | Adult female was observed with bottomfish hook in mouth. | Resighted without hook at FFS. |
| 1985 NWHI - Kure Atoll | Female weaned pup hooked in lip. | Hook removed by NMFS personnel; small hook and rig characteristic of on-site recreational fishery. |
| 1986 NWHI - Necker | Monk seal caught in bridle rope of lobster trap. | Carcass not retrieved |
| 1990 MHI - Kauaʻi | Juvenile observed with hook. | NMFS response included capture and hook removal. Hook identified as type used in the *ulua* shore-based fishery. |
| 1991 NWHI - FFS | Adult male observed with hook, trailing monofilament line, in chest. | Hook removed,. Reported to be a longline hook. |
| 1991 NWHI - FFS | Adult male observed with hook, trailing monofilament line, in lower jaw. | Hook removed. Reported to be a longline hook. |
| 1991 NWHI - Kure Atoll | Weaned female pup observed with hook in lip. | NMFS personnel captured seal and removed hook. Hook was small, characteristic of on-site recreational fishery. |
| 1991 NWHI - Kure Atoll | Subadult female observed with hook in corner of mouth. | Seal subsequently seen without hook; hook never recovered or identified. |
| 1993 MHI - Kauaʻi (Kipu Kai Ranch) | Adult male observed with ulua hook, trailing monofiliament line and swivel, in mouth | Seal later seen to have lost hook without intervention. |
| 1994 NWHI- FFS | Pregnant female with hook. | Hook stated by observers to be a swordfish fishery hook. No confirmation of report. |
| 1994 NWHI | Seal reported taken and released injured. | Reported in longline logbook. |
| 1994 MHI, Kauaʻi | Seal observed with hook, trailing monofilament line, in mouth. | Outcome unknown. |

| DATE AND LOCATION | DESCRIPTION | OUTCOME |
|---|---|---|
| 1994 MHI - O'ahu | Dead seal found entangled by gillnet off Waianae. | Necropsy conducted, condition of lungs consistent with drowning. |
| 1994 NWHI-"No Name Bank" | Active hooking of adult seal during bottomfishing; seal had stolen catch and had become hooked. | Fisherman pulled seal to boat and cut leader 12"-18" from the seal. |
| 1995 MHI - Kaua'i (Hanama'ulu Bay) | Juvenile male found dead, necropsy revealed fishhook in lower esophagus. | Mortality; hook was a "slide rig" characteristic of shore-based *ulua* fishery. |
| 1996 MHI - O'ahu (Ala Moana Beach) (first sighted on Maui) | Adult male observed with hook in base of tongue. The seal was identified as a seal that had been translocated from Laysan Island, NWHI. | Hook removed by NMFS. Hook identified as from slide rig, shore based *ulua* fishery. |
| 1996 NWHI - FFS | Adult male observed with hook in mouth. | Independent researchers identified hood as ulua or bottomfish hook. No identifying gear attached to hook. |
| 1996 MHI - Maui | Adult hooked during fishing tournament. | Cut loose, probably with hook in mouth or jaw. |
| 1996 MHI Oahu | Weaned male pup born on Kaneohe Marine Corps Base observed with 1" long hook in foreflipper. | Hook removed by bystander; hook not retained. |
| 1998 MHI - Maui (Hana) | Hooked seal reported to NMFS; Juvenile female. Observers stated it was a #7 or #9 *ulua* hook. | NMFS response included capture and physical exam, No hook was found, but some minor trauma was observed in mouth where hook had been present. |
| 2000 MHI - Moloka'i | Juvenile male observed with 2 hooks and line embedded in chest (ventral) area. | NMFS response included capture and physical exam of seal. No hooks or line present, but slight injury was documented by veterinarian. |
| 2000 MHI - Kaua'i (Ha'ena Beach) | Adult female observed with hook in mouth. | NMFS response included capture and hook removal. Hook identified as type used in the *ulua* shore-based fishery. |
| 2001 MHI - Kaua'i (Maha'ulepu Beach) | Juvenile female with hook in lower lip and base of jaw. | Hook removed by DLNR personnel. Hook and leader determined to be from shore casting ulua fishery. |
| 2001 MHI - Kaho'olawe | Adult male with hook, trailing line, in abdomen or front flipper. | Sightings ceased. Seal disappeared or hook lost. |

| DATE AND LOCATION | DESCRIPTION | OUTCOME |
|---|---|---|
| 2001 MHI - Hawai'i (South Point) | Weaned pup from Kau area reported hook on back. | NMFS dispatched personnel but could not locate seal. Seal later located when hooked in lip and showed no signs of hook injury to back. |
| 2001 MHI - Hawai'i (South Point) | Weaned pup from Kau hooked in lip. | NMFS removed hook; Hook identified as type used in the *ulua* shore-based fishery. |
| 2002 MHI - O'ahu (Makua) | Seal tangled in nearshore gillnet. | Seal released by recreational divers. |
| 2002 MHI - Kaua'i | Seal hooked in neck, line trailing. | DLNR sighted seal. |
| 2002 MHI - O'ahu (Ewa) | Seal hooked in lower lip, steel leader trailing. | NMFS removed hook, *ulua* slide rig. |
| 2003 MHI Kaua'i (Kapa'a) | Seal hooked in back corner of mouth training lightweight monofilament. | NMFS removed hook; gear characteristic of *sabiki* rig. |
| 2003 MHI - Kaua'i (Poipu) | Seal hooked in mouth, trailing line. | NMFS contractor cut part of trailing line; seal observed 2 weeks later without hook. |
| 2003 Molokai (La'au Pt.) | Seal hooked in mouth outside mandible. | Fisherman pulled in seal and cut line; NMFS removed hook 2 weeks later; *ulua* slide rig. |
| 2003 MHI - Kaua'i (Poipu) | NMFS contractor notified that shorecasting fisherman had hooked seal. | Fisherman cut line; no subsequent sightings of hooked seal. |
| 2003 MHI - Kaua'i (Ahukini Pier) | Multiple reports to NMFS of *kawakawa* fisherman hooking seal in mouth/lip. | Fisherman cut line; no subsequent sightings of hooked seal. |
| 2004 MHI Kaua'i (Kapa'a) | Seal hooked in lower lip by hook still baited with squid. Hook training leader which subsequently became caught on nearshore gillnet (see below). | Fisherman cut line. |
| 2004 MHI Kaua'i (Kapa'a) | Seal entangled in nearshore gillnet; point of entanglement was monofilament leader from incident above. | Fisherman cut net, releasing seal; later in day NMFS removed hook, leader, and net fragment. |

| DATE AND LOCATION | DESCRIPTION | OUTCOME |
|---|---|---|
| 2004 MHI Kaua'i (Larsen's) | Seal ingested hook and slide rig. | NMFS captured seal and surgically removed hook/rig; seal recovered and was released. |
| 2004 MHI - Kaua'i (Poipu) | Seal hooked in mouth. | NMFS capture attempt failed; seal later observed to have lost hook. |
| 2004 MHI - O'ahu (Mokuleia) | Seal observed by camp counselor with hook in lip; reported to NMFS. | No subsequent sightings of hooked seal. |

Source: NMFS unpub. data 2004 (J. Henderson, PIFSC, pers. comm.)

NMFS researchers and veterinarians have responded to some of the above reports and have treated the Hawaiian monk seals and provided descriptions of the wounds caused by the hook. Based on these descriptions and outcome (when known), the injuries sustained by Hawaiian monk seals from embedded hooks have been classified into injuries or serious injuries. An embedded hook was considered a serious injury if it hooked in the mouth deeper than the lip. Thus, hooks embedded inside the mouth, in the tongue, the mandible or upper jaw, throat, or deeper are classified as serious injuries, whereas "lip hookings" and other shallow embedded hooks are considered nonserious. The rationale for this division is that foraging would likely be impeded by the serious injuries. Hooks embedded in the lip or shallowly embedded hooks in other body areas would most likely fall out and would not impair feeding or other activities. Considering the information available, the above classification approach is consistent with the views expressed by researchers and veterinarians in a workshop held to discuss the serious injury guidelines.[13]

**Marine Debris:** Marine debris, particularly derelict fishing nets, poses a serious risk of injury and death to Hawaiian monk seals. The inquisitive nature of seals, particularly pups and juveniles, tends to make them attracted to debris. Subsequent interactions can lead to entanglement and, unless they are able to free themselves quickly, entangled seals risk drowning or death through injuries caused by the entangling gear. Between 1982 (the year NMFS first began to collect information on marine debris entanglement) and 2000 a total of 204 entanglements were documented. In 1999, a record 25 Hawaiian monk seals were reported to have been found entangled in marine debris (HMSRT 1999). Most of the net debris in the NWHI appears to be trawl webbing. Although its origin is unclear, no trawl or gillnet fishing occurs in the NWHI, and it is assumed that virtually all of this debris has been transported by ocean

[13]"Injury of pinnipeds: A brief discussion of injuries reported for pinnipeds indicated that an animal hooked in the mouth (internally) or trailing gear should be considered seriously injured. Some participants felt that an animal hooked in its body would likely not be seriously injured." (Differentiating Serious and Non-Serious Injury of Marine Mammals Taken Incidental to Commercial Fishing Operations: Report of the Serious Injury Workshop held in Silver Spring, MD, April 1-2, 1997).

currents from distant fisheries around the rim of the North Pacific Ocean (Marine Mammal Commission 2000).

In 1998, NMFS organized a multi-agency cleanup effort to remove derelict fishing nets and other debris from the reefs surrounding FFS and Pearl and Hermes Reef. NMFS was able to remove only a small proportion of this debris and estimated that 38,000 pieces of netting remained in the waters surrounding each of these locations (Marine Mammal Commission 2000). In 1999 the NMFS-HL led a multi-agency effort to survey and remove derelict fishing gear from Lisianski Island and Pearl and Hermes Atoll (Donohue et al. 2001). Reef debris density ranged from 3.4 to 62.2 items/km$^2$. Fourteen tons of debris were removed from these two islands. The 2000 data include the first examination of marine debris at Kure Atoll, as well as estimations of accumulation rates at Lisianski Island and Pearl and Hermes Atoll. These three locations were resurveyed in 2001 allowing refinement of accumulation rate estimates. Additionally, in 2001 a fleet of three chartered vessels again worked to clean the reefs around Kure Atoll and Pearl and Hermes Atoll. About 62 tons of debris was removed from the two sites, with Kure essentially cleaned of derelict fishing gear during this effort (Laurs 2002). These efforts continued in 2002 and 2003, and are underway in the summer of 2004. To date, five sites have been surveyed: FFS, Lisianski Island, Pearl and Hermes, Kure and Midway Atolls. Approximately 330 tons of marine debris have been removed from NWHI reefs during these surveys. Net samples collected from the NWHI between 1998 and 2002 were about 86% trawl/seine nets. These types of fisheries do not exist in Hawaii, and it is presumed that this debris originates in various fisheries in the northern Pacific. Gillnet made up about 8% of the total. Longline gear comprised about 1.4%.

Information on marine debris entanglement and injuries, including mortalities, has been collected by NMFS since 1982, and is summarized in the Biological Opinion for the bottomfish fishery (Appendix H). Seven categories of debris were defined: nets (of fishery origin), lines or ropes (not necessarily of fishery origin), net/line combinations (of fishery origin), cones (from hagfish traps), rings (circular items of unknown origin), plastic packing straps (of fishery and non-fishery origin), and other /unknown. A total of 204 entanglements was documented, 96 by fishery items (5.05 per year), 96 by non-fishery items (5.05 per year), and 12 by unknown items (0.64 per year). From the total number of entanglements, 47 serious injuries were documented, including 27 by fishery items (1.42 per year), 8 by non-fishery items (0.42 per year), and 12 by unknown items (0.64 per year). Seven mortalities from entanglement were documented: 6 from fishery items (0.32 per year) and 1 from a non-fishery item (0.05 per year) (Table 3-9). Five of the six debris-related mortalities were caused by trawl netting and the other from unidentified line. Trawl fishing does not occur in areas under Council jurisdiction. Assigning the unknown items to either the fishery or non-fishery categories on a proportional basis results in a minimum estimated rate of 2.48 serious injuries and mortalities per year attributable to fishery-related marine debris.

**TABLE 3-9: Known Marine Debris Related Monk Seal Mortalities: 1982-2000**

| YEAR AND LOCATION | DESCRIPTION |
|---|---|
| 1986– FFS | Weaned male tangled in wire which was relic of USCG or Navy occupation; in water |
| 1987–Lisianski Is. | Pup (uncertain if nursing or weaned) dead in aggregate of trawl net and line on shore |
| 1987–FFS | Juvenile dead in aggregate of trawl net and line on shore |
| 1988–Lisianski Is. | Weaned pup dead in large trawl net on shore |
| 1995–Pearl and Hermes Reef | Bones of adult found scattered in line awash on shore |
| 1997-FFS | Subadult dead in trawl net on reef |
| 1998–Laysan Island | Weaned pup dead in trawl net on nearshore reef |

Source: NMFS unpub. data 2001

**Vessels:** Hawaiian monk seals may be injured by collisions with vessels or indirectly by vessel groundings that result in the release of hazardous or toxic chemicals or gear that creates an entanglement hazard. Collisions are much more likely with small high-powered vessels. For example, a pup born at the Pacific Missile Range Facility on Kauai was reported dead in 1999. There was an anonymous and unconfirmed report that the pup may have been hit by a zodiac-type vessel employed in the tourist industry.

In August 1998, Tesoro Hawaii Corporation tanker offloading operations resulted in a spill of about 5,000 gallons of bunker fuel off Barber's Point, leeward O'ahu. The waters and shoreline of Kaua'i were affected, and oiled Hawaiian monk seals were reported in the area. During September 1998, up to five oiled Hawaiian monk seals were observed. One Hawaiian monk seal had its entire oral mucosa coated with red, blood-like fluid. This Hawaiian monk seal was later resighted and exhibited signs of a respiratory infection. Another Hawaiian monk seal exhibited "gagging behavior." As there were no physical exams conducted on the animals observed, the wildlife resource agencies could not reach a conclusion about the effects of the oil on the Hawaiian monk seals (Natural Resources Trustees 2000).

In April 1999, a longline vessel (*F/V Van Loi*) grounded on a reef off of Kapa'a, Kaua'i. The vessel had 6,000 gallons of diesel fuel on board and was carrying three tons of bait and gear. All fuel, bait and gear (including monofilament line and hooks) went overboard into the marine environment. Monk seals and sea turtles were observed in the area, but no adverse interaction with fuel or gear was reported by wildlife resource managers on scene.

3.3.1.4 Other Pinniped: The Northern Elephant Seal

Although uncommon in the action area of the bottomfish fishery, the northern elephant seal (*Mirounga angustirostris*) has been observed in the MHI and the NWHI. In 2002 a yearling appeared on the island of Hawaiʻi, was captured, and transported to the Marine Mammal Center in California for rehabilitation and reintroduction to the wild.

Although this species may occasionally be found within the action area and could interact with the U.S. fisheries of the Western Pacific Region, no reported or observed incidental takes of this species have occurred in the bottomfish fishery. There is no current expectation of future interactions between this species and the bottomfish fishery and therefore, this species will not be considered further in this document.

### 3.3.2 Sea Turtles

All sea turtles are designated as either threatened or endangered under the Endangered Species Act. The five species of sea turtles known to be present in the region in which bottomfish vessels operate are: the leatherback (*Dermochelys coriacea*), the olive ridley (*Lepidochelys olivacea*), the hawksbill (*Eretmochelys imbricata*), the loggerhead (*Caretta caretta*), and the green turtle (*Chelonia mydas*).

Leatherback turtles and hawksbill turtles are classified as endangered. The breeding populations of Mexico olive ridley turtles are currently listed as endangered, while all other olive ridley populations are listed as threatened. The loggerhead turtles and the green turtles are listed as threatened (note that the green turtle is listed as threatened under the ESA throughout its Pacific range, except for the endangered population nesting on the Pacific coast of Mexico).

Leatherbacks have the most extensive range of any living reptile and have been reported circumglobally from latitudes 71°N to 42°S in the Pacific and in all other major oceans. The diet of the leatherback turtle generally consists of cnidarians (i.e., medusae and siphonophores) in the pelagic environment. They lead a completely pelagic existence, foraging widely in temperate waters except during the nesting season, when gravid females return to beaches to lay eggs. Typically, leatherbacks are found in convergence zones and upwelling areas in the open ocean, along continental margins, and in archipelagic waters.

The loggerhead turtle is a cosmopolitan species found in temperate and subtropical waters and inhabiting continental shelves, bays, estuaries and lagoons. Major nesting grounds are generally located in warm temperate and subtropical regions, generally north of 25°N or south of 25°S latitude in the Pacific Ocean. For their first several years of life, loggerheads forage in open ocean pelagic habitats. Both juvenile and subadult loggerheads feed on pelagic crustaceans, mollusks, fish and algae. As they age, loggerheads begin to move into shallower waters, where, as adults, they forage over a variety of benthic hard and soft bottom habitats.

The olive ridley is one of the smallest living sea turtles (carapace length usually between 60 and 70 cm) and is regarded as the most abundant sea turtle in the world. Since the directed take of sea turtles was stopped in the early 1990s, the nesting populations in Mexico seem to be recovering, with females nesting in record numbers in recent years. The olive ridley turtle is omnivorous and identified prey include a variety of benthic and pelagic items such as shrimp, jellyfish, crabs, snails and fish, as well as algae and sea grass.

The hawksbill turtle is rapidly approaching extinction in the Pacific, primarily due to the harvesting of the species for its meat, eggs and shell, as well as the destruction of nesting habitat. Hawksbills have a relatively unique diet of sponges.

Green turtles in Hawai'i are genetically distinct and geographically isolated which is uncharacteristic of other regional sea turtle populations. Both nesting and foraging populations of green turtles in Hawai'i appear to have increased over the last 20 years. In Hawai'i, green turtles nested historically on beaches throughout the archipelago, but now nesting is restricted for the most part to beaches in the NWHI. More than 90% of the Hawaiian population of the green turtle nests at FFS. Satellite tagging of these animals indicates that most of them migrate to the MHI to feed and then return to breed. The four other species of sea turtles are seen in the waters of the NWHI only on rare occasions.

### 3.3.3 Seabirds

Although there are several seabird colonies in the MHI, the NWHI colonies harbor more than 90% of the total Hawaiian Archipelago seabird population. The NWHI provide most of the nesting habitat for more than 14 million Pacific seabirds. More than 99% of the world's Laysan albatross (*Phoebastria immutabilis*) and 98% of the world's black-footed albatross (*P. nigripes*) return to the NWHI to reproduce. Of the 18 species of seabirds recorded in the NWHI, only the short-tailed albatross (*P. albatrus*) is listed as endangered under the ESA. The short-tailed albatross population is the smallest of any of the albatross species occurring in the North Pacific. Land-based sighting records indicate that 15 short-tailed albatrosses have visited the NWHI over the past 60 years. Five of these visits were between 1994 and 1999 (NMFS 1999).

### 3.3.4 Value of Threatened and Endangered Species

Most of the information in this section pertains only to the value of the Hawaiian monk seal, as it is the potential interaction between this endangered species and the bottomfish fishery that was identified as a particular environmental concern during scoping (Section 1.2).

### 3.3.4.1 Categories of Economic Values

Preserving an environmental asset such as an ecosystem or particular species may generate a range of potential benefits for humans. The Endangered Species Act acknowledges this fact with respect to the preservation of wildlife, noting that at-risk species "...are of aesthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people... ." (Sec. 2(a)(3)). Resource economists have developed a similar taxonomy of wildlife preservation values, although there are divergent opinions in the definitions of some benefits. Moreover, categories of benefits within a given list may overlap. Typically, economists divide the total value an environmental asset may generate into use values and non-use values. Use values are generated when management decisions affect the enjoyment people get from current use of the environmental asset. They involve either *in situ* contact with the resource in question or personal consumption of products derived from the resource (Bishop 1987). Use values include consumptive values, non-consumptive use values, indirect use values and option values (Table 3-10). Consumptive direct use values can be subdivided into commercial value if the purpose of the extractive activity is to sell products to others; recreational value if the purpose is recreational enjoyment; and subsistence value if the purpose is to provide one's family, or others, with food and no remuneration is involved.

Non-use values, also referred to as passive-use values, may include bequest or existence values (Table 3-10). These values do not involve personal consumption of derived products nor *in situ* contact. They are generated when management decisions impinge on people's inter-generational altruistic concerns or affect the utility people receive from simply knowing that a particular asset exists or is being preserved (Bishop 1987).

**TABLE 3-10: Categories of Economic Values Attributed to Environmental Assets Such as a Species or Ecosystem.**

| ECONOMIC VALUE | DESCRIPTION |
|---|---|
| Consumptive direct use value | Value derived from extractive activities |
| Non-consumptive direct use value | Value gained through activities such as observing a species or ecosystem |
| Secondary value | Value obtained by viewing or hearing about a species or ecosystem via a communication medium |
| Scientific value | Value stemming from new information about medicine, genetics or other areas of scientific research resulting from the study of a species or ecosystem |

| ECONOMIC VALUE | DESCRIPTION |
|---|---|
| Indirect value | Value of the ecological functions and services of a species or ecosystem that indirectly provides support and protection to people, economic activity and property |
| Option value | The premium that individuals are willing to pay for retaining an option for future use of a species or ecosystem |
| Quasi-option value | Value of additional information on which to base decisions about preserving a species or ecosystem |
| Bequest value | Value derived from the knowledge that a species or ecosystem will be preserved for future generations |
| Existence value | Value emanating from the satisfaction of just knowing that a particular species or ecosystem survives in a natural state |

Sources: Cocheba 1987; Mendelsohn 1985; Mitchell and Carson 1989; Pearce and Moran 1994; Randall 1986

Option and quasi-option values exist under conditions of uncertainty about the future demand and availability of an environmental asset or uncertainty about the future benefits of preserving the asset. The application of these values will tend to support postponement of a management decision if the possible negative effects of the decision are irreversible. For example, recovery from a decision that results in extinction of a species is not possible. The foregone benefits of that species will effectively be irreplaceable and further benefits that are as yet unknown or not well understood, will be lost. The MSA implicitly acknowledges the significance of option and quasi-option values by stating that the term conservation and management refers, in part, to measures designed to assure that "...irreversible or long-term adverse effects on fishery resources and the marine environment are avoided; and there will be a multiplicity of options available with respect to future uses of these resources...." (Sec. 3(5)).

While it is important to recognize that the opportunity costs of management decisions that result in irreversible species or ecosystem losses may be particularly high, it is also important to note that some individuals may hold a positive value for avoiding losses of part of a species' population even if recovery is fairly rapid (Bishop and Welsh 1992) – witness the opposition by some members of the public to the gray whale (*Eschrichtius robustus*) hunt by the Makah people of the Pacific Northwest, despite the fact that NMFS deemed the gray whale stock to be in good condition and capable of withstanding a restricted harvest. It is likely that for some opponents to the whale hunt the harvest of even a single whale is one too many because of the value of the special qualities they ascribe to a living whale or because of the sympathy or empathy they hold for animals in general.

## 3.3.4.2 Possible Economic Values Attributed to the Hawaiian Monk Seal

### *3.3.4.2.1 Consumptive Direct Use Value*

Although there are some exceptions, most populations of endangered species have little or no consumptive direct use value because of their low numbers. In the early nineteenth century, Hawaiian monk seals experienced mass hunting for their oil and pelts. Within a few years, the population had been reduced to the point that the seal hunt was no longer profitable. Perhaps the last year Hawaiian monk seals were killed for commercial purposes was in 1859, when the Hawaiian bark *Gambia* spent three and a half months fishing around the NWHI and returned with a large quantity of seal oil and skins (Kenyon and Rice 1959). It is unlikely there will be renewed demand for monk seal oil or pelts, therefore, the consumptive value of the Hawaiian monk seal is likely to remain at zero, even if the population were to increase dramatically.

### *3.3.4.2.2 Non-consumptive Direct Use Value*

Hawaiian monk seals usually reside on the remote and essentially uninhabited atolls and islands that comprise the NWHI. Furthermore, access to these areas has been limited by a very restrictive permit process (USFWS 1986). Consequently, generally there have been limited opportunities for people other than a few military personnel and scientists to observe a live Hawaiian monk seal in the wild. However, the number of Hawaiian monk seals occurring in the main Hawaiian Islands increased in the 1990s, and sightings of Hawaiian monk seals in these islands by residents and tourists have become more common. On Kaua'i's south shore, for example, Hawaiian monk seals are seen almost daily, and several of them may haul out at a time (Johanos 2000; G. Antonelis, pers. comm. 2000. NMFS-HL). Certain beachfront hotel staff and "monk seal watch" volunteers have begun to rope off and place educational signs around areas where seals haul out (Ching 1994; G. Antonelis pers. comm. 2000. NMFS-HL).

In addition, from 1996 to 2001, there was limited eco-tourism and public use within the Midway Atoll National Wildlife Refuge in the form of charter fishing, diving and wildlife observation. Midway Phoenix Corporation, a privately-owned company, was awarded a concession to develop and manage the tourist facilities. Midway Atoll was the only remote island National Wildlife Refuge open to public visitation. The number of visitors allowed on the atoll at any one time was limited to reduce impacts to wildlife. Midway Phoenix Corporation's agreement with the USFWS allowed a maximum of 100 visitors to reside on the atoll per week. The company advertised wildlife tours that let visitors "...gain first hand knowledge of the albatross, resident seabirds, migrant shorebirds, threatened green turtles and endangered Hawaiian monk seals...." (Midway Phoenix Corporation undated). The most common way for visitors to access the Midway Atoll National Wildlife Refuge was by air service from Honolulu. However, the Midway Phoenix Corporation also arranged for cruise ships to make stopovers at the Refuge.

As the chances of viewing a Hawaiian monk seal in its natural habitat improve, one would expect its non-consumptive value to increase (at least up to the point that a sighting becomes mundane). An example of the non-consumptive value that direct encounters with the Hawaiian monk seal might generate is described by Ching (1994:36):

> *Events like those ...are precious indeed as many people are experiencing the joy of watching monk seals in the wild without causing them stress. Something magical happens when people actually get to see an endangered animal in real life. It instills within them a sense of protective enthusiasm, thus strengthening conservation efforts.*

Non-consumptive direct use value may also decrease as larger beachfront areas are cordoned off where seals are hauled-out, birthing or pupping, and making nearshore waters inaccessible to users, especially if it is on a relatively long-term basis. In one instance, an aggressive monk seal prevented users from swimming in the nearhsore waters, and more recently, a tourist on Kauai was bitten by a monk seal that was positioned itself between the person and the shore.

*3.3.4.2.3 Secondary Value*

Opportunities for accruing secondary value from the Hawaiian monk seal may also have significantly increased over the past few years. A book for the lay reader has been published describing the natural history and endangered status of the Hawaiian monk seal (Ching 1994). Dozens of Web sites have been created by government and private organizations to provide Internet users with detailed information about the Hawaiian monk seal. Information about the Hawaiian monk seal was also conveyed to the public when the U. S. Postal Service issued a new postage stamp and post card honoring the Hawaiian monk seal as part of its 1996 endangered species series.

*3.3.4.2.4 Scientific Value*

The Hawaiian monk seal may have scientific value for its evolutionary characteristics. Some of the anatomical features of the Hawaiian monk seal have been unchanged by evolution for 15 million years, and this species is the oldest and most primitive of all living seals (Kenyon 1980). It is sometimes referred to as a "living fossil" because of the retention of several primitive skeletal features.

In addition, the Hawaiian monk seal may be perceived by some as having some yet unrealized biomedical value that renders it worth preserving (i.e., the Hawaiian monk seal has a quasi-option value). Several current lines of research indicate that seals may be useful in human medicine. To cite some examples – an examination of the physiological factors that render the internal organs of seals resistant to anoxia may improve human organ transplants (Kooyman 1981); studies of the Weddell seal's (*Leptonychotes weddelli*) ability to routinely recover from near total lung collapse during deep dives may prove useful in understanding sudden infant death syndrome (Kooyman 1981); and investigations of what are apparently normal sleep apneas in the northern elephant seal (*Mirounga angustirostris*) may provide insights into similar but more pathological events seen in humans (Castellini 1994). These potential benefits suggest that the Hawaiian monk seal could also have some valuable biomedical use in the future.

*3.3.4.2.5 Indirect Value*

Due to the complex nature of ecosystem relationships, the removal or disturbance of one part of the ecosystem could affect the functioning of many other components of the ecosystem. The role that the Hawaiian monk seal plays in maintaining the integrity of the ecosystem is uncertain. Such uncertainty is not unusual; knowledge of ecosystem relationships is often incomplete, and the results of disturbance are thus to some extent unpredictable. To have indirect value the Hawaiian monk seal does not necessarily have to be a "keystone species" on which the persistence of a large number of other species in the ecosystem depends. As Ehrlich and Ehrlich (1981) have noted, the removal of any particular species may in itself not be catastrophic, but its occurrence increases the likelihood that the next extinction could unravel the whole ecosystem.

*3.3.4.2.6 Existence Value*

Non-use values may be the most important benefit derived from some endangered species, simply because species become endangered because they are few in number which means that many people are unlikely to have seen them or to have had very much tangible experience regarding them. People demonstrate their existence values in the marketplace by donating funds to private organizations that support activities to preserve endangered species. However, whether people enjoy existence values of resources is not contingent upon whether they donate money to support a cause. The fact that some individuals are willing to donate money is just the most obvious manifestation of these existence values.

The discussion by Metrick and Weitzman (1996) of the possible components of existence value can be used as a basis for speculating about the nature and relative magnitude of the existence value of the Hawaiian monk seal. First, the authors note that people often speak of the large amount of attention paid to "charismatic megafauna." Presumably, therefore, the existence value of a species may be a function of its charisma. Metrick and Weitzman were unable to identify a satisfactory measure of charisma in the context of endangered species, but they note that eye-size or eye-body ratio have been suggested. Based on these eye-related criteria the Hawaiian monk seal would be rated as highly charismatic by some people if one accepts Ching's (1994:36) statement that "...one look into those big, dark eyes and you, too, could become an incurable monk seal *groupie*." In any case, the Hawaiian monk seal is a large mammal with a "cute and furry" visage that is typical of some high-profile threatened and endangered species that people are willing to protect.

Another possible component of existence value is the degree to which a species is considered to be a higher form of life and possibly possess (anthropomorphic) capabilities for feeling, thought and pain (Metrick and Weitzman 1996; Kellert 1986). Ching (1994) and others describe the close maternal care that the female Hawaiian monk seal provides for her pup, the playful behavior of young monk seals, the ability of the seals to vocalize and communicate with each other and the curiosity of adult monk seals. While none of these attributes proves that the Hawaiian monk seal possesses human-like intelligence or emotions, it is likely that many people would "identify" with these characteristics and interpret them to mean that monk seals do, in fact, represent a relatively advanced form of life.

Finally, Metrick and Weitzman argue that, since we may have existence value for biodiversity as a whole, some measure of the amount that a species adds to this diversity may play a role in deciding how much people are willing to pay to preserve it. With regard to the taxonomic uniqueness of the Hawaiian monk seal, Kretzmann (1998:5) states: "If one assigns conservation value to species based on their evolutionary distinctiveness, then the Hawaiian monk seal ... seems likely to represent an especially worthy cause." The Hawaiian monk seal is endemic to the Hawaiian Islands. Furthermore, the Hawaiian monk seal and the Mediterranean monk seal (*Monachus monachus*), which is also in danger of going extinct, are the sole representatives of an entire genus. Although monk seals as a group are closely related to other Phocidae or "true seals," they are genetically distinct and represent the only genus of seals found in tropical waters (Kenyon and Rice 1959).

### 3.3.4.3 Estimate of the Economic Value of the Hawaiian Monk Seal

Market prices express the value of environmental assets in monetary terms if these assets were bought and sold. However, other benefits of environmental assets are less readily translated into dollar values. Resource economists have developed an array of valuation techniques that do not rely on market data. One such technique is the contingent valuation method (CVM). CVM allows for the estimation of the full range of species and ecosystem preservation values set forth in Table 3-10, and it is the only method available for estimating non-use values directly.

CVM employs survey techniques to ask people about the values they would place on certain environmental assets or other non-market commodities if markets did exist or if other means of payment were in effect. When individuals are asked in CVM studies to evaluate an environmental asset they make a holistic judgment based on the configuration of benefits they believe will accrue to them (Mitchell and Carson 1989). Consequently, it may not be possible to identify the value of each separate type of benefit. It is also important to note that a valuation of a particular species may include implicit valuation of the components of the ecosystem that support that species (Loomis and White 1996).

A 1986 CVM study estimated the total economic value of the Hawaiian monk seal (Hollyer 1987; Samples and Hollyer 1990). The hypothetical market in the study was for the "purchase" of the continued existence of the Hawaiian monk seal population. Individuals were asked their willingness to pay to provide one-time emergency assistance to prevent a complete loss of the Hawaiian monk seal population. The study employed a dichotomous choice CVM format administered through in-person interviews to a stratified sample of Hawai'i residents living on O'ahu.

The study found that the value of preserving the Hawaiian monk seal was positive and substantial. Estimates of the benefit of Hawaiian monk seal preservation ranged from $81.17 to $232.54 per household, with an overall mean of $148.65 (all values adjusted for inflation to 1999 dollars using the Honolulu consumer price index). If the one-time payment is amortized over a 20-year period at a 7% discount rate the estimated mean annual value per Hawai'i household is $14.03. Extrapolating this value estimate across the total number of households in Hawai'i as reported in DBEDT (1999) results in an estimated gross preservation benefit of $5.45 million.

Hollyer (1987) also estimated the net preservation value by subtracting the costs of Hawaiian monk seal preservation efforts from the gross preservation value. Cost data were collected from both government agencies and private organizations. The highest costs were those incurred by the Marine Mammal Research Program at the PIFSC. In FY 2000, the budget of this program for Hawaiian monk seal conservation was about $1.9 million for NMFS research and additional "in-kind" support for logistics (e.g., use of NOAA R/V *Townsend Cromwell*) and from other agencies (e.g., U.S. Coast Guard) for marine debris removal from Hawaiian monk seal habitat (G. Antonelis pers. comm. 2000. NMFS-HL). In the absence of a current estimate of the contributions of private organizations and other government agencies to Hawaiian monk seal preservation activities, the estimate provided by Hollyer for 1986 can be used after adjusting for inflation. The inflation-adjusted estimate is $258,000. Therefore, the total public and private sector costs of Hawaiian monk seal preservation are estimated to be about $2.16 million per year. Subtracting this value from the estimated gross preservation benefit of $5.45 million yields an annual net benefit to the nation of $3.29 million.

This net annual economic value estimate of preserving the Hawaiian monk seal may be conservative for at least two reasons. First, the valuation responses were treated as household responses rather than individual responses. Treating the responses as individual responses would increase net benefits substantially. Secondly, because the benefits of preserving federally listed threatened and endangered species are national in scope, both the value per household (or individual) and number of households to aggregate over should include all U.S. households (Loomis and White 1996). However, it may be inappropriate to extrapolate the estimated values obtained by Hollyer to this much wider population. Hawai'i residents may value the Hawaiian monk seal appreciably more than the average U.S. resident because it is Hawai'i's only pinniped and one of only two endemic mammals (the other being the Hawaiian Hoary Bat (*Lasirus cinereus semotus*)). On the other hand, it is likely that many individuals residing on the U.S. mainland attach at least some positive value to preserving the Hawaiian monk seal.

Economists acknowledge that questions of validity, bias and reliability persist in the use of CVM to evaluate environmental assets. In 1992, NOAA commissioned a "blue ribbon" panel to advise the agency on the use of CVM for measuring non-use values (Arrow et al. 1993). The panel concluded that CVM studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages, including loss of non-use values, as long as certain sampling and survey design guidelines are adhered to. It is beyond the scope of this EIS to critique the methodology employed by Hollyer (1987) to evaluate the benefits of preserving the Hawaiian monk seal, but that study's use of personal interviews and a willingness-to-pay and dichotomous choice format are consistent with guidelines set forth by Arrow et al. (1993).

#### 3.3.4.4 Alternative Value Paradigms

Apart from debates about the technical acceptability of CVM with respect to its validity and reliability, there are criticisms of the economic-utilitarian paradigm underlying the economic valuation of at-risk species and ecosystems. A number of these criticisms contend that economic valuation methods such as CVM are inherently inadequate because they capture only the instrumental value to current members of society.

For example, Berrens et al. (1998) note that irreversible species or ecosystem losses involve inter-generational equity issues since they constrict the choice sets of future generations. Economic valuations are based on the preferences of the current generation and neglect the ethical issue of the inter-generational allocation of natural endowments. Preserving species where positive net benefits are to be earned is obviously a good idea, but preserving species only when doing so meets economic efficiency criteria may place future generations in a disadvantaged position (Bishop 1993).

Other critics focus on the fact that economic valuations are rooted in anthropocentric or human-centered benefits. Albers et al. (1996), for instance, note that some would argue that human uses and the values to which they give rise are not deserving of any special consideration when it comes to a decision on whether to preserve a species and its habitat. According to one interpretation of this view, nature has rights; to exploit nature is just as wrong as to exploit people (Nash 1989). Another interpretation is that non-human species are intrinsically valuable, independent of any use they may be to humans (Callicott 1986). The latter conviction may be related to religious principles, such as a belief in the sacredness of all or certain life forms.

All of these "moral arguments" are inconsistent with the economic paradigm of trade-offs between money and wildlife species or ecosystems because they present individuals with the moral imperative that we ought to preserve plants and animals (Stevens et al. 1991). As Costanza et al. (1997) and Pearce and Moran (1994) note, concerns about the preferences of future generations or ideas of intrinsic value translate the valuation of environmental assets into a set of dimensions outside the realm of economics.

It is difficult to gauge how prevalent such ethically motivated values are among members of the general public. For example, according to a 1997 public opinion poll conducted in the U.S., only 6% of the respondents who advocated an end to the harvest of the Minke whale (*Balaenoptera acutorostrata*) indicated that their opposition to whaling stemmed from animal rights concerns (Aron et al. 2000). On the other hand, when a Gallup poll asked Americans to indicate the degree to which they agree or disagree with the goals of the animal rights movement, 29% expressed strong agreement, 43% indicated some agreement and only 25 % were strongly or somewhat opposed (The Gallup Organization 2000). Additional in-depth public surveys are needed before we can better understand people's motivations for supporting efforts to protect the Hawaiian monk seal and other species.

## 3.4 ESSENTIAL FISH HABITAT, BIODIVERSITY AND ECOSYSTEMS

### 3.4.1 Essential Fish Habitat for Bottomfish Management Unit Species

The MSA identifies essential fish habitat (EFH) as those waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. This includes the marine areas and their chemical and biological properties that are utilized by the organism. Substrate includes sediment, hard bottom, and other structural relief underlying the water column along with their associated biological communities.

NMFS produced guidelines to assist in the implementation of the EFH requirements of the MSA. These guidelines state that the quality of the available life history data for management unit species (MUS) should be rated using a four level system, as follows:

Level 1: All that is known is the occurrence of a species based on distribution data for all or part of the geographic range of the species.

Level 2: Data on habitat-related densities or relative abundance of the species where available.

Level 3: Data on growth, reproduction, or survival rates within habitats where available.

Level 4: Data on production rates by habitat.

At present there are not enough data on relative productivity of various habitats for bottomfish species within the region to develop EFH designations based on Level 3 or Level 4 data. To address the requirements in Section 305 (b)(1)(A) of the MSA, the Council drafted Amendment 6 to the Bottomfish FMP. The recommendation of EFH by the Council to NMFS was based on the best available scientific information, which was obtained through an iterative process consisting of a series of public meetings, and through scientific, industry, and FMP panel meetings. The Council worked in close cooperation with scientists in the NMFS Southwest Fisheries Science Center, the PIFSC, the NMFS-PIRO and the NMFS Southwest Region Office (WPRFMC 1998a). To reduce the complexity and number of EFH identifications required for individual species and life stages, the Council proposed EFH for bottomfish species assemblages. The definition of these assemblages is based on the ecological relationships among species and their preferred habitats. The bottomfish species are separated into shallow-water and deep-water assemblages based on known depth distributions of the individual species. The seamount groundfish are included in a separate assemblage because of their similar habitat requirements. The species included in each assemblage are summarized in Table 3-11.

**TABLE 3-11: Species Assemblages for Bottomfish Management Unit Species**

| SPECIES ASSEMBLAGE | INCLUDED SPECIES |
|---|---|
| Shallow-water bottomfish (0-100m) | *Aprion virescens, Pseudocaranx dentex, Variola louti, Epinephilus fasciatus, Lethrinus amboinensis, L. rubrioperculatus, Caranx ignobilis, C. lugubris, Seriola dumerili, Lutjanus kasmira* |
| Deep-water bottomfish (100-400m) | *Etelis carbunculus, E. coruscans, Pristipomoides filamentosus, P. auricilla, P. flavipinnis, P. sieboldii, P. zonatus, Epinephelus quernus, Aphareus rutilans* |
| Seamount Groundfish (seamounts 80-600m) | *Pseudopentaceros richardsoni, Hyperoglyphe japonica, Beryx splendens* |

Source: WPRFMC 1998a

The distribution of adult bottomfish in the region is correlated with suitable physical habitat. Because of the volcanic nature of the islands within the region, most bottomfish habitat consists of steep slope areas on the margins of the islands and banks. The habitat of the six most important bottomfish species tend to overlap to some degree, as indicated by the depth range where they are caught. Within the overall depth range, however, individual species are more common at specific depths. Depth alone, however, does not assure satisfactory habitat. Both the quantity and quality of habitat at depth are important. Bottomfish are typically distributed in a non-random patchy pattern, reflecting bottom habitat and oceanographic conditions. Much of the habitat within the depths of occurrence of bottomfish is a mosaic of sandy low-relief areas and rocky high relief areas. An important component of the habitat for many bottomfish species appears to be the association of high-relief areas with water movement. In the Hawaiian Islands and at Johnston Atoll, bottomfish density is correlated with areas of high-relief and current flow (Haight 1989; Haight et al. 1993b; Ralston et al. 1986). Although the water depths utilized by bottomfish may overlap somewhat, the available resources may be partitioned by species-specific behavioral differences. In a study of the feeding habitats of the commercial bottomfish in the Hawaiian Archipelago, Haight et al. (1993a) found that ecological competition between bottomfish species appears to be minimized through species specific habitat utilization. Species may partition the resource through both the depth and time of feeding activity, and through different prey preferences.

The Council used the best available scientific information to propose EFH for each life stage (egg, larvae, juvenile, adult). Careful judgment was used in determining the extent of EFH that should be designated to ensure that sufficient habitat in good condition is available to maintain a sustainable fishery and the managed species contribution to a healthy ecosystem. Because there are large gaps in scientific knowledge about life histories and habitat requirements of many of the managed species in the Western Pacific Region, the Council adopted a precautionary approach in proposing EFH to ensure that enough habitat is protected to sustain the managed species. Under this precautionary approach the Council proposed EFH for bottomfish as extending from the shoreline to a depth of 400 m, encompassing steep slope areas and drop-offs.

The eggs and larvae of all the bottomfish MUS are pelagic, and are subject to advection by prevailing ocean currents. Very little information exists on the advection process and distribution of bottomfish larvae. Because of this uncertainty the Council proposed EFH for larval bottomfish as the water column from the shoreline to the outer limit of the EEZ to a depth of 400 m.

Because of the lack of information other than the general distribution of adult seamount groundfish, the Council proposed EFH for these species as the waters surrounding the seamount where they occur. A summary of the Council's proposed EFH for bottomfish and seamount groundfish is presented in Table 3-12.

**TABLE 3-12: Essential Fish Habitat for Bottomfish Management Unit Species**

| LIFE STAGE | HABITAT | EFH |
|---|---|---|
| Bottomfish - Larval | Pelagic | Shoreline to EEZ boundary, water column 0-400m |
| Bottomfish - Juvenile, Adult | Water Column, Benthos | Shoreline to EEZ boundary, water column and bottom habitat which encompass steep-slope and high relief habitat 0-400 m |
| Seamount Groundfish - Larval, Juveniles | Water Column, Benthos | Epipelagic zone at ~200m in all waters bounded by 29° - 35°N, 171°E - 179°W |
| Seamount Ground fish - Adult | Water Column, Benthos | Water column and benthos between 80-600m bounded by 29° - 35°N, 171°E - 179°W |

### 3.4.2 Habitat Areas of Particular Concern for Bottomfish Management Unit Species

In addition to the EFH, the Council proposes Habitat Areas of Particular Concern (HAPC) based on the following criteria: ecological function of the habitat is important, habitat is sensitive to anthropogenic degradation, development activities are or will stress the habitat, or the habitat type is rare.

The HAPC for adult bottomfish is based on the known distribution of the species and the associated habitat requirements. The Council proposed all escarpments and slopes between 40 and 280 m as HAPC for adult bottomfish in the region. Juvenile *P. filamentosus* have been found to utilize nursery areas well away from the adult habitat. The juveniles occupy flat, open bottom, of primarily soft substrate with depths of 40 to 73 m. Juvenile densities in these areas are correlated with the proximity of transport mechanisms (current outflow) from island runoff. In a comprehensive survey of the low relief, nearshore areas in the MHI, NMFS found high concentrations of juvenile *P. filamentosus* restricted to two areas off O'ahu, and one off Moloka'i.

Because of the rarity of these habitats and their susceptibility to human-induced degradation, the two areas near the Island of O'ahu, and the one area near the Island of Moloka'i are proposed as HAPC for juvenile *Pristipomoides filamentosus.*

### 3.4.3 Coral Reef Ecosystems in the Western Pacific Region

In October 2001, the Council released a final EIS for its Coral Reef Ecosystems (CRE) FMP, the first ecosystem-based FMP in the United States. In June 2002, NMFS approved the CRE FMP except for those measures governing fishing activities in the EEZ waters surrounding the NWHI. The CRE FMP establishes a flexible, precautionary approach for management of coral reef ecosystems in the Western Pacific Region. Its holistic approach provides for better understanding of impacts due to natural environmental changes, other FMP-managed fisheries, and non-fishing anthropogenic impacts such as dredging. Although many nearshore reefs around settled areas have been heavily exploited, this is not generally the case for reef ecosystems in the EEZ. However, there is potential for fisheries to expand in these areas. These potential expansions include current nearshore fisheries for coral reef species, new fisheries for the live fish markets in Southeast Asia, expanded fisheries for coral and "live rock" for the aquarium trade, and developing fisheries for pharmaceutical uses. The Council, therefore, established as objectives for the CRE FMP promotion of sustainable use of coral reef resources, implementation of an adaptive management approach based on fishery-dependent and fishery-independent research, establishment of marine protected areas (MPAs) for resource and habitat conservation, promotion of cooperative and coordinated management, development of educational programs, encouragement of surveillance and enforcement activities, and encouragement of sustainable participation of fishing communities in coral reef fisheries (WPRFMC 2000a).

Significant management measures that were implemented to achieve the FMP's objectives include:

1. Marine Protected Areas - EEZ coral reefs in unpopulated areas (the PRIAs, Guam's Southern Banks and Rose Atoll in American Samoa) are designated MPAs out to the 50-fm isobath. The MPAs are zoned as no-take or low-use. In the no-take MPAs, no fishing is allowed, including that by existing FMP fisheries. (Thus the CRE FMP supercedes in some aspects the Council's other FMPs for activities occurring in coral reef ecosystems,

defined as federal waters less than 100m deep.) No-take MPAs are delineated by the 10-fm isobath except in certain ecologically sensitive areas where the boundary is extended to the 50-fm isobath. These areas are Jarvis Island, Howland Island, Baker Island, Kingman Reef, Palymyra Atoll and Rose Atoll. All other areas within the 50-fathom isobath would be low-use MPAs where fishing is tightly controlled by a special permit requirement and other conditions for fishing. The bottomfish FMP is amended by the CRE FMP[14] to prohibit take of bottomfish MUS from no-take MPAs. In low-use MPAs existing fishing activities, certain new fishing activities and recreational fisheries by residents on certain remote islands would be allowed under special permits. In low-use MPAs, existing FMP fisheries such as the bottomfish fishery would be regulated under the existing FMPs and no additional permits would be required.

2. Permits and Monitoring - A framework process established under the CRE FMP would allow rapid development of a general permit system if it became necessary. Special permits would regulate fishing and other types of fishing-related resource use around unpopulated areas. Harvesting of live rock and coral would be prohibited except by special permit for harvest by indigenous people for traditional uses, aquaculture seedstock collection and scientific activities. Incidental catch of coral reef taxa by permit-holders in other FMP-managed fisheries would not require an additional permit.
3. Fishing Gears and Methods - The CRE FMP includes lists of allowable and prohibited gears, and conditions on their use.
4. Other Management Measures - The FMP establishes a framework process for simplified amendment of the plan, and allows for implementation by the Council of certain non-regulatory measures outside of the FMP amendment process.

Section 4.5.1 compares the areas designated Preservation Zones in Alternative 4 of this EIS with the MPAs of the CRE FMP.

Coral reefs and reef-building organisms are confined to the shallow upper photic zone and are normally restricted to depths less than 50 to 100 m (25-50 fm) (Maragos and Holthus 1999). Holthus and Maragos (1995) define reefs as extending to 200 meters. Maragos and Jokiel 1986 found zooxanthellate corals at 165 meters. Although maximum reef growth and productivity occurs between 5 and 15 m, maximum diversity occurs at 10 to 30 m (Hunter 1995). Even within a thriving coral reef habitat, not all space is occupied by corals or coralline algae; reefs are typically patchworks of coral, algae and sand. For example, Grigg and Dollar (1980) estimated that coral cover at sites within the Hawaiian Archipelago ranged between 8 and 98%. The following sections describe the coral reef ecosystems in the Western Pacific Region.

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[14]The CRE FMP includes Amendment 7 to the Bottomfish FMP, Amendment 11 to the Crustaceans FMP, Amendment 5 to the Precious Corals FMP, and Amendment 10 to the Pelagics FMP.

3.4.3.1 Hawai'i

Reefs in Hawai'i constitute the vast majority (89%) of coral reef area in the U.S. Pacific islands. By far the largest coral reef area in the EEZ is located in Hawai'i (10,004 km$^2$), of which 90% is in the NWHI (9,124 km$^2$). The EEZ around the MHI also includes a sizeable area of coral reef (880 km$^2$), almost all of which is located on Penguin Bank, between the islands of Moloka'i and O'ahu.

The MHI represent the young portion of the Hawaiian Archipelago. Consequently, they have less well-developed fringing reefs that have not subsided as far below sea level as those in the NWHI (Green 1997). The best reef development and highest live coral cover in the MHI are found in areas sheltered or partially sheltered from open ocean swell (Grigg 1997). The Hawaiian nearshore marine community includes numerous species of fish (557 including BMUS), algae (~400), molluscs (~1,000) and other invertebrates (~1,350) (WPRFMC 2000a; USFWS 1986). Furthermore, the isolation of the Hawaiian Islands has produced a large proportion of endemic coral reef species (Fielding and Robinson 1987). It is estimated that 20 to 30% of the fish, 18% of the algae, 20% of the molluscs and 20% of the seastars and brittlestars are endemic to Hawai'i. Hawai'i's coral reefs are also unique in that some species that are relatively uncommon in other areas are quite abundant in Hawai'i (Fielding and Robinson 1987).

Coral reef resources in Hawai'i are characterized by relatively low biological diversity. Only 47 species of reef-building corals belonging to 16 genera have been recorded (Grigg 1983). This compares to about 65 genera in the Indo-West-Pacific region. On the other hand, Hawai'i's isolation has produced a large proportion of endemic coral reef species. It is estimated that 20 to 30% of the fish, 18% of the algae and 20% of the molluscs are endemic to Hawai'i (Fielding and Robinson 1987). Hawai'i's coral reefs are also unique in that some species that are relatively uncommon in other areas of the Pacific are quite abundant in Hawai'i.

Coral species richness tends to be higher in the NWHI, where the genus *Acropora*, not found in the MHI, is present. A peak in coral species diversity occurs in the middle of the Hawaiian Archipelago at FFS and Maro Reef (Grigg 1983). Many reefs in the NWHI are comprised of calcareous algae (Green 1997). In general, fish species diversity appears to be lower in the NWHI than in the MHI. Although the inshore fish assemblages of the two regions are similar, fish size, density and biomass is higher in the NWHI. Fish communities in the NWHI are dominated by apex predators (sharks and jacks), whereas those in the MHI are not (Friedlander and DeMartini 2002). Some fish species are common in parts of the NWHI that are rare elsewhere in the archipelago (Green 1997).

Perhaps the most important factor in the population dynamics of many coral reef species in the NWHI and the ecosystem as a whole are cyclical oceanographic events which affect productivity over large areas and may account for large fluctuations in population abundance. In a study of climatic and oceanographic events and their effect on productivity in the NWHI, Polovina et al. (1994) found that declines of 30 to 50% in a number of species from various trophic levels, from the early 1980s to the present, could be explained by a shift in oceanographic conditions. Prior to this time period, oceanographic conditions that lasted from the late 1970s until the early 1980s moved nutrient-rich deep ocean water into the euphotic zone, resulting in higher survival of reef fish, crustaceans, Hawaiian monk seals and seabirds.

3.4.3.2 American Samoa

Coral reefs are limited in area (296 $km^2$) and only a small fraction is located within the EEZ (25 $km^2$), mostly on offshore banks (Green 1997). The main islands are volcanic mountains that descend steeply below sea level. They are fringed by narrow reef flats (50-500 m) that drop to a depth of 3 to 6 m and descend gradually to 40 m. From this depth, the ocean bottom drops rapidly, reaching depths of 1,000 m within 1 to 3 km from shore (Craig et al. in press). Almost 300 coral species occur in American Samoa (Green 1997). The reefs also support a diverse assemblage of nearly 900 fish species. Dominant families are damselfish, surgeonfish, wrasse and parrotfish. Spawning for some, and perhaps most, species occurs year-round, although peak spawning may be seasonal (Craig et al. in press).

Little is known about the biological assemblages on offshore banks in the EEZ around American Samoa. Species composition on the offshore reefs may be similar to that on the outer reef slopes, although species diversity may be less because of the absence of estuarine, reef flat and shallow lagoon habitats (Green 1997).

3.4.3.3 Guam

Guam is largely a raised limestone island on a volcanic base. Approximately half of the shoreline is bordered by well-developed coral reefs with reef flats as wide as 600 m. A broad barrier reef encloses Cocos Lagoon at the southwest tip of the island. A raised barrier reef, a greatly disturbed barrier reef and a coral bank enclose the deep lagoon of Apra Harbor. Coral reefs on offshore banks in the EEZ (110 $km^2$) account for about 60% of the total reef area in Guam (Green 1997).

Over 250 stony coral species have been recorded in the Southern Mariana Islands (Birkeland 1997). Guam's reefs also support a diverse assemblage of about 800 fish species. Fish families with the most species that are important in coral reef fisheries are wrasses, groupers, surgeonfish, jacks, squirrelfish, snappers, parrotfish, emperors and goatfish (Green 1997).

Little is known about the biological assemblages on offshore banks in the EEZ around Guam.

The tops of these banks are relatively deep (20-40 m) (Green 1997). Myers (1997) has suggested species composition on these banks may be similar to that on the outer reef slope around the island of Guam, although the relative abundance of species would probably be different because of the isolation of the banks from continuous reef tracts and from heavy fishing pressure.

3.4.3.4 Northern Mariana Islands

In nearshore areas (0-3 nm)of the Northern Mariana Islands, Saipan has the best developed reefs, including fringing reefs, inshore and offshore patch reefs and a well-developed barrier reef-lagoon system along most of the leeward coast. In contrast, the northern islands (Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, Maug and Uracas) are geologically young volcanic islands having steep seaward slopes. In general, reef development there is poor to non-existent. In addition, there are numerous shoals along the island chain (Green 1997). A chain of small shallow banks topped with coral reefs lie in a parallel arc 240 to 320 km to the west of the Marianas (Myers 1997).

The number of stony coral and reef fish species in the southern portion of the CNMI is similar to that of Guam. Diversity drops markedly off the northern volcanic islands, where only 159 species of stony coral and only about 360 species of reef fish have been recorded (Birkeland 1997). Dominant fish families are the same as in Guam.

3.4.3.5 U.S. Pacific Remote Island Areas

The total reef area around the U.S. Pacific remote island areas is 620 $km^2$, of which 112 $km^2$ is offshore (3-200 nm). The biological diversity of coral reef ecosystems in these areas varies considerably from island to island. Fish densities and biomass are higher than around the populated islands in the region. Rare species occur in some areas. For example, giant clams are prolific throughout the lagoon at Wake Atoll (Green 1997).

Johnston Atoll has a unique mix of coral reef species not duplicated elsewhere in the Pacific. Invertebrates from both the western and central Pacific are present, indicating that the atoll serves as a bridge connecting distributions of Polynesian and Micronesian invertebrate fauna. The coral fauna has a strong affinity with that of Hawaiʻi but the appearance of the reef is quite different. This is due to the dominance of *Acropora*, not found in the main Hawaiian Islands, and the lack of the common Hawaiian species, *Porites compressa* (Green 1997).

### 3.4.4 Value of Ecosystems and Biodiversity

Most of the information in this section pertains only to the value of the coral reef ecosystem around the NWHI, as it is the impact of the bottomfish fishery on this ecosystem that has been identified as a particular environmental concern in scoping (Section 1.2).

3.4.4.1 Categories of Economic Values

As noted in Section 3.3.4, preserving an environmental asset such as an ecosystem or particular species may generate a range of use and non-use values for humans. Categories of benefits arising from the conservation of ecosystems and components of biological diversity are listed in Table 3.10. In this section those categories are used as a framework to examine the economic value of the coral reef ecosystem around the NWHI.

3.4.4.2 Possible Economic Values Attributed to the Coral Reef Ecosystem of the NWHI

*3.4.4.2.1 Consumptive Direct Use Value*

Potential consumptive direct uses of the coral reef ecosystem include harvesting reef species for commercial purposes, including food, the aquarium trade, construction materials, curios, jewelry, pharmaceuticals and traditional medicines. At present, the only consumptive commercial use of the coral reef ecosystem in the NWHI is the harvest of bottomfish resources. This fishery occurs in waters deeper than 20 m. Most of the shallow reefs of the NWHI lie within the boundaries of the Hawaiian Islands National Wildlife Refuge where fishing is prohibited. Recreational fishing occurs within the Midway Atoll National Wildlife Refuge but is largely limited to "catch-and-release" fishing.

*3.4.4.2.2 Non-consumptive Direct Use Value*

As a result of the rise in tourism-related ocean recreation in Hawai'i, a premium has been placed on non-consumptive direct uses of near-shore marine resources (Pooley 1993a). This emphasis on the recreational benefits of coral reefs is not limited to Hawaii. Constanza et al. (1997) reported that the highest valued use of coral reefs world-wide is recreation. Because the coral reef ecosystem around parts of the NWHI is arguably among the most pristine in the world, the non-consumptive value of this ecosystem is likely to be substantial. Historically, the recreational use of the coral reefs around the NWHI has been negligible due to the remoteness of the islands, lack of visitor facilities and legal restrictions. However, as discussed in Section 3.3.4.2.2, public access to the NWHI was, for a time, improved by the establishment of an eco-tourism operation in the Midway Atoll National Wildlife Refuge. Tourist activities in the refuge included sport fishing, diving and wildlife observation. Additional outdoor recreational activities for the public are included in the public use plan for the refuge and may be offered to visitors in the future (USFWS 1997). Among these activities are shoreline fishing, lobstering, night diving, night fishing, kayaking tours and glass-bottom boat excursions.

*3.4.4.2.3 Secondary Value*

Opportunities for the public to acquire information about the marine and terrestrial ecosystems of the NWHI are provided by various books, brochures, films, interpretive exhibits and other communication media that have been produced by public and private sector organizations. Considering the visual beauty of the relatively pristine coral reefs around parts of the NWHI, it is likely that the value of viewing this ecosystem in books or on film and television is high.

*3.4.4.2.4 Scientific Value*

The potential biochemical and genetic benefits of coral reef ecosystems are generally considered to be significant due to their high species diversity. In fact, coral reefs are considered to be the primary source of new medicines and biochemicals in the twenty-first century (The Working Groups of the U.S. Coral Reef Task Force 1999). A number of bio-prospecting ventures are currently collecting samples from coral reef areas around the Pacific. For example, the U.S. National Cancer Institute has contracted the Coral Reef Research Foundation, a non-profit organization based in the Republic of Belau, to collect and identify coral reef and other marine organisms for anti-cancer and anti-AIDS screening tests (Coral Reef Research Foundation undated). In addition, the Marine Laboratory of the University of Guam is seeking new examples of the chemical deterrents that coral reef organisms possess to deter predators (Guyer undated). That study is being conducted in collaboration with researchers at the University of Hawai‘i who are examining the properties of these chemical deterrents. Some of these substances could have biomedical uses - they might kill cancer cells, halt inflammatory responses, or deter microbes and viruses - and others may be effective insecticides for use in agriculture.

In addition to their value as a reservoir of genetic material, the marine and terrestrial ecosystems of the NWHI provide unique opportunities for study, both as undisturbed areas and as sites whose history of human intrusion is well documented (Shallenberger 1980). For example, pristine areas can provide environmental baselines against which the extent of impacts elsewhere can be measured.

*3.4.4.2.5 Indirect Value*

Coral reef ecosystems world-wide play an important role in climate regulation, nutrient storage and cycling, shoreline erosion inhibition and storm protection (WPRFMC 2000a). Additionally, coral reefs may serve important ecological functions that support offshore commercial and recreational fisheries (WPRFMC 2000a). For example, the larvae of many coral reef organisms contribute to the diets of tuna and other pelagic species. Several types of bottomfish, including snapper and grouper, use the coral reef habitat as juveniles.

*3.4.4.2.6 Existence Value*

The following excerpt from the HINWR Master Plan/EIS suggests that the marine and terrestrial ecosystems of the NWHI may have significant existence value due to their distinctive qualities:

> *Many concerned individuals and groups have acknowledged the desirability of measures to limit public access to the HINWR (including their own) if, as a result, the unique values of the area are preserved. For these people, the "quality of life" is enhanced by simply knowing this unique resource is protected, whether or not they experience it first hand* (USFWS 1986:3.35).

The uniqueness of the coral reef ecosystem in the NWHI is related, in part, to the fact that such relatively pristine marine areas are quite rare in the U.S. The remote geographic location of the NWHI has helped protect its resources from the impacts of humans. It is likely that a significant number of people derive pleasure from the contemplation of the varied life forms existing in Hawai'i's coral reef ecosystem.

3.4.4.3 Estimate of the Economic Value of the NWHI Coral Reef Ecosystem

An analysis of the economic value of the coral reefs around U.S. Pacific Islands roughly estimated the net value (consumer surplus) of recreational fishing for coral reef species in the Midway Atoll National Wildlife Refuge to be $8,000 to $38,000 per year while it operated (WPRFMC 1999). The analysis assumed that in the commercial coral reef fisheries fishermen as a group are earning a net economic return (producer surplus) of zero because of excess fishing effort in those fisheries. The annual net value of marine-based tourism in the State of Hawai'i was calculated to be between $0.34 billion and $1.35 billion. It was estimated that recreational SCUBA diving accounted for 3 to 4% of this value. The analysis noted that the potential for marine-based tourism in the NWHI is low compared to the rest of the state because of the limited accessibility of the NWHI. However, the analysis also noted that the option value of preserving the relatively pristine reefs in the NWHI for SCUBA diving and other recreational uses may be very high.

A management regime that preserves sufficient area of habitat to conserve the ecosystem of which the endangered Hawaiian monk seal is a part would tend to enhance the monk seal population and increase the probability of species survival. Consequently, an implicit value of protecting the NWHI coral reef ecosystem may be the value that people assign to preservation of the Hawaiian monk seal (Section 3.3.4.3). Of course, preserving habitat would also help safeguard populations of other types of plants and animals, and one would expect this habitat protection to be worth more than just the benefits provided to a single endangered species.

3.4.4.4 Alternative Value Paradigms

As discussed in Section 3.3.4.4, some individuals may hold religious or philosophical convictions that humankind has an ethical obligation to preserve species and ecosystems, notwithstanding any utilitarian benefits. While these moral arguments may be relevant to conservation decisions, it is difficult to gauge how prevalent such convictions are among Americans. Additional surveys and polls are needed to better understand the motives underlying public support of activities that protect species and ecosystems.

## 3.5 COMMERCIAL, RECREATIONAL AND CHARTER FISHING SECTORS

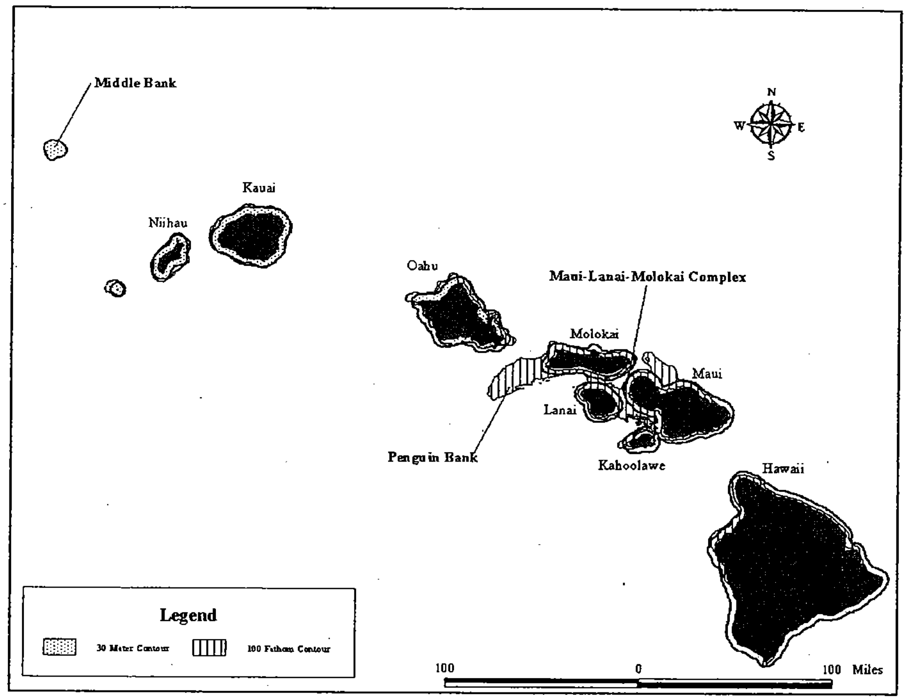
### 3.5.1 Hawai'i

The deep-slope bottomfish fishery in Hawai'i concentrates on species of eteline snappers, carangids and a single species of grouper concentrated at depths of 30-150 fm. The fishery can be divided into two geographical areas (see Figure 2-8): the inhabited main Hawaiian Islands (MHI) with their surrounding reefs and offshore banks; and the Northwestern Hawaiian Islands (NWHI), a chain of largely uninhabited islets, reefs and shoals extending 1,200 nm across the North Pacific. In the MHI approximately 80% of the bottomfish habitat lies in state waters. Bottomfish fishing grounds within federal waters around the MHI include Middle Bank, most of Penguin Bank and approximately 45 nm of 100-fathom bottomfish habitat in the Maui-Lāna'i-Moloka'i complex (Figure 3-7). For management purposes the NWHI fishery has been separated into the Mau Zone, closer to the MHI, and the Ho'omalu Zone.

In addition to the deep-slope fisheries in the MHI and NWHI, there is a potential seamount groundfish fishery in the Hawaiian Islands. A trawl and bottom longline fishery targeting alfonsin and armorhead at the southeast Hancock Seamount in the NWHI was started by Russian and Japanese fishing vessels in the late 1960s (Okamoto 1982). Large catches were made by foreign fishing vessels for about 10 years until overfishing caused the fishery to collapse. A moratorium on the harvest of alfonsin and armorhead on the Hancock Seamounts has been in effect since 1986 in an effort to rebuild the stocks (63 FR 35162, June 29, 1998). The moratorium was reissued by the Council in June 2004 and therefore in effect until 2010.. Because periodic reviews of the stocks indicate that no recovery has occurred and it is unlikely that the moratorium will be lifted in the near future, the seamount groundfish fishery will not be discussed further.

Bottomfish fishing also occasionally occurs in the waters around the U.S. Pacific remote island areas, but the catches have been small. The last recorded commercial harvest was in 1999 when a vessel from Hawai'i harvested 40,000 lbs. of spot snapper at Kingman Reef. The vessel ceased fishing in the area after part of the catch tested positive for ciguatera poisoning. Because the bottomfish fisheries occurring around the remote islands are very limited and sporadic, they will not be further discussed in this section.

**FIGURE 3-7: Bottomfish Habitat in the Main Hawaiian Islands**




## 3.5.1.1 History

Bottomfish fishing was a part of the economy and culture of the indigenous people of Hawai'i long before European explorers first visited the islands. Descriptions of traditional fishing practices indicate that Native Hawaiians harvested the same deep-sea bottomfish species as the modern fishery and used some of the same specialized gear and techniques employed today (Iversen et al. 1990). The *po'o lawai'a* (expert fishermen) within the community knew of dozens of specific *ko'a* (fishing areas) where bottomfish could be caught (Kahaulelio 1902). As Beckley (1883:10) noted, each *ko'a* could be precisely located:

*Every rocky protuberance from the bottom of the sea for miles out, in the waters*

> *surrounding the islands, was well known to the ancient fishermen, and so were the different kinds of rock fish likely to be met with on each separate rock....[They] took their bearing for the purpose of ascertaining the rock which was the habitat of the particular fish they were after, from the positions of the different mountain peaks.*

European colonization of the Hawaiian Islands during the early nineteenth century and the introduction of a cash economy led to the development of a local commercial fishery. As early as 1832, fish and other commodities were sold near the waterfront in Honolulu (Reynolds 1835). Other fish markets were established on the islands of Maui and Hawai'i. John Cobb (1902), who investigated Hawai'i's commercial fisheries in 1900 for the U.S. Fish Commission, reported that the bottomfish *'ula 'ula*, *uku* and *ulua* were three of the five fish taken commercially on all the Hawaiian Islands.

Initially, the commercial fishing industry in Hawai'i was monopolized by Native Hawaiians, who supplied the local market with fish using canoes, nets, traps, spears and other traditional fishing devices (Jordan and Evermann 1902; Cobb 1902). However, the role that Native Hawaiians played in Hawai'i's fishing industry gradually diminished during the latter half of the nineteenth century as successive waves of immigrants of various races and nationalities arrived in Hawai'i. Between 1872 and 1900, the non-indigenous population increased from 5,366 to 114,345 (OHA 1998). Kametaro Nishimura, credited by some to be the first Japanese immigrant to engage in commercial fishing in Hawai'i, began his fishing career in the islands in 1885 harvesting bottomfish such as *'ōpakapaka*, *ulua* and *uku* (Miyaski 1973). By the turn of the century, Japanese immigrants to Hawai'i dominated the bottomfish fishery using wooden-hulled "sampans" propelled by sails or oars (Cobb 1902). The sampan was brought to Hawai'i by Japanese immigrants during the late nineteenth century, and over time Japanese boat-builders in Hawai'i adapted the original design to specific fishing conditions found in Hawai'i (Goto et al. 1983). The bottomfish fishing gear and techniques employed by the Japanese immigrants were imitations of those traditionally used by Native Hawaiians, with slight modifications (Konishi 1930).

During the early years of the commercial bottomfish fishery, vessels restricted their effort to areas around the MHI. Cobb (1902) records that some of the best fishing grounds were off the coasts of Moloka'i and notes that large sampans with crews of 4 to 6 men were employed in the fishery. Typically, the fleet would leave Honolulu for the fishing grounds on Monday and return on Friday or Saturday. The fishing range of the sampan fleet increased substantially after the introduction of motor powered vessels in 1905 (Carter 1962). Fishing activity was occurring around the NWHI at least as early as 1913, when one commentator recorded: "Fishing for *ulua* and *kāhala* is most popular, using *bonito* for bait, fishermen seek this [sic] species in a 500 mile range toward Tori-Jima [NWHI]" (Japanese Consulate 1913, as cited in Yamamoto 1970:107).

Within a few years more than a dozen sampans were fishing for bottomfish around the NWHI (Anon. 1924; Konishi 1930). Fishing trips to the NWHI typically lasted 15 days or more, and the vessels carried seven to eight tons of ice to preserve their catch (Nakashima 1934). The number of sampans traveling to the more distant islands gradually declined due to the limited shelter the islands offered during rough weather and the difficulty of maintaining the quality of the catch during extended trips (Konishi 1930). However, during the 1930s, at least five bottomfish fishing vessels ranging in size from 65 to 70 ft continued to operate in the waters around the NWHI (Hau 1984). In addition to catching bottomfish, the sampans harvested lobster, reef fish, turtles and other marine animals (Iversen et al. 1990).

During World War II the bottomfish fishery in Hawai'i virtually ceased operations, but it recommenced shortly after the war ended (Haight et al. 1993b). The late 1940s saw as many as nine vessels fishing around the NWHI, but by the mid-1950s, vessel losses and depressed fish prices resulting from large catches had reduced the number of fishery participants. During the 1960s, only one or two vessels were operating around the NWHI.

There was renewed interest in harvesting the bottomfish resources of the NWHI in the late-1970s following a collaborative study of the marine resources of the region by state and federal agencies (Haight et al. 1993b). The entry of several modern boats into the NWHI fishery and the resultant expanding supply of high-valued bottomfish such as *'ōpakapaka* and *onaga* made possible the expansion of the tourism-linked restaurant market by allowing a regular and consistent supply of relatively fresh fish (Pooley 1993a). Markets for Hawai'i bottomfish further expanded after wholesale seafood dealers began sending fish to the U.S. mainland. By 1987, 28 vessels were active in the NWHI bottomfish fishery, although only 12 were fishing for bottomfish full time. Some of the non-full time vessels also engaged in the pelagic or lobster fisheries (Iversen et al. 1990). In 1989, the Council developed regulations that divided the fishing grounds of the NWHI bottomfish fishery into the Ho'omalu Zone and Mau Zone. Limited access programs were established for the Ho'omalu Zone and Mau Zone in 1988 and 1999, respectively, to avoid economic overfishing (Pooley 1993b; WPRFMC 1998b).

The 1970s also saw major changes in the composition and operations of the bottomfish fishery around the main Hawaiian Islands. The fishery changed from one dominated, in terms of catch and effort, by a relatively small number of full-time professional fishermen to one dominated by hundreds of part-time commercial and recreational fishermen. This change was the result of a number of factors. The popularity of offshore fishing increased in Hawai'i with the increase in the availability of locally-built and imported small fiberglass boats. In addition, the rise in fuel prices during the 1970s made fishing for bottomfish particularly attractive to fishermen as it consumed less fuel than trolling and generated higher-value fish catches to offset fuel costs. Finally, as navigation systems, bottom-sounders and hydraulic or electric powered reels became more affordable, the skill level and experience necessary to fish bottomfish successfully was reduced and the labor associated with hauling up the long lines was considerably lightened.

During the early 1980s, with the development of a much larger market for bottomfish, bottomfish fishermen fishing around the main Hawaiian Islands were able to obtain premium prices for their catches, and thus were motivated to increase their landings (Pooley 1993a). However, the number of vessels participating in the MHI fishery declined after reaching a peak of 583 in 1985. The decrease in fishing effort suggests that some bottomfish fishermen perceived a growing shortage of bottomfish in the MHI fishery and switched to other fisheries. In 1998, concerns about decreasing catch rates led the State of Hawai'i to close certain areas around the MHI to bottomfish fishing, including areas of Penguin Bank within the EEZ[15]. In addition, new state rules established a recreational bag limit of five *onaga* or *ehu*, or a mix of both, per person.

Hawai'i's sportfishing charter boat fleet began to develop during the early 1950s as Hawai'i became an increasingly popular tourist destination (Markrich 1994). What started as a few charter boats operating out of harbors such as Kewalo Basin and Kona has evolved into a highly competitive industry involving nearly 200 vessels state-wide (Hamilton 1998; Walker 1996). The charter boat fleet mainly targets pelagic game fish such as billfish and tuna. However, a few charter boats take bottomfish fishing trips if patrons are interested (Hamilton 1998). Most of the charter boats engaged in bottomfish fishing are based on the islands of Maui and Kaua'i.

3.5.1.2 Fishing Methods and Current Use Patterns

The basic design of the handline gear used in Hawai'i's bottomfish fisheries has remained essentially unchanged from gear used by early Native Hawaiians (Haight et al. 1993b). The gear consists of a main line with a 2-4 kg weight attached to the terminus. Several 40-60 cm sidelines with circle hooks are attached above the weight at 0.5-1 m intervals. A chum bag containing chopped fish or squid may be suspended above the highest of these hooks. The gear is pulled after several fish are hooked.

Circle hooks used in the bottomfish fishery are flat by design. "Kirbed" hooks (bent or offset to the side) are also available but are not generally used. The flat circle hooks are designed to be self-setting and work well for fish that engulf the bait and move off with it in their mouth. As a fish moves off with the baited hook, the line will trail out of the corner of the fish's mouth. The hook will be drawn into the corner of the mouth where the motion of the fish in relation to the pull of the line will rotate the hook through the corner of the jaw. Circle hooks, unlike "J" type

[15]The State of Hawai'i claims the authority to manage and control the marine, seabed and other resources within "archipelagic waters." These archipelagic waters encompass a number of bottomfish fishing grounds, such as parts of Penguin Bank, that lie inside the EEZ. An October 24, 1997 memorandum from NOAA/General Counsel Southwest Region to the Council Chairman declared that, despite any contentions by the State of Hawai'i to the contrary, for purposes of federal fishery management, state waters do not extend beyond three miles from the coast.

hooks, are generally not effective for fish that pick at the bait or mouth the bait and spit it out (Kawamoto pers. comm.).

Fishermen use the circle hook for its self-setting ability and for its curved design with its long inward pointing hook point that makes it difficult for the fish to rid itself of the hook once it is embedded. The circle hook shank is typically thicker and round in cross section (unlike the thinner straight J type hooks), which tends to minimize ripping or wearing a hole in the fish's jaw. An additional characteristic of the circle hook design that appeals to fishermen is that it's less prone to snagging on rocky or hard substrate bottoms and very difficult to snag flat or smooth surfaces. This characteristic minimizes the loss of gear (Kawamoto pers. comm.).

All bottomfish fishermen in Hawai'i target the same assemblage of bottomfish species. The ability to target particular species varies widely depending on the skill of each captain. Electronic navigation and fish-finding equipment greatly aid fishermen in returning to a particular fishing spot and catching desired species with little incidental catch (Haight et al. 1993). According to Hau (1984), *'ōpakapaka* is one of the primary target species due to the relatively high price it commands as a result of its constant demand at the fish auction. *Hāpu'upu'u* and white *ulua* are sought because of their sturdiness and ability to retain good flesh quality. In addition, white *ulua* can be caught in rough sea conditions when other species are difficult to capture. *Kāhala* are one of the least valuable bottomfish because large specimens have a reputation for carrying ciguatera toxin.

*3.5.1.2.1 MHI*

In the small boat fishery around the MHI the distinction between "recreational" and "commercial" fishermen is extremely tenuous (Pooley 1993a). A state-wide survey of small boat fishermen conducted in 1995-96 indicated that of the 42 fishermen interviewed who predominately use bottomfish fishing gear, 80 percent sell a portion of their catch (WPRFMC 1996). However, most of those selling fish are just trying to cover fishing trip expenses and do not expect a profit from their operation.

The individuals participating in the MHI fishery who make trips longer than 24 hrs are mostly full-time commercial fishermen. They typically operate larger boats than the part-time commercial/recreational fishermen and are able to fish during rough weather and venture further from port to fish less-exploited areas off Kaua'i, Ni'ihau and east Maui that are less accessible to the small boat fishermen.

The majority of participants in the MHI fishery shift from species group to species group and from the bottomfish fishery to other fisheries, primarily the pelagics fishery, in response to seasonal fish abundance or fluctuations in price. Except for those individuals who fish commercially on a full-time basis, most fishermen usually fish for bottomfish no more than 60 days a year (WPRFMC 1996). Seasonal price variability causes part-time commercial fishermen to concentrate their bottomfish fishing effort during December, when they can take advantage of the year-end holiday demand for red snappers. Pelagic species are often an important secondary target during bottomfish fishing trips regardless of the season.

Data from various surveys indicate that the importance of the MHI fishery varies significantly among fishermen of different islands. According to a 1987 survey of boat fishing club members, bottomfish represented roughly 13% of the catch of Hawaiʻi fishermen, 25% of the catch of Oʻahu and Kauaʻi fishermen and 75% of the catch of Maui fishermen (Meyer Resources 1987). A survey of licensed commercial fishermen conducted about the same time indicated that the percentage of respondents who used bottomfish fishing methods was 25% on Hawaiʻi, 28% on Kauaʻi, 29% on Oʻahu, 33% on Lānaʻi, 50% on Molokaʻi and 51% on Maui (Harman and Katekaru 1988). Presumably, the differences among islands relate to the proximity of productive bottomfish fishing grounds.

Favored grounds in the MHI include banks off Molokaʻi, Maui, Lānaʻi and Kauaʻi. These grounds account for more than about two-thirds of the bottomfish harvested in the MHI. Specific bottomfish fishing locales favored by fishermen vary seasonally according to sea conditions and the availability and price of target species. Historically, Penguin Bank is one of the most important bottomfish fishing grounds in the MHI, as it is the most extensive shallow shelf area in the MHI and within easy reach of major population centers. Penguin Bank is particularly important for the MHI catch of *uku*, one of the few bottomfish species available in substantial quantities to Hawaiʻi consumers during summer months. For the period 1991 to 1995, 8% of the licensed commercial fishermen who participated in the MHI bottomfish fishery reported catches from Penguin Bank (WPRFMC 1996). A comparison of the percentage of the total commercial landings of five major bottomfish species in the MHI represented by Penguin Bank from 1980 to1984 and 1991 to 1995 shows that the bank has increased in importance over the years (Table 3-13).

**TABLE 3-13: Average Percentage of Total MHI Commercial Catch of Major Bottomfish Species Harvested from Penguin Bank, 1980-1984 and 1991-1995**

| SPECIES | AVERAGE ANNUAL PERCENT OF TOTAL MHI CATCH | |
|---|---|---|
| | 1980-1984 | 1991-1995 |
| ʻŌpakapaka | 9.63 | 16.11 |
| Uku | 12.06 | 44.04 |

| SPECIES | AVERAGE ANNUAL PERCENT OF TOTAL MHI CATCH | |
|---|---|---|
| Onaga | 14.87 | 20.24 |
| Ehu | 12.15 | 17.60 |
| Hāpuʻupuʻu | 4.31 | 6.64 |

Source: WPRFMC 1996

Data for 1995 indicate that the importance of Penguin Bank and other bottomfish fishing areas may vary among fishermen of different islands. If it is assumed that the port of landing is also the vessel's home port, Table 3-14 indicates that Penguin Bank is frequented mostly by bottomfish fishermen residing on Oʻahu, while Middle Bank is especially popular among fishermen living on Oʻahu and Kauaʻi. The Maui-Lānaʻi-Molokaʻi complex is frequented mostly by bottomfish fishermen residing on Maui, Molokaʻi and Oʻahu.

*3.5.1.2.2 NWHI*

In contrast to the MHI fishery, bottomfish fishing in the NWHI is conducted solely by part-time and full-time commercial fishermen. The vessels venturing into the NWHI tend to be larger than those fishing around the MHI, as the distance to fishing grounds is greater (Haight et al. 1993b). As the number of vessels participating in the NWHI fishery increased during the 1980s, the fleet characteristics of the fishery became more diverse. Pooley and Kawamoto (1990) divided the fleet into three groups based on size and mode of propulsion: motor sailors, medium-sized powered vessels and large-sized powered vessels. The motor sailors are 46 to 66 ft long and are more streamlined in hull design than the standard powered vessels. The sail can be used to save on fuel costs, but it also limits the hold capacity compared with powered vessels of similar length. The powered vessels generally share one characteristic: a large working area on the back deck. The medium-sized powered vessels are 42 to 49 ft long. Because their smaller size limits fishing range and hold capacity, they usually operate in the lower (southeastern) end of the NWHI (Mau Zone) or in the MHI. The larger powered vessels are 47 to 64 ft long. With an average fuel capacity of 1,500 gallons, the vessels have a maximum range (round-trip) of 1,800 miles. The average maximum hold capacity is 4,000 pounds.

**TABLE 3-14: Number of Vessels Harvesting Bottomfish by Fishing Area and Port of Landing, 1995.**

| FISHING AREA | PORT OF LANDING | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hawaiʻi | Maui | Lānaʻi | Molokaʻi | Oʻahu | Kauaʻi | Unknown | Total |
| Penguin Bank | 0 | 3 | 0 | 1 | 64 | 0 | 0 | 67 |

| FISHING AREA | PORT OF LANDING | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hawai'i | Maui | Lāna'i | Moloka'i | O'ahu | Kaua'i | Unknown | Total |
| Middle Bank | 0 | 0 | 0 | 0 | 4 | 6 | 0 | 9 |
| Hawai'i | 315 | 1 | 0 | 0 | 4 | 0 | 0 | 317 |
| Maui-Lāna'i-Moloka'i | 0 | 174 | 12 | 26 | 16 | 0 | 0 | 286 |
| O'ahu | 0 | 0 | 0 | 0 | 208 | 0 | 2 | 210 |
| Kaua'i | 0 | 0 | 0 | 0 | 2 | 169 | 0 | 180 |
| NWHI | 0 | 0 | 0 | 0 | 13 | 4 | 1 | 16 |
| Other | 0 | 1 | 0 | 0 | 7 | 4 | 2 | 12 |
| Total | 315 | 178 | 12 | 27 | 271 | 176 | 3 | 963 |

Note: Columns and rows may not sum due to multiple ports of landing and fishing areas for individual license holders.
Source: WPRFMC 1996

Many of the boats that fish in the Mau Zone switch to different fisheries and move to other fishing grounds during the year. The majority of vessels fish in the Mau Zone during a season that generally extends from November to April.

A 1993 survey of participants in the NWHI fishery found that vessels fishing in the Mau Zone made an average of 12.7 trips to the area to target bottomfish and 3.4 trips to target pelagic fish or a mixture of pelagic species and bottomfish (Hamilton 1994). In addition, during that year an average of 5.6 trips were made by these vessels to bottomfish fishing grounds around the MHI. Although bottomfish fishing in the Mau Zone is not the only activity of these boats, it may be vital to the year-round operations of some fishermen.

The fishing strategies and catch levels of vessels fishing in the Ho'omalu Zone tend to be fairly uniform (Pan 1994). The 1993 survey referred to above found that all boats fishing in the Ho'omalu Zone were engaged exclusively in commercial bottomfish fishing (Hamilton 1994). They averaged 9 trips per year to the zone, and the average trip length was about three weeks.

Popular fishing grounds in the Mau Zone include the waters around Nihoa Island and Necker Island (Table 3-15). Especially productive fishing areas in the Ho'omalu Zone are Brooks Bank, Laysan Island and Gardner Pinnacles. During rough sea conditions bottomfish fishing vessels that take refuge and fish in the relatively sheltered waters around FFS (WPRFMC 2000a).

**TABLE 3-15: Approximate Percentage of Total Catch in NWHI Bottomfish Fishery from Selected Areas Based on Historical Fishing Data**

| AREA | PERCENT OF TOTAL CATCH |
|---|---|
| Nihoa Island and Twin Banks | 16.6 |
| Brooks Bank and St. Rogatien Bank | 14.2 |
| Laysan Island | 13.6 |
| Necker Island | 13 |
| Gardner Pinnacles | 12.9 |
| Lisianski Island | 6.8 |
| French Frigate Shoals | 5.6 |
| Kure Atoll | 4.4 |
| Maro Reef | 4.2 |
| Pioneer Bank | 4 |
| Raita Bank | 2.6 |
| Pearl and Hermes Reef | 2.1 |
| Midway Atoll | 0 |

Note: Percentages from NMFS landings data for 1997-1999.
Source: M. Mitsuyasu pers. comm. 2000. WPRFMC

### 3.5.1.3 Harvest

#### *3.5.1.3.1 MHI*

Only commercial landings data are available for the MHI fishery because the State of Hawai'i does not require a saltwater recreational fishing license and there are no state or federal reporting requirements for recreational fishing in the waters around Hawai'i (Section 3.9.1). It is estimated that the recreational/subsistence catch in the MHI bottomfish fishery is about equal to the commercial catch (WPRFMC 1999). Charter boat operators are considered to be commercial fishermen under Hawai'i statute and therefore are required to submit monthly catch reports. Consequently, charter boat catches are included in estimates of commercial landings.

Based on recent (1998-2002) harvest data, commercial bottomfish catches in the MHI fishery represent approximately 60 percent of the total commercial bottomfish harvest in Hawai'i (WPRFMC 2004). The annual bottomfish harvest in the MHI has been fairly stable for the past 10 years (Figure 3-8; Table 3-16). However, the catch per unit effort (CPUE, in pounds landed per trip) in the MHI fishery shows a long-term decreasing trend, with current values approximately 25% that of the first recorded estimates (Figure 3-9; Table 3-17). MHI CPUE values decreased in 2002 by about 8% from the 2001 level, but remained above the 1996-1998 values, which were the lowest on record. The 1999 increase in MHI CPUE was due primarily to a large increase in *uku*, and to a lesser degree *onaga*, catches and catch rates. This relative peak in CPUE is similar to that of the late 1980s, which was due to increased *uku* catch rates alone, and may not indicate an increase in abundance of other species in either case. Rapid decreases in CPUE from the 1989-90 *uku*-derived peaks appear to be a return to the prevailing slow decline (WPRFMC 2004).

**TABLE 3-16: Commercial Bottomfish Landings in the MHI and NWHI 1986-2002** (1000 lb)

| YEAR | MAU | HO'OMALU | MHI[2] |
|---|---|---|---|
| 1986 | NA | NA | 810 |
| 1987 | NA | NA | 784 |
| 1988 | NA | NA | 1164 |
| 1989 | 118 | 184 | 1006 |
| 1990 | 249 | 173 | 646 |
| 1911 | 103 | 283 | 548 |
| 1921 | 71 | 353 | 587 |
| 1931 | 98 | 287 | 348 |
| 1941 | 160 | 283 | 458 |
| 1951 | 166 | 202 | 440 |
| 1961 | 135 | 176 | 440 |
| 1971 | 105 | 241 | 513 |
| 1981 | 66 | 266 | 479 |
| 1992 | 54 | 269 | 455 |
| 2000 | 49 | 213 | 497 |
| 2001 | 50 | 236 | 367 |
| 2002 | 108 | 120 | 362 |
| mean | 109.43 | 234.71 | 582.55 |
| s.d. | 55.32 | 60.84 | 232.03 |

Notes: 1. NWHI data from combination NMFS and HDAR; 2. Data from HDAR
Source: WPRFMC 2004

# TABLE 3-17: Bottomfish CPUE in the MHI and NWHI, 1948-2002 (lb/trip)

| YEAR | MHI | MAU | HO'OMALU | YEAR | MHI | MAU | HO'OMALU |
|---|---|---|---|---|---|---|---|
| 1948 | 614 | 5968 | 14635 | 1977 | 527 | 4387 | 4000 |
| 1949 | 713 | 6788 | 4614 | 1978 | 635 | 4753 | 3550 |
| 1950 | 677 | 4966 | 6072 | 1979 | 380 | 5361 | 4951 |
| 1951 | 621 | 4980 | 8228 | 1980 | 421 | 6210 | 6687 |
| 1952 | 577 | 7407 | 4766 | 1981 | 416 | 1336 | 8167 |
| 1953 | 645 | 8937 | 7627 | 1982 | 307 | NA | 7953 |
| 1954 | 887 | 6158 | 8613 | 1983 | 214 | 2242 | 3025 |
| 1955 | 755 | 4659 | 9336 | 1984 | 220 | 4308 | 4085 |
| 1956 | 784 | 2523 | 5202 | 1985 | 230 | 4239 | 5909 |
| 1957 | 789 | 3958 | 1535 | 1986 | 274 | 2206 | 5301 |
| 1958 | 533 | NA | 6254 | 1987 | 237 | 2889 | 8187 |
| 1959 | 519 | NA | 5897 | 1988 | 329 | 2136 | 4702 |
| 1960 | 630 | 6379 | 8139 | 1989 | 361 | 5412 | 5328 |
| 1961 | 496 | 6999 | 7978 | 1990 | 245 | 4454 | 4793 |
| 1962 | 491 | 4641 | NA | 1991 | 202 | 2413 | 5928 |
| 1963 | 518 | 6410 | NA | 1992 | 228 | 2092 | 7388 |
| 1964 | 619 | 8028 | 8390 | 1993 | 213 | 1992 | 8040 |
| 1965 | 503 | 6656 | NA | 1994 | 218 | 3748 | 4651 |
| 1966 | 536 | 4413 | NA | 1995 | 193 | 2460 | 5544 |
| 1967 | 602 | 14749 | NA | 1996 | 125 | 2823 | 5870 |
| 1968 | 478 | 6055 | NA | 1997 | 176 | 3294 | 5234 |
| 1969 | 480 | 11484 | NA | 1998 | 130 | 2518 | 5198 |
| 1970 | 433 | 7111 | NA | 1999 | 209 | 2926 | 4605 |
| 1971 | 433 | 4784 | NA | 2000 | 187 | 2654 | 5212 |
| 1972 | 514 | 2386 | NA | 2001 | 194 | 2066 | 5300 |
| 1973 | 421 | 3224 | NA | 2002 | 179 | 2496 | 4651 |
| 1974 | 329 | 3367 | NA | mean | 428 | 4703 | 6135 |
| 1975 | 430 | 5439 | NA | s.d. | 195 | 2510 | 2199 |
| 1976 | 485 | 4653 | NA | | | | |

Source: WPRFMC 2004

**FIGURE 3-8: Commercial Landings of Bottomfish in the MHI and NWHI Bottomfish Fisheries, 1986-2002**

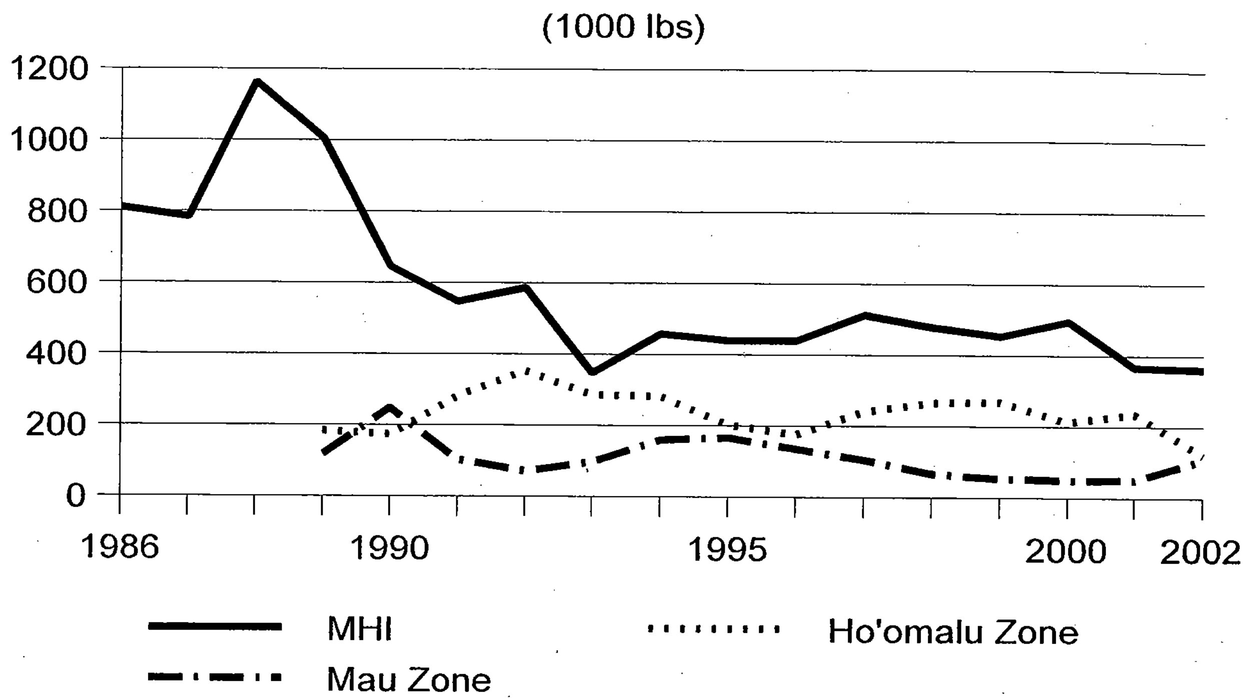
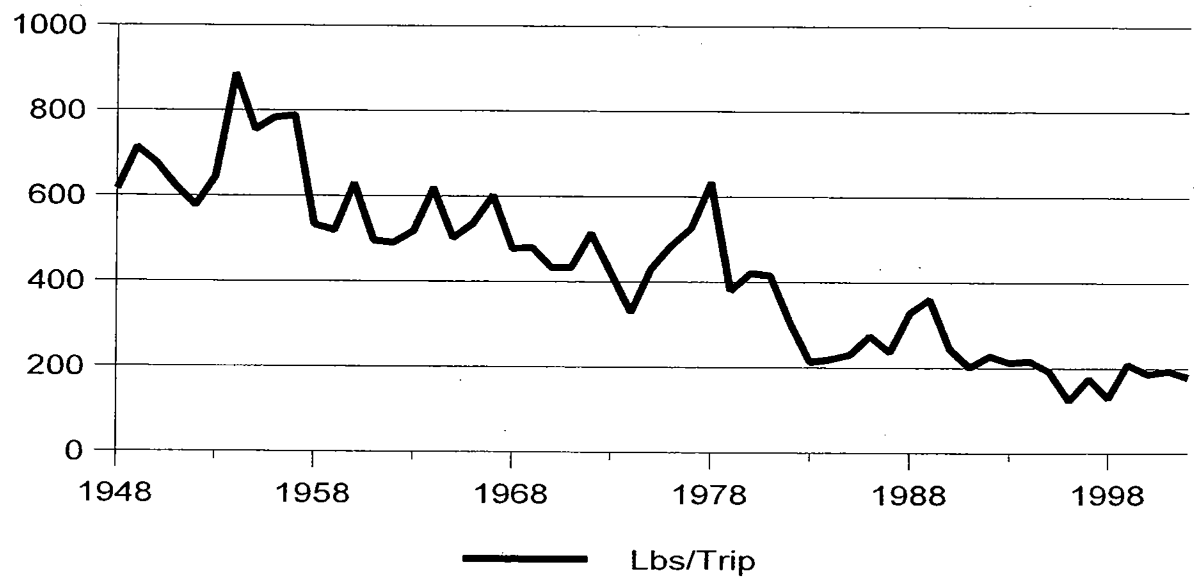



**FIGURE 3-9: Catch Per Unit Effort in the MHI Bottomfish Fishery, 1948-2002**



*3.5.1.3.2 NWHI*

Virtually all of the bottomfish caught in the NWHI fishery are sold, and therefore are required to be reported under State of Hawai'i law (Section 3.9.1). Total NWHI bottomfish landings grew dramatically in the mid-1980s and then tailed off, stabilizing in the 1990s at a level slightly below the MHI bottomfish landings (Figure 3-8; Table 3-16).

The ex-vessel sales of BMUS in 2002 clearly show the substantial effects of changes in fishing strategy and participation in the fishery. The overall vessel sales reports indicate that the total NWHI BMUS landings were substantially lower in 2002 (Table 3-16). A single vessel dropped out of each management zone with varying effects on the overall zone landings. Although the Mau Zone lost a vessel, there were some vessels that did increase their targeting of bottomfish contrary to their usual pelagic species/mixed species targeting strategy. The BMUS landings in the Mau Zone increased by 116% (Table 3-17) while the number of trips increased by 38%. The Ho'omalu Zone lost a single participating highliner[16] vessel and the effects of that loss were realized in the 49% decrease in landings from that zone (Table 3-17). The number of trips there decreased by 36%.

The Mau Zone 2002 average landings per trip increased by about 500 lbs (Table 3-17; Figure 3-10) or 54% over 2001. Most of the major BMUS landings increased substantially, with only *ehu* and *butaguchi* landings categories decreasing (WPRFMC 2004). Trip lengths varied by vessel and trip strategy/target. Most of the trips incorporated some trolling activity.

The Ho'omalu Zone 2002 BMUS landings per trip fell by 19%, as one highliner vessel dropped out of the fleet (Table 3-17; Figure 3-10). Up until 2002 the Ho'omalu Zone fleet had very stable participation and landings for the last 7-8 years.

In the Mau Zone, trip CPUE dropped 14 percent from 1999 values to about 42 percent of early values. On a catch-per-day basis[17] (Figure 3-11; Table 3-18), the 2000 Mau Zone CPUE dropped 23 percent to 61 percent of earliest values. Declines in CPUE for this zone may be largely due to the departure of highliners and greater concentration on other fishing methods, e.g., trolling, by participants.

[16]A highliner is one of the most successful vessels in the fleet.

[17]Data collected by HDAR and used for the MHI CPUE estimates do not include trip length. The NWHI bottomfish trip logs collected by NMFS include trip length, and this provides a more standardized measure of CPUE.

**FIGURE 3-10: Catch Per Unit Effort of Vessels Fishing in the Mau Zone and Ho'omalu Zone, 1948-2002 (HDAR Data)**

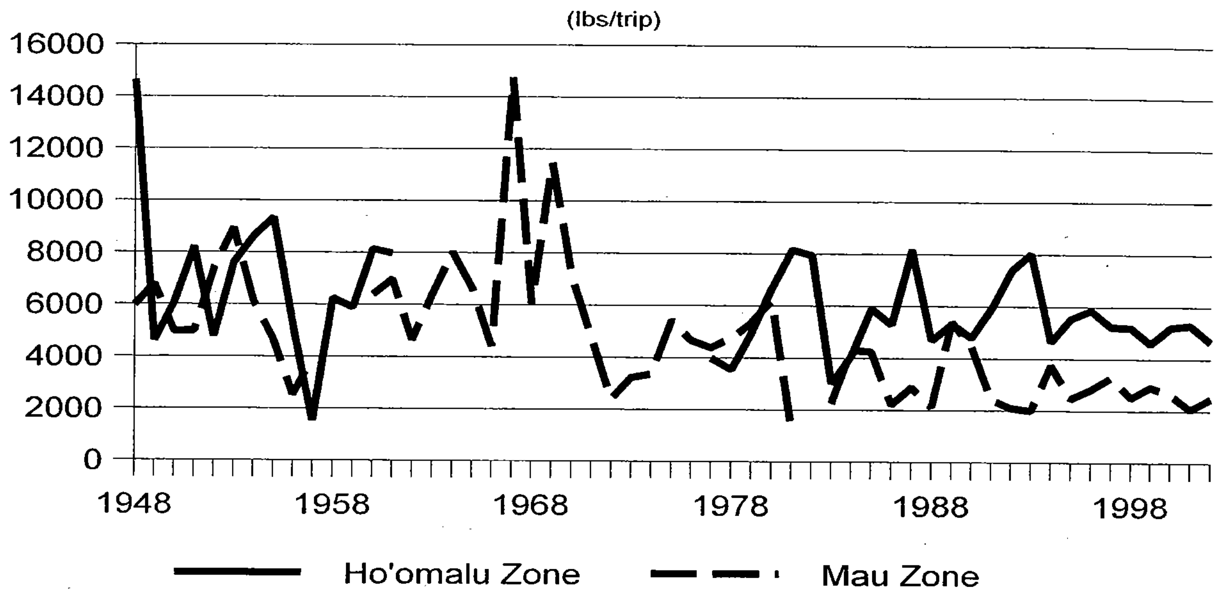
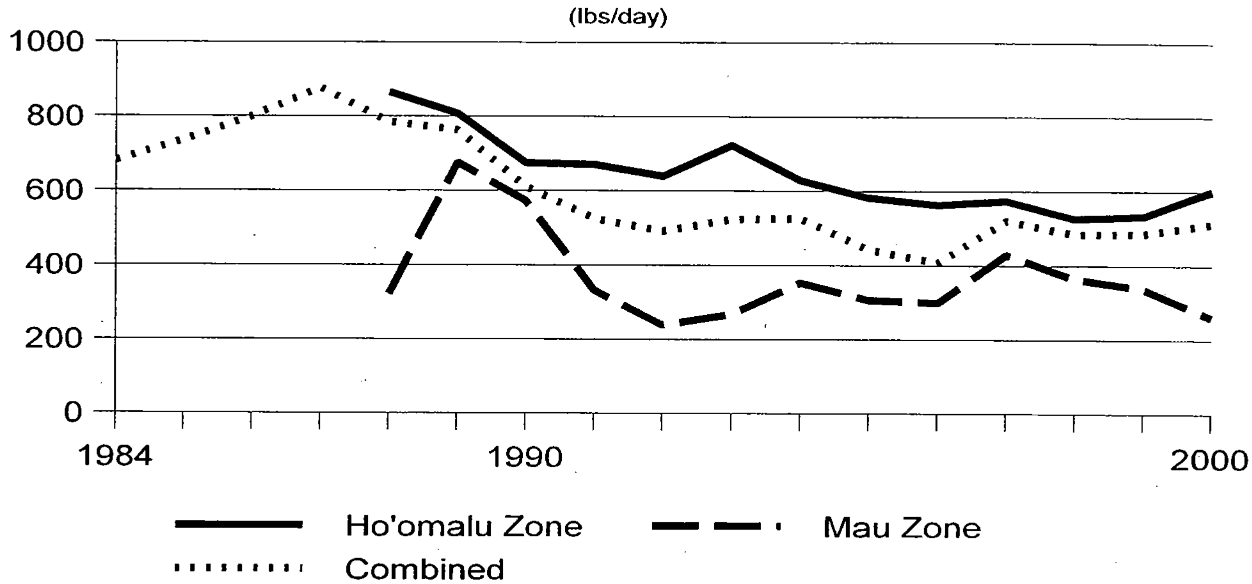



**TABLE 3-18: Bottomfish CPUE in the MHI and NWHI, 1984-2000** (lb/day)

| YEAR | MAU | HO'OMALU | COMBINED | YEAR | MAU | HO'OMALU | COMBINED |
|---|---|---|---|---|---|---|---|
| 1984 | NA | NA | 682 | 1993 | 267 | 723 | 523 |
| 1985 | NA | NA | 736 | 1994 | 353 | 629 | 526 |
| 1986 | NA | NA | 800 | 1995 | 306 | 582 | 442 |
| 1987 | NA | NA | 877 | 1996 | 298 | 563 | 407 |
| 1988 | 322 | 866 | 786 | 1997 | 429 | 574 | 521 |
| 1989 | 677 | 808 | 763 | 1998 | 364 | 527 | 484 |
| 1990 | 573 | 675 | 611 | 1999 | 337 | 534 | 486 |
| 1991 | 333 | 671 | 525 | 2000 | 260 | 601 | 513 |
| 1992 | 239 | 639 | 491 | mean | 366 | 645.54 | 602.24 |
| | | | | s.d. | 126.81 | 102.99 | 140.02 |

Source: WPRFMC 2003

**FIGURE 3-11: Catch Per Unit Effort of Vessels Fishing in the Mau Zone and Ho'omalu Zone, 1984-2000 (NMFS Data)**




## 3.5.1.4 Participation

### *3.5.1.4.1 MHI*

The number of fishermen engaged in bottomfish fishing in the MHI increased dramatically in the 1970s and 1980s but then declined in the early-1990s, rebounded somewhat in the late 1990s, but in 2002 reached its lowest level since 1977 (Figure 3-12; Table 3-19). The decline in vessels and fishing effort may be due to the long-term decrease in catch rates in the bottomfish fishery and a shift of fishing effort towards tuna and other pelagic species.

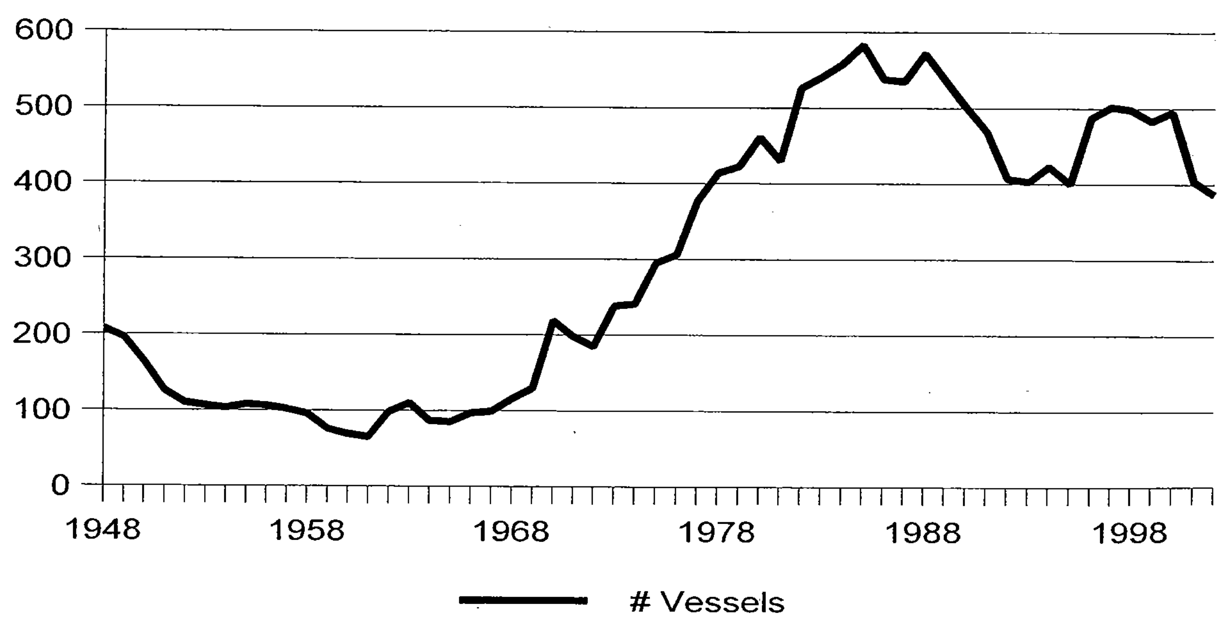
**TABLE 3-19: Number of Commercial Vessels in the MHI Bottomfish Fishery, 1948-2002**

| YEAR | # VESSELS | YEAR | # VESSELS | YEAR | # VESSELS |
|---|---|---|---|---|---|
| 1948 | 207 | 1968 | 116 | 1988 | 572 |
| 1949 | 196 | 1969 | 130 | 1989 | 537 |
| 1950 | 164 | 1970 | 219 | 1990 | 501 |
| 1951 | 126 | 1971 | 198 | 1991 | 469 |
| 1952 | 110 | 1972 | 185 | 1992 | 407 |
| 1953 | 106 | 1973 | 238 | 1993 | 403 |

| YEAR | # VESSELS | YEAR | # VESSELS | YEAR | # VESSELS |
|---|---|---|---|---|---|
| 1954 | 103 | 1974 | 241 | 1994 | 423 |
| 1955 | 108 | 1975 | 295 | 1995 | 400 |
| 1956 | 106 | 1976 | 306 | 1996 | 487 |
| 1957 | 102 | 1977 | 377 | 1997 | 502 |
| 1958 | 96 | 1978 | 414 | 1998 | 498 |
| 1959 | 76 | 1979 | 423 | 1999 | 483 |
| 1960 | 69 | 1980 | 461 | 2000 | 495 |
| 1961 | 65 | 1981 | 430 | 2001 | 404 |
| 1962 | 98 | 1982 | 526 | 2002 | 386 |
| 1963 | 110 | 1983 | 541 | mean | 299 |
| 1964 | 87 | 1984 | 558 | s.d. | 179 |
| 1965 | 85 | 1985 | 583 | | |
| 1966 | 97 | 1986 | 538 | | |
| 1967 | 99 | 1987 | 535 | | |

Source: WPRFMC 2004

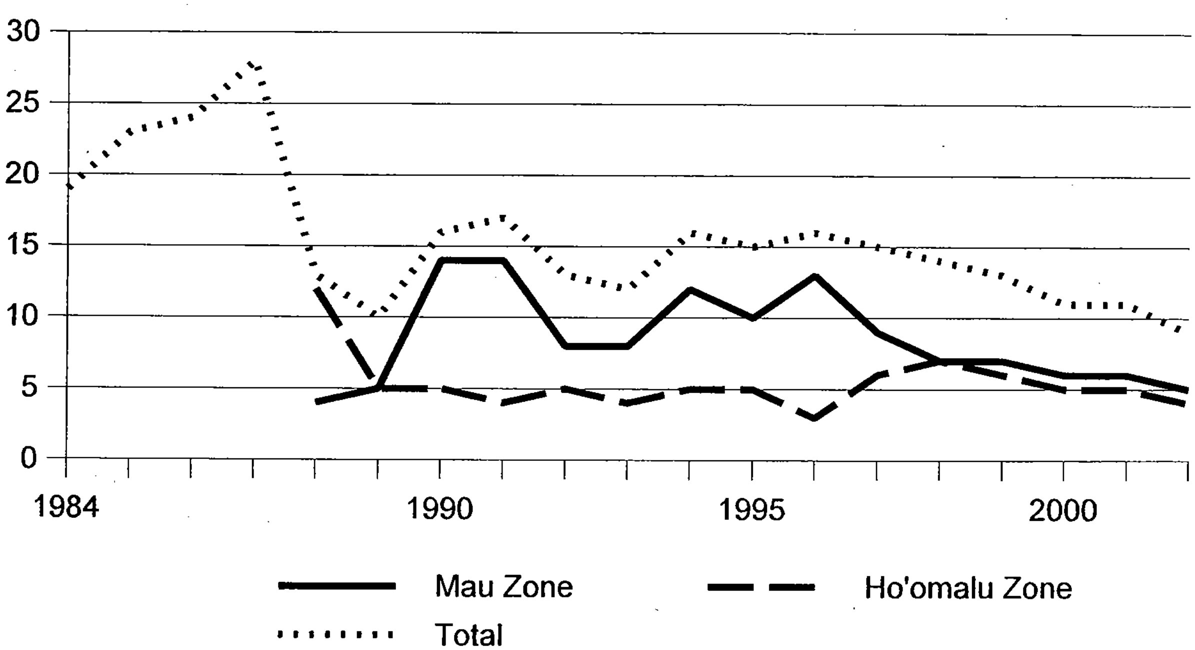
**FIGURE 3-12: Number of Vessels Participating in the MHI Bottomfish Fishery, 1948-2002**



*3.5.1.4.2 NWHI*

Since the NWHI bottomfish fishing grounds were divided into the Mau Zone and Ho'omalu Zone in 1988, the Mau Zone has generally seen a greater share of the fishing effort as access to the Ho'omalu Zone was restricted under a limited access program (WPRFMC 1999). Only five vessels harvested bottomfish in the Mau Zone in 1989, but during the 1990s an average of ten vessels fished in the area (Figure 3-13; Table 3-20). The amount of effort (fishing days) expended in the Mau Zone has fluctuated along with the number of active vessels. Mau Zone activity levels peaked in 1994 with a total of 594 fishing days as a result of a combination of relatively large fleet size and intensive activity by each vessel.

**FIGURE 3-13: Number of Vessels Fishing in the Mau Zone and Ho'omalu Zone, 1984-2002**



## TABLE 3-20: Number of Vessels in the NWHI Bottomfish Fishery, 1984-2003

| YEAR | MAU | HO'OMALU | TOTAL | YEAR | MAU | HO'OMALU | TOTAL[2] |
|---|---|---|---|---|---|---|---|
| 1984 | NA | NA | 19 | 1995[1] | 10 | 5 | 15 |
| 1985 | NA | NA | 23 | 1996[3] | 13 | 3 | 16 |
| 1986 | NA | NA | 24 | 1997[3] | 9 | 6 | 15 |
| 1987 | NA | NA | 28 | 1998[2] | 7 | 7 | 13 |
| 1988 | 4 | 12 | 13 | 1999[3] | 7 | 6 | 13 |
| 1989 | 5 | 5 | 10 | 2000[3] | 6 | 5 | 11 |
| 1990 | 14 | 5 | 16 | 2001[3] | 6 | 5 | 11 |
| 1991[1] | 14 | 4 | 17 | 2002[3] | 5 | 4 | 9 |
| 1992[1] | 8 | 5 | 13 | mean | 8.53 | 5.33 | 15.47 |
| 1993[1] | 8 | 4 | 12 | s.d. | 3.36 | 2.02 | 5 |
| 1994[1] | 12 | 5 | 16 | | | | |

Notes: 1. Based on a combination of NMFS and HDAR data; 2. Total may not match sum of areas due to vessel participation in both areas; 3. Based on HDAR data; Source: WPRFMC 2004

Eighty-one permits to fish in the Mau Zone have been issued since 1989, but only 37 of the permits were actually used. The turn-over rate has been high, with only 38% of the 37 active vessels fishing in the Mau Zone for more than two years (Table 3-21). A limited access program was established for the Mau Zone in 1999, and currently ten vessels are allowed to fish in the area. Permits to fish in the Mau Zone are non-transferable and subject to a use-it-or-lose-it requirement. At present, there is no procedure for issuance of new Mau Zone limited access permits. Alternative 1B contains a procedure recommended by the Council (see Section 2.3.5.2)

## TABLE 3-21: Entry and Exit Pattern of Vessels Fishing in the Mau Zone, 1989-2003

| Permit Holder/Vessel | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 1999 | 0 | 01 | 02 | 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | x | x | x | x | x | x | x | x | | | | |
| 2 | | | | | | x | | | | x | x | | | | |
| 3 | | | | | x | x | x | | | | | | | | |
| 4 | | x | | x | | x | x | | | | | | | | |
| 5 | | x | | | | x | | | | | | | | | |
| 6 | | x | | | | | | | | | | | | | |

| Permit Holder/Vessel | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 19 99 | 0 | 01 | 02 | 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | | | | x | | | | | | | | | | | |
| 8 | | | x | x | | x | | | | | | | | | |
| 9 | | | x | | | | | | | | | | | | |
| 10 | | | x | | x | x | | | | | x | x | x | x | x |
| 11 | | x | | | | | | | | | | | | | |
| 12 | | | | | x | | | x | | x | x | x | x | x | x |
| 13 | | | x | x | x | x | x | | | | | | | | |
| 14 | | | | | | | x | x | x | | | x | x | x | x |
| 15 | | | x | x | | | | | | | | | | | |
| 16 | | | | | | | x | x | x | x | x | x | x | x | x |
| 17 | | x | | | | | | | | | | | | | |
| 18 | | x | x | | | | | | | | | | | | |
| 19 | | | | | | x | x | x | x | | | | | | |
| 20 | x | | | | | | | | | | | | | | |
| 21 | | x | x | | | | | | | | | | | | |
| 22 | | | | | | | | x | | x | | | | | |
| 23 | | | x | x | | | | | | | | | | | |
| 24 | | x | x | | | | | | | | | | | | |
| 25 | | x | | | | | | | | | | | | | |
| 26 | x | x | x | | | | | | | | | | | | |
| 27 | | x | x | x | x | x | x | x | | | | | | | |
| 28 | | | x | | | | | | | | | | | | |
| 29 | x | | | | | | | | | | | | | | |
| 30 | | | | | | x | x | x | x | x | x | x | x | x | x |
| 31 | x | | | | | | | | | | | | | | |
| 32 | | | | | | | | x | | | | | | | |
| 33 | | | | | | | | x | | | x | x | x | x | x |
| 34 | | | | | | | | x | x | | | | | | |

| Permit Holder/Vessel | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 19 99 | 0 | 01 | 02 | 03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | | | | | | | | | x | | | | | | |
| 36 | | | | | | | | | x | | | | | | |
| 37 | | | | | | | | | x | | | | | | |

[1] An "x" appears in those years in which the permit holder fished in the Mau Zone.
Source: A. Katekaru, pers. comm. 2004. NMFS-PIRO

A limited access program was established for the Ho'omalu Zone in 1989. Since 1995, the number of vessels allowed to fish in the area has been set at seven. Permits to fish in the Ho'omalu Zone are non-transferable and subject to a use-it-or-lose-it requirement. New Ho'omalu Zone limited access permits are issued based on a point system (see Section 2.3.4).

Since 1989, 17 permits to fish in the Ho'omalu Zone have been issued, of which 15 have been used. In comparison to the Mau Zone, the Ho'omalu Zone exhibits more continuity in participation, but the turnover has still been fairly high. Only about half of the active vessels fished in the Ho'omalu Zone for more than two years. (Table 3-22). Currently four vessels are active in the fishery.

**TABLE 3-22: Entry and Exit Pattern of Vessels Fishing in the Ho'omalu Zone, 1989-2003**

| Permit Holder/Vessel | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | x | | | | | | | | | | | | | | |
| 2 | x | x | x | x | x | x | x | x | x | x | | | | | |
| 3 | x | x | x | x | x | | | | | | | | | | |
| 4 | | | | | | | | | x | x | x | | | | |
| 5 | | | | | | x | x | | | | | | | | |
| 6 | | | | | | | | | | x | | | | | |
| 7 | x | x | x | x | x | x | x | x | x | x | x | x | x | | |
| 8 | | | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 9 | x | | | | | | | | | | | | | | |
| 10 | | | | | | | | | x | x | x | x | x | x | x |
| 11 | | | | | | | x | | | | | | | | |
| 12 | | | | | | | | | | | x | x | x | x | x |
| 13 | x | | | x | | | | | x | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | | | | | | x | x | | | | | | | | |
| 15 | | | | | | | | | | | x | x | x | x | x |

[1] An "x" appears in those years in which the permit holder fished in the Ho'omalu Zone.
Source: A. Katekaru, pers. comm. 2004. NMFS-PIRO.

## 3.5.1.5 Economic Performance

### *3.5.1.5.1 MHI*

Inflation-adjusted gross revenue in the MHI bottomfish fishery grew steadily in the 1980s (Figure 3-14; Table 3-23) as a result of increases in both real prices and landings (WPRFMC 2003). However, between 1988 and 1993, revenue in the MHI fishery decreased sharply as both MHI bottomfish prices and landings declined. Historically, bottomfish catches from the MHI have tended to command higher aggregate prices than those caught in the NWHI (Table 3-23), reflecting a larger proportion of preferred species and greater freshness. In the late 1990s, however, the prices appeared to converge, perhaps due to the softness of the upscale part of the Hawai'i market as the state's economic recession continued (WPRFMC 1999). In recent (1995-2000) years, the annual ex-vessel value of bottomfish landings in the MHI fishery has averaged about $1.7M.

As noted above, the recreational/subsistence catch in the MHI bottomfish fishery is estimated to be about equal to the commercial catch. The majority of participants in the MHI fishery appear to be small boat fishermen who for several years have relied on the bottomfish fishery for a portion of their subsistence needs or household earnings or simply to earn enough money to cover their fishing expenses. No data on the profitability of commercial operations in the MHI fishery are available, nor is there information on the non-market value of subsistence or recreational bottomfish fishing activity around the MHI. However, it is likely that without the supplement to basic incomes obtained from subsistence or part-time commercial fishing, many of these fishermen would face economic hardships in Hawai'i's expensive economic climate.

As the result of an influx of new charter boat operators over the past two decades Hawai'i's charter boat industry has become highly competitive (Hamilton 1998; Walker 1996). In harbors such as Honokōhau the charter fleet has become so large that it is extremely difficult for any one operation to succeed.

### *3.5.1.5.2 NWHI*

As shown in Figure 3-14 and Table 3-23, the inflation-adjusted gross revenue in the NWHI fishery grew dramatically in the mid-1980s and then declined as landings fell. Inflation-adjusted revenue in 2002 was only 20% of the 1987 peak. In recent years, the annual ex-vessel value of bottomfish landings in the NWHI fishery has averaged about $1M.

Inflation-adjusted revenue from the MHI bottomfish fishery are steadily through the 1970s and 1980s as both *real* prices and total landings increased substantially. Beginning in 1988, total landings began to decline, falling almost 60% in the subsequent decade.

Revenue from the MHI fishery was always greater than that from the NWHI. Before the mid-1980s, MHI bottomfish revenue made up over 80% of the total Hawaiʻi bottomfish revenue. The proportion declined due to a dramatic increase of NWHI bottomfish landings in the mid-1980s, and the MHI revenue was about 50% of the total during the period 1985-87. Since then, revenues in both areas have declined, but revenue from the MHI fishery remains above that of the NWHI. It was 64% of the total in 2002.

**FIGURE 3-14: Inflation-adjusted Gross Revenue in the MHI and NWHI Bottomfish Fisheries, 1984-2002**

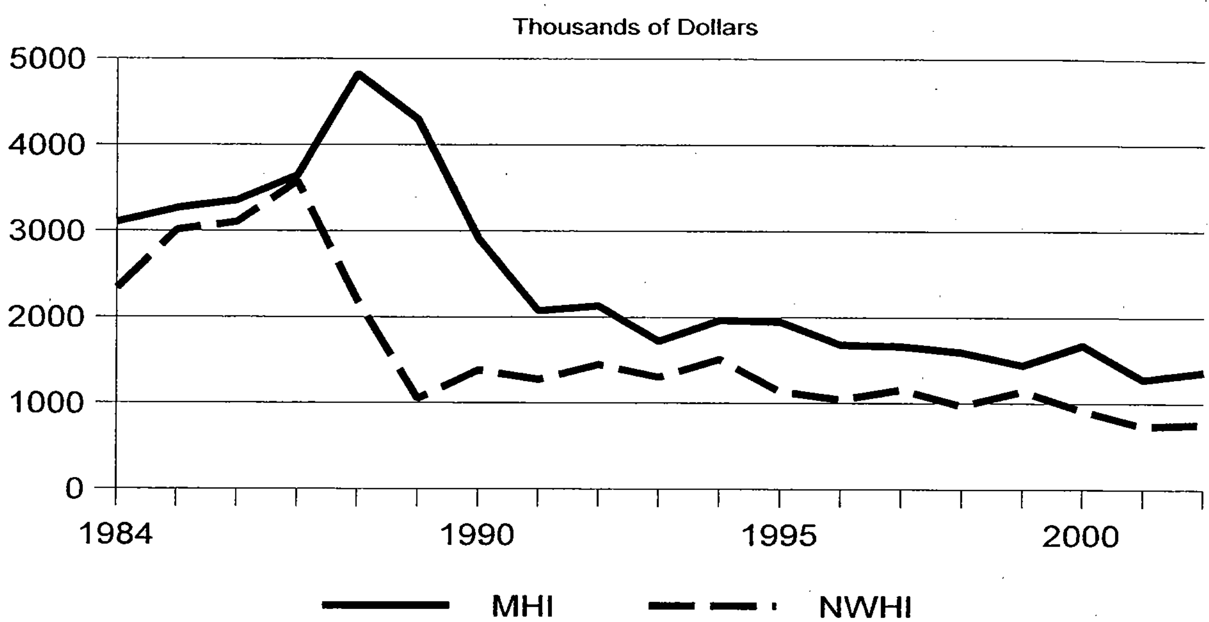



**FIGURE 3-15: Inflation-adjusted Gross Revenue per Trip of Vessels Bottomfish Fishing in the Mau Zone and Ho'omalu Zone, 1989-2002**

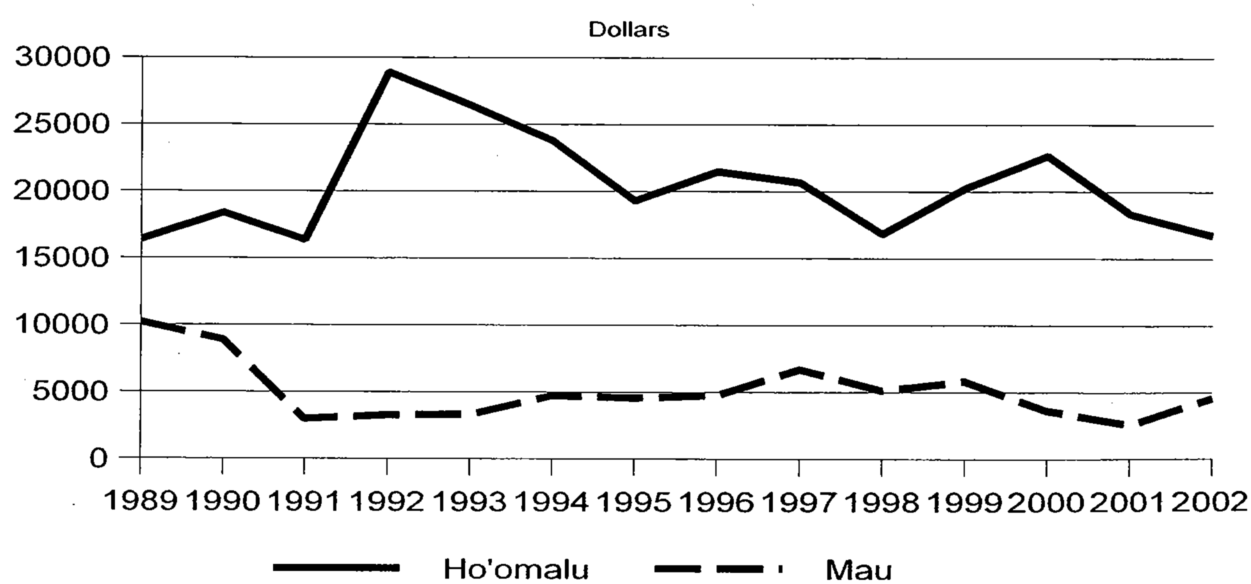


**TABLE 3-23: Inflation-adjusted BMUS Revenue and Price, MHI and NWHI, 1984-2000**

| YEAR | MHI REVENUE (1,000$) | NWHI REVENUE (1,000$) | MHI PRICE | NWHI PRICE |
|---|---|---|---|---|
| 1984 | 3106 | 2334 | 4.11 | 3.53 |
| 1985 | 3265 | 3008 | 4.55 | 3.26 |
| 1986 | 3354 | 3106 | 4.43 | 3.58 |
| 1987 | 3648 | 3578 | 4.88 | 3.53 |
| 1988 | 4828 | 2202 | 4.36 | 3.52 |
| 1989 | 4296 | 1051 | 4.57 | 3.48 |
| 1990 | 2910 | 1384 | 4.88 | 3.27 |
| 1991 | 2074 | 1275 | 4.06 | 3.29 |
| 1992 | 2130 | 1451 | 3.93 | 3.42 |
| 1993 | 1722 | 1306 | 4.04 | 3.39 |
| 1994 | 1963 | 1513 | 4 | 3.42 |
| 1995 | 1946 | 1135 | 3.73 | 3.07 |
| 1996 | 1680 | 1043 | 4.13 | 3.37 |
| 1997 | 1664 | 1158 | 3.55 | 3.35 |
| 1998 | 1594 | 971 | 3.65 | 3.12 |
| 1999 | 1448 | 1146 | 3.57 | 3.56 |
| 2000 | 1678 | 922 | 3.75 | 3.76 |
| 2001 | 1279 | 733 | 3.7 | 3.13 |
| 2002 | 1364 | 759 | 4.04 | 3.13 |

Note: 2001 and 2002 data are preliminary. Source: WPRFMC 2004

**TABLE 3-24: Inflation-adjusted Revenue per Trip, Mau and Ho'omalu Zones, 1989-2000**

| YEAR | MAU ZONE ($) | HO'OMALU ZONE ($) |
|---|---|---|
| 1989 | 14195 | 16387 |

| YEAR | MAU ZONE ($) | HO'OMALU ZONE ($) |
|---|---|---|
| 1990 | 11558 | 18387 |
| 1991 | 3610 | 16364 |
| 1992 | 3785 | 28900 |
| 1993 | 3733 | 26397 |
| 1994 | 5196 | 23762 |
| 1995 | 4908 | 19294 |
| 1996 | 5016 | 21496 |
| 1997 | 7017 | 20664 |
| 1998 | 5390 | 16817 |
| 1999 | 6064 | 20255 |
| 2000 | 3722 | 22677 |
| 2001 | 2591 | 18339 |
| 2002 | 4576 | 16746 |

Notes: Data are compiled from NMFS shoreside market monitoring for 1984-95 and then combined with HDAR data for 1996-97. Since 1998, data are compiled from HDAR figures. Revenue is adjusted for inflation to the current base year by the Honolulu consumer price index. 2001 and 2002 data are preliminary. Source: WPRFMC 2004

Independent, owner-operator fishing operations prevail in both zones of the NWHI bottomfish fishery. In 1988, a limited access program was established for the Ho'omalu Zone, the primary motivation for which was avoidance of economic overfishing (Pooley 1993b). When the limited access program provisions began to take effect in 1989-91, the revenue per trip for Ho'omalu Zone vessels rose dramatically (Figure 3-15; Table 3-24). Since that time the revenue per trip in the Ho'omalu Zone has consistently been higher than that of the Mau Zone.

Estimates of annual net revenue for vessels operating in the Mau Zone and Ho'omalu Zone were first presented in a 1993 cost-earnings profile of the NWHI bottomfish fishery (Hamilton 1994). The study revealed that on average Ho'omalu Zone vessels realized a positive return of $2,238 per vessel in 1993 while Mau Zone vessels averaged a loss of $21,947 per vessel. The principal factor explaining the disparity in the economic performance of vessels operating in the two zones was the difference in catch rates (Pan 1994). In comparison to boats fishing in the Mau Zone, boats operating in the Ho'omalu Zone caught more fish per fishing day and more of their catch consisted of high-valued bottomfish such as *onaga* and *'ōpakapaka*.

Since 1993 however, the revenues of Ho'omalu Zone vessels have shown a downward trend due to decreasing catch rates for some species, particularly the high-priced *ʻōpakapaka* (Figure 3-14). As a result of this decrease in revenues, in recent years the average vessel fishing in the Hoʻomalu Zone has failed to cover its total annual costs through bottomfish fishing (WPRFMC 2003). In 2000, Hoʻomalu vessels averaged a loss of $38,047 per vessel (Table 3-25). The average vessel earned a positive return on operations, and presumably vessel owners derive sufficient income from other economic activities to cover fixed costs.

**TABLE 3-25: Average Income Statement for Vessels Fishing in the Mau Zone and Hoʻomalu Zone, 2000** (Source: WPRFMC 2003)

| CATEGORY | MAU ZONE VESSELS | HOʻOMALU ZONE VESSELS |
|---|---|---|
| **Revenue** | **$38,639** | **$148,522** |
| **Fixed Costs:** | | |
| Capital | $4,093 | $18,056 |
| Annual Repair | $4,840 | $12,694 |
| Vessel Insurance | $2,833 | $31,516 |
| Administrative | $1,535 | $7,441 |
| Other | $0 | $1,970 |
| **Total** | **$13,301** | **$71,678** |
| **Operating Costs:** | | |
| Fuel and Oil | $4,158 | $9,958 |
| Ice | $1,094 | $2,298 |
| Bait | $1,641 | $5,253 |
| Handling | $3,900 | $14,900 |
| Provisions | $1,751 | $7,113 |
| Gear and Supplies | $2,407 | $8,426 |
| Other (trip basis) | $3,283 | $10,943 |
| Crew's Income | $6,100 | $35,000 |
| Captain's Income | $8,800 | $21,000 |
| **Total** | **$33,134** | **$114,892** |
| **Net on Operations** | **$5,505** | **$33,631** |

| CATEGORY | MAU ZONE VESSELS | HO'OMALU ZONE VESSELS |
|---|---|---|
| **Total Cost** | **$46,435** | **$186,569** |
| **Net Revenue** | **- $7,796** | **- $38,047** |

Updated cost-earnings data for vessels operating in the Mau Zone indicate that the net revenue of the average boat is still negative (Table 3-25). The poor economic performance of a substantial number of Mau Zone vessels has resulted in a considerable turnover pattern of entry and exit (Hamilton 1994). Between 1989 and 1997, over 15 vessels entered and left the fishery (Table 3-21). Because access to the Mau Zone was unrestricted, economic failure of vessels in the fishery did not reduce fishing effort to more appropriate levels (WPRFMC 1998b). Bankrupt vessels were sometimes bought for a fraction of their initial capital cost and returned to the Mau Zone with new owners who believed that reduced capital servicing obligations would give them a competitive edge over other fishermen. In addition, vessels displaced from overfished U.S. mainland fisheries arrived in Hawai'i at a steady rate on a "look-see" basis. These owners and captains were largely unaware of the economic performance of those vessels already fishing in the Mau Zone.

In 1999, a limited access program was established for the Mau Zone to support long-term productivity of bottomfish resources in the zone and to improve the economic stability of the fishery (WPRFMC 1998b). The limited access program is intended to decrease the large reserve of potential effort that could threaten the resources and allow attrition due to market forces and freedom of choice to reduce the Mau Zone fleet to more economically rational levels.

3.5.1.6 Markets

A market for locally caught bottomfish was well-established in Hawai'i by the late nineteenth century (see Section 3.7). Today, fresh bottomfish continues to be an important seafood for Hawai'i residents and visitors. Nearly all bottomfish caught in the NWHI fishery are sold through the Honolulu fish auction (United Fishing Agency, Ltd.). Prices received at the auction change daily, and the value of a particular catch may even depend on the order in which it is placed on the floor for bidding (Hau 1984). Bottomfish caught in the MHI fishery are sold in a wide variety of market outlets (Haight et al. 1993b). Some are marketed through the fish auction in Honolulu and intermediary buyers on all islands. Sales of MHI bottomfish also occur through less formal market channels. For example, local restaurants, hotels, grocery stores and individual consumers are important buyers for some fishermen. In addition to being sold, MHI bottomfish are consumed by fishermen and their families, given to friends and relatives as gifts, and bartered in exchange for various goods and services.

Historically, the demand for bottomfish in Hawai'i has been largely limited to fresh fish. Seventy years ago Hamamoto (1928) remarked on the fact that fish dealers in Honolulu refused to buy fish that had been harvested in the NWHI and frozen on-board because the demand for this product was so low. In the last few years the price differential between frozen and fresh product has narrowed for some species of bottomfish, but it remains substantial for *onaga* and *ehu*, the two highest priced fish. Until the market for frozen bottomfish develops, participants in the NWHI fishery will be caught in the same on-going dilemma – they must stay out long enough to cover trip expenses, but keep the trips short enough to deliver a readily saleable, high-quality product (Pan 1994). In the past, bottomfish catches from the MHI have tended to command higher aggregate prices than those caught in the NWHI, reflecting a larger proportion of preferred species and greater freshness. Bottomfish caught around the MHI are iced for only one to two days before being landed, whereas NWHI fresh catches may be packed in ice for ten days or more. By the late 1990s, however, the prices appeared to converge, perhaps due to the softness of the upscale part of the Hawai'i market as the state's economic recession continued (WPRFMC 1999).

Catches of bottomfish around the MHI typically consist of plate-sized fish preferred by household consumers in Hawai'i and by restaurants where fish are often served with the head on. Bottomfish caught around the NWHI tend to be the medium to large fish (over 5 pounds) preferred for the restaurant fillet market. Because the percent yield of edible material is high, handling costs per unit weight are lower and more uniform portions can be cut from the larger fish.

Pooley (1987) showed that Hawai'i auction market prices increase when MHI landings drop. However, during the 1990s the relationship between price and volume faltered, perhaps due to an increase in imported fresh fish that competed in the market with locally-caught bottomfish (WPRFMC 1999). According to U.S. Customs data for the Port of Honolulu, 715,000 pounds of snapper were imported in CY 2002 worth $1.92 million ($2.68 per pound) (WPRFMC 2004). This amount exceeded domestic supplies and thus was a significant factor in ex-vessel prices. Not only has the quantity of foreign-caught fresh fish increased during the last few years, but the number of countries exporting fresh fish to Hawai'i has also increased. A decade ago, for example, fresh snapper was exported to Hawai'i mainly from within the South Pacific region. In recent years Tonga and Australia were the largest sources of fresh snapper, with Fiji and New Zealand also being major sources, but fresh snapper has also been received from Viet Nam, Chad (fresh water) and Madagascar.

### 3.5.2 American Samoa

3.5.2.1 History

Long before the arrival of Europeans in the islands of Samoa the indigenous people of those islands had developed specialized techniques for catching bottomfish from canoes. Some bottomfish, such as *ulua*, held a particular social significance and were reserved for the *matai* (chiefs) (Severance and Franco 1989).

By the 1950s, many of the small boats in American Samoa were equipped with outboard engines, steel hooks were used instead of ones made of pearl shell, and monofilament fishing lines had replaced hand woven sennit lines. However, bottomfish fishing remained largely a subsistence practice. It was not until the early 1970s that the bottomfish fishery developed into a commercial venture (Ralston 1979). Surveys conducted around Tutuila Island from 1967 to 1970 by the American Samoa Office of Marine Resources indicated that the potential existed for developing a small-scale commercial bottomfish fishery. Four major fishing grounds were identified around the island of Tutuila: Taputapu, Matatula, Leone West Banks and Steps Point (Severance and Franco 1989). In 1972, a government-subsidized boat building program was initiated to provide local fishermen with gasoline and diesel powered 24 ft wooden dories capable of fishing for bottomfish in offshore waters. Twenty-three boats were eventually built and used by fishermen. By 1980, however, mechanical problems and other difficulties had reduced the dory fleet to a single vessel (Itano 1996).

In the early 1980s, the 28-ft FAO-designed *alia* catamaran was introduced into American Samoa, and local boat builders began constructing these inexpensive but seaworthy fishing vessels. A recovery in the size of the fishing fleet, together with a government-subsidized development project aimed at exporting deep-water snapper to Hawai'i, caused another notable increase in bottomfish landings (Itano 1996). Between 1982 and 1988, the bottomfish fishery comprised as much as half of the total catch of the local commercial fishery. However, since 1988, the nature of American Samoa's fisheries has changed dramatically, with a shift in importance from bottomfish fishing to trolling and longlining for pelagic species (WPRFMC 1999). Landings trends in the bottomfish fishery have also been periodically adversely impacted by hurricanes. The 1987 hurricane, in particular, damaged or destroyed a large segment of American Samoa's small boat fishing fleet.

3.5.2.2 Fishing Methods and Current Use Patterns

The bottomfish fishery of American Samoa is typically commercial overnight jigging on 28-foot aluminum catamarans using skipjack tuna as bait (WPRFMC 1999). The fishing technology employed by the small boat fleet continues to be relatively unsophisticated. Many of the boats are outfitted with wooden hand reels that are used for both trolling and bottomfish fishing. Less than 10% of the boats carry a depth recorder, electronic fish finder or global positioning system (Severance et al. 1999). Because few of the small boats carry ice they typically fish within twenty miles of shore. In recent years, however, a growing number of fishermen in American Samoa have been acquiring larger (>35 ft) vessels with capacity for chilling or freezing fish and a much greater fishing range. For example, a local non-profit organization recently purchased a 53-ft vessel with a grant from the Administration for Native Americans. The boat will be equipped to catch bottomfish and is to be used to train young American Samoans for fishing occupations (WPRFMC 2000b).

3.5.2.3 Harvest

In recent years, the commercial landings of bottomfish accounted for almost all of the total bottomfish catch. The amount of bottomfish caught for recreational or subsistence purposes was very small. In 2002, there were no recreational or charter landings recorded. The commercial catch declined significantly in 1987, recovered slightly in 1988, but then decreased dramatically again during the early 1990s (Figure 3-16; Table 3-25). The overall decline was due to the effects of hurricanes that struck the territory in 1987, 1990, and 1991, the departure of several highliners from the fishery and a shift by the fleet from bottomfish fishing to trolling for pelagic species (WPRFMC 1999). In addition, fishermen began to experience competition in local markets from fresh bottomfish imported from Samoa and Tonga. In 1991, bottomfish imports exceeded local landings of bottomfish. The significantly greater 1994 total landings, when compared to previous years, occurred primarily because of improved catch recording, an increase in effort by highline vessels and a high fish demand for government and cultural events. However, the 1998 harvest was only 25% of the 17-year average and was the smallest catch since 1992. This decline was primarily due to a shift by highliners in the local fleet from bottomfish fishing to fishing for pelagic species with longline gear. Since 1998 some alias have returned to bottomfish fishing when longline catches and prices for pelagic species declined.

**FIGURE 3-16: Total Landings of Bottomfish in the American Samoa Bottomfish Fishery, 1982-2002**

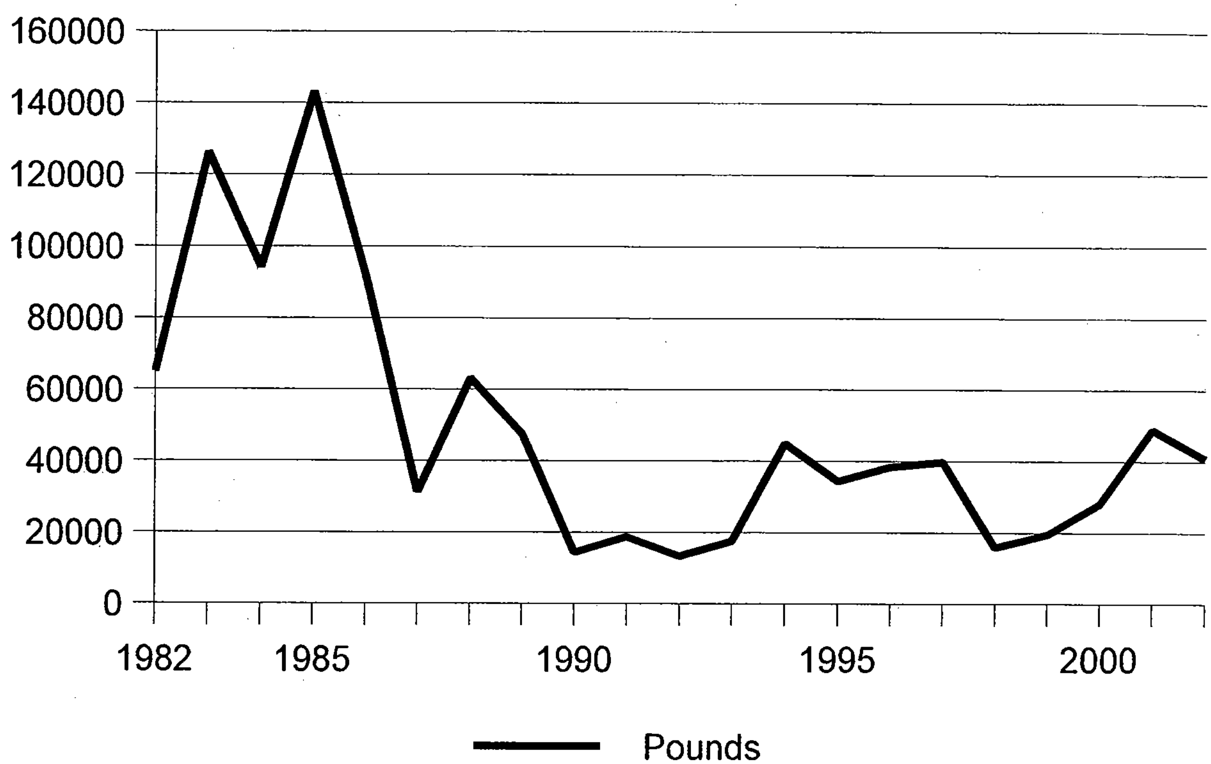



**TABLE 3-26: American Samoa Bottomfish Participation, Landings and CPUE, 1982-2002**

| YEAR | # VESSELS | # TRIPS | LANDINGS (lb) | CPUE (lb/trip-hr) |
|---|---|---|---|---|
| 1982 | 27 | 548 | 64942 | 8.5 |
| 1983 | 38 | 621 | 126327 | 10 |
| 1984 | 48 | 468 | 94104 | 10.7 |
| 1985 | 47 | 1116 | 143225 | 8.1 |
| 1986 | 34 | 717 | 91533 | 8.3 |
| 1987 | 20 | 220 | 31232 | 11.9 |
| 1988 | 27 | 354 | 63251 | 17.3 |

| YEAR | # VESSELS | # TRIPS | LANDINGS (lb) | CPUE (lb/trip-hr) |
|---|---|---|---|---|
| 1989 | 29 | 313 | 47482 | 16.7 |
| 1990 | 19 | 122 | 14303 | 9.2 |
| 1991 | 20 | 145 | 18677 | 9.1 |
| 1992 | 14 | 101 | 13316 | 9.3 |
| 1993 | 22 | 141 | 17518 | 7.3 |
| 1994 | 19 | 341 | 44982 | 7.7 |
| 1995 | 25 | 270 | 34414 | 9.8 |
| 1996 | 26 | 265 | 38519 | 14.8 |
| 1997 | 24 | 290 | 39867 | 14.7 |
| 1998 | 16 | 100 | 15862 | 14 |
| 1999 | 22 | 145 | 19563 | 12.9 |
| 2000 | 17 | 244 | 28215 | 10.2 |
| 2001 | 18 | 342 | 48944 | 15.2 |
| 2002 | 14 | 533 | 40769 | 7.4 |
| mean | 25 | 352 | 49383 | 11.1 |
| s.d. | 9 | 242 | 35689 | 3.11 |

Note: Data are from the DMWR Offshore Creel Survey and reflect all bottomfish caught, not just BMUS.
Source: WPRFMC 2004

## TABLE 3-27: American Samoa Inflation-adjusted Bottomfish Revenue and Price, 1982-2002

| YEAR | REVENUE ($) | PRICE ($/lb) | REVENUE/TRIP ($) |
|---|---|---|---|
| 1982 | 192229 | 3.09 | 312 |
| 1983 | 451790 | 3.61 | 573 |
| 1984 | 274745 | 2.96 | 442 |
| 1985 | 230778 | 2.25 | 246 |
| 1986 | 185265 | 2.04 | 236 |
| 1987 | 68870 | 2.24 | 269 |
| 1988 | 142944 | 2.36 | 338 |
| 1989 | 78495 | 2.17 | 230 |
| 1990 | 27102 | 2.17 | 209 |
| 1991 | 37184 | 2.1 | 189 |
| 1992 | 33333 | 2.51 | 236 |
| 1993 | 36548 | 2.35 | 197 |
| 1994 | 91171 | 2.2 | 201 |
| 1995 | 66929 | 1.97 | 261 |
| 1996 | 76737 | 2.03 | 245 |
| 1997 | 89430 | 2.34 | 206 |
| 1998 | 38124 | 2.65 | 184 |
| 1999 | 45459 | 2.63 | 216 |
| 2000 | 55700 | 2.13 | 211 |
| 2001 | 92459 | 2.38 | 113 |
| 2002 | 75727 | 2.13 | 180 |
| mean | 1113858 | 2.4 | 252 |
| s.d. | 101273 | 0.4 | 97 |

Note: Data are from the DMWR Offshore Creel Survey and reflect all bottomfish caught, not just BMUS.
Source: WPRFMC 2004

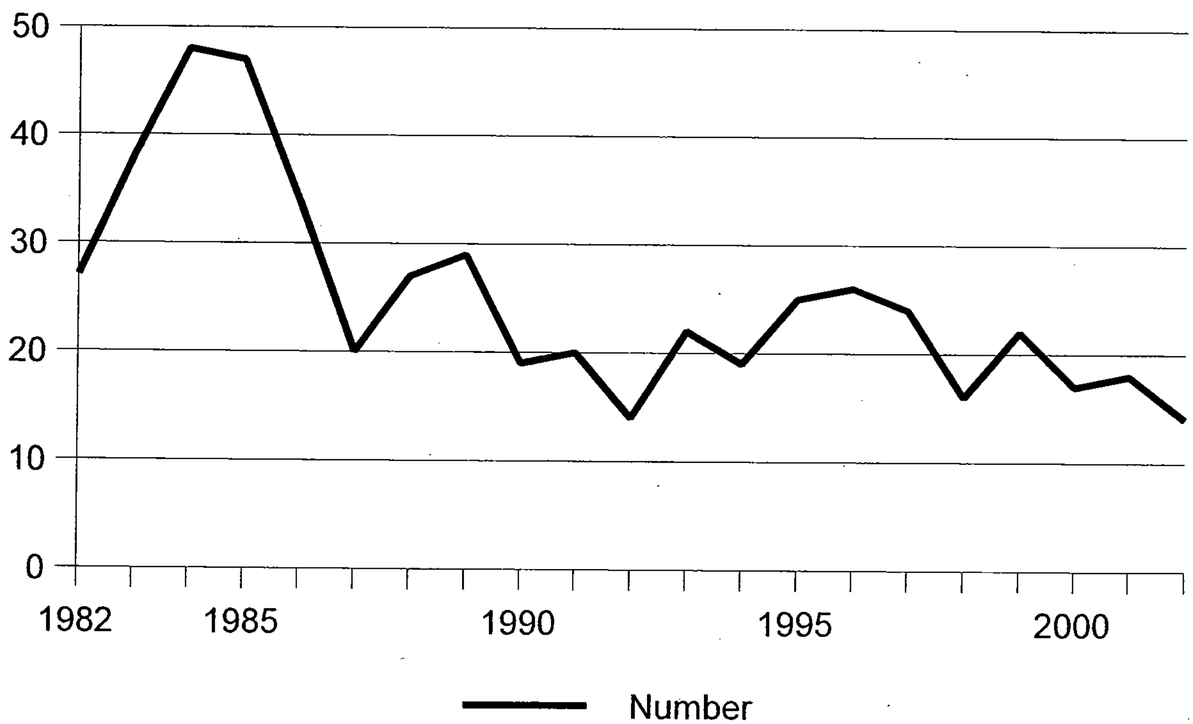
During 2002, a total of 14 boats landed an estimated 40,769 pounds of bottomfish. This was about 17 percent lower than in 2001, representing more than double the landings in the 1998-99 period, but still less than 20 percent of the peak 1985 landings. No bycatch was recorded in 2002.

CPUE (measured by pounds landed per trip-hour) was fairly consistent at about 13 to 15 from 1996 to 2001, but dropped to 7.4 in 2002, possibly because three very experienced bottomfish fishermen left the fishery (WPRFMC 2004) (Table 3-26).

### 3.5.2.4 Participation

The number of boats participating in the American Samoa bottomfish fishery fell from 26 to 14 between 1996 and 2002 (Figure 3-17; Table 3-26). Rather than indicating a problem with the resource, the decrease in effort was primarily caused by highliners redirecting their effort from the bottomfish fishery to the more lucrative pelagics fishery (WPRFMC 2004).

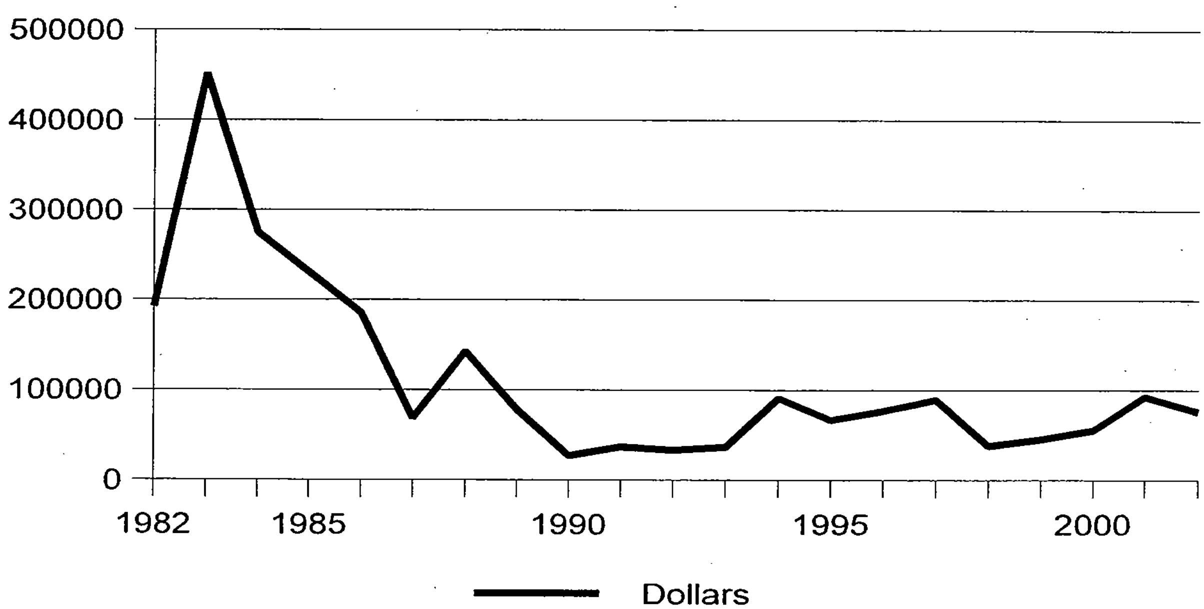
**FIGURE 3-17: Number of Vessels Participating in the American Samoa Bottomfish Fishery, 1982-2002**



3.5.2.5 Economic Performance

In the past ten years (1993-2002) years, the inflation-adjusted, annual ex-vessel value of commercial landings of bottomfish has averaged about $66,800 (Figure 3-18). The adjusted gross revenue per fishing trip has slowly declined since its peak in the early 1980s, with the 2001 figure the lowest to date by a considerable margin and the 2002 figure the second lowest recorded (Figure 3-19; Table 3-27). Information on the net revenue of vessels targeting bottomfish is unavailable.

**FIGURE 3-18: Inflation-adjusted Gross Revenue in the American Samoa Bottomfish Fishery, 1982-2002**



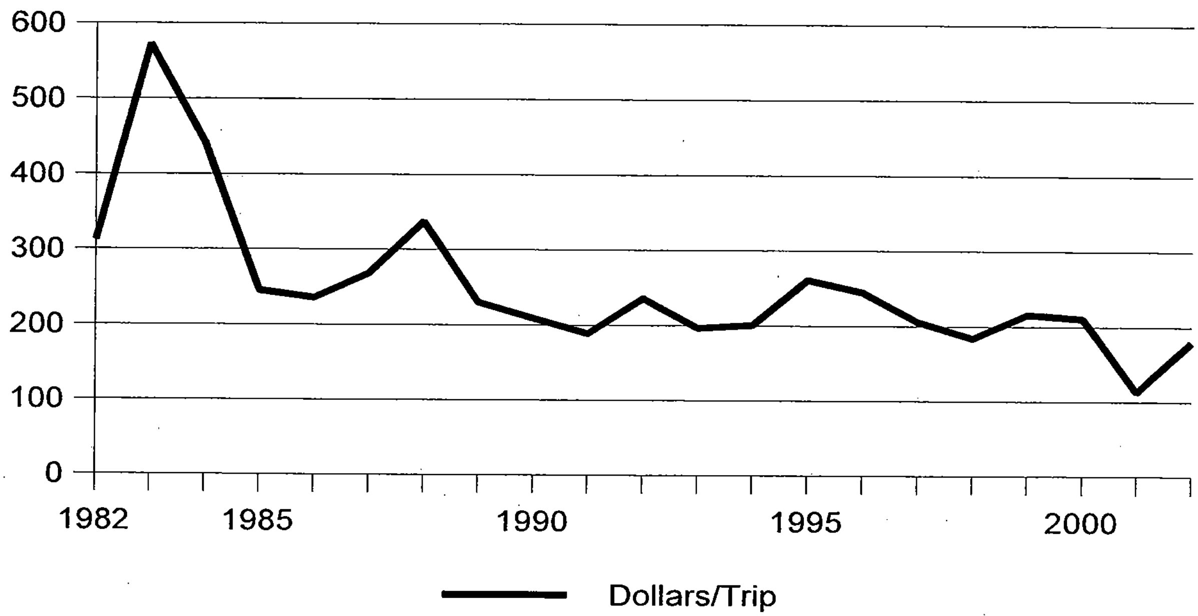

No data on the profitability of commercial bottomfish fishing operations are available, nor is there information on the non-market benefits of subsistence or recreational bottomfish fishing activity.

3.5.2.6 Markets

Prices for bottomfish in the American Samoa market were relatively high during the early 1980s (Table 3-27) when a large portion of the bottomfish catch was exported to Hawaiʻi (WPRFMC 1999). Prices fell in 1985 when exporting ceased, but have been fairly constant since then.

Bottomfish imported mainly from the neighboring independent country of Samoa has assisted in satisfying the local demand for fresh bottomfish and maintaining a stable price (WPRFMC 2004). However, the imported bottomfish is considered to be of lower quality than locally-caught fish.

**FIGURE 3-19: Inflation-adjusted Gross Bottomfish Revenue per Trip in the American Samoa Bottomfish Fishery, 1982-2002**




### 3.5.3 Guam

Guam's bottomfish fishery has two distinct components that can be separated by depth and species. The deep-water component (500-700 ft) consists primarily of snappers and groupers of the genera *Pristipomoides*, *Etelis*, *Aphareus*, *Epinephelus*, and *Cephalopholis*. The shallow-water component (100-500 ft) makes up a larger portion of the total bottom fish harvest and is comprised of reef-dwelling snappers, groupers and jacks of the genera *Lutjanus*, *Lethrinus*, *Aprion*, *Epinephelus*, *Variola*, *Cephalopholis* and *Caranx*. The shallow-water component occurs mainly in waters under the jurisdiction of the Territory of Guam.

3.5.3.1 History

Prior to the arrival of Europeans in Guam and the other Mariana Islands in the sixteenth century, the Chamorros, as the original inhabitants of those islands were called, possessed large sailing canoes that enabled them to fish on offshore banks and sea mounts (Amesbury and Hunter-Anderson 1989). The manufacture of these canoes was monopolized by the *matua* (noble caste) who were also the deep-sea fishermen and inter-island traders within Chamorro communities (Jennison-Nolan 1979). In the early seventeenth century a Spanish priest described the Chamorros as "...the most skilled deep-water fishing people yet to have been discovered" (Driver 1983:208). However, during the 1700s the large, oceangoing canoes of the Chamorros were systematically destroyed by the Spanish colonizers of the Mariana Islands in order to concentrate the indigene population in a few settlements, thereby facilitating colonial rule as well as religious conversion (Amesbury and Hunter-Anderson 1989). After the enforced demise of the sailing canoes, fishing for offshore species was no longer possible. By the mid-nineteenth century, there were only 24 outrigger canoes on Guam, all of which were used only for fishing inside the reef (Meyers 1993). Another far-reaching effect of European colonization of Guam and other areas of the Mariana archipelago was a disastrous decline in the number of Chamorros, from an estimated 40,000 persons in the late seventeenth century to approximately 1,500 persons a hundred years later (Amesbury and Hunter-Anderson 1989).

After the U.S. acquired Guam in 1898 following the Spanish-American War, the U.S. colonial government held training programs to encourage local residents to participate in offshore commercial fishing (Amesbury and Hunter-Anderson 1989). However, the residents were deterred from this endeavor by a lack of capital to purchase and maintain boats of sufficient size and a reticence to be at sea overnight or longer. Shortly after the end of World War II the U.S. military assisted several villages in developing an inshore commercial fishery using nets and traps (Anon. 1945). Post-World War II wage work enabled some fishermen to acquire boats with outboard engines and other equipment for offshore fishing (Amesbury and Hunter-Anderson 1989).

In the late 1970s, the Guam Fishermen's Cooperative Association began operations. After the co-op established a small marketing facility at the Public Market in Agaña, fishermen were no longer forced to make their own individual marketing arrangements after returning from fishing trips (AECOS, Inc.1983). In 1980, the co-op acquired a chill box and ice machine, and emphasis was placed on wholesaling. Today, the co-op's membership includes over 100 full-time and part-time fishermen, and it processes and markets (retail and wholesale) an estimated 80% of the local commercial catch (Duenas undated).

As Guam's tourism industry grew in the1980s a fleet of marina-berthed charter vessels developed that were used by tourists and residents for bottomfish fishing (Meyers 1993). The charter boats made multiple 2-hour to 4-hour trips daily. Two types of charter bottomfish fishing trips were organized. The more typical charter boats involved 3 to 6 patrons, while the larger "party-boat" vessels carried as many as 30 patrons on a single trip. Most of these bottomfish charters operate out of the Agat Marina and primarily target the shallow water complex of bottomfish. Since most of the charter fishing trips are of short duration, it is unlikely that many of the trips are conducted in federal waters (WPRFMC 1999).

#### 3.5.3.2 Fishing Methods and Current Use Patterns

For the past two decades bottomfish fishing around Guam has been a highly seasonal, small-scale commercial, subsistence and recreational fishery. The majority of the participants in the bottomfish fishery operate vessels less than 25 feet long and primarily target the shallow-water bottomfish complex because of the lower expenditure and relative ease of fishing close to shore (Meyers 1993). Participants in the shallow-water component seldom sell their catch as they fish mainly for recreational or subsistence purposes (WPRFMC 1999). Some of the charter boats practice "catch and release" fishing, which tends to artificially depress CPUE values. The commercially-oriented highliner vessels tend to be longer than 25 feet, and their effort is usually concentrated on the deep-water bottomfish complex.

Small spincasting reels are often used for catching the species occurring in the shallower waters, and electric reels, which may have multiple hooks per line, are used to catch deeper-dwelling fish (Meyers 1993). Lines may be baited with pieces of skipjack tuna and chumming is practiced (Amesbury and Hunter-Anderson 1989).

Bottomfish fishing effort is largest during the summer months (May to September) when sea conditions are generally much calmer. Most of the offshore banks are only accessible during this period. Galvez Bank is fished most heavily as it is closest to shore. Other banks, such as White Tuna, Santa Rosa and Rota, can only be fished during exceptionally good weather conditions (Green 1997).

Nearly all participants in the bottomfish fishery also troll for pelagic species, and most participate in both fisheries on the same trip (Meyers 1993). For example, fishermen might fish for bottomfish in the morning when the water is calm and then switch to trolling in the afternoon, or as they return to shore (Amesbury and Hunter-Anderson 1989).

#### 3.5.3.3 Harvest

Table 3-28 summarizes Guam's landings of all bottomfish and BMUS by commercial, charter and the recreational/subsistence sectors. Total bottomfish landings include the shallow-water reef species. Prior to 1994, total harvest consisted of more than 50 percent BMUS. Since 1994, that trend has been reversed, with BMUS comprising less than 50 percent of the total bottomfish harvested. Within the BMUS category, recent data show that about three-quarters of the landed

BMUS is caught by the recreational/subsistence sector (Figure 3-20). Annual fluctuations of BMUS landings on Guam, however, are usually due to highliners entering or leaving the fishery during a given year. The 1985 peak followed by the apparent crash in 1986 of BMUS harvests was the result of a few highliner fishermen who fished in 1985 and then left the fishery the following year.

The increase in total bottomfish and total BMUS in 1999 was due to fishermen concentrating on the deep-water complex. The significant increase in *onaga* landings in 1999 was due to a single fisherman fishing that complex. In 2000, an increase in BMUS landings was due to significant increases in *lehi*, the red-gilled emperor, the yellowtail *kalikali*, and jacks landings (280, 180, 200, and 256 percent, respectively). This may be due to fishermen fishing the boundary between shallow and deep water (WPRFMC 2003). All landings categories declined slightly in 2001 and all categories except charter bottomfish landings decreased more markedly in 2002.

Anecdotal evidence from local fishermen and creel census data indicate that the Guam bottomfish fishery is stressed. Sizes of harvested botomfish are decreasing, especially those of the shallow water and coral reef complex.Total and BMUS bottomfish harvest decreased in 2002. Total bottomfish landings decreased 33 percent, with non-charter decreasing 39 percent. Charter catch increased 58 percent, but makes up a small portion of the overall harvest. Total BMUS landings decreased 40 percent, with the non-charter and charter components decreasing 45 percent and 31 percent, respectively. Some of this may be due to the effects of two supertyphoons that hit Guam in 2002. Nevertheless, the CPUE for all bottomfish decreased 21%, while the non-charter and charter CPUEs decreased 20 percent and 19 percent, respectively.

**FIGURE 3-20: Total and Commercial Landings of BMUS in the Guam Bottomfish Fishery, 1980-2002**

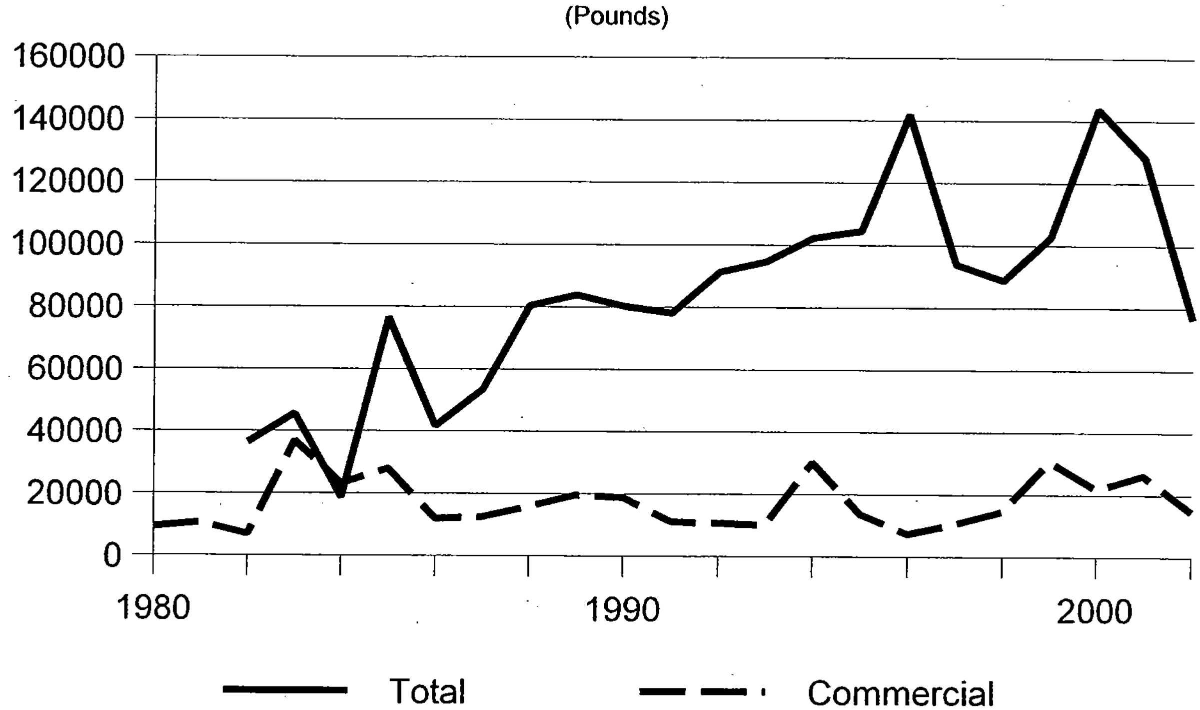



**TABLE 3-28: Bottomfish and BMUS Landings by Sector in the Guam Bottomfish Fishery, 1980-2002**

| YEAR | TOTAL BOTTOMFISH (lb) | TOTAL BMUS (lb) | COMMERCIAL BMUS (lb) | CHARTER BOTTOMFISH (lb) | CHARTER BMUS (lb) |
|---|---|---|---|---|---|
| 1980 | NA | NA | 9434 | NA | NA |
| 1981 | NA | NA | 10596 | NA | NA |
| 1982 | 40080 | 36449 | 6947 | 20 | 20 |
| 1983 | 46976 | 45609 | 36984 | 0 | 0 |
| 1984 | 57523 | 18707 | 23291 | 0 | 0 |
| 1985 | 104526 | 76623 | 28028 | 188 | 174 |
| 1986 | 49748 | 41775 | 12110 | 1475 | 1475 |
| 1987 | 57806 | 53430 | 12639 | 458 | 311 |

| YEAR | TOTAL BOTTOMFISH (lb) | TOTAL BMUS (lb) | COMMERCIAL BMUS (lb) | CHARTER BOTTOMFISH (lb) | CHARTER BMUS (lb) |
|---|---|---|---|---|---|
| 1988 | 83668 | 80422 | 15933 | 931 | 931 |
| 1989 | 91201 | 83844 | 19630 | 848 | 848 |
| 1990 | 83334 | 80353 | 18916 | 384 | 354 |
| 1991 | 81491 | 78159 | 11278 | 1246 | 894 |
| 1992 | 96692 | 91275 | 10668 | 2181 | 1539 |
| 1993 | 104044 | 94659 | 10191 | 1049 | 665 |
| 1994 | 115473 | 102452 | 30356 | 755 | 470 |
| 1995 | 118576 | 104629 | 13815 | 5581 | 4483 |
| 1996 | 160196 | 142022 | 7389 | 5674 | 4805 |
| 1997 | 113945 | 94015 | 10621 | 3607 | 2565 |
| 1998 | 112181 | 88899 | 14737 | 5442 | 3168 |
| 1999 | 147837 | 102801 | 30757 | 4330 | 3428 |
| 2000 | 156853 | 143707 | 21924 | 2673 | 2673 |
| 2001 | 132260 | 128025 | 26289 | 2482 | 2492 |
| 2002 | 88840 | 76434 | 14639 | 3931 | 1720 |
| mean | 97293 | 84014 | 17268 | 2060 | 1572 |
| s.d. | 35078 | 32533 | 8432 | 1956 | 1480 |

Source: WPRFMC 2004

### 3.5.3.4 Participation

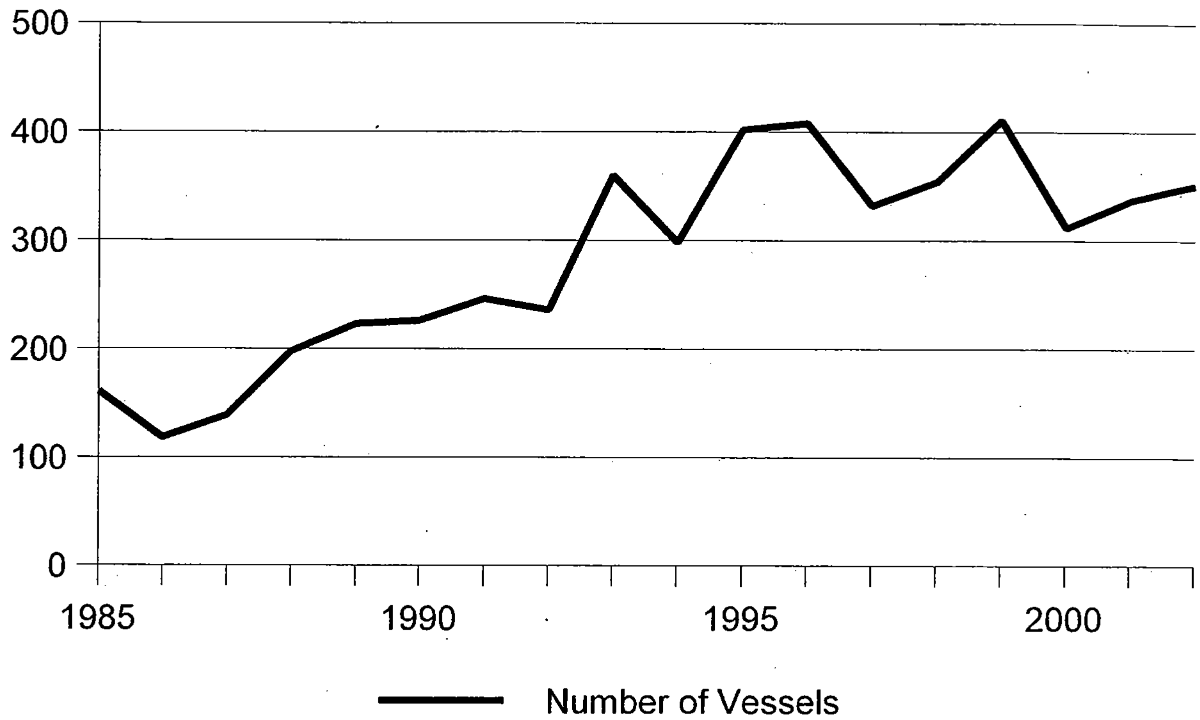
The number of boats participating in this fishery has leveled off in recent years (Figure 3-21; Table 3-29). The 57 percent increase in participation from 1992 and 1993 could be due to the inclusion of the Merizo Pier as a survey site in 1991, as well as a healthy economy that made it possible for more residents to afford boats. The 57 percent increase that occurred in 1995 over the previous year could be due to the inclusion of the Agat Marina as an offshore creel survey site in October 1994. In general, most of the newcomers in the last five years are recreational and subsistence fishermen who bottomfish only part-time and primarily target the shallow-water bottomfish complex of non-BMUS species. A decrease in participation in 2000 may have been due to boats dropping out the fishery due to low catches in the shallow-water bottomfish complex . In 2002, overall hours and trips decreased significantly, 43 percent and 44 percent, respectively, with non-charter hours and trips decreasing 45 percent and 47 percent, respectively. The charter hours and trips also significantly decreased, 18 percent and 25 percent, respectively. This sector, which is tourist dependent, continues to decrease due to a decrease in tourist numbers, a shift to less expensive activities by tourists, and the number of storms preventing tourists from visiting Guam year round (WPRFMC 2004).

**TABLE 3-29: Number of Vessels Participating in the Guam Bottomfish Fishery, 1982-2002**

| YEAR | # VESSELS | YEAR | # VESSELS |
|---|---|---|---|
| 1982 | 154 | 1994 | 298 |
| 1983 | 106 | 1995 | 402 |
| 1984 | 144 | 1996 | 408 |
| 1985 | 161 | 1997 | 332 |
| 1986 | 118 | 1998 | 354 |
| 1987 | 139 | 1999 | 411 |
| 1988 | 198 | 2000 | 312 |
| 1989 | 223 | 2001 | 337 |
| 1990 | 226 | 2002 | 351 |
| 1991 | 246 | mean | 263 |
| 1992 | 236 | s.d. | 102 |
| 1993 | 360 | | |

Source: WPRFMC 2004

**FIGURE 3-21: Number of Vessels Participating in the Guam Bottomfish Fishery, 1985-2002**




### 3.5.3.5 Economic Performance

Highliners have generally been responsible for the peaks in the Guam commercial BMUS landings, as was the case in 1983, 1985, 1994, 1998, and 1999. The nearly 300 percent increase in the 1994 commercial BMUS harvest (Figure 3-20; Table 3-28) and revenue (Figure 3-22; Table 3-30) compared with 1993 is the result of highliner vessels entering the fishery during 1994. The 39 percent reduction in BMUS harvest and 56 percent decline in commercial harvest for 1995 are best explained by the absence or reduced effort of about six highliners who combined landed an average of 18 percent of the total BMUS harvests between 1992 and 1996, and 68 percent of the unexpanded commercial landings for the same period. Harvest records for these six highliners indicate a 45 percent reduction in 1995 of their total bottomfish harvest, from 13,349 pounds in 1994 to 6,023 pounds in 1995. This decline in highliner landings accounts for about two-thirds of the 1995 reduction in commercial BMUS harvest.

The peak in 1996 followed by a 46 percent decline the following year in total BMUS harvest is believed to have been influenced more by weather conditions than any other factor. In 1997, storms decreased the number of calm fishing days.

In 2002, there were two direct hits by supertyphoons and an increase in the number of bad weather days that decreased bottomfishing effort. Total BMUS harvest decreased 40 percent, with the commercial harvest decreasing 44 percent. Adjusted revenue decreased 46 percent (WPRFMC 2004).

As noted above, nearly all participants in the bottomfish fishery also troll for pelagic species, and most participate in both fisheries on the same trip. Estimates of the profitability of vessels involved in the commercial harvest of bottomfish are unavailable.

**TABLE 3-30: Inflation-adjusted Guam Bottomfish Revenues and Prices, 1985-2002**

| YEAR | REVENUE ($) | REVENUE/TRIP ($) | PRICE ($/lb) |
|---|---|---|---|
| 1980 | 43185 | 284 | 4.58 |
| 1981 | 58547 | 248 | 5.53 |
| 1982 | 39672 | 212 | 5.71 |
| 1983 | 191591 | 416 | 5.18 |
| 1984 | 116281 | 252 | 4.99 |
| 1985 | 132451 | 277 | 4.73 |
| 1986 | 53836 | 211 | 4.45 |
| 1987 | 55581 | 209 | 4.4 |
| 1988 | 66882 | 193 | 4.2 |
| 1989 | 95820 | 268 | 4.88 |
| 1990 | 89398 | 255 | 4.73 |
| 1991 | 50915 | 194 | 4.51 |
| 1992 | 44257 | 191 | 4.15 |
| 1993 | 39742 | 159 | 3.9 |
| 1994 | 121000 | 395 | 3.99 |
| 1995 | 49037 | 338 | 3.55 |
| 1996 | 20332 | 123 | 2.75 |
| 1997 | 32273 | 158 | 3.04 |

| YEAR | REVENUE ($) | REVENUE/TRIP ($) | PRICE ($/lb) |
|---|---|---|---|
| 1998 | 49251 | 302 | 3.34 |
| 1999 | 111387 | 370 | 3.62 |
| 2000 | 76854 | 300 | 3.51 |
| 2001 | 85424 | 135 | 3.25 |
| 2002 | 46145 | 82 | 3.15 |
| mean | 72603 | 242 | 4.18 |
| s.d. | 40358 | 87 | 0.81 |

Source: WPRFMC 2004

As noted above, the amount of bottomfish caught for recreational or subsistence purposes accounts for approximately three-quarters of the total catch. No information on the non-market value of this catch is available. Nearly all bottomfish fishermen hold jobs outside the fishery (Meyers 1993). However, fishing for bottomfish and other types of offshore fishing provide an important subsistence supplement to many Guam families (Amesbury and Hunter-Anderson 1989).

Most bottomfish fishing is done by Guam residents from owner-operated vessels, but tourists and residents also fish for bottomfish from charter boats (Meyers 1993). No information on the profitability of these charter fishing operations is available.

3.5.3.6 Markets

The importation of bottomfish from other islands throughout Micronesia has depressed the price of bottomfish in the Guam market (Meyers 1993; Table 3-30). Low wages in those areas enable importers to acquire fish at low cost (AECOS, Inc.1983). The Guam Fishermen's Cooperative Association has attempted to counter this price competition from imported fish by emphasizing the higher quality of fresh local fish landed by co-op members (AECOS, Inc. 1983). However, the competitive pricing and consistent availability of imported fish has discouraged local attempts to supplant foreign catches with Guam-caught fish.

**FIGURE 3-22: Inflation-adjusted Gross Revenue for Commercial BMUS in the Guam Bottomfish Fishery, 1980-2002**

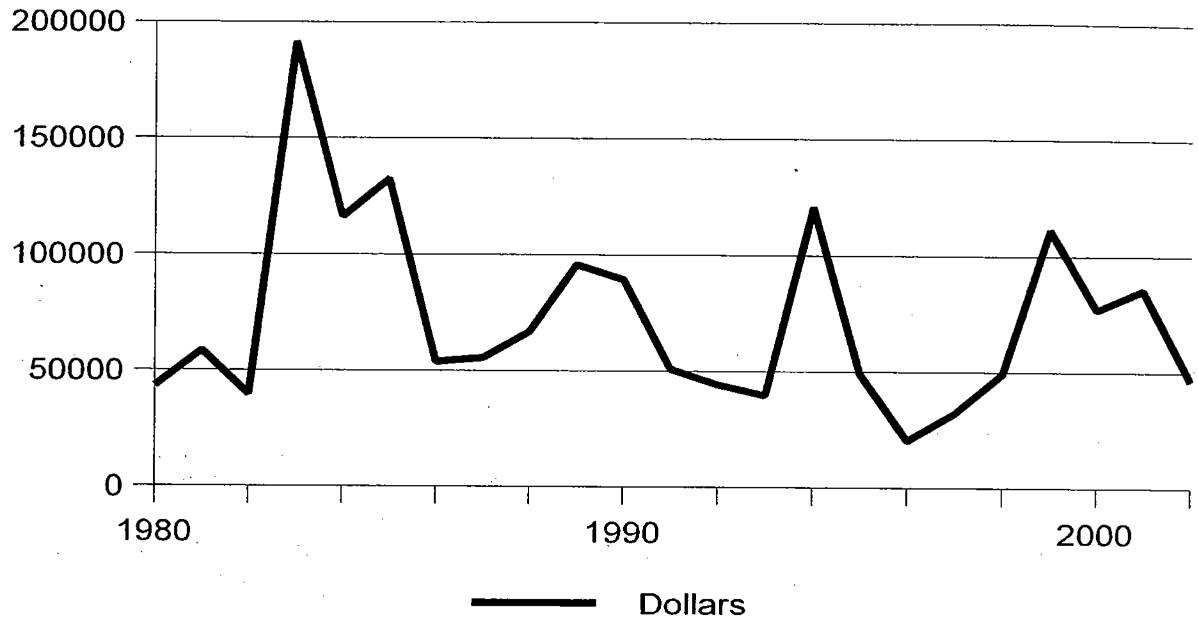
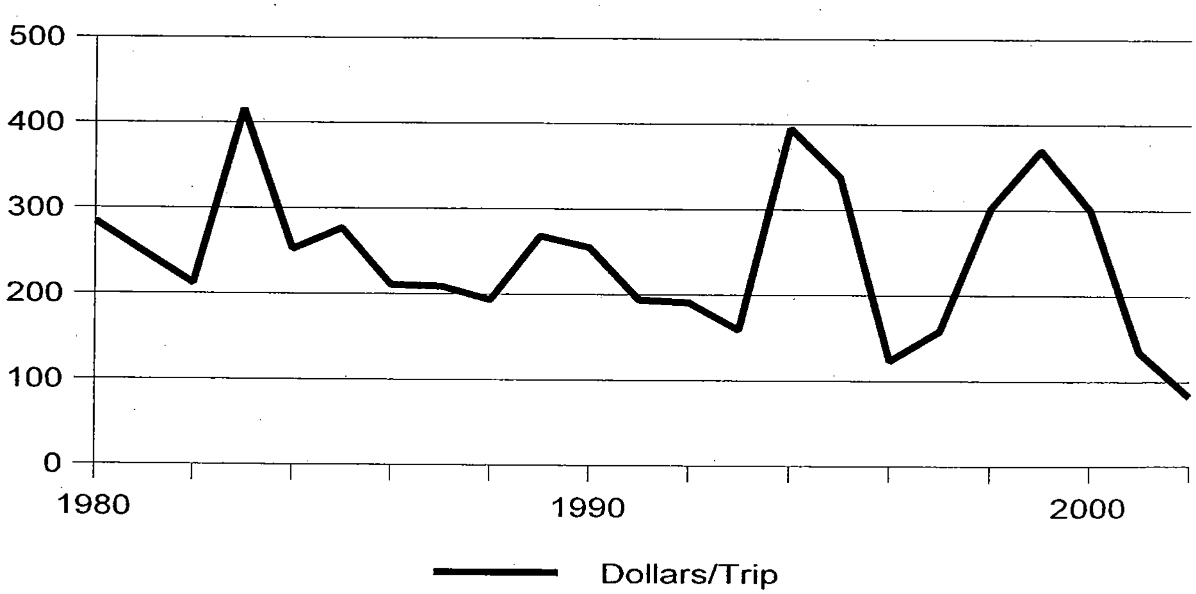



**FIGURE 3-23: Inflation-adjusted Gross Bottomfish Revenue per Trip in the Guam Bottomfish Fishery, 1980-2002**



### 3.5.4 The Northern Mariana Islands

The bottomfish fishery in the CNMI is similar to that of Guam in that it can be separated into deep-water and shallow-water components. The deep-water component (>500 ft) targets primarily snappers of the genera *Pristipomoides* and *Etelis*, and the eight-banded grouper (*Epinephelus octofasciatus*). The shallow-water component (100-500 ft) targets the red-gilled emperor (*Lethrinus rubrioperculatus*).

#### 3.5.4.1 History

Following the arrival of Europeans in 1521, the Northern Mariana Islands were colonies of Spain (1521-1898), Germany (1899-1914) and Japan (1915-1944). The Chamorros of the Northern Mariana Islands suffered the same deprivations under early Spanish colonial administration as those living on Guam. During the early 1800s people from the Caroline Islands were encouraged by the Spanish government to establish permanent settlements in the Mariana Islands (Amesbury et al. 1989). The Carolinians who settled in the Mariana Islands came with a well-developed sea-faring tradition. Their fishing activity largely centered on the harvest of lagoon and reef species, but small paddling canoes were sometimes used to fish a short distance outside the reef (Amesbury et al. 1989). Bottomfish fishing gear used by the Carolinians included coral sinkers and line made from hibiscus fiber.

Under Japanese rule the Northern Mariana Islands became a major fishing base, primarily for the harvest of skipjack tuna. However, the Chamorros or Carolinians of the Northern Marianas had little or no involvement in these industrial-scale fish harvesting or processing operations. According to Joseph and Murray (1951), the colonial policy of the Japanese prohibited the Chamorros and Carolinians from engaging in commercial fishing and most other remunerative enterprises. During this period the Chamorros and Carolinians presumably relied heavily on subsistence use of inshore marine resources (Amesbury et al. 1989). When the Americans assumed control of the islands at the end of World War II the fishing industry was left in the hands of Japanese civilian prisoners until their repatriation in 1946.

The post-World War II years saw a gradual involvement of the Chamorros and Carolinians of the Northern Marianas in commercial fishing. According to Orbach (1980), the Carolinians were the leaders in forming crews for fishing enterprises involving larger craft and offshore fishing. Orbach attributed the predominance of Carolinians in these initial offshore fishing ventures to the importance of fishing in traditional Carolinian culture and the closely-knit family and community structures within Carolinian settlements on Saipan that facilitated cooperative efforts in fishing.

By 1980, several boats over 25 feet in length were actively engaged in commercial fishing for bottomfish and pelagic species (Orbach 1980). One vessel was operated by a Carolinian company, one was owned and operated by the Tinian Fishing Cooperative whose membership was Chamorro and two other boats were skippered and crewed mainly by Japanese fishermen. In addition, some of the charter vessels that had been operating in the CNMI since 1978, catering to the Japanese tourists, were also being used to catch fish for sale to hotels and restaurants on Saipan (Orbach 1980).

Although many of the early offshore commercial fishing ventures received support from the CNMI government in the form of loans and fishing supplies (Orbach 1980), all of the enterprises failed within a few years because of inadequate markets, lack of management expertise and other factors. Eventually, other large vessels entered the bottomfish fishery, but they too dropped out. This pattern of frequent entry and exit of vessels into and out of the fishery has continued over the past two decades. In 1999, there were two major bottomfish fishing operations. One of the owners suspended his entire operation toward the end of the year because of financial problems. The number of large-vessel commercial bottomfish fishing ventures active in the northern islands appeared to increase during 2000, but only four were active for more than a few trips. Of these four, two primarily sold their catches off the island of Saipan (mostly to the large hotels on Tinian).

3.5.4.2 Fishing Methods and Current Use Patterns

The CNMI bottomfish fishery consists mainly of small (<24 ft) boats engaged in commercial and subsistence fishing within a 20-mile radius around the islands of Saipan, Tinian, and Rota. However, larger vessels have periodically entered the fishery that are capable of traveling to the northernmost islands of the NMI. The larger vessels fish primarily for commercial purposes and target both deep-water and shallow-water bottomfish species, the latter primarily on the extensive banks and reefs surrounding Farallon de Medinilla (WPRFMC 1999). The smaller vessels fish both commercially and for subsistence, and target shallow water species.

Handlines, handmade hand reels and electric reels are the common gear used for small-scale fishing operations, and electric and hydraulic reels are the common gear used for the larger operations in the bottomfish fishery (WPRFMC 1999). Assorted types of bait are used, including tuna, squid and crabs, and some fishermen practice chumming by lowering a screen container of fish parts into the water (Amesbury et al. 1989).

Bottomfish fishing can still be described as "hit or miss" for most of the smaller size vessels (WPRFMC 1999). The majority of fishermen do not possess fathometers or even nautical charts and rely on land features for guidance to a fishing area. The larger vessels are generally equipped with a global positioning system (GPS), fathometer and other modern navigation and fish-finding equipment.

Fishing trips by the smaller vessels are generally restricted to daylight hours, with all vessels returning before or soon after sunset. Fishing trips to the northern end of the island chain by the large boats are usually limited to 10 days in order to preserve the quality of bottomfish held in ice. Although longer trips would be possible for vessels having on-board rapid-freezing equipment, such equipment may not be economical, particularly because consumer demand is for fresh fish rather than frozen products (AECOS, Inc. 1984).

The small boat participants switch between bottomfish fishing and trolling for pelagic species. Sea and weather conditions determine which type of fishing is undertaken. Bottomfish fishing is most successful during the summer months (May to September) when sea conditions are calmer. Fishermen often troll to and from a bottomfish fishing site, thus acquiring a mixed catch of pelagic species and bottomfish (WPRFMC 1999).

Amesbury et al. (1989) found that fishermen on Saipan slightly favored trolling for pelagic species over bottomfish fishing, as the success of the latter is dependent on calm sea conditions. However, bottomfish fishing is preferred by many fishermen on Tinian because it requires less fuel than trolling and bottomfish, especially *onaga*, bring a high price. In addition, Tinian is close to good bottomfish fishing grounds.

In recent years, there have been one or two charter vessels that target shallow-water bottomfish and reef fish (WPRFMC 2000a, 2004). The vessels typically take four two-hour long trips per day. Favored fishing grounds include the barrier reef off Chalan Kanoa and the Nikko Hotel.

3.5.4.3 Harvest

Landings data are available only for that portion of the catch that is sold to local commercial establishments (Section 3.9.4). The commercial catch of bottomfish declined during the late 1980s (WPRFMC 1999; Figure 3-24; Table 3-31). However, landings increased substantially between 1991 and 1996. The increase was due mainly to the entry of large (>50-ft) vessels that conducted regularly scheduled long trips to the islands north of Saipan, where bottomfish are more abundant (WPRFMC 1999).

Landings of bottomfish decreased (34.3 percent fewer pounds in 2002 than in 2001) from the highest total landings last year, to slightly higher than the 20-year mean. Bottomfish landings in the CNMI have been higher than the 20-year mean for the last seven years. The number of trips during which bottomfish were caught also decreased to near the 20-year mean, and the average bottomfish catch per trip increased to just above the 20-year mean. This fishery continues to show a high turnover with changes in the highliners participating in the fishery and an increased number of local fishermen focusing on reef fish in preference to bottomfish.

Revenues and prices for bottomfish were lower in 2002 than in 2001, with the inflation-adjusted revenue greater than the 20-year mean, but the average price per pound (adjusted) continued to be lower than the 20-year mean. Only five years in the last 20 have had lower values.

**FIGURE 3-24: Commercial Landings of Bottomfish in the CNMI Bottomfish Fishery, 1983-2002**

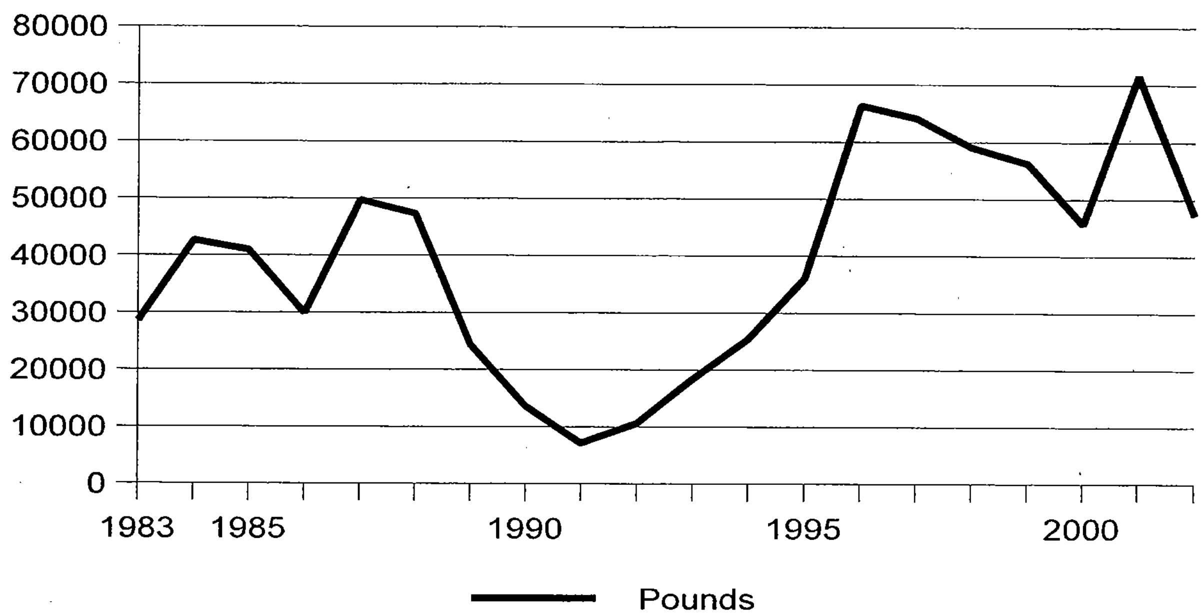



**TABLE 3-31: CNMI Bottomfish Landings, Participation, Effort and CPUE, 1983-2002**

| YEAR | LANDINGS (lb) | # VESSELS | # TRIPS | CPUE (lb/trip) |
|---|---|---|---|---|
| 1983 | 28529 | 90 | 536 | 53 |
| 1984 | 42664 | 102 | 493 | 87 |
| 1985 | 40975 | 55 | 283 | 145 |
| 1986 | 29912 | 54 | 229 | 131 |
| 1987 | 49715 | 43 | 237 | 210 |
| 1988 | 47313 | 29 | 211 | 224 |
| 1989 | 24438 | 29 | 257 | 95 |

| YEAR | LANDINGS (lb) | # VESSELS | # TRIPS | CPUE (lb/trip) |
|---|---|---|---|---|
| 1990 | 13628 | 29 | 129 | 106 |
| 1991 | 7116 | 20 | 124 | 57 |
| 1992 | 10598 | 37 | 143 | 74 |
| 1993 | 18461 | 20 | 178 | 104 |
| 1994 | 25470 | 32 | 276 | 92 |
| 1995 | 36102 | 34 | 311 | 116 |
| 1996 | 66362 | 70 | 448 | 148 |
| 1997 | 64090 | 69 | 376 | 170 |
| 1998 | 59040 | 50 | 319 | 185 |
| 1999 | 56201 | 51 | 287 | 196 |
| 2000 | 45619 | 66 | 635 | 72 |
| 2001 | 71660 | 75 | 834 | 86 |
| 2002 | 47110 | 53 | 374 | 126 |
| mean | 39250 | 50 | 334 | 124 |
| s.d. | 19107 | 23 | 181 | 51 |

Source: WPRFMC 2004

### 3.5.4.4 Participation

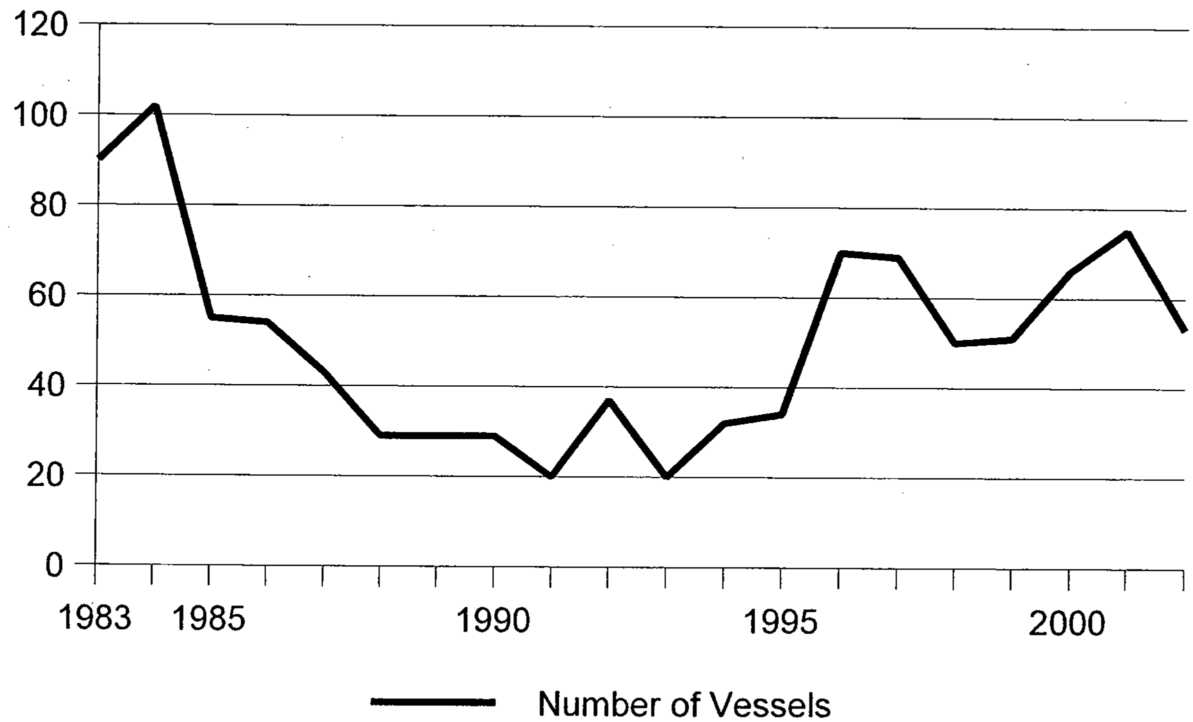
Participation in the CNMI bottomfish fishery was fairly stable throughout the late 1980s and early 1990s, and then abruptly more than doubled in 1996 (Figure 3-25; Table 3-31). The increase was in vessels of all sizes, including large (>50-ft) vessels (WPRFMC 1999). However, over 60 percent of the vessels selling bottomfish between 1997 and 2000 sold bottomfish in only one of those four years. Between 19 and 34 percent of these fishermen also made a limited number of sales (two) of any type of fish in any one of the years. Only six percent sold bottomfish in all four years. This represents a high rate of turnover, and seems to be a result of more of the smaller vessels focusing on reef fish in preference to bottomfish. During the 1997-2000 period, the number of fishermen selling both pelagic fish and bottomfish decreased from 11.1 to 3.0 percent, the number selling both pelagic and reef fish increased from 4.8 to 9.9 percent, and the number selling only reef fish increased from 10.3 to 36.2 percent.

The relatively large number of trips from 1983 to 1989 reflected activity around the island of

Farallon de Medinilla. This activity largely ceased between 1990 and 1994, but subsequently resumed and continues through the present.

The number of trips in 2002 decreased to near the 20-year mean, probably as a result of fewer fishermen focusing on bottomfish. The percentage of fishermen who incorporated bottomfish into their sales was lower in 2002 for all categories of fishermen. No fisherman exclusively sold bottomfish in 2002. In contrast, the percentage of fishermen selling reef fish increased.

**FIGURE 3-25: Number of Vessels Participating in the CNMI Bottomfish Fishery, 1983-2002**




3.5.4.5 Economic Performance

Landings, revenues, and adjusted revenues for 2002 all fell significantly to near the 20-year mean. Although the landings, revenues, and adjusted revenues for bottomfish have been comparatively high for the past seven years compared to the preceding 13 years, there have been considerable changes in the composition of the fishery during the last seven years. Prices for bottomfish have also decreased in recent years. Local buyers seem to increasingly prefer reef fishes and these species are commanding higher prices each year (WPRFMC 2004).

The gross revenue earned per trip increased markedly during the 1990s as a result of an increase in both the average catch rate and market price (Figure 3-27; Table 3-32). In 2000, however, revenue per trip dropped over 70 percent from its 1999 high to about half its long-term average. Inflation-adjusted revenues per trip recovered somewhat in 2001 and 2002 from the marked decrease of 2000.

The unadjusted average price increased steadily from 1988 to 1991, where it reached what was once a record high of $2.83. In 1995, the price increased to a new record high of $3.34. This unadjusted price remained constant through 1997, increased to $3.41 in 1998, and reached a new record high of $3.61 in 1999. The adjusted price continued to increase from 1997. Both the unadjusted and adjusted prices fell steeply in 2000, recovered slightly in 2001, but fell again in 2002. Other than the drop in 2000, the unadjusted and adjusted prices were the lowest since 1993. Only five years in the last 20 have had lower adjusted prices. Bottomfish are not commanding the high prices they once did (WPRFMC 2004).

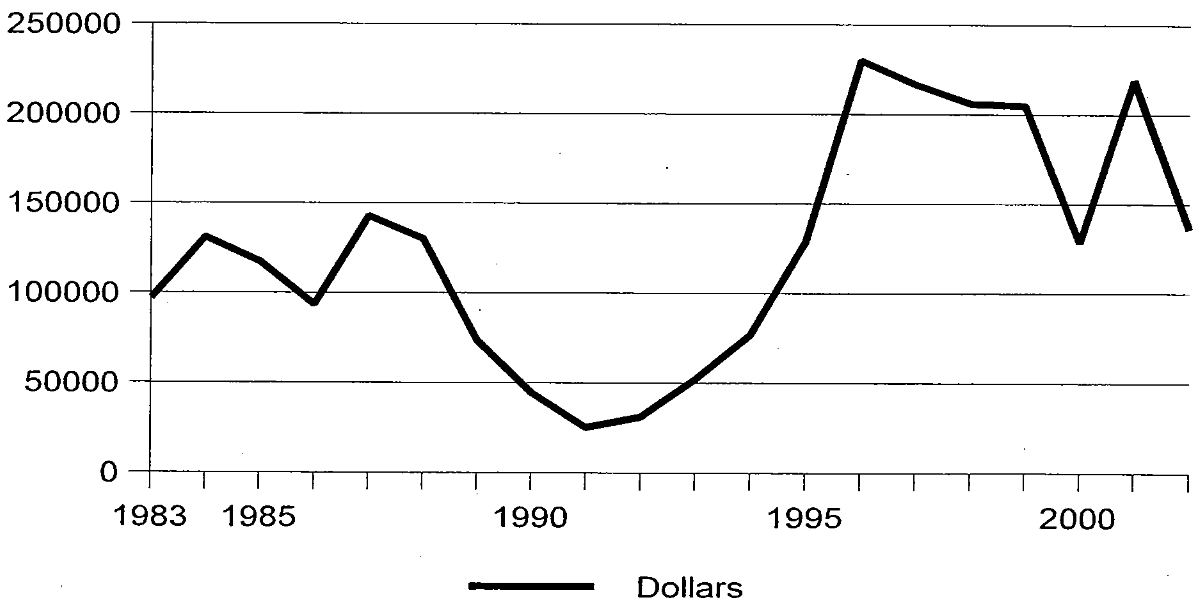
**TABLE 3-32: CNMI Bottomfish Inflation-adjusted Revenues and Prices, 1983-2002**

| YEAR | REVENUE ($) | REVENUE/TRIP ($) | PRICE ($) |
|---|---|---|---|
| 1983 | 97054 | 181 | 3.4 |
| 1984 | 131267 | 266 | 3.08 |
| 1985 | 117717 | 417 | 2.87 |
| 1986 | 93539 | 408 | 3.13 |
| 1987 | 142838 | 603 | 2.87 |
| 1988 | 130336 | 618 | 2.75 |
| 1989 | 73965 | 287 | 3.03 |
| 1990 | 44748 | 347 | 3.28 |
| 1991 | 25385 | 204 | 3.57 |
| 1992 | 31144 | 218 | 2.94 |
| 1993 | 52235 | 293 | 2.83 |
| 1994 | 76905 | 279 | 3.02 |
| 1995 | 128992 | 415 | 3.57 |
| 1996 | 230123 | 514 | 3.47 |
| 1997 | 216833 | 576 | 3.38 |

| YEAR | REVENUE ($) | REVENUE/TRIP ($) | PRICE ($) |
|---|---|---|---|
| 1998 | 206157 | 646 | 3.51 |
| 1999 | 205158 | 715 | 3.65 |
| 2000 | 128488 | 202 | 2.82 |
| 2001 | 219183 | 263 | 3.06 |
| 2002 | 135823 | 363 | 2.88 |
| mean | 124395 | 391 | 3.15 |
| s.d. | 64522 | 163 | 0.29 |

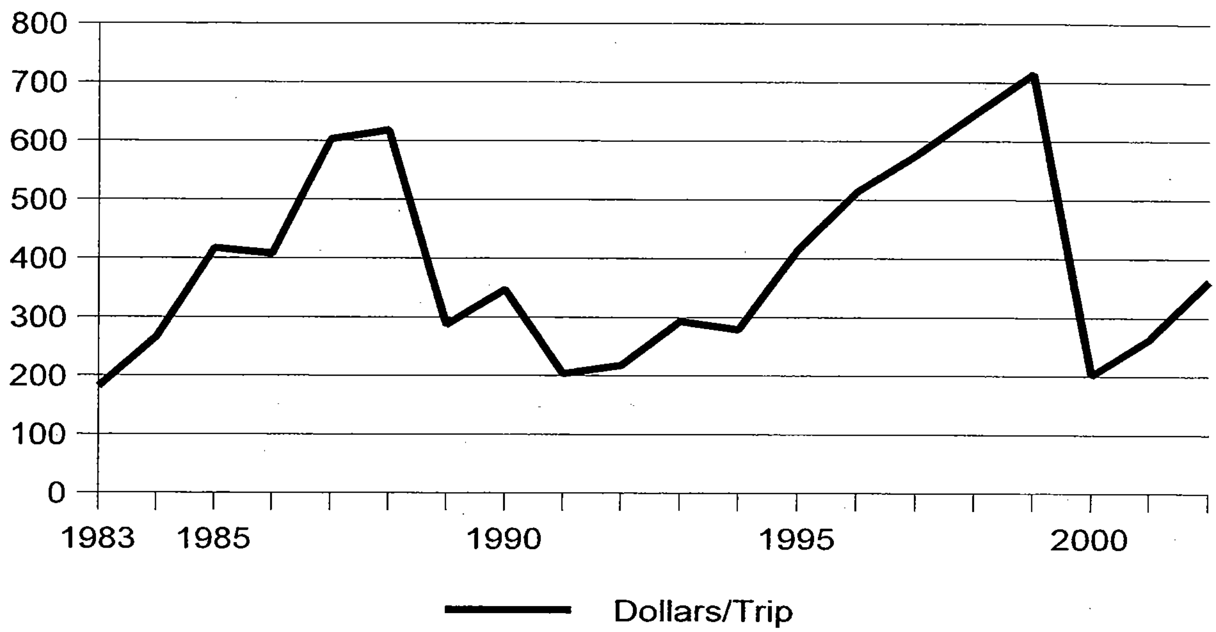
Source: WPRFMC 2004

**FIGURE 3-26: Inflation-adjusted Gross Revenue in the CNMI Bottomfish Fishery, 1983-2002**




Estimates of the profitability of vessels involved in the commercial harvest of bottomfish are unavailable. Nor is there information on the quantity or non-market value of the bottomfish caught for recreational or subsistence purposes. According to a survey of fishermen in the CNMI, few fishermen depend on fishing for all of their income (Hamnett et. al. 1998). Two-thirds of those interviewed sold less than 75% of their catch. Eleven percent sold all of their catch, and an equal number sold no fish. Many fishermen try to sell enough fish to cover trip operating expenses, but the primary motivation for fishing is to catch fish for home consumption and to give away "extra" catch to friends and extended family members.

**FIGURE 3-27: Inflation-adjusted Gross Revenue per Trip in the CNMI Bottomfish Fishery, 1983-2002**




3.5.4.6 Markets

Because of the small scale of the harvesting sector, no system for handling large quantities of fresh fish landings has developed (AECOS, Inc. 1984). Although there have been some exports of fish to Guam and Hawai'i, nearly all of the domestic catch is consumed locally. The major commercial outlets for locally caught fish are small retail markets, resort hotels and restaurants on Saipan (Radtke and Davis 1995). Restricted market outlets curtail harvesting activities during the peak fishing season because of the difficulties in marketing catches. During other times of the year fishing activities are vulnerable to disruption by periods of even moderately rough seas because of the small size of many of the boats.

Bottomfish, particularly deep-water snappers and groupers, are in relatively high demand by the resort hotels. During the mid-1990s, however, consistent supply and quality were market requirements that were not being met by the local fishing industry (Radtke and Davis 1995). Fishermen utilizing larger vessels have had greater access to deep-water bottomfish resources, especially those in the northern islands, and the supply of high-quality fish is expected to improve (WPRFMC 1999).

## 3.6 REGIONAL ECONOMY

### 3.6.1 Hawai'i

The State of Hawai'i lies 2,500 miles southwest of North America, the nearest continental land mass. The eight main islands are part of a 137-island archipelago stretching 1,523 miles from Kure Atoll in the northwest to the island of Hawai'i in the southwest. The total land area of the archipelago is 6,423 square miles. The main islands include O'ahu, Maui, Kaua'i, Ni'ihau, Hawai'i, Moloka'i, Kaho'olawe and Lāna'i. Hawai'i was established as a territory of the United States in 1900 and became the 50th state in 1959.

#### 3.6.1.1 Overview of the Economy

Income generation in Hawai'i is characterized by tourism, federal defense spending and, to a lesser extent, agriculture (Table 3-33). Tourism is by far the leading industry in Hawai'i in terms of generating jobs and contributing to gross state product. The World Travel and Tourism Council (1999) estimates that tourism in Hawai'i directly generated 134,300 jobs in 1999. This figure represents 22.6 percent of the total workforce.

For 2002, DBEDT estimates that direct and indirect visitor contribution to the state economy was 22.3%. A bit less than half of that (10.2%) was generated in Waikiki. Total visitor expenditures in Hawaii were $9,993,775,000. Tourism's direct and indirect contribution to Hawaii's Gross State Product in 2002 was estimated at $7,974,000,000, or 17.3% of the total. Directly and indirectly, tourism accounted for 22.3% of all civilian jobs, and 26.4% of all local and state taxes.

Department of Defense expenditures in Hawaii in 2002 were $4,293,459,000. Defense expenditures in Hawaii are expected to increase significantly in the near future. These expenditures fall into two broad categories: monies for the pending arrival of the Stryker force, which requires changes in facilities and additional facilities; and the renovation of old military housing as well as the construction of new military housing. As of late July 2004, Hawaii is expected to receive $496.7 million in defense-related spending. When combined with funds earmarked for construction that are contained in a measure before the Senate, Hawaii stands to receive more than $865 million in defense dollars, which do not include funds for day to day operations or payroll (Inouye 2004).

Agricultural products include sugarcane, pineapples (which together brought in $269.2 million in 1997), nursery stock, livestock, and macadamia nuts. In 2002, agriculture generated a total of $510,672,000 in sales. Agricultural employment decreased from 7,850 workers in 2000 to 6,850 in 2003. This change may be due to the increasing use of lots zoned for agriculture for construction of high-end homes, a trend which is evident throughout the state.

**TABLE 3-33: Statistical Summary of Hawai'i's Economy, 1995-1999, 2002**

| CATEGORY | UNITS | 1995 | 1996 | 1997 | 1998 | 1999 | 2002 |
|---|---|---|---|---|---|---|---|
| Civilian Labor Force | Number | 576400 | 590200 | 592000 | 595000 | 594800 | 582200 |
| Unemployment | Percent | 5.9 | 6.4 | 6.4 | 6.2 | 5.6 | 4.2 |
| Gross state product in 1996 dollars | $ Millions | 37963 | 37517 | 37996 | 38015 | 38047 | 38,839 (2001) |
| Manufacturing Sales | $ Millions | 2045 | 1724.1 | 1468.8 | NA | NA | NA |
| Agriculture (all crops and livestock) | $ Millions | 492.7 | 494.6 | 486.5 | 492.6 | 512992 | 510672 |
| Construction completed | $ Millions | 3153.3 | 3196.4 | 2864.9 | NA | NA | NA |
| Retail sales | $ Millions | 15693.3 | 16565 | 16426 | NA | NA | NA |
| Defense expenditures | $ Millions | 3782.5 | 3883.5 | 4074.9 | 4103.7 | 4174.2 | 4293459 |

Source: DBEDT 1999, 2002; BOH 1999a

Median household income in Hawai'i was calculated to be $40,827 in 1990, rising to $49,820 in 1999. Statewide per capita income in 1989 was calculated to be $15,770, rising to $25,684 in 1995 and $27,544 in 1999. The figure for 2002 is $30,040, or 97% of the national average. Hawaii per capital income as a percentage of the national average figure has fallen steadily since 1970 (DBEDT 2003). The poverty rate in Hawai'i grew more over the 1990s than in the nation as a whole. Despite this growth, Hawai'i's poverty rate, which increased from 11.2 percent in 1988-89 to 12.4 percent in 1997-98, remained lower than the national rate (13.0 percent in 1997-98). In 1999, 8% of Hawaii's families were below poverty level, compared to 9% nationally according to the 2000 Census. Hawai'i employment growth was virtually nil for most of the 1990s, continuing through to the end of 1998. Civilian employment has decreased from 411,250 in 1991 to 396,050 in 2002, which is a decrease from 98% of all civilian labor force having employment, to 96%.

For several decades Hawai'i benefitted from the strength of regional economies around the Pacific that supported the state's dominant economic sector and principal source of external receipts – tourism (BOH 1999a). In addition, industries of long-standing importance in Hawai'i, such as the federal military sector and plantation agriculture, also experienced significant growth. However, Hawai'i's economic situation changed dramatically in the 1990s. The state's main tourist market, Japan, entered a long period of economic malaise that caused the tourism industry in Hawai'i to stagnate. The post-Cold War era brought military downsizing. Tens of thousands of acres of plantation lands, along with downstream processing facilities, were idled by the end of the decade due to high production costs. Employment in Hawai'i sugar production fell by 20% between 1990 and 1993 and by an additional 50% from 1994 to 1995 (Yuen et al. 1997). Net out-migration became the norm in Hawai'i, notwithstanding the state's appeal as a place to live. In 1998, the state-wide unemployment rate was 6.2%, and unemployment on the island of Moloka'i reached 15% (DBEDT 1999).

By 2002, an improving economy showed a statewide unemployment rate of 4.4%, with Molokai down to 8.6% (DBEDT 2003). Despite downswings in tourism in the last few years due to the events of 9/11, the SARS scare, Japanese economic issues, and world political conditions, tourism in Hawaii is improving to the point that there are fears that there will not be enough hotel rooms to accommodate all the Japanese tourists who want to come for O Bon season in August 2004 (Schafers 2004).

As a consequence of the economic upheaval of the 1990s and the extensive bankruptcies, foreclosures and unemployment, Hawai'i never entered the period of economic prosperity that many U.S. mainland states experienced. Between 1998 and 2000, Hawai'i's tourism industry recovered substantially, mainly because the strength of the national economy promoted growth in visitor arrivals from the continental U.S. (Brewbaker 2000). However, efforts to diversify the economy and thereby make it less vulnerable to future economic downturns have met with little success. The events of September 11, 2001 and their negative effects on travel and tourism have halted Hawai'i's short-lived economic recovery. To date, economic development initiatives such as promoting Hawai'i as a center for high-tech industry have attracted few investors. It is unlikely that any new major industry will develop in Hawai'i in the near future to significantly increase employment opportunities and broaden the state's economy beyond tourism, the military, and construction.

3.6.1.2 Fishing Related Economic Activities

The harvest and processing of fishery resources play a minor role in Hawai'i's economy. The most recent estimate of the contribution of the commercial, charter and recreational fishing sectors to the state economy indicated that in 1992, these sectors contributed $118.79 million of output (production) and $34.29 million of household income and employed 1,469 people (Sharma et al. 1999). These contributions accounted for only 0.25% of total state output ($47.4 billion), 0.17% of household income ($20.2 billion) and 0.19% of employment (757,132 jobs). However, in contrast to the sharp decline in some traditional mainstays of Hawai'i's economy such as large-scale agriculture the fishing industry has been fairly stable during the past decade. Total revenues in Hawai'i's pelagic, bottomfish and lobster fisheries in 1998 were about 10% higher than 1988 revenues (adjusted for inflation) in those fisheries.

Hawai'i's commercial fishing sector includes a wide array of fisheries. The Hawai'i longline fishery is by far the most important economically, accounting for 73 percent of the estimated ex-vessel value of the total commercial fish landings in the state in 1999 (Table 3-34). As shown in that table, the NWHI and MHI bottomfish fisheries account for a relatively small share of the landings and value of the state's commercial fisheries.

**TABLE 3-34: Volume and Value of Commercial Fish Landings in Hawai'i by Fishery, 1999**

| FISHERY | POUNDS LANDED (1,000s) | PERCENT OF TOTAL POUNDS LANDED | EX-VESSEL VALUE ($1,000s) | PERCENT OF TOTAL EX-VESSEL VALUE |
|---|---|---|---|---|
| Pelagic longline | 28300 | 75% | 47400 | 73% |
| Troll | 2960 | 8% | 4550 | 7% |
| Pelagic handline | 2340 | 6% | 3950 | 6% |
| Aku pole and line | 1450 | 4% | 1850 | 3% |
| MHI bottomfish handline | 420 | 1% | 1300 | 2% |
| NWHI bottomfish handline | 370 | 1% | 1210 | 2% |
| NWHI lobster trap | 260 | 1% | 1040 | 2% |
| All other fisheries | 1650 | 4% | 3330 | 5% |
| Total | 37750 | 100% | 64630 | 100% |

Source: Preliminary data compiled by PIFSC.

Another perspective on the role of bottomfish in Hawaii is to compare landings with pelagic, reef fish, and other fish. Table 3-34A shows the changing patterns from 2000 to 2003 (National Marine Fisheries Service 2004).

**TABLE 3-34A: Annual Estimated Commercial Landings in Hawaii (1000lbs), 2000-2003**

| YEAR | PELAGIC FISH | BOTTOMFISH | REEF FISH | OTHER FISH |
|---|---|---|---|---|
| 2000 | 26763 | 718 | 199 | 957 |
| 2001 | 22011 | 660 | 250 | 591 |
| 2002 | 22330 | 621 | 345 | 662 |
| 2003 | 21993 | 602 | 315 | 661 |

Estimates of the economic activity in the various sectors (commercial, charter and recreational) of Hawai'i's bottomfish fishery can be obtained from various published data. According to the WPRFMC (1999a), for the period 1994-1998, the ex-vessel value of annual commercial landings in the NWHI and MHI bottomfish fisheries averaged about $1,096,200 and $1,625,800, respectively. Based on data collected in a cost-earnings study of Hawai'i's charter fishing industry (Hamilton 1998), it is estimated that the charter boat fleet earns about $342,675 per year from taking patrons on bottomfish fishing trips. Finally, based on information gathered in a cost-earnings study of Hawaiʻi's small boat fishery (Hamilton and Huffman 1997), it is estimated that annual personal consumption expenditures for recreational vessels engaged in bottomfish fishing total about $2,827,096. Recreational vessels are fishing boats that do not sell any portion of their catch.

However, the above values reflect only the direct revenues and expenditures in the various sectors of the bottomfish fishery. They do not take into account that employment and income are also generated indirectly within the state by commercial, recreational and charter fishing for bottomfish. The fishery has an economic impact on businesses whose goods and services are used as inputs in the fishery such as fuel suppliers, chandlers, gear manufacturers, boatyards, tackle shops, ice plants, bait shops and insurance brokers. 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. Both the restaurant and hotel trade and the charter fishing industry are closely linked to the tourism base that is so important to Hawaiʻi's economy. Finally, people earning incomes directly or indirectly from the fishery make expenditures within the economy as well, generating additional jobs and income.

A more accurate assessment of current contributions of the bottomfish fishery to the economy can be obtained using the Type II output, income and employment multipliers calculated by Sharma et al. (1999) for Hawaiʻi's (non-longline) commercial, charter and recreational fishing sectors. Applying these multipliers to an approximation of the final demand in each of the sectors involved in bottomfish fishing, it is estimated that this fishing activity contributes $10.78 million of output (production) and $2.51 million of household income to the state economy and creates the equivalent of 113 full-time jobs (Table 3-35).[18]

**TABLE 3-35: Estimated Output, Household Income and Employment Generated by Bottomfish Fishing Activity in Hawaiʻi**

| FISHERY | SALES ($) | FINAL DEMAND ($) | OUTPUT ($) | HOUSEHOLD INCOME ($) | EMPLOYMENT (JOBS)[1] |
|---|---|---|---|---|---|
| NWHI bottomfish fishery | | | | | |

[18] Several input-output models other than the one used here are available to study economic impacts. The model developed by Sharma et al. (1999) is based on data collected in Hawaiʻi over a number of years, and is believed to be the best available for analyzing Hawaiʻi's fisheries. It should be noted, however, that different practitioners may apply a model in different ways.

| FISHERY | SALES ($) | FINAL DEMAND ($) | OUTPUT ($) | HOUSEHOLD INCOME ($) | EMPLOYMENT (JOBS)[1] |
|---|---|---|---|---|---|
| Commercial vessels[2] | 1096200 | 580,986 | 1,382,747 | 482,218 | 25 |
| MHI bottomfish fishery | | | | | |
| Commercial vessels[2] | 1625800 | 861,674 | 2,050,784 | 715,189 | 36 |
| Charter vessels[3] | 305664 | 293,437 | 760,002 | 269,962 | 14 |
| Recreational vessels[4] | | 2827096 | 6587134 | 1046026 | 38 |
| Total | | | 10780667 | 2513431 | 113 |

[1] Calculated as full-time jobs. The input-output model assumes that fishing accounts for 20% of the employment time of part-time commercial fishermen (Sharma et al. 1999).
[2] Average annual sales estimate for 1994-1998 from WPRFMC (1999a).
[3] Sales estimate based on the following assumptions: 199 active vessels; average annual sales of $76,800 per vessel from charter fees and mount commissions; and 2% of total sales attributed to bottomfish fishing trips (Hamilton 1998).
[4] Expenditure estimates based on the following assumptions (Hamilton and Huffman 1997; Pan et al. 1999):

| | |
|---|---|
| Number of recreational boats | 2490 |
| Annual number of bottomfish fishing trips | 3.81 |
| Average trip costs | 84.75 |
| Average fixed costs: apportioned according to ratio of bottomfish fishing trips to total number of trips | 213 |

### 3.6.2 American Samoa

The Territory of American Samoa is a group of islands with a total land area of 76 square miles lying approximately 2,300 miles southwest of Hawai'i. The islands of the territory include Tutuila, the three islands of Ofu, Olosega, and Ta'u of the Manu'a group, Aunu'u, Rose Atoll and Swain's Island. Formal annexation of Tutuila and Aunu'u by the United States occurred in 1900, Manu'a agreed to cede its authority to the United States in 1904, and Swain's Island was annexed in 1925. The islands remained under naval administration from 1900 to 1951, when the administration of American Samoa was transferred to the Secretary of the Interior.

#### 3.6.2.1 Overview of the Economy

American Samoa has a small developing economy, dependent mainly on two primary income sources: the American Samoa Government, which receives income and capital subsidies from the federal government, and the two fish canneries on Tutuila (BOH 1997). These two primary income sources have given rise to a third: a services sector that derives from and complements the first two. In 1993, the latest year for which the ASG has compiled detailed labor force and employment data, the ASG employed 4,355 persons (32.2 percent of total employment), followed by the two canneries with 3,977 persons (29.4 percent) and the rest of the services economy with 5,211 persons (38.4 percent). As of 2000, there were 17,644 people 16 years and older in the labor force, of whom 16,718, or 95%, were employed (American Samoa Census 2000 file, table PGB 35).

A large proportion of the territory's work force is from Western Samoa (now officially called Samoa) (BOH 1997). While it would be true to say that Western Samoans working in the territory are legally alien workers, in fact they are the same people, by culture, history, and family ties.

Statistics on household income indicate that the majority of American Samoans live in poverty according to U.S. income standards. American Samoa has the lowest gross domestic product and highest donor aid per capita among the U.S.-flag Pacific islands (Adams et al. 1999). However, by some regional measures American Samoa is not a poor economy. It's estimated per capita income of $4,357 (Census 2000) is almost twice the average for all Pacific island economies, although it is less than half of the per capita income in Guam, where proximity to Asia has led to development of a large tourism sector. Sixty-one percent of the population in 1999 was at or below poverty level (Census 2000).

3.6.2.2 Fishing-Related Economic Activities

The excellent harbor at Pago Pago and certain special provisions of U.S. law form the basis of American Samoa's largest private industry, fish processing, which is now more than forty years old (BOH 1997). The territory is exempt from the Nicholson Act, which prohibits foreign ships from landing their catches in U.S. ports. American Samoan products with less than 50 percent market value from foreign sources enter the United States duty free (Headnote 3(a) of the U.S. Tariff Schedule). The parent companies of American Samoa's fish processing plants enjoy special tax benefits, and wages in the territory are set not by federal law but by recommendation of a special U.S. Department of Labor committee that reviews economic conditions every two years and establishes minimum wages by industry.

In 1998, Pago Pago received 208,300 tons of fish worth more than $200 million, making it the leading U.S. port in terms of the dollar value of fish landings. Furthermore, with a production increase of 50 percent over the past three years, Star-Kist Samoa, Inc. has become the largest tuna cannery in the world. Nearly all of the fish processed by the canneries is harvested by domestic and foreign industrial fishing fleets operating in areas of the Pacific far from American Samoa.

The ASG estimates that the tuna processing industry directly and indirectly generates about 15 percent of current money wages, 10 to 12 percent of aggregate household income and 7 percent of government receipts in the territory (BOH 1997). On the other hand, both tuna canneries in American Samoa are tied to multinational corporations that supply virtually everything but unskilled labor, shipping services and infrastructure facilities (Schug and Galea'i 1987). Even a substantial portion of the raw tuna processed by Star-Kist Samoa is landed by vessels owned by the parent company. The result is that few backward linkages have developed, and the fish-processing facilities exist essentially as industrial enclaves. Furthermore, most of the unskilled labor of the canneries is imported. Up to 90 percent of cannery jobs are filled by foreign nationals from Western Samoa and Tonga. The result is that much of the payroll of the canneries "leaks" out of the territory in the form of overseas remittances.

Harsh working conditions, low wages and long fishing trips have discouraged American Samoans from working on foreign longline vessels delivering tuna to the canneries. American Samoans prefer employment on the U.S. purse seine vessels, but the capital-intensive nature of purse seine operations limits the number of job opportunities for locals in that sector as well. Only about 16 American Samoans are employed on U.S. purse seiners (Gillette and McCoy 1997). However, the presence of the industrial tuna fishing fleet has had a positive economic effect on the local economy as a whole. Ancillary businesses involved in reprovisioning the fishing fleet generate a significant number of jobs and amount of income for local residents. Fleet expenditures for fuel, provisions and repairs in 1994 were estimated to be between $45 million and $92 million (Hamnett and Pintz 1996).

Despite the substantial increases in cannery production, the future of the tuna processing industry in American Samoa is uncertain (BOH 1997). The North American Free Trade Agreement (NAFTA) may result in competition from Mexican tuna processors. The General Agreement on Tariffs and Trade (GATT) may prevent preferential entry into the United States of processed tuna from American Samoa. Tax exemptions for the subsidiaries of American companies operating in U.S. territories are under pressure in Congress and are no longer assured for the cannery owners. Also, low labor costs in tuna canning operations in Thailand make for serious pressure from foreign competition.

The tuna processing industry has had a mixed effect on the commercial fishing activities undertaken by American Samoans. The canneries often buy fish from the small-scale domestic longline fleet based in American Samoa, although the quantity of this fish is insignificant compared to cannery deliveries by the U.S. purse seine, U.S. albacore and foreign longline fleets. The ready market provided by the canneries is attractive to the small boat fleet, and virtually all of the albacore caught by the *alia*-style vessels that fished with longline gear during the late 1990s was sold to the canneries. Nevertheless, local fishermen have long complained that a portion of the frozen fish landed by foreign longline vessels enters the American Samoa restaurant and home-consumption market, creating an oversupply and depressing the prices for fresh fish sold by local fishermen.

Although the domestic longline fleet in Pago Pago consists mainly of small vessels, five locally owned vessels larger than 50 ft are also engaged in the longline fishery. These latter vessels are outfitted with modern electronic equipment for navigation, communications and fish finding, and they are able to chill and freeze tuna catches. In addition, several other fishermen in American Samoa are acquiring larger (38-50 ft) boats with a greater fishing range and capacity for chilling fish. At least in the short-term, most of the tuna landed by these vessels will likely be sold for canning. Local fishermen have indicated an interest in participating in the far more lucrative overseas market for fresh fish. To date, however, inadequate shore-side ice and cold storage facilities in American Samoa and infrequent and expensive air transportation links have been restrictive factors.

Pago Pago Bay has the appearance of a "working harbor" dedicated to the landing, processing and export of vast quantities of fish. The harbor supports mostly large fishing vessels, tankers and container vessels, but some small fishing and cruising boats moor there as well. However, the shore-side support facilities for small vessels are minimal. The fisheries occurring in the waters around American Samoa are typically small boat, one-day fisheries. Between 1994-1998, the annual ex-vessel value of commercial landings of bottomfish and pelagic species has averaged about $633,700 (WPRFMC 1999). The bottomfish catch accounts for only about 9% of the total revenues generated by local fisheries. Existing planning data for American Samoa are not suited to examining the direct and indirect contributions attributed to various inter-industry linkages in the economy. It is apparent, however, that bottomfish fishing plays a relatively minor role in the domestic small boat fishery, which itself represents only a small fraction of the economic activity in the territory.

Another perspective on the role of bottomfish in American Samoa is to compare landings with pelagic, reef fish, and other fish. Table 3-35A shows the changing patterns from 2000 to 2003 (National Marine Fisheries Service 2004).

**TABLE 3-35A: Annual Estimated Commercial Landings in American Samoa (1000 lbs), 2000-2003**

| YEAR | PELAGIC FISH | BOTTOMFISH | REEFFISH | OTHER FISH |
|---|---|---|---|---|
| 2000 | 1757 | 26.16 | 40.98 | 2.78 |
| 2001 | 7953 | 38.77 | 14.81 | 2.11 |
| 2002 | 15346 | 37.35 | 15.12 | 0.87 |
| 2003 | 10848 | 12.54 | 17.87 | 1.55 |

### 3.6.3 Guam

The Territory of Guam is an island located at the southern end of the Mariana archipelago, which lies about 1,500 miles from Japan and 3,700 miles from Hawai'i. The land area of Guam is approximately 212 square miles. The island was ceded to the United States following the Spanish American War of 1898 and has been an unincorporated territory since 1949.

#### 3.6.3.1 Overview of the Economy

The main income sources on Guam include tourism, national defense, and trade and services. Per capita income in Guam was $12,722 in 1999, up from $10,152 in 1991. Median household income was $39,317 in 1999, up from $31,118 in 1991. Twenty-three percent of the population in 1999 was at or below poverty level (Census 2000).

The Guam Department of Labor estimated the number of employees on payroll to be 64,230 in 1998, a decrease of 3.8 percent from the 1997 figure. Of the 64,230 employees, 44,780 were in the private sector and 19,450 were in the public sector. The federal government employs 7.6 percent of the total work force, while the Government of Guam employs 22.7 percent. Guam had an unemployment rate of 15.2 percent in 1999. As of 2000, Guam had 39,143 men age 16 and over in the labor force, of whom 81% were employed. There were 29,751 women age 16 and over in the labor force, of whom 86% were employed (Guam Census 2000, Table PGB 35).

The major economic factor in Guam for most of the latter part of the twentieth century was the large-scale presence of the U.S. military (BOH 1999b). In the 1990s, however, the military's contribution to Guam's economy has waned and been largely replaced by Asian tourism. Guam's macro-economic situation exhibited considerable growth between 1988 and 1993 as a result of rapid expansion of the tourist industry. In fact, Guam's economy has become so dependent on tourists from Asia, particularly Japan, that any significant economic, financial and foreign exchange development in the region has had an immediate impact on the territory (BOH, 1999b). During the mid- to late-1990s, as Japan experienced a period of economic stagnation and cautious consumer spending, the impact was felt just as much in Guam as in Japan. Visitor arrivals in Guam dropped 17.7 percent in 1998. Despite recent efforts to expand the tourist market, Guam's economy remains dependent on Japanese tourists.

The Government of Guam has been a major employer on Guam for many years. However, recent deficits have resulted from a steady rise in government spending at the same time that tax bases have not kept up with spending demands. Many senior government workers have been offered and have accepted early retirement to reduce the payroll burden.

In the 1990s, after three decades of troop reductions, the military presence on the island diminished to the lowest level in decades, but with the post-9/11 emphasis on homeland security, the war in Iraq, and repositioning of military assets from Asia and the mainland U.S., military spending on Guam has rebounded significantly, and the effects have been felt throughout the economy including in employment and housing prices (*Los Angeles Times*, July 25, 2004).

### 3.6.3.2 Fishing-Related Economic Activities

The importance of commercial fishing in Guam lies mainly in the territory's status as a major regional fish transshipment center and re-supply base for domestic and foreign tuna fishing fleets. Among Guam's advantages as a home port are well-developed and highly efficient port facilities in Apra Harbor; an availability of relatively low-cost vessel fuel; a well-established marine supply/repair industry; and recreational amenities for crew shore leave (Hamnett and Pintz 1996). In addition, the territory is exempt from the Nicholson Act, which prohibits foreign ships from landing their catches in U.S. ports. Initially, the majority of vessels calling in Apra Harbor to discharge frozen tuna for transshipment were Japanese purse seine boats and carrier vessels. Later, a fleet of U.S. purse seine vessels relocated to Guam, and since the late 1980s, Guam has become an important port for Japanese and Taiwanese longline fleets. The presence of the longline and purse seine vessels has created a demand for a range of provisioning, vessel maintenance and gear repair services.

By the early 1990s, an air transshipment operation was also established on Guam. Fresh tuna is flown into Guam from the Federated States of Micronesia and elsewhere on air cargo planes and out of Guam to the Japanese market on wide-body passenger planes (Hamnett and Pintz, 1996). A second air transshipment operation that began in the mid-1990s is transporting to Europe fish that do not meet Japanese *sashimi* market standards.

Currently, Guam is the most important re-supply and transshipment center for the international tuna longline fleet in the Pacific. However, the future of home port and transshipment operations in Guam depends on the island's ability to compete with neighboring countries that are seeking to attract the highly mobile longline fleet to their own ports. Trends in the number of port calls made in Guam by various fishing fleets reflect the volatility of the industry. The number of vessels operating out of Guam decreased by almost half from 1996 to 1997, and further declined in 1998 (Hamnett and Anderson 2000).

The Guam Department of Commerce reported that fleet expenditures in Guam in 1998 were about $68 million, and a 1994 study estimated that the home port and transshipment industry employed about 130 people (Hamnett and Pintz 1996). This industry constitutes an insignificant percentage of the gross island product, which was about $2.99 billion in 1996, and is of minor economic importance in comparison to the tourist or defense industries (Hamnett and Anderson 2000). Nevertheless, home port and transshipment operations make an important contribution to the diversification of Guam's economy (Hamnett and Pintz 1996). As a result of fluctuations in the tourism industry and cuts in military expenditures in Guam, the importance of economic diversification has increased.

Guam's local fishery also has limited economic importance relative to the economy as a whole. Offshore fishing typically involves small boats and 1 to 2-day fishing trips. Between 1994-1998, the annual ex-vessel value of commercial landings of bottomfish and pelagic species has averaged about $616,500 (WPRFMC 1999). The bottomfish catch accounts for only about 8% of the total revenues generated by local fisheries. Existing planning data for Guam are not suited to examining the direct and indirect contributions attributed to various inter-industry linkages in the economy. However, it is apparent that bottomfish fishing plays a relatively minor role in the domestic fishery, which itself represents only a small fraction of the economic activity in the territory.

Another perspective on the role of bottomfish in Guam is to compare landings with pelagic and other fish. Table 3-35B shows the changing patterns from 2000 to 2003 (National Marine Fisheries Service 2004).

**TABLE 3-35B: Annual Estimated Commercial Landings in Guam (1000 lbs), 2000-2003**

| YEAR | PELAGIC FISH | BOTTOMFISH | OTHER FISH |
|---|---|---|---|
| 2000 | 607.69 | 145.74 | 184.72 |
| 2001 | 752.22 | 122.51 | 174.21 |
| 2002 | 508.42 | 74.67 | 73.6 |
| 2003 | 485.43 | 111.58 | 76.56 |

### 3.6.4 The Northern Mariana Islands

The Commonwealth of the Northern Mariana Islands consists of 14 islands, five of which are inhabited, with a total land area of 176.5 square miles spread over about 264,000 square miles of ocean. The Northern Mariana Islands became part of the Pacific Trust Territory administered by the United States under a mandate granted in 1947. The Covenant that created the commonwealth and attached it to the United States was fully implemented in 1986, pursuant to a Presidential Proclamation that terminated the Trust Territory of the Pacific Islands as it applied to the Northern Mariana Islands.

### 3.6.4.1 Overview of the Economy

Per capita income in the CNMI in 1999 was $9,151. The median household income for the CNMI was $22,898. For Saipan, the median household income was $19,698 in the first quarter of 1999, as compared to $21,457 in 1990. The commonwealth had an unemployment rate in 1999 of 5.5 percent. Forty-six percent of the CNMI population was at or below poverty in 1999 (Census 2000).

In 2000, CNMI had 20,378 men ages 16 and over in the labor force, of whom 19,458 were employed, or 96 %. There were 24,093 women ages 16 and over in the labor force, of whom 23,268 were employed, or 97 % (CNMI Census 2000 file, Table PBG 35).

The economy of the CNMI has historically benefitted substantially from financial assistance from the United States, but in recent years this assistance has declined as locally generated government revenues have grown. Between 1988 and 1996, tourism was the commonwealth's largest income source. During that period tourist traffic to the CNMI tripled from 245,505 to 736,117 (BOH 1999c). Total tourist expenditures in the CNMI were estimated to be a record $587 million in 1996. In 1997 and 1998, however, the loss of air service between the CNMI and Korea, together with the impact of the Asian financial crisis on both Korean and Japanese travelers, caused tourist arrivals in the CNMI to drop by one-third (BOH 1999c).

At present, garment production is the CNMI's fastest growing industry, with shipments of $1 billion to the United States under duty and quota exemptions (BOH 1999c). The garment industry is credited with preventing an economic depression in the commonwealth following the decline of its tourist industry, but the future of the CNMI's garment manufacturers is uncertain. When the commonwealth was created it was granted an exemption from certain U.S. immigration, naturalization and labor laws. These economic advantages are now a matter of national political debate centered on what some regard as unfair labor practices in the CNMI's garment industry. The two main advantages for manufacturing garments in the CNMI are low-cost foreign labor and duty-free sale in the United States. The controversy over labor practices in the CNMI may cause the commonwealth to lose these unique advantages, forcing garment-makers to seek alternative low-cost production sites. The end of the quota on foreign textiles in 2005 may cause garment manufacturers to move to China, which has some competitive advantages (Bank of Hawaii 2004).

### 3.6.4.2 Fishing-Related Economic Activities

In the early 1980s, U.S. purse seine vessels established a transshipment operation at Tinian Harbor. The CNMI is exempt from the Jones Act, which requires the use of U.S.-flag and U.S.-built vessels to carry cargo between U.S. ports. The U.S. purse seiners took advantage of this exemption by offloading their catch at Tinian onto foreign reefer vessels for shipment to tuna canneries in American Samoa. In 1991, a second type of tuna transshipment operation was established on Saipan (Hamnett and Pintz 1996). This operation transships fresh tuna caught in the Federated States of Micronesia from air freighters to wide-body jets bound for Japan. The volume of fish flown into and out of Saipan is substantial, but the contribution of this operation to the local economy is minimal (Hamnett and Pintz 1996) .

With the exception of the purse seine support base on Tinian (now defunct), the CNMI has never had a large infrastructure dedicated to commercial fishing. The majority of boats in the local fishing fleet are small, outboard engine-powered vessels. Between 1994-1998, the annual ex-vessel value of commercial landings of bottomfish and pelagic species has averaged about $473,900 (WPRFMC 1999). The bottomfish catch accounts for about 28% of the total revenues. Existing planning data for the CNMI are not suited to examining the direct and indirect contributions attributed to various inter-industry linkages in the economy. It is apparent, however, that fishing by the local small-boat fleet represents only a small fraction of the economic activity in the commonwealth.

Another perspective on the role of bottomfish in Hawaii is to compare landings with pelagic, reef fish, and other fish. Table 3-35C shows the changing patterns from 2000 to 2003 (National Marine Fisheries Service 2004).

**TABLE 3-35C: Annual Estimated Commercial Landings in CNMI (1000lbs), 2000-2003**

| YEAR | PELAGIC FISH | BOTTOMFISH | REEF FISH | OTHER FISH |
|---|---|---|---|---|
| 2000 | 186.85 | 45.7 | 170.04 | 31.2 |
| 2001 | 178.78 | 71.66 | 149.24 | 34.18 |
| 2002 | 256.64 | 47.11 | 158.77 | 27.19 |
| 2003 | 226.48 | 42.43 | 93.25 | 17.4 |

## 3.7 FISHING COMMUNITY

The 1996 SFA amendments to the MSA added a definition of "fishing community" (MSA §(16)) and required that fishing communities be considered in the fishery impact statement (§303(a)(9)) and in certain other contexts, such as any proposal for limited access to a fishery (§303(b)(6)) and any plan to end overfishing (§304(e)(4)).

The MSA defines "fishing community" (§3(16)):

> *The term "fishing community means a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and included fishing vessel owners, operators, and crew and United States fish processors that are based in such community.*

The SFA also added National Standard 8 (§301(a)(8)), which states:

> *Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and the 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.*

The National Standard Guidelines further specify that (50 CFR 600.345):

> *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).*

And further:

> *The term "sustained participation" means continued access to the fishery within the constraints of the condition of the resource.*

To address the requirements of the SFA, the Council prepared a comprehensive document with amendments to all four of its FMPs. Amendment 6 to the Bottomfish FMP, Amendment 8 to the Pelagics FMP, Amendment 10 to the Crustaceans FMP, and Amendment 4 to the Precious Corals FMP were published in September 1998 and submitted to NMFS for review. NMFS only partially approved the amendments, as described in a *Federal Register* notice published on April 19, 1999 (64 FR 19067). Three components of the amendments were disapproved: the bycatch provisions (MSA §301(a)(9), §303(a)(11), and other sections) for the Bottomfish and Pelagics FMPs, the overfishing provisions (§303(a)(10) and other sections) for the Botomfish, Pelagics, and Crustaceans FMPs, and for all four FMPs, the description of the State of Hawai'i as a single fishing community (MSA §301(a)(8), §303(a)(9), and other sections).

The Council prepared and submitted supplements to the amendments to address the disapproved sections of Bottomfish FMP Amendment 6, Pelagic FMP Amendment 8, Crustaceans FMP

Amendment 10, and Precious Corals Amendment 4 regarding the identification of fishing communities. The fishing communities supplement (WPRFMC 2002e) reconsidered the original identifications and identified a new set of fishing communities within Hawaiʻi. It provided additional background and analysis to justify those identifications. It does not modify the identification of American Samoa, the Northern Mariana Islands, and Guam as fishing communities, as these definitions were approved in the original SFA amendments.

With respect to Hawaiʻi, the findings indicated that fishing and related services and industries are important to all of Hawaiʻi's inhabited islands, that the social and economic cohesion of fishery participants is particularly strong at the island level, and that fishing communities are best not distinguished according to fishery or gear type. The most logical unit of analysis for describing the community setting and assessing community-level impacts is the island. In each of the four FMP amendments, each of the islands of Kauaʻi, Niʻihau, Oʻahu, Maui, Molokaʻi, Lānaʻi, and Hawaiʻi is identified as a fishing community 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. These definitions were subsequently approved by NMFS.

The social analysis provided in this section is driven by the SFA requirement that impacts to fishing communities be considered in the context of fishery management decisions and by the NEPA requirement that the social and cultural effects of alternatives be discussed (40 CFR 1508.8). Section 3.6 of this EIS provided an overview of the standard socioeconomic variables typically found in an EIS, including a summary of income and employment data for the affected area. The present section includes data on population size and ethnicity and a description of the sociocultural setting of the bottomfish fisheries in the Western Pacific Region.

The sociocultural aspects of a fishery include the shared technology, customs, terminology, attitudes and values related to fishing. While it is the fishermen that benefit directly from the fishing lifestyle, individuals who participate in the marketing or consumption of fish or in the provision of fishing supplies may also share in the fishing culture. An integral part of this framework is the broad network of inter-personal social and economic relations through which the cultural attributes of a fishery are transmitted and perpetuated. The relations that originate from a shared dependence on fishing and fishing-related activities to meet economic and social needs can have far-reaching effects in the daily lives of those involved. For example, they may constitute important forms of social capital, i.e., social resources that individuals and families can draw on to help them achieve desired goals.

The products of fishing supplied to the community may also have sociocultural significance. For instance, beyond their dietary importance fish may be important items of exchange and gift giving that also help develop and maintain social relationships within the community.

Alternatively, at certain celebratory meals various types of seafood may become imbued with specific symbolic meanings.

Finally, the sociocultural context of fishing may include the contribution fishing makes to the cultural identity and continuity of the broader community or region. As a result of this contribution the activity of fishing may have existence value for some members of the general public. Individuals who do not fish themselves and are never likely to may derive satisfaction and enjoyment from knowing that this activity continues to exist. They may value the knowledge that the traditions, customs and life ways of fishing are being preserved.

### 3.7.1 Hawai'i

#### 3.7.1.1 Population Size and Ethnicity

The 1990 census listed the population of Hawai'i as 1,108,229. This figure rose to 1,179,198 in 1995 and to 1,211,537 in 2000. The population increased by a rate of 6.9 percent between 1990 and 1999.

The state of Hawai'i is divided into five counties. The county of Maui includes the islands of Kaho'olawe, Lāna'i, Maui and Moloka'i. The county of Honolulu encompasses the island of O'ahu and the Northwestern Hawaiian Islands excluding Midway Atoll. Kaua'i County consists of the islands of Kaua'i and Ni'ihau. The population of each county is provided in Table 3-36.

**TABLE 3-36: Hawai'i Population by County**

| AREA | 1990 CENSUS | 2000 CENSUS |
|---|---|---|
| Hawai'i State | 1108229 | 1211537 |
| Honolulu County, HI | 836231 | 874154 |
| Hawai'i County, HI | 120317 | 148677 |
| Kaua'i County, HI | 51177 | 58463 |
| Maui County, HI | 100374 | 128094 |

Source: U.S. Census Bureau

The 2000 Census redefined the way race is measured in a number of ways, allowing individuals to identify themselves as one race or a combination of races, as well as having a separate classification system for Hispanic or Latino and race. As a result, describing the makeup of Hawaii's population is more complex. Perhaps the most accurate way to describe Hawaii's population is to report the proportions of race alone or in combination with one or more other races. In 2000, 39.3 percent of Hawaii residents described themselves as white, 2.8 percent as black or African American, 2.1 percent as American Indian or Alaska native, 58 percent as

Asian, 23.3 percent as native Hawaiian and other Pacific Islander, and 3.9 percent as some other race. These proportions add up to more than 100 percent because many individuals reported more than one race. Of the 78.6 percent of residents who reported just one race, 24.5 percent listed White, 1.8 percent Black or African American, 41.6 percent Asian (including 4.7 percent Chinese, 14.1 percent Filipino, 16.7 percent Japanese, 1.9 percent Korean, and .6 percent Vietnamese), and 9.4 percent Native Hawaiian and other Pacific islander.

In 1995-1996, Hamilton and Huffman (1997) conducted a survey of small-boat owners who engage in Hawai'i's commercial and recreational fisheries, including the troll, pelagic handline and bottomfish handline fisheries. The survey found that the three largest ethnic groups represented in the sample were Japanese (33 percent), mixed with part-Hawaiian (16 percent) and Caucasian (12 percent). Hamilton and Huffman speculated that the high proportion of Japanese and part-Hawaiians in the sample reflects the traditional connections that these two ethnic groups have with the sea. These sociocultural connections are discussed further in the following section.

With specific regard to the NWHI bottomfish fishery, a 1993 survey of 15 owner-operators and hired captains who participate in the fishery found that 87 percent were Caucasian and 13 percent were part-Hawaiian (Hamilton 1994). However, it is likely that the ethnic composition of the deckhands aboard these vessels is much more mixed and reflects the highly diverse ethnic character of the state's total population

3.7.1.2 Sociocultural Setting

*Blue sampans ride in the harbor at Kewalo*
*under the copper brilliance of the sun;*
*blue sampans reel and tilt into the trade wind*
*on sea-paths traced by the Hawaiian moon;*
*blue sampans stagger and rise gallantly out of chasms of sea*
*in storms blowing out of the sultry south,*
*in hurricanes howling over the barren isles*
*far to the north, in a world of wind and foam.*
Clifford Gessler/ Tropic Landfall: The Port of Honolulu, 1942, p.267

Over the past 125 years the sociocultural context of fishing in Hawai'i has been shaped by the multi-ethnicity of local fisheries. Although certain ethnic groups have predominated in Hawai'i's fisheries in the past and ethnic enclaves continue to exist within certain fisheries, the fishing tradition in Hawai'i is generally characterized by a partial amalgamation of multi-cultural attributes. An examination of the way in which the people of Hawai'i harvest, distribute and consume seafood reveals remnants of the varied technology, customs and values of Native

Hawaiians and immigrant groups from Japan, China, Europe, America, the Philippines and elsewhere.

*3.7.1.2.1 Social Aspects of Fish Harvest*

Commercial fishing first became important in the Hawaiian Islands with the arrival of the British and American whaling fleets during the early nineteenth century. The whalers made the islands their provisioning and trading headquarters because of their central location in the Pacific (Nakayama 1987). This trade reached its zenith in the 1850s when more than 400 whaling vessels arrived in Honolulu annually (Shoemaker 1948). European- and American-owned trading concerns, called "factors," were established to service the whalers and gradually became the dominant enterprises in Honolulu. The significance of whaling to Hawaiʻi's economy waned considerably during the late-nineteenth century by which time plantation agriculture centered on sugar and pineapple production had grown in importance. A number of the trading companies that supported the whaling industry, however, adjusted to these economic changes and remained at the heart of Hawaiʻi's industrial and financial structure (Shoemaker 1948).

The introduction of a cash economy into Hawaiʻi and the establishment of communities of foreigners in the islands also led to the development of a local commercial fishery. As early as 1832, it was the custom for fish and other commodities to be sold in a large square near the waterfront in Honolulu (Reynolds 1835). In 1851, the first regular market house for the sale of fishery products was erected (Cobb 1902). The territorial government replaced this market in 1890 with an elaborate structure that Cobb (1902:435) referred to as "one of the best [market houses] in the United States." Other fish markets were established on the islands of Maui and Hawaiʻi. Locally caught bottomfish were in high demand at these markets. In Bryan's (1915) list of seafood preferences by the various "nationalities" in Hawaiʻi, all of the bottomfish species listed (i.e., *hāpuʻupuʻu*, *kāhala*, *ʻōpakapaka* and *uku*) were among the types of fish purchased by all social groups. Bryan (p.371) noted that some of the "snappers" "...may be procured almost every day, there being more than a hundred thousand pounds sold annually in the Hawaiian markets." Jordan and Evermann (1903:240) wrote of *uku*: "This fish is common about Honolulu, being brought into the market almost every day. It is one of the best of food-fishes." *Gindai* is also referred to as "one of our best food fishes" by Brigham (1908:17). Cobb (1902) reported that *ʻulaʻula*, *uku* and *ulua* were among the five species of fish taken commercially on all the islands. Titcomb (1972) writes that *ʻōpakapaka* was one of the most common fish on restaurant menus prior to World War II.

Initially, commercial fishing in Hawaiʻi was monopolized by Native Hawaiians, who supplied the local market with fish using canoes, nets, traps, spears and other traditional fishing devices (Jordan and Evermann 1902; Cobb 1902; Konishi 1930). However, the role that Native Hawaiians played in Hawaiʻi's fishing industry gradually diminished through the latter half of the nineteenth century. During this period successive waves of immigrants of various races and nationalities arrived in Hawai'i increasing the non-indigenous population from 5,366 in 1872 to 114,345 in 1900 (OHA 1998). The new arrivals included Americans, Chinese, Portuguese and Filipinos, but particularly significant in terms of having a long-term impact on the fishing industry was the arrival of a large number of Japanese. The Japanese, like the majority of the early immigrants, were contracted to work on Hawai'i's sugar cane plantations. When contract terms expired on the plantations many of the Japanese immigrants who had been skilled commercial fishermen from the coastal areas of Wakayama, Shizuoka and Yamaguchi Prefectures in Japan turned to the sea for a living (Okahata 1971). Later, experienced fishermen came from Japan to Hawai'i for the specific purpose of engaging in commercial fishing. As noted in Section 3.5.1.1, the bottomfish fishing gear and techniques employed by the Japanese immigrants were slight modifications of those traditionally used by Native Hawaiians.

During much of the twentieth century Japanese immigrants to Hawai'i and their descendants were preeminent in Hawai'i's commercial fishing industry. The tightly knit communities that the first Japanese immigrants formed both helped ease the transition to American society and retarded the process of acculturation (Tamura, 1994). The Japanese were able to maintain their separate communities in Hawai'i more effectively than any other immigrant group. Among those Japanese communities of particular significance were the settlements of commercial fishermen and their families in the Palama, River Street and Kākā'āko areas of Honolulu adjacent to the harbor (Lind 1980).

The adherence of Japanese immigrants to traditional cultural practices included Japanese religious observances, and many of the religious activities of communities such as Kākā'āko were centered on fishing (Miyasaki 1973). Various traditional Japanese taboos and rituals directed how a new fishing boat was to be launched, when a vessel could leave or return to port, what items could be brought on board a boat and many other aspects of fishing behavior (Hamamoto 1928; Katamoto 1984). Over the years, succeeding generations of fishermen of Japanese ancestry in Hawai'i became more "Americanized," but many Japanese fishing traditions persisted. For example, Japanese immigrant fishermen brought from Japan the Shinto practice of building a *jinsha* (shrine) dedicated to a deity such as *Konpira-sama* or *Ebisu-sama* (Kubota 1984; Miyasaki 1973). Today, an *Ebisu jinsha* constructed at Ma'alaea on the island of Maui during the early 1900s still stands, and fishermen of Japanese ancestry as well as others who share a common bond in fishing continue each year to ceremonially bless individual fishing vessels (Kubota 1984; T. Arine, pers. comm. 2000. Maui *Jinsha*).[19]

In addition to ethnic and community ties, the physical danger of fishing as an occupation also

[19]In some communities in Japan *Ebisu* is regarded specifically as the god of fishing, farming and commerce (Tokihiko 1983). He is depicted holding a fishing rod in his right hand and a sea bream under his left arm.

engendered a sense of commonality among fishermen. Describing the captains and crews of the early sampan fleet in Hawai'i, Okahata (1971:208) wrote: "It is said that the fishermen were in a clan by themselves and were imbued with a typical seaman's reckless daring spirit of 'death lies only a floor board away.'" The extreme isolation of the NWHI and the limited shelter they offered during rough weather made fishing trips to these islands particularly hazardous. The perils of fishing in the NWHI for bottomfish and other species captured the attention of the public media (e.g., Inouye 1931; Lau 1936), and inspired one individual to compose the poem included in the preface to this section.

As late as the 1970s, the full-time professional fishermen in Hawai'i were predominately of Japanese descent (Garrod and Chong 1978). However, by that period hundreds of local residents of various ethnicities were also participating in Hawai'i's offshore fisheries as part-time commercial and recreational fishermen. In addition, a growing number of fishermen from the continental U.S. began relocating to Hawai'i. Many of the new arrivals came to the islands because declining catch rates in some mainland fisheries had led to increasingly restrictive management regimes.

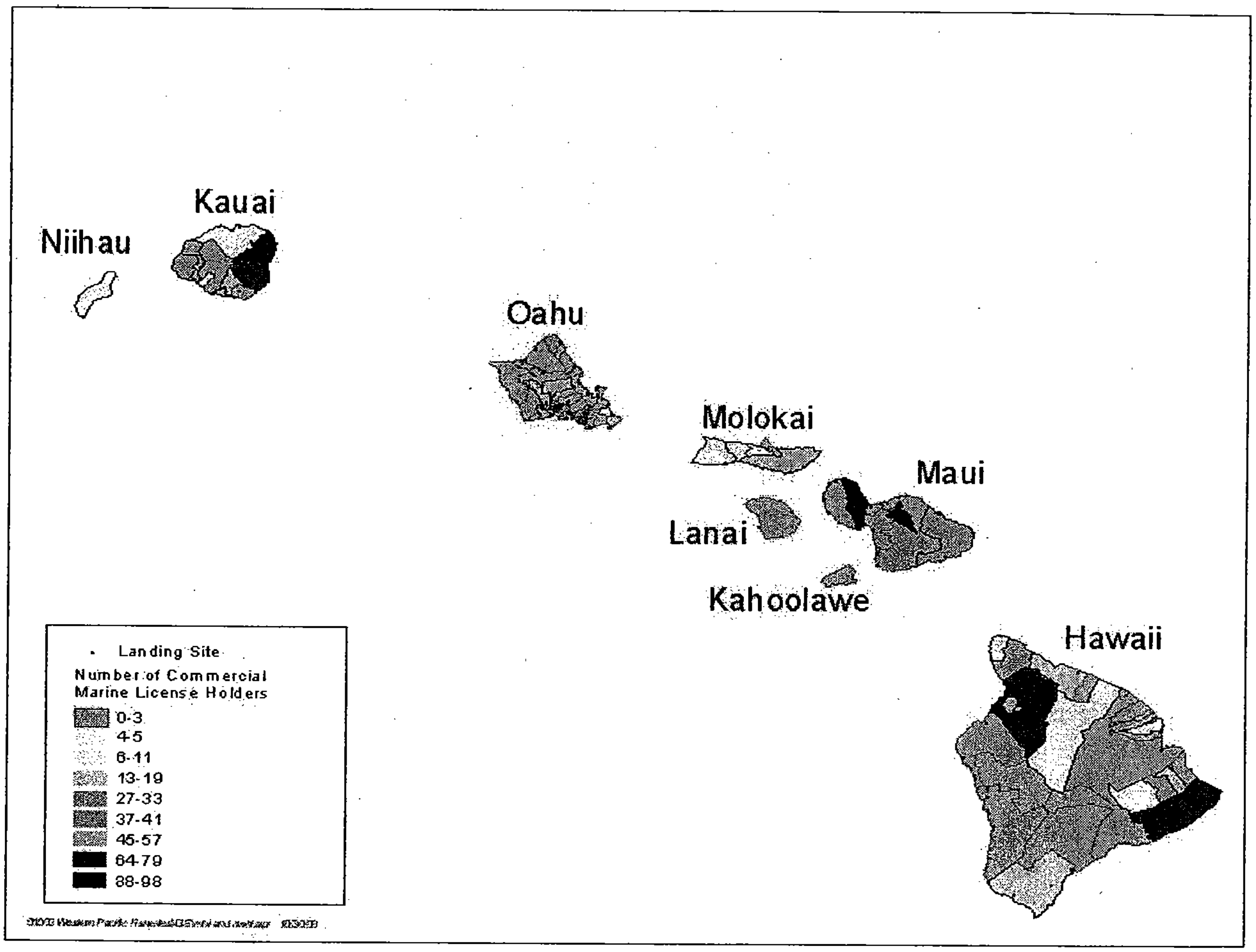
Today, the people who participate in Hawai'i's bottomfish fishery and other offshore fisheries comprise an ethnically mixed and spatially dispersed group numbering several hundred individuals, although actual numbers are difficult to ascertain. Most are year-round residents of Hawai'i, but some choose to maintain principal residences elsewhere. Participants in the bottomfish fishery do not reside in a specific location and do not constitute a recognizable fishing community in any geographical sense of the term. There are a few rural villages in the state where most residents are at least partially economically dependent on fishing for pelagic species (Glazier 1999). In general, however, those who are dependent on or engaged in the harvest of fishery resources to meet social and economic needs do not include entire cities and towns, but subpopulations of metropolitan areas and towns. These subpopulations comprise fishing communities in the sense of social groups whose members share similar lifestyles associated with fishing.

The dispersal of bottomfish fishery participants can be examined by mapping residence information from relevant fishery license or permit holders. The Hawai'i Division of Aquatic Resources (HDAR) administers a register of State of Hawai'i commercial marine license holders. State 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 HDAR. For a particular vessel this regulation applies to each person aboard (captain or deckhand) who catches or attempts to catch a fish for commercial purposes. Figure 3-28 shows the distribution of the business or home mailing address zip codes of commercial marine license holders who indicate that their primary fishing gear is bottomfish handline gear. Each of the five larger main islands has significant concentrations of participants.

Another potential source of information on the distribution of participants in the MHI bottomfish fishery is the HDAR list of registered bottomfish fishing vessels. Hawaii Administrative Rule Chap. 13-94 requires any vessel owner who fishes for certain bottomfish species to register their vessels for bottomfish fishing. To date, approximately 2,960 vessels have been registered (W. Ikehara, pers. comm. 2002. HDAR). The residences of the owners of these boats were not mapped, however, as the list contains many individuals who do not actually harvest bottomfish but who registered their vessels in anticipation of a future limited entry program for the MHI bottomfish fishery. There are currently no fees to register a vessel for bottomfish fishing, and many individuals may have registered, not because they intended to enter the bottomfish fishery at this time, but because they wanted to be ensured access to the fishery in the future.

Information on the residences of Mau Zone and Ho'omalu Zone limited entry program permit holders is available from the register of permit holders administered by NMFS. The register indicates that eight permit holders reside in various communities on Oahu, three reside in two different communities on Kaua'i, one resides on Maui, one resides on the island of Hawai'i and three have mailing addresses at separate locations on the U.S. mainland.

**FIGURE 3-28: Distribution of Mailing Address Zip Codes of HDAR Commercial Maine License Permit Holders Who Participated in the Hawaii Bottomfish Fishery, 1998 (n=1,133)**




Most of the vessels that comprise the NWHI bottomfish fishing fleet utilize harbor facilities at Kewalo Basin, a harbor located in the metropolitan Honolulu area. Three vessels operate from Port Allen Harbor on Kauai. Nearly all of the participants in the NWHI bottomfish fishery reprovision in Honolulu and offload their catch at Kewalo Basin because it is close to the fish auction. In addition, most of the large-volume, restaurant-oriented wholesalers that buy, process and distribute fishery products are located in the greater Honolulu area. Businesses whose goods and services are used as inputs in Hawai'i's offshore commercial fisheries, such as ice plants, marine rail ways, marine suppliers, welders and repair operations, are similarly concentrated in Honolulu. However, the contribution of the harvesting and processing of fishery resources to the total economic fabric of Honolulu is negligible in comparison to other economic activities in the metropolitan area, such as tourism. In other words, Honolulu is the center of a major portion of commercial fishing-related activities in the state but is not a community substantially dependent upon or substantially engaged in fisheries in comparison to its dependence upon and engagement in other economic sectors.

The bottomfish fishing fleet that concentrates its effort in the waters around the MHI consists mainly of trailered vessels operating from numerous launching facilities scattered throughout the state (Hamilton 1997). Glazier (1999) identified 55 ramps and harbors used by commercial and recreational fishing boats. This number does not include several private boat mooring and launching facilities. Many of these harbors and ramps offer minimal shore-side support services, and even some of the large, well-developed harbors are remote from any central business district or residential area. However, the extensive network of launching sites provides fishermen living anywhere on a given island ready access to multiple fishing grounds (Glazier, 1999).

The motivations for fishing among contemporary Hawai'i fishermen tend to be mixed even for a given individual (Glazier 1999). In the small boat fishery around the MHI the distinction between "recreational" and "commercial" fishermen is extremely tenuous (Pooley 1993a). Hawai'i's seafood market is not as centralized and industrialized as U.S. mainland fisheries, so that it has always been feasible for small-scale fishermen to sell any or all of their catch for a respectable price. Money earned from part-time commercial fishing is an important supplement to the basic incomes of many Hawai'i families.

It is also important to note that many people in Hawai'i who might be considered "commercial" fishermen hold non-fishing jobs that contribute more to their household income than does fishing (Pooley 1993a). For some fishermen non-fishing jobs are not a choice, but a necessity due to the inability to earn an adequate return from fishing. Many participants in Hawai'i's offshore fisheries often catch insufficient fish to cover even fuel, bait and ice expenses, but they continue fishing simply for the pleasure of it. Some go so far as to pursue non-fishing occupations that allow them to maximize the time they can spend fishing regardless if it is profitable or not (Glazier 1999).

Even those fishermen who rely on fishing as their primary source of income have other reasons for their occupational choice besides financial gain. For example, a 1993 survey of owner-operators and hired captains who participate in the NWHI bottomfish fishery found that enjoyment of the lifestyle or work itself is an important motivation for fishing among fishery participants (Table 3-37).

**TABLE 3-37: Motivations of 1993 Active Vessel Captains and Owners in the NWHI Bottomfish Fishery**

| MOTIVATION | MAU ZONE | | | | | | HO'OMALU ZONE | |
|---|---|---|---|---|---|---|---|---|
| | Owner-operated vessels N=5 | | Hired captain vessels N=3 | | | | All vessels N=4 | |
| | | | Captain | | Owner | | | |
| | Most Important | Somewhat Important | Most Important | Somewhat Important | Most Important | Somewhat Important | Most Important | Somewhat Important |
| Enjoy the lifestyle | 20% | 60% | 67% | 33% | N/A | N/A | | 50% |
| Enjoy the work | | 20% | | 67% | N/A | N/A | 25% | 25% |
| Primary source of income | 60% | 40% | 33% | | | | 50% | 25% |
| Source of additional income | | 20% | | | | 33% | | |
| No other source of employment | | 20% | | | | | | |
| Long term family tradition | | | | 33% | | | | 50% |
| Long term investment goals | 20% | 20% | N/A | N/A | 33% | 33% | | 50% |
| Tax write off | | | N/A | N/A | | 33% | | |
| Cover a portion of fixed costs | 20% | | N/A | N/A | | | | |
| Recreational purposes | | | N/A | N/A | 33% | | | |
| Plan to operate it myself | N/A | N/A | N/A | N/A | 33% | | | |

Source: Hamilton (1994)

Fulfillment of social obligations may also at times be an important reason for fishing. Fish are an important food item among many of the ethnic groups represented in Hawai'i, especially during various social events. Fishermen are expected to provide fish during these occasions and may make a fishing trip especially for that purpose (Glazier 1999).

Finally, some Hawai'i fishermen feel a sense of continuity with previous generations of fishermen and want to perpetuate the fishing life style. The aforementioned 1993 survey of participants in the NWHI bottomfish fishery found that half of the respondents who fish in the Ho'omalu Zone were motivated to fish by a long term family tradition (Table 3-37). This sense of continuity is also reflected in the importance placed on the process of learning about fishing from "old timers" and transmitting that knowledge to the next generation. A sociocultural survey of small trolling vessel captains in Hawai'i found that many of those interviewed either descend from long time fishing families or have worked in fishing or fishing-related work since they were in their teens (Glazier 1999). The average captain had almost 18 years of offshore fishing experience. The survey found that 35% of boat captains were taught how to fish by their fathers, grandfathers or uncles, while 32% reported being taught by friends (Glazier 1999). Only 14% indicated that they taught themselves. Most Hawai'i' fishermen consider knowledge and experience to be more important factors in determining fishing success than "high-tech" gear. An example of the value placed on information passed down from previous generations of fishermen is the monument that one town on Oʻahu has proposed to commemorate the *kūpuna* (elders) of that area who are recognized for their fishing skills and knowledge (Ramirez 2000).

Whatever the motivations for fishing, the contributions of friends and family members to these efforts are often substantial. Small boat fishing in Hawaiʻi is almost always a cooperative venture involving friends or relatives as crew members (Glazier 1999). In addition, wives, in particular, often play an essential role in shore-side activities such as the transport of fish to markets, purchase of ice, vessel maintenance, bookkeeping and so forth (Glazier 1999).

In Hawaiʻi during the past several years there have been a number of highly publicized clashes between the owners of large and small fishing boats and between fishermen who are newcomers and those who are established residents (Glazier 1999). The reasons for these conflicts are complex, but the perception that the state's marine resources are being damaged and depleted by certain groups of fishermen is a central factor. Fish landing statistics support the notion that catch rates in some fisheries are on the decline. Many fishermen have found that fishing is no longer a profitable enterprise and have dropped out of the industry (Glazier 1999). The situation is aggravated by a depressed state economy that has made it more difficult for many fishermen to find the financial resources to support marginal fishing operations.

In some cases, government regulations have helped alleviate competition among fishermen. In 1991, for example, a longline vessel exclusion zone ranging from 50 to 75 nm was established around the MHI to prevent gear conflicts between large longline vessels and small troll and handline boats. However, government regulations have also added to the level of tension and feelings of frustration among fishermen. For instance, many fishermen in Hawaiʻi have adjusted to natural variations in the availability of various types of fish by adopting a multi-species, multi-gear, highly flexible fishing strategy. However, this strategy is increasingly constrained by the implementation of limited access programs in Hawaiʻi's major commercial fisheries (Pooley 1993a).

Despite this highly competitive and divisive environment fishermen have been able to develop and maintain networks of social relations that foster collaboration and mutual support. For example, fishermen's attempts at organizing to promote their shared interests, whether in the market or lobbying government for changes in policy, have generally been fragmented. Nevertheless, some fishermen in Hawaiʻi are represented by a *hui* or organization, and these voluntary associations often facilitate coordination and cooperation for the mutual benefit of their members. A case in point is the Maui Cooperative Fishermen's Association, which is comprised of bottomfish fishermen many of whom are part-timers. The Association negotiates product prices with one or more seafood distributors who, in turn, supply local hotels and restaurants with fresh fish.

Glazier (1999) observed that membership in a Hawai'i fishing *hui* can instill a strong feeling of camaraderie and solidarity among fishermen. The cohesion within these organizations constitutes available social capital for both their members and the broader community. For example, fishing clubs often organize or participate in community service projects (Glazier 1999). Examples of more ad hoc forms of cooperation among fishermen are also common. For instance, fishermen may take turns trucking each other's fish from distant landing sites to the central fish auction in Honolulu, thereby reducing transportation costs (Glazier 1999).

Close social relationships also continue to be maintained between some fishermen and fish buyers. For example, small boat fishermen on Kaua'i and the Kona side of the island of Hawai'i tend to sell their catch directly to local buyers who, in turn, sell it to restaurants or retail markets (Glazier 1999). By sending their fish directly to dealers fishermen not only avoid the commission charged by the auction but also enjoy the price stability over the long-term that comes with an established reciprocal relationship. As Peterson (1973:59) noted, "A fisherman feels that if he is 'good to the dealer' in supplying him with fish that he needs to fill his order, 'the dealer will be good to him' and give him a consistently fair price for his fish."

*3.7.1.2.2 Social Aspects of Fish Distribution and Consumption*

Archaeological evidence indicates that seafood was part of the customary diet of the earliest human inhabitants of the Hawaiian Islands (Goto 1986). An early European visitor to Hawai'i observed that, "There is no animal food which a Sandwich Islander esteems so much as fish" (Bennett 1840:214). Nineteenth century immigrants to Hawai'i from Asia also possessed a culture in which fish was an integral part of the diet. Despite the "exorbitant" fish prices that Hawai'i residents have often encountered in the markets, the level of consumption of seafood in the islands has historically been very high. One early commentator noted:

> *In the Honolulu market 2,000,000 pounds of fresh salt water fish valued at $5,000,000 are sold annually. These figures represent a high price for a food that abounds in the waters all around the Islands, yet the people of this community, who are great lovers of the products of the sea, will gratify their tastes even at this expense* (Anon. 1907:17).

Today, per capita seafood consumption in Hawai'i is still at least twice as high as the national average (Shomura 1987).

Because seafood was such a significant item in the diets of local residents, the fish markets themselves became important institutions in Hawai'i society. Dole (1920:20) noted that the fish market located in the busiest section of Honolulu was more than a commercial establishment, it was also "...Honolulu's political center where impromptu mass meetings were held ...; it was, in a way, a social center also, especially on Saturdays for then business was at its height." Much of the retailing of fish now occurs through self-service supermarkets, but Honolulu's fish markets have endured and continue to be centers of social interaction for some island residents.

The fish markets are comprised of retail units the majority of which are single proprietorship-family type operations. Close social connections have developed between retailers and consumers, as the success of the dealers is largely a function of their ability to maintain good relations with their customers and maintain a stable clientele (Garrod and Chong 1978). One journalist wrote of the O'ahu Market, where fresh fish and produce have been sold for nearly a century: "In the hustle and bustle of daily life in downtown Honolulu, many people are drawn to O'ahu Market because of its informal charm and the feeling of family one gets while shopping there" (Chinen 1984:9).

Early in the last century Bryan (1915) developed a list of the various fish purchased in the Honolulu market by each of Hawaii's principal "nationalities." The ethnic identification of Hawai'i's *kama 'āina* (long-time residents) with particular species has continued to the present day. The large variety of fish typically offered in Hawai'i's seafood markets reflects the diversity of ethnic groups in Hawai'i and their individual preferences, traditions, holidays and celebrations.

Many of the immigrant groups that came to Hawai'i brought with them cultures in which fish are not only an integral part of the diet but given symbolic and even transformative connotations. Certain fish communicate messages of solidarity, favor, opulence and the like, or are believed to impart specific desirable traits to the diners (Anderson 1988; Baer-Stein 1999). For example, some types of bottomfish that are red in color have found acceptance within the Japanese community in Hawai'i as a substitute for red *tai* (sea bream, *Pagrus major*) – a traditional Japanese symbol of good luck and, therefore, an auspicious fish to be served on festive occasions (HDAR 1979; Shoji 1983). The red color of these fish also symbolizes prosperity and happiness.[20] The December peak in landings of *'ōpakapaka*, *onaga*, *kalekale* and *ehu* reflect the demand for them as an important dish in feasts celebrating *Oshogatsu* (Japanese New Year's), considered the most important cultural celebration for people of Japanese ancestry in Hawai'i. Serving these fish is also important during non-seasonal events such as wedding and birthday banquets. For Hawai'i residents of Chinese descent fish or "*yu*" is an important item during feasts celebrating *Tin nien* (Chinese lunar New Year) and other ritual observances, as it is a homophone

[20]The reason *tai* is regarded as a celebratory fish among Japanese is thought to be due not only to its beauty of form and color but also because "*tai*" suggests the word "*medetai*," meaning auspicious (Shoji 1983)

for abundance (Choy 1989). Fish also symbolize regeneration and freedom because of their rapid ability to propagate as well as their speed and unconfined lifestyle (Baer-Stein 1999). Fish with white, delicately-flavored flesh are in particularly high demand by the Chinese community during New Year celebrations and other festive occasions (Peterson 1973).

An insistence on quality, as well as quantity and variety, has also long been a hallmark of Hawai'i's seafood markets. For example, the Japanese immigrants to Hawai'i came from a society in which fishermen, fish dealers and even cooks typically handle prized fish with considerable care (Joya 1985). Hawai'i seafood consumers continue to demand fresh fish. Both the discriminating tastes of local residents and the symbolic meaning with which some fish are imbued are linked to the importance of fish as gifts from one person or family to another. In Hawai'i various types of high-priced fish such as red snapper are highly regarded as gifts (Peterson 1973). Such sharing and gift giving may play an important role in maintaining social relations, as exemplified by the traditional Japanese obligation to engage in reciprocal exchanges of gifts according to an intricate pattern of established norms and procedures (Ogawa 1973). Those who neglect the obligation to reciprocate risk losing the trust of others and eventually their support.

The sharing of fish among members of the extended family and community is also an early tradition of the indigenous people of Hawai'i. The social responsibility to distribute fish and other resources among relatives and friends remains a salient feature of the lives of many Native Hawaiians that is enacted on both a regular basis and during special occasions (Glazier 1999). Among Native Hawaiians fish is considered a customary food item for social events such as a wedding, communion, school graduation, funeral or child's first birthday (baby *lū'au*) (Glazier 1999).

### *3.7.1.2.3 Social Significance of Fishing to the Broader Community*

Commercial fishing has been part of Hawai'i's economy for nearly two centuries. Long-established fishing-related infrastructure in Honolulu such as the fish markets and Kewalo Basin mooring area has helped define the character of the city. Moreover, for some major ethnic groups in Hawai'i such as the Japanese and Native Hawaiians the role that their forebears played in the development of commercial fisheries in the islands remains an important part of their collective memory. In 1999, for example, the Japanese Cultural Center of Honolulu organized an exhibition commemorating the past involvement of Japanese in Hawai'i's commercial fishing industry.

Given the historical significance of commercial fishing in Hawai'i, it likely that some local residents consider the fishing industry to be important in the cultural identity and heritage of the islands. Individuals who have never fished and do not intend to may nonetheless value the knowledge that others are fishing and that this activity is continuing to contribute to Hawai'i's social, cultural and economic diversity. This existence value may be expressed in various ways. For example, some individuals may engage in vicarious fishing through the consumption of books, magazines and television programs describing the fishing activities that others are pursuing in the waters around Hawai'i.

Just as Hawai'i's fishing tradition is an integral part of the islands' heritage and character, the image of Hawai'i has become linked with some types of locally caught seafood. Among the fish species that have become closely identified with Hawai'i are bottomfish such as *ōpakapaka* and *onaga*. The continued availability of these seafoods in Hawai'i has important implications for the mainstay of the state economy - tourism.[21] Many Japanese tourists visiting Hawai'i want to enjoy the traditional foods and symbols of prosperity of Japan while they vacation in Hawai'i, including various types of high quality fresh fish (Peterson, 1973). Hawai'i tourists from the U.S. mainland and other areas where fish is not an integral part of the customary diet typically want to eat seafood because it is perceived as part of the unique experience of a Hawai'i vacation. For both Japanese and U.S. mainland tourists, the experience of consuming fish in Hawai'i may be enriched if the fish eaten is actually caught in the waters around Hawai'i. Suryanata (2000) observes that markets within the state for "grown in Hawai'i" products have expanded in the past decade through the proliferation of gourmet restaurants that feature "Pacific Rim" and "Hawai'i Regional Cuisine." This marketing strategy eschews traditional symbols constructed by the tourism industry in favor of inciting an appreciation of the social relationships and physical environment that make Hawai'i an unique place.

Suryanata (2000) also notes that place-based speciality food can retain its appeal to buyers beyond a vacation period or even attract buyers who have never been to the place in question. Just as a consumption of organic food may signify a commitment to a certain environmental and social value, a consumption of products from Hawai'i can symbolize a partial fulfillment of a desire to experience or relive a Hawai'i vacation. According to a national seafood marketing publication, the power of this constructed value to influence prospective buyers has not been lost on Hawai'i's seafood dealers:

> *When it comes to selling seafood the Hawaiians have a distinct advantage. Their product comes with built-in aloha mystique, and while they've emphasized the high quality of the fish taken from their waters, they've also taken full advantage*

[21]Suryanata (2000) notes that many attributes of Hawai'i have been constructed in the marketing of Hawai'i by the tourist industry, and unusual or exotic food complements the marketed image. In describing the current initiative to revive Hawai'i's agricultural sector by diversifying into high-value non-traditional export crops, such as tropical flowers, gourmet coffee and tropical speciality fruits, she writes "None of these products is unique to Hawai'i in a true sense to merit a higher price, but marketing strategies seek to define a strong place-association of these products with Hawai'i, to capitalize on Hawai'i's exotic image and to develop niche markets for speciality products from paradise." This statement is equally true for locally-produced seafood sold in Hawai'i.

> *of the aura of exotic Hawaii itself in promotion on the mainland and, now, in Europe* (Marris 1992:75).

Local production of food as opposed to a reliance on imports also creates opportunities to foster social connections between consumers and their food producers. As noted above, much of the retailing of fish in Hawai'i now occurs through supermarkets, and a large quantity of the seafood sold is imported. However, there still exists in Hawai'i personal connections between consumers and the individuals who harvest and retail fish. Such connections may have broad public value. For example, an article by agricultural researchers identified proximity as one of the key attributes of a sustainable food system:

> *A sustainable food system is one in which "food is grown, harvested, processed, marketed, sold, [and] consumed as close to home as possible." An emphasis on locally grown food, regional trading associations, locally owned processing, local currency, and local control over politics and regulation is found within a proximate system. A proximate food system will have "grocery stores close to home which carry local items with little or no corporately owned products to compete," and would provide "specialty items that characterize the bioregion"* (Kloppenburg et al. 2000:182).

### 3.7.2 American Samoa

#### 3.7.2.1 Population Size and Ethnicity

The American Samoa Government estimated the total population in 1995 to be 56,350, up 20.5 percent from 1990, when the decennial census was conducted. The Census 2000 figure is 57,291. Between 1990 and 1995, American Samoa's population grew at an annual rate of 3.8 percent, one of the highest growth rates in the Pacific Islands and the world. The 2000 census reported that 96 percent of residents listed just one race or ethnic origin; 88 percent reported being Samoan, 2.8 percent Tongan, 2.8 percent Asian, and 1.1 percent White. Just four percent reported belonging to two or more races or ethnic groups; 3.5 percent listed Samoan and one or more other groups.

The large majority of participants in the fisheries occurring in the EEZ around American Samoa are of Samoan ancestry. A 1987 survey of 36 small vessel operators in American Samoa found that 72 percent were Samoan, 17 percent were Caucasian and 11 percent were some other ethnicity (Kasaoka 1989). It is likely that the percentage of those involved in off-shore fishing who are of Samoan ancestry has increased in recent years with the expansion of the domestic longline fleet.

3.7.2.2 Sociocultural Setting

The activity of fishing, including the preparatory rituals on shore, application of fishing skills at sea and distribution of the catch according to strict protocols, has been an integral part of Samoan culture since time immemorial. It shaped the traditional Samoan religion, diet, material culture, oral traditions and calendar (Severance and Franco 1989). Fishing and its products also played a fundamental role in the social structure. In traditional Samoan society every adult participated as a member of an extended family or *aiga* that shared resources and responsibilities. Each *aiga* was headed by a titled "chief" or *matai* who was the decision-maker and spokesperson for the family in many matters of village life. Untitled men and women had a myriad of obligations for service to the *aiga* and *matai* and were expected to contribute goods (including fish) and labor to important village ceremonies ranging from weddings to title investitures. Such service was expected of untitled individuals if they were to rise in status and perhaps achieve their own *matai* title and position. In addition, other, less formal exchanges of goods and services occurred among kinsmen and friends as expressions of a sustained relationship.

The introduction of a cash economy in American Samoa did not weaken this network of social obligations as much as provide new opportunities for customary exchange of goods and services within American Samoa's tightly held *aiga* system. Fishing has become increasingly commercialized, but fish, whether it be caught or purchased, remains a significant component of the customary exchange system. Fish supports the food needs of the extended family as well as the status of the family and the broader community.

Traditionally, *ulua* were accorded a high level of cultural importance and were reserved for consumption by members of the village elite (Severance and Franco 1989). Today, large specimens of *ulua* and other bottomfish are still occasionally ceremonially cut up for formal presentation to the *matai*, village pastor, village council members and others of high social status within the community. However, pelagic species, especially yellowfin and skipjack tuna, are the preferred offerings for village events (WPRFMC 2000b). The amount of bottomfish caught that is not sold is relatively small. But even the fish that is sold may be fulfilling obligations to friends and members of the extended family. A survey of American Samoan fishermen indicated that a significant portion of the catch that is sold is done so at a reduced price to friends and kinsmen as an expression of an established social relationship (Severance et al. 1999). Furthermore, commercial fishermen are expected to catch fish when village ceremonies are pending and to be generous in sharing their harvest. Some fishermen keep fish in freezers with the expectation they will be called upon to provide food for cultural purposes by their *matai*.

Fishing as a commercial activity not only contributes to the extended family's welfare, but also to social cohesion within the broader island community. It offers individuals an occupation that is consistent with Samoan cultural values and the island lifestyle. Furthermore, to the extent that unemployment among the younger population can cause both economic and social ills, commercial fishing provides an additional opportunity for young people to be economically productive and socially responsible.

The "community" of American Samoans involved in the small-scale offshore fisheries targeting pelagic and bottomfish species is not localized to any significant degree. A fisheries survey in American Samoa reported that small boat fishermen are found in nearly every village in the territory (Severance et al. 1999). The residential distribution of individuals who are substantially dependent on or substantially engaged in the harvest of offshore fishery resources approximates the total population distribution. These individuals are not set apart – physically, socially or economically – from the population of American Samoa as a whole.

### 3.7.3 Guam and the Northern Mariana Islands

#### 3.7.3.1 Population Size and Ethnicity

Guam's population was 154,805 in Census 2000. The 1970 total was 84,996. Regarding ethnic origin and race, 86.1 percent of Guam's residents reported being one ethnicity or race, including 37 percent Chamorro, 26.3 percent Filipino, 6.8 percent White, 4 percent Chuukese, 2.5 percent Korean, 1.7 percent Chinese, 1.4 percent Palauan, 1.3 percent Japanese, and 1 percent Black or African American. Just under 14 percent reported belonging to two or more races or ethnic groups; 7 percent reported that one of these groups was Asian and 5.1 percent reported one of theses groups as Chamorro.

The total population of the CNMI increased from 16,780 in 1990 to 69,221 in Census 2000. The development of a garment industry based on imported foreign labor accounts for this phenomenal population growth (BOH 1999c). Most of the population increase has been on Saipan, the commonwealth's commercial, governmental and civic center as well as its garment manufacturing capital. Regarding ethnic origin and race, 90.1 percent of CNMI residents reported being one ethnicity or race, including 26.2 percent Filipino, 22.1 percent Chinese, 21.3 percent Chamorro, 3.8 percent Carolinian, 2.9 percent Korean, 2.4 percent Palauan, 2 percent Chuukese, and 1 percent White. Just under 10 percent reported belonging to two or more races or ethnic groups; 6.3 percent reported one of theses groups as Chamorro, 4.4 percent reported that one of these groups was Asian, and 3.1 percent Carolinian.

The majority of fishermen in the offshore commercial and recreational fisheries around Guam are Chamorros (Vaughn et al. 2000), while Chamorros and Carolinians dominate the offshore fisheries around the CNMI (Hamnett et al. 1998).

#### 3.7.3.2 Sociocultural Setting

Over the centuries of acculturation beginning with the Spanish conquest in the late seventeenth century, many elements of traditional Chamorro and Carolinian culture in Guam and the Northern Mariana Islands were lost. But certain traditional values and attitudes were retained and have been melded with elements of Western culture that are now a part of local life and custom. Amesbury et al. (1989:48) note that the practice of sharing one's fish catch with relatives and friends during Christian holidays is rooted in traditional Chamorro and Carolinian culture:

> *A strongly enduring cultural dimension related to offshore fishing is the high value placed on sharing of the catch, and the importance of gifts of fish to relatives and friends. Such gifts are not limited to offshore fish; often they are made up of reef fish. Sometimes pelagic or bottomfish are sold in order to earn money to buy gifts for friends and relatives on important religious (Catholic) occasions such as novenas, births and christenings, and other holidays.*

In addition, the people of Guam and the CNMI participate in many banquets throughout the year associated with neighborhood parties, wedding and baptismal parties and especially the village fiestas that follow the religious celebrations of village patron saints. All of these occasions require large quantities of fish and other traditional foods (Orbach 1980; Hamnett et al. 1998; Vaughn et al. 2000).

The social obligation to share one's fish catch extends to part-time and full-time commercial fishermen. In Guam and the CNMI locally caught fish are often sold informally (Amesbury and Hunter-Anderson 1989; Amesbury et al. 1989). The buyers are mainly friends, neighbors, and relatives, especially in the CNMI. This non-anonymous, very personal "market" tends to restrain the price asked and paid.

Orbach (1980) notes that the fisheries in the CNMI are inextricably involved with the lifestyles and plural-occupational patterns of the participants. Part-time fishing performed in conjunction with other activities has a prominent place in the socioeconomic adaptations of local residents. People fish for bottomfish and pelagic species to supplement their family subsistence, which is gained by a combination of small scale gardening and wage work (Amesbury et al.1989). Orbach suggests that the availability of economic activities such as part-time fishing is among the major reasons that the CNMI has not experienced more of the problems of other island entities such as out-migration or high rates of crime and juvenile delinquency.

Fishing in Guam and the CNMI continues to be important not only in terms of contributing to the subsistence needs of the Chamorro and Carolinian people of the Mariana Islands but also in terms of preserving their history and identity. As noted above, many aspects of traditional Chamorro and Carolinian culture have been lost. Fishing has assisted Chamorros and Carolinians in keeping alive what remains of the maritime attributes of their traditional culture and helped them maintain their connection to the sea and its resources.

The preservation of the Chamorro culture and its ties to marine resources were cited as a major goal of Vision 2001/2005:

> "The commercial value of the industry is just one component of the importance fisheries plays in the lives of Guam's people. It is estimated that the prehistoric settlement of Guam occurred 2500 years ago, and throughout the history of the island, there is perhaps no other natural resource that is as fundamentally critical to the quality of life for the people of Guam as the benefits we derive from our surrounding ocean...it is the island marine resources which provide the greatest natural potential for economic self-sufficiency." (Gov. Of Guam, 2001)

Participants in the small-scale offshore fisheries targeting pelagic and bottomfish species are not concentrated in specific locales. Surveys of fishery participants in Guam and the CNMI found that these individuals reside in towns throughout the islands (Hamnett et al. 1998; Vaughn et al. 2000). Given the small size of Guam and the Northern Mariana Islands, dispersal of fishery participants and extensive community networks for sharing locally caught fish, it likely that the social benefits of fishing are experienced by most of the islands' long-term residents.

## 3.8 NATIVE HAWAIIAN COMMUNITY

> *The challenge for the anthropologist and for the policy maker concerned with traditional Hawaiian social and religious beliefs is to resist the ethnocentrism that arises from the unquestioned assumption that one's own world view is somehow the only correct one. Only then can one begin to appreciate the social and religious significance of fish and fishing in Hawaii* (Iversen et. al. 1990:25).

Executive Order 12898, signed in 1994, requires federal agencies to address the environmental effects, including human health, economic and social effects, of federal actions on minority populations and low-income populations. This section describes environmental justice considerations and supplements the socio-economic analyses in other sections of the EIS. Opportunities for community input in the NEPA process, including identification of environmental justice issues, were provided during the scoping process described in Section 1.3.1 and Chapter 6.

As the current management regime for the bottomfish fishery in the Western Pacific Region and environmental concerns related to that fishery both focus on fishing activities in the waters around Hawai'i, environmental justice issues identified during the scoping process also tended to center on Hawai'i.

As discussed in Section 3.7.1, the individuals who participate in Hawai'i's bottomfish fishery and other offshore fisheries comprise an ethnically mixed group. A survey by Hamilton and Huffman (1997) of small-boat owners who engage in Hawai'i's commercial and recreational fisheries, including the troll, pelagic handline and bottomfish fisheries, found that the overall distribution of survey participants' ethnicities is similar to that found in Hawai'i's statewide population in that the three most common ethnicities are Japanese, part-Hawaiian and Caucasian.

Vessels used in the NWHI bottomfish fishery were not included in the Hamilton and Huffman (1997) survey, but information on the ethnicity of some participants in this fishery is available from a 1993 survey conducted by Hamilton (1994). This earlier survey of 15 owner-operators and hired captains who participate in the NWHI bottomfish fishery found that 87 percent were Caucasian and 13 percent were part-Hawaiian. However, it is likely that the ethnic composition of the deckhands aboard these vessels is much more mixed and reflects the highly diverse ethnic character of the state's total population (Section 3.8.1.).

With regard to the income levels of small-boat owners in Hawai'i, Hamilton and Huffman (1997) reported that the mean household incomes of the survey respondents are above the state average, although the income levels of full-time fishermen tend to be less than those of recreational fishermen. Information on the household income of participants in the NWHI bottomfish fishery is unavailable.

The public scoping process for this EIS identified people of Hawaiian ancestry as being both a minority population and low-income population with a particular interest in the use of the marine resources of the NWHI, including the bottomfish resources. These interests arise from complex historical and contemporary economic, social, cultural and political circumstances that are discussed below. Given the significance of these special circumstances, impacts on the Native Hawaiian community were made a separate impact topic in the Environmental Consequences section of this document.

### 3.8.1 *Mai Kīnohi Mai* (From the Very Beginnings)

The foundation of a people's culture is often revealed in the stories told about their origins. Native Hawaiians define their relationship to the *'āina* (land) as the relationship between younger sibling (*po'e Hawai'i* - Native Hawaiians) and elder sibling (*'āina*) both of whom were descended from *Papa* (Earth mother) and *Wākea* (Sky father) (Kame'eleihiwa 1992). The relationship of *po'e Hawai'i* with the ocean was one defined in sacred terms as manifested by the embodiment of the ocean as the realm of *Kanaloa*, one of four primary *Akua* (Divine Beings) in the pantheon of Native Hawaiian *Akua*. The customary and traditional relationship of *po'e Hawai'i* to the fauna and flora of this oceanic realm was one of *'ohana* (family) in which many of the naturally occurring plants and animals (including fish) were regarded as ancestors embodied in temporal form who acted as divine family guardians (Kamakau 1976; Malo 1951).

This spiritual connection was the foundation of the Hawaiian commitment to care for the land and sea and protect them for use by future generations. The understanding of Native Hawaiians in the interdependence of people and the natural resources that sustain them was preserved in the wisdom of *kūpuna* (ancestors) and articulated in *ʻōlelo no ʻeau* (sayings of wisdom). The following sample of proverbs compiled by Pukuʻi (1983) illustrate the conservation ethic of Native Hawaiians.

*E ʻai i kekahi, e kāpi kekahi.*
Eat some now and save some for another time. (#252)

*He pono ka pākiko ma mua o ka hoʻokelakela wale aku.*
Better to be economical than too liberal. (#912)

*Lilo akula ka nui a koe ka unahi.*
Most [of the fish] are taken and only the scales are left.
Said after one has taken the "lion's share" for himself. (#2004)

The Hawaiian sense of stewardship was essential given the dense human population in Hawaiʻi and the islands' limited natural resources. Estimates of the population of Hawaiʻi prior to European contact vary. An analysis of the Hawaiian population by Stannard (1989) suggests that the population may have approached one million people prior to foreign penetration into the Pacific. Such a large population could also explain how it was that the Native Hawaiian people came to use the area now known as the Northwestern Hawaiian Islands. A population approaching the population that inhabits these islands today would have likely sought to expand its fishing territory as far as possible in order to survive and prosper.

It is part of the historic record that voyages between the MHI and the southern reaches of the NWHI were undertaken on a regular basis. There is also ample evidence that Native Hawaiians were skilled and prolific fishermen both in inshore waters, including the banks near the main islands and extending into the open ocean (e.g., Beckley 1883; Goto 1986; Kahaulelio 1902; Murakami and Freitas 1987; Scobie 1949). It is likely, therefore, that Native Hawaiians frequented the NWHI for ritual and food gathering. Physical evidence found on both Nihoa and Necker islands indicates that Native Hawaiians frequented these islands long enough to build a series of religious temples and agricultural terraces (Emory, 1928).

Evidence of Hawaiian habitation of the NWHI can also be found in the oral traditions of Native Hawaiians. Moses Keale, a recently deceased native of Niʻihau, related a tradition of Niʻihauans voyaging to Nihoa for extended periods of time in conjunction with changing weather patterns.

These stays were long enough to plant sweet potatoes and harvest those that had been planted on the previous visits. Fish were also caught and preserved for transport back to the MHI (pers. comm. 1980). More recently, in answer to a question regarding extent of the aforementioned voyages, a *kūpuna* (elder) from Niʻihau stated that these voyages went beyond Nihoa (and possibly Necker) to "*mokupuni palahalaha*" (small flat islands) where one could see from one side of the island to the other (Malaki Kanahele, pers. comm. 2000).

Another example of Hawaiian familiarity with the Northwestern Hawaiian Islands found in the oral record is a section of the story of *Pele* and *Hiʻiaka* published in the Hawaiian language newspaper *Kūʻokoʻa Home Rula* (1911) in which *Pele* recites the wind names of Nihoa.

*Na Makani o Nihoa*
*He Honouli ka makani o Nihoa*
*He Waialoha ka makani noho ana o Nihoa*
*He Lupekiikai ka makani kaapuni o Nihoa*

Rauzon (2001) suggests that other *mele* (chants) and legends as well as accounts of the navigational assistance that Hawaiians provided to early European explorers indicate that Hawaiians were familiar with many of the NWHI.

### 3.8.2 *Komo Ka Poʻe Haole* (Penetration of Foreigners)

By the time Captain James Cook came upon the Hawaiian Islands in 1778, the sovereign line of Hawaiʻi had persisted for more than 23 generations - or more than 500 years - of a sustained, stable system of governance. In 1810, Kamehameha succeeded in establishing political control over all of the major islands. In order to cope with increasing foreign contacts, the Hawaiian Kingdom began adopting western legal systems such as a parliament, a constitution and treaties with other nations, including several with the United States. However, during the remainder of the century the succession of Hawaiian monarchs that followed Kamehameha were unsuccessful in warding off the increasing encroachment by various colonial powers. In 1883, the Kingdom of Hawaiʻi was overthrown by a group of mostly American businessmen backed by U.S. soldiers (Kuykendall, 1953). The provisional government sought annexation by the United States, and after passage of the "Newlands Resolution" in 1898, Hawaiʻi was considered a territory of the United States.

Today, a fundamental question for many Native Hawaiians and others is the legality of the methods used by the United States to acquire the Hawaiian Islands in the 19th century. In 1993, the U.S. Congress passed the Apology Bill which states that "...the indigenous Hawaiian people never directly relinquished their claims to their inherent sovereignty as a people over their national lands to the United States, either through their monarchy or through a plebiscite or referendum."

In the absence of any treaty or voluntary relinquishment, the lingering sovereign claim by Native Hawaiians may dictate that a higher right to the living marine resources within the U.S. EEZ surrounding the Hawaiian Islands might still be justified. Murakami and Freitas (1987) argue that legal claims of Native Hawaiians to the fishery have not been extinguished by the U.S. government. He notes that, "...Congressional enactments and the 1983 Presidential Proclamation to extend U.S. jurisdiction over mineral resources of the EEZ and the fisheries of the FCZ [200-mile Fishery Conservation Zone] would not affect the viability of this claim in the absence of any treaty or settlement act resolving the potential Hawaiian claim to the fishery, mineral and other natural resources of the FCZ and EEZ around the Hawaiian and Northwest Hawaiian Islands."

Murakami and Freitas (1987:27) summarize the legal aspects of U.S. participation in the conservation of fisheries around the Hawaiian Archipelago in regard to Native Hawaiian claims:

> *The U.S. government has the power to affect the Hawaiian claim to portions of the Hawaiian and Northwest Hawaiian Island FCZ and EEZ by either: 1) condemning the fisheries granted to Hawaiian commoners and their successors in the FCZ, which will require it to compensate the Hawaiian people for the taking of their fishing grounds; or 2) exercising its public trust duties to protect the aboriginal claims to the resources of the EEZ and FCZ, which will require it to determine what allocation of the revenues it will allow to Hawaiians and what form and extent of participation it will grant to protect the marine environment in which the communal right to fish and gather may take place. The resolution of these issues may have to involve a resolution of the Hawaiian claim for reparations or restitution linked to the 1893 overthrow.*
>
> *The legal uncertainty is rooted in the failure of the U.S. to resolve the potential aboriginal or other claims of Hawaiians for restitution or reparations as a domestic, dependent nation of people, as those of native Americans and Alaska natives have been, or are being resolved. There is ample precedent to support such a claim in Congress. So long as that claim is outstanding, Hawaiians will continue to have a defensible claim to the fishery resources of the FCZ and mineral and other resources of the EEZ.*

The aforementioned Apology Bill stated that

> *The Congress ...(4) expresses its commitment to acknowledge the ramifications of the overthrow of the Kingdom of Hawai'i, in order to provide a proper foundation for reconciliation between the United States and the Native Hawaiian people; and*

*(5) urges the President of the United States to also acknowledge the ramifications of the overthrow of the Kingdom of Hawai'i and to support reconciliation efforts between the United States and the Native Hawaiian people.*

Some progress has been made in resolving the Hawaiian claim for reparations or restitution linked to the 1893 overthrow. In December 1999, a series of reconciliation hearings attended by federal representatives, Native Hawaiians and the general public was conducted in Hawai'i. In addition, in July 2000, Hawai'i's congressional delegation introduced a bill to express the policy of the United States regarding the United States' relationship with Native Hawaiians, to provide a process for the reorganization of a Native Hawaiian government and the recognition by the United States of the Native Hawaiian government.

As these reconciliation efforts proceed, it is also likely that clarification of rights will be an outgrowth of litigation in the courts. The Hawai'i Supreme Court, for example, has addressed the nature of certain Hawaiian traditions and customs in a number of cases where it had been asked to address the protection of traditional and customary practices under state law. In *Public Access Shoreline Hawai'i v. Hawai'i County Planning Commission* , 79 Hawai'i 425, 903 P.2d 1246 (1995), the court emphasized the obligation of a state agency to preserve and protect Native Hawaiian rights. In its consideration of an action by the Hawai'i Planning Commission arising under the Coastal Zone Management Act, the court concluded that the legitimate customary and traditional practices must be protected to the extent feasible in accordance with Article XII, Section 7 of the state constitution and that the state does not have the unfettered discretion to regulate the rights of ahupua'a tenants out of existence.[22] The court reiterated that the Native Hawaiian rights protected by the state constitution may extend beyond the *ahupua'a* in which a Native Hawaiian resides. Moreover, the rights remain intact "...notwithstanding arguable abandonment of a particular site, although this right is potentially subject to regulation in the public interest." Finally, the court went one step further in supporting traditional practices. It said that ancient practices can revive themselves and still have legal authority. In the words of the court, "...continuous exercise is not absolutely required to maintain the validity of a custom."

### 3.8.3 Socio-economic Conditions of Native Hawaiians

At present, people of Native Hawaiian ancestry comprise about 21% of Hawai'i's population (DBEDT 1999). By most statistical measures, they have the lowest incomes and poorest health of any ethnic group in the state. Native Hawaiians have long been among the most economically

[22] Article XII, Section 7 of the Hawai'i Constitution states: "The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by *'ahupua'a* tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights."

disadvantaged ethnic or racial group in Hawai'i in terms of standard of living, degree of unemployment, dependence on transfer payments and limited alternative employment opportunities. In recent years, Native Hawaiians have had the highest proportion of individuals living below the poverty line. In 1989, 6% of all the families in the state had incomes classified below the federal poverty level (OHA 1998). During the same period, 14% of Native Hawaiians were below the poverty line. Nearly 15% of Native Hawaiian households receive public assistance income, compared to 6.8% of households in the State (OHA 1998). In several residential areas over a third of Native Hawaiian households receive public assistance.

For centuries Native Hawaiians relied on seafood as their principle source of protein. However, the availability of many traditional seafoods has been significantly diminished. Overfishing and ecological degradation of inshore areas by pollution has had a pronounced negative impact on Native Hawaiian marine subsistence practices. Shomura (1987), for instance, notes that between 1900 and 1986, the harvest of coastal fish species in Hawai'i declined by 80 percent, and catches of neritic-pelagic species declined by 40 percent. The changes in diet that resulted from loss of access to sea resources have contributed to the poor health of Native Hawaiians. Of all racial groups living in Hawai'i, Native Hawaiians are the group with the highest proportion of multiple risk factors leading to illness, disability and premature death (Look and Braun 1995).

As noted earlier, there is abundant historical and archaeological evidence of the social importance of fishing in traditional Hawaiian culture. With specific regard to bottomfish, this significance was of both an economic and ritual nature (Iversen et al. 1990). Bottomfish such as *kāhala*, *ulua* and *'ula'ula* (*onaga*) are specifically mentioned in traditional prayers used by fishermen, and fishing for these species was associated with religious rites. The cultural significance of bottomfish species to Hawaiian society is also indicated by the growth stage names for *'ōpakapaka*, white *ulua*, *kāhala* and the varietal names for *'ula'ula* and *uku*.

There may continue to be a strong cultural and religious connection between contemporary Native Hawaiians and certain species of bottomfish (Iversen et al. 1990). Some present day Native Hawaiian consumers of these bottomfish may still associate these fish with traditional beliefs and with their dependence upon the fish for food. Because of the high cost of some bottomfish, they may be frustrated in maintaining such a traditional connection. Industry sources report that Native Hawaiians purchase proportionally less bottomfish than other ethnic groups, possibly because other types of fish cost less, and if Native Hawaiians have less disposable income to spend on fish, they would likely opt to purchase less costly species (Iversen et al. 1990). Nonetheless, the social and economic importance of fishing and available marine resources remains vital to the continuation and perpetuation of Native Hawaiians and their culture.

## 3.9 ADMINISTRATION AND ENFORCEMENT

Enforcement costs are incurred by NMFS and USCG in dockside and at-sea (e.g., boardings and aerial surveillance) inspections. The USCG conducts surveillance of the NWHI utilizing C-130 aircraft and cutters.

Administrative costs are incurred in maintaining fisheries data collection systems and issuing limited access permits for the Mau and Ho'omalu Zones. Brief descriptions of the fisheries data collection systems in Hawai'i, American Samoa, Guam and the Northern Mariana Islands are provided below.

### 3.9.1 Hawai'i

State of Hawai'i 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 Hawai'i Division of Aquatic Resources (HDAR). Every holder of a commercial marine license must furnish to HDAR a monthly catch report commonly referred to as the "C3" form. Catches of bottomfish in the NWHI are reported separately to HDAR on the NWHI Bottomfish Trip Daily Log. A trip sales report is also completed by fishermen after the fish are sold. HDAR staff monitor the Honolulu Harbor and Kewalo Basin docks on a daily basis to collect logbooks and sales reports.

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 administers a fish market monitoring program. In a cooperative effort with HDAR, staff from both NMFS and HDAR visit the fish auction managed by the United Fishing Agency and obtain size frequency and economic data on pelagic fish and bottomfish sold.

### 3.9.2 American Samoa

Fish catch data are collected through creel surveys 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 fishermen between 0500 and 2100 hours. Two DMWR data collectors also collect fishing data on the islands of Tau and Ofu.

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 separate dealer invoice data collection system. A vessel inventory conducted twice a year provides data on vessel numbers and fishing effort.

### 3.9.3 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 effort for all the major fishing methods used in commercial and recreational fishing. In 1982, the Western Pacific Fisheries Information Network (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 fishermen also voluntarily provide data to WPacFIN using invoices ("trip tickets") provided by DAWR.

### 3.9.4 Northern Mariana Islands

The Division of Fish and Wildlife (DFW) of the Commonwealth of the Northern Mariana Islands monitors the commercial fishery by summarizing sales ticket receipts from commercial establishments. 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.