Marine Mammal Commission. 2000. Hawaiian monk seal (*Monachus schauinslandi*). Pages 44-55 in Chapter III, Species of Special Concern, Annual Report to Congress, 1999. Marine Mammal Commission, Bethesda, Maryland.

Hawaiian Monk Seal
(*Monachus schauinslandi*)

The Hawaiian monk seal is the most endangered seal in the United States and one of the world's most endangered pinnipeds. Along with Mediterranean monk seals, Galapagos fur seals, and Galapagos sea lions, Hawaiian monk seals are one of only four seal species found in the tropics. They breed only in the Hawaiian archipelago. With the exception of a few births over the past decade in the main Hawaiian Islands, all of the species' pups are born in the remote Northwestern Hawaiian Islands. This chain of small, largely uninhabited islets and atolls extends about 1,100 nmi (2,000 km) between Kauai and Niihau, the easternmost of the main Hawaiian Islands, and the Midway Islands and Kure Atoll (Fig. 2). Most of the Northwestern Hawaiian Islands are low sand islands a few acres in size; the largest, covering about 0.5 to 1.5 square miles, are Laysan Island, Lisianski Island, Green Island at Kure Atoll, and Sand and Eastern Islands at Midway Atoll.

There are six major breeding colonies of Hawaiian monk seals. These are located at French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, the Midway Islands, and Kure Atoll. Because most monk seals return to their island of birth to rest, molt, and pup, each of these constitutes a relatively discrete breeding colony. However, the close proximity of the chain's three westernmost atolls (Kure, Midway, and Pearl and Hermes Reef), there is a greater degree of inter-atoll movement at these sites compared with the islands located at the eastern end of the Northwestern Hawiian Islands.

The current size of the Hawaiian monk seal population is estimated at 1,300 to 1,400 animals. This estimate appears to be less than half its abundance in the late 1950s when the first relatively complete monk seal counts were made. There are no reliable estimates of abundance before then, but considering intense human activity during World War II and human occupation of some islands dating back to the early 1900s, it is possible that monk seal numbers observed in the 1950s were already reduced from previous levels.

Relatively few counts of monk seals were made during the 1960s or 1970s, and by the early 1980s when the National Marine Fisheries Service began yearly monitoring, counts were about 40 percent lower than those made in the late 1950s. The sharpest declines were at the western end of the species' range. The colony at Midway, where counts as high as 60 seals were made in the 1950s, all but disappeared, and counts at Pearl and Hermes Reef and Kure Atoll declined by nearly 90 and 75 percent, respectively. During the early 1980s the overall population appeared to be increasing slightly, with counts at French Frigate Shoals increasing rapidly and counts at other colonies stable or increasing slightly. By 1985 the French Frigate Shoals colony had grown to a point where it included nearly half of the entire population. Then, between the late-1980s and mid-1990s, the overall population again declined due to a sharp decrease at French Frigate Shoals, where mean beach counts (excluding pups) plummeted from nearly 300 seals in 1985 to about 100 animals in 1995. Since 1995 the total population size has been relatively stable, with the decline in beach counts at French Frigate Shoals slowing somewhat and counts at other breeding colonies remaining stable or continuing to grow at a steady rate.

A variety of natural and human factors appears to have contributed to the declines and slow

recovery rates at the various monk seal colonies. Among the natural factors are shark predation, die-offs due to biotoxins or disease, natural changes in environmental conditions that have affected prey availability, attacks on female and juvenile seals by aggressive adult males attempting to mate, and the limited extent of suitable pupping and haul-out beaches. Human factors include disturbance of seals on haul-out beaches, interactions with commercial fishermen and their gear, entanglement in lost and discarded fishing gear and other

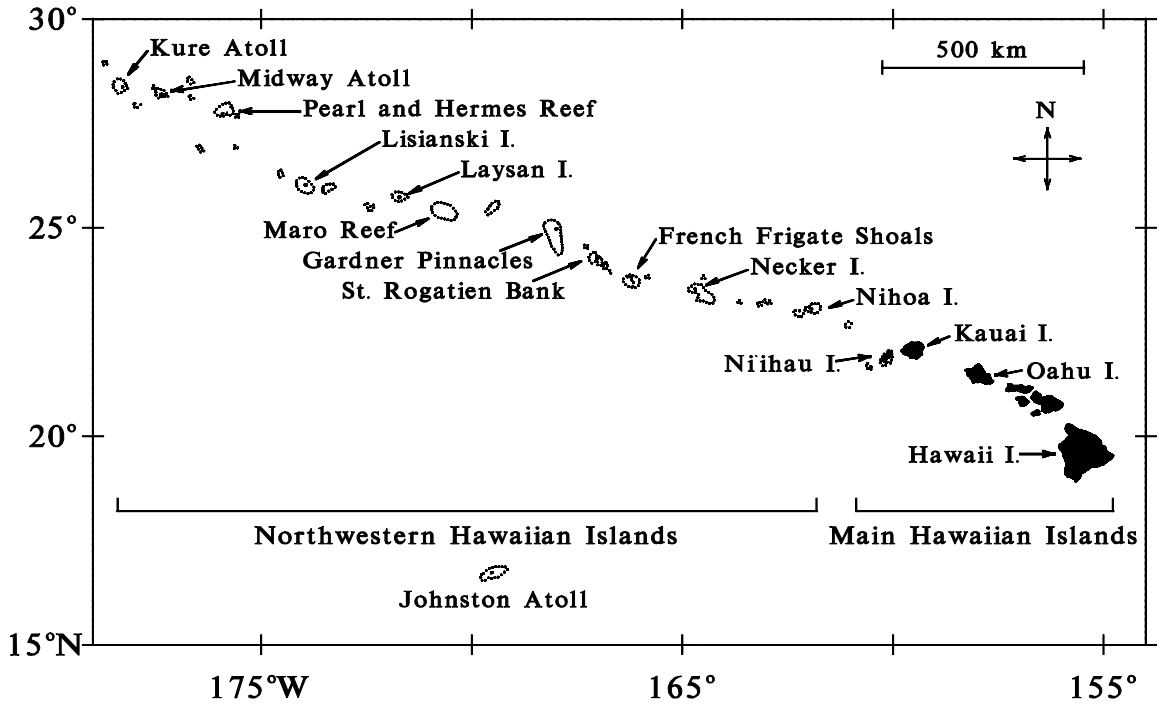

Figure 2. The Hawaiian Archipelago. The Northwestern Hawaiian Islands provide pupping beaches for all major breeding colonies of Hawaiian monk seals.

marine debris, entrapment behind deteriorating seawalls, environmental contamination, and depletion of prey resources by commercial fishing.

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. For example, human disturbance was probably the principal cause of declines before the 1980s. As noted above, between the 1950s and 1980s some of the largest declines occurred at colonies in the western end of the Northwestern Hawaiian Islands where most human activity was concentrated. In the mid-1950s the Navy undertook a major expansion of its Naval Air Station on the Midway Islands, and in 1960 the Coast Guard established a LORAN station occupied by a staff of 18 to 20 people on Kure Atoll. With little understanding or awareness of the possible effects of disturbing monk seals, personnel stationed at these facilities and their pets likely walked the beaches, chasing resting pups and other seals into the water where shark predation poses an ever-present risk. With repeated disturbance and few alternative hauling sites, preferred pupping beaches were abandoned and pup mortality increased.

Since the early 1980s steps have been taken to prevent human disturbance of monk seals, and the western colonies have begun to increase slowly. Other factors, however, may now limit

their recovery. For example, accumulations of lost and discarded fishing gear have increased the likelihood of seals becoming entangled and drowned, and pollution from discarded equipment and years of human use may have worked its way into atoll food chains, affecting the health of resident animals. At other locations, where human disturbance may have been less extensive, different combinations of factors may have contributed to declines and limited population growth. Trends in monk seal abundance at the six major breeding colonies since the early 1980s are shown in Figure 3.

The National Marine Fisheries Service has lead responsibility for protecting Hawaiian monk seals under the Endangered Species Act and the Marine Mammal Protection Act. To guide recovery efforts, the Service adopted a Hawaiian Monk Seal Recovery Plan in 1983, established a Hawaiian Monk Seal Recovery Team that now meets annually, designated all beaches and waters out to 20 fathoms around the Northwestern Hawaiian Islands (with the exception of Sand Island at Midway) as critical habitat, and implemented a research and monitoring program that now covers all major breeding locations. As discussed in previous annual reports, the Marine Mammal Commission provided recommendations and assistance to initiate all of these efforts. Since then, it has continued to provide advice on priority research and management needs.

Because all of the Northwestern Hawaiian Islands except Kure Atoll, which is owned by the State of Hawaii, lie within either the Hawaiian Islands National Wildlife Refuge or the Midway Islands National Wildlife Refuge, the Fish and Wildlife Service also plays an important role in protecting Hawaiian monk seals and their habitat. Efforts by the Marine Mammal Commission to help the Fish and Wildlife Service replace a deteriorating seawall, needed to maintain logistical support of research and management work at French Frigate Shoals, and with the transfer of the Midway Islands from the Navy to the Service for use as a national wildlife refuge are discussed in past annual reports. Other agencies and groups involved in monk seal recovery work include the Navy, the Coast Guard, the Army Corps of Engineers, the Western Pacific Regional Fisheries Management Council, the Hawaii Department of Land and Natural Resources, the University of Hawaii and its Sea Grant College Program, the Hawai'i Wildlife Fund, and the Center for Marine Conservation.

Hawaiian monk seal conservation and recovery efforts during 1999 are discussed below.

Prey Availability and Commercial Lobster Fishing

The steady increase in monk seal numbers at French Frigate Shoals during the 1970s and early 1980s reversed into a sharp decline in the late-1980s due to an abrupt decrease in juvenile survival rates. Whereas first-year survival rates for pups at the atoll in the early 1980s were between 80 and 90 percent, they plunged to as low as 15 percent between the mid-1980s and 1998. Thus, over the past decade, almost no pups survived to breeding age, usually about 5 to 7 years. Although the first-year survival increased to about 50 percent for the 1998 cohort of pups, it remains far below levels seen early in the 1980s.

The most likely explanation for poor juvenile survival at this site is decreased prey availability. Although other factors may have contributed, Service researchers concluded that, during the mid- to late-1980s, the colony either had grown to a point where it exceeded its carrying capacity, its carrying capacity had declined, or both. Evidence of limited prey availability included small and, in some cases, emaciated pups, nursing females that were smaller and thinner than those at other colonies, and a delay in the age of first reproduction to 11 or 12 years of age for most females. Because of poor juvenile survival over the past decade,

the colony now consists almost entirely of seals 10 years of age or older. As older animals die or reach reproductive senescence, it is expected that pup production at French Frigate Shoals, which has accounted for up to half of all monk seal pups since the early 1980s, will drop significantly, perhaps further exacerbating the colony's decline.

The monk seal decline at French Frigate Shoals started shortly after commercial lobster fishing began in the Northwestern Hawaiian Islands early in the 1980s. Most fishing was concentrated at three banks in the eastern end of the chain (Necker Island, Maro Reef, and Gardner Pinnacles) east and west of French Frigate Shoals. Based on analyses of monk seal scat and spew samples, monk seals are known to eat lobsters as well as small reef fish, octopuses, and crabs. The relative importance of different prey items is difficult to assess from scat samples and, although lobsters were a small proportion of prey items identified in scats, the Commission became concerned that lobsters could be important prey items, especially for young seals. Studies of other pinnipeds have found that, as young seals mature, their diets shift from crustaceans to fish, and it seemed possible that young monk seals learning to feed could depend more on lobsters for food than adult seals (*e.g.*, slow-moving lobsters may be somewhat easier to catch than fish for young seals with poorly developed foraging skills).

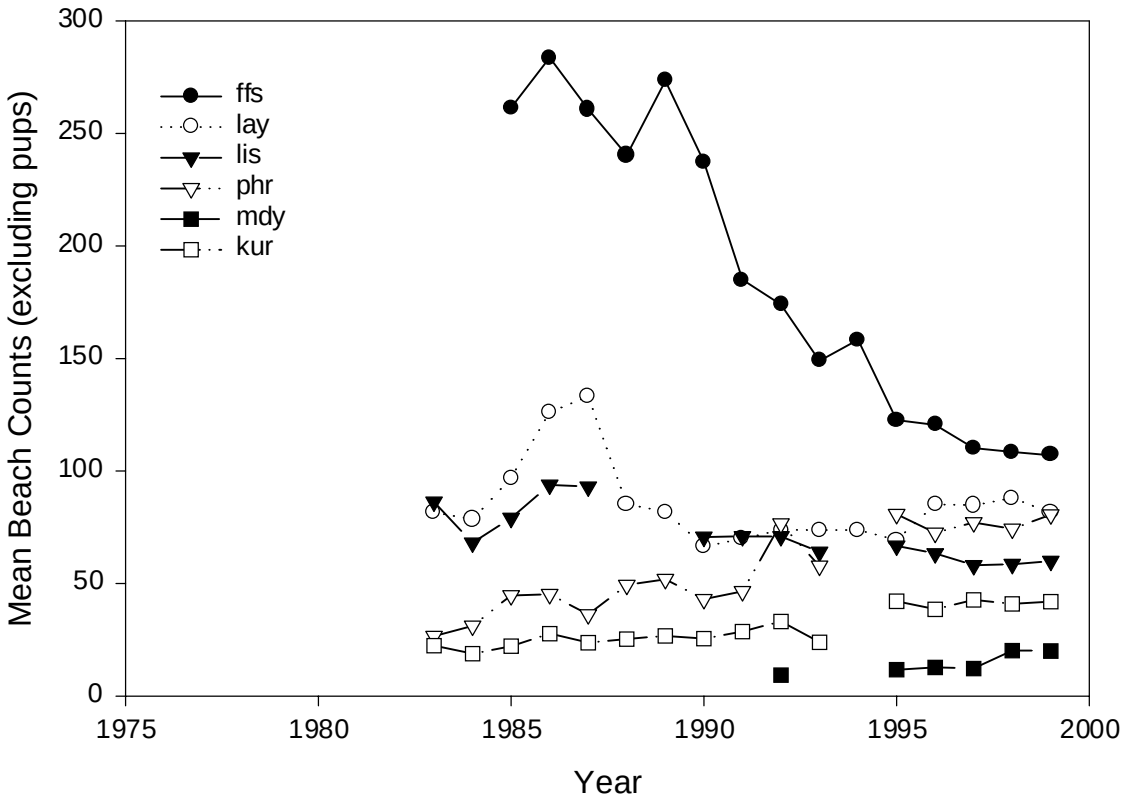

Figure 3. Mean beach counts of Hawaiian monk seals at major breeding colonies from 1983 through 1999. (Source: National Marine Fisheries Service, unpublished data)

Given the alarming decline in juvenile survival at French Frigate Shoals, the evidence linking decline to limited prey availability, and the belief that young seals probably learn to forage at the atoll of their birth, the Commission recommended in 1994 that the Service consider closing French Frigate Shoals to lobster fishing pending the development of better information on the importance of lobsters in monk seal diets. The Service and the Western Pacific Regional Fisheries Management Council considered the recommended action but took no steps to implement it. Instead, they concluded that there was insufficient evidence to demonstrate that lobsters were important prey for monk seals or that lobster fishing had caused the decline in the French Frigate Shoals monk seal colony. They also noted that there had been little lobster fishing reported at French Frigate Shoals, and that prey availability may have been reduced by natural environmental changes.

Notwithstanding these points, the Commission remained concerned and continued to believe that, as a precautionary step, lobster fishing should be suspended at French Frigate Shoals pending better information on lobster in monk seal diets. Between 1995 and 1998 it continued to recommend that the measure be adopted. In addition to the reasons for concern already noted, the Commission pointed out that octopuses, crabs, and small reef fish taken as bycatch in lobster traps also were eaten by monk seals, that large declines in catch rates at banks fished since the lobster fishery began indicated fishing could significantly decrease lobster abundance at individual banks in the Northwestern Hawaiian Islands, and that, although factors other than lobster fishing may have been the principal cause of the decline in French Frigate Shoals monk seal numbers, lobster fishing could further reduce the monk seals' already limited food supply and thereby exacerbate constraints to potential monk seal recovery. To resolve uncertainties about the importance of lobsters in monk seal diets, the Commission recommended that the Service undertake satellite tracking studies to determine where monk seals feed and initiate studies using fatty acid signatures of prey species in blubber samples to determine the composition of monk seal diets.

A satellite tracking study was subsequently undertaken by researchers at the University of Minnesota in collaboration with the Service, and in 1997 the Service began funding research on fatty acid signatures of monk seal prey. However, the Service continued to reject the Commission's repeated recommendations to limit lobster fishing at French Frigate Shoals pending results of the research. In doing so, the Service cited a lack of evidence about potential effects of the fishery on monk seals and noted that management measures being developed to protect lobster stocks would serve to prevent monk seal prey resources from being jeopardized. In late 1997 preliminary findings of the fatty acid signature studies indicated that the technique held potential for resolving questions about monk seal prey species and that lobsters may be a more important dietary component than previously thought. However, because the results were preliminary, the Service did not consider them in its assessment of potential effects of lobster fishing on monk seals.

In 1998 the Service, at the recommendation of the Western Pacific Regional Fisheries Management Council, adopted a new bank-specific catch guideline (*i.e.*, quota) for lobster fishing in the Northwestern Hawaiian Islands. Whereas previously single area-wide catch limits had been set for lobsters, the new catch guideline set separate catch limits for four areas: Maro Reef, Gardner Pinnacles, Necker Island, and "Area 4," which included all remaining banks in the island chain. The purpose of the measure was to reduce fishing pressure at Maro Reef, Gardner Pinnacles, and Necker Island, where declining lobster stocks could no longer sustain past levels of fishing effort, and to encourage fishing at other banks where little or no lobster fishing had occurred. As a result, in 1998 lobster fishing was reported for the first time in many years at French Frigate Shoals, as well as at other banks supporting major monk seal colonies.

As noted in last year's annual report, in the summer of 1998 one of the lobster fishing vessels ran aground at Kure Atoll. It was carrying about 7.5 miles of line, 500 traps, and 7,500 gallons of fuel. The crew was rescued safely and 4,000 gallons of fuel were removed; however, lacking funds and resources to return to the wreck, the vessel soon broke up releasing the remaining fuel, line, and traps. The Commission and the recovery team urged the Service to secure funding or assistance to clean up the wreck and debris, but it was not able to do so before the end of 1998. During 1999, however, it was the Commission's understanding that the Service had removed some of the line, and about 450 traps had been either picked up from the island shoreline or pulled from the wreck site.

For the 1999 lobster fishing season, the Service, at the recommendation of the regional fisheries management council, considered making the bank-specific harvest guidelines first tried in 1998 a permanent part of the lobster fishery management program. Concerned about the action's intent to increase fishing in key monk seal foraging areas and its potential to reduce prey resources, the Commission wrote to the Service on 31 December 1998, 13 May 1999, and 30 June 1999 opposing the idea. It also wrote to the Western Pacific Regional Fisheries Management Council on 13 May 1999 and the Hawaii Department of Land and Natural Resources on 27 May 1999.

In its letters, the Commission noted that the long decline and seriously depleted status of Hawaiian monk seals required application of precautionary management principles that take into account the possible effects of lobster fishing on monk seals. It again recommended that the Service immediately close French Frigate Shoals to lobster fishing until better information is available on the importance of lobsters in monk seal diets and the effects of lobster fishing on monk seal prey resources. To avoid possible impacts on other recovering but still seriously depleted monk seal colonies, the Commission recommended that the Service immediately prohibit lobster fishing at all other atolls that support major monk seal colonies pending further research on monk seal prey preferences and abundances. To respond to future vessel groundings as had occurred in 1998, the Commission urged that steps be taken to ensure that funding would be adequate to mount an effective clean-up effort in the event of a new accident.

The Service responded to the Commission's letters on 5 August 1999, noting that it did not agree with the Commission's recommendations to prohibit lobster fishing at atolls supporting major monk seal colonies. In this regard, the Service enclosed its informal consultation finding prepared on the proposed 1999 harvest guideline pursuant to section 7 of the Endangered Species Act. The 7 June 1999 finding concluded that there is no evidence to suggest that the guideline or the establishment of permanent lobster fishing areas in the Northwestern Hawaiian Islands is likely to adversely affect Hawaiian monk seals. It recommended that further research be undertaken on monk seal prey preferences and that no more than 20 percent of the lobster catch limit established for Area 4 (all banks other than Maro Reef, Gardner Pinnacles, and Necker Island) be taken at any one bank. The Service therefore advised the Commission that it had published final rules on 8 July 1999 adopting the 1999 harvest guidelines as proposed with a 20 percent catch limit from any one bank in Area 4, and it took no action to prohibit lobster fishing at major monk seal colonies.

As indicated above, the Commission believes that, in the absence of evidence showing that the fishery does not affect prey availability, both the Endangered Species Act and common sense dictate that precautionary measures be taken to ensure that the fishery is not causing or contributing to the observed population decline. Therefore, to pursue the matter, the Commission asked representatives of the Service to review its lobster fishery management program and the results of the 1999 fishing season at the Marine Mammal Commission's 19-21 October 1999 annual meeting. During that meeting, the Commission was advised that the Service planned to reexamine the lobster fishery pursuant to section 7 of the Endangered Species Act before the next

fishing season and that actions to close French Frigate Shoals and other locations would be reconsidered. No information was provided to allay the Commission's concern about the possible effects of lobster fishing on monk seal prey resources or the prudence of applying a precautionary management approach in light of current uncertainties about both monk seal diets and prey abundances.

The Commission therefore wrote to the Service on 23 November 1999 noting that it was pleased that the Service would reconsider the issue in 2000, but that by acting to direct lobster fishing toward major monk seal breeding atolls it believed the Service had increased the risk of adversely affecting monk seals by possibly reducing essential prey resources in the species' most important feeding areas. The Commission therefore again recommended that the Service prohibit lobster fishing at all major monk seal breeding atolls until there is sufficient information to assess (1) the relative importance of lobsters and other monk seal prey species taken by the fishery in the diet of different age and sex classes of Hawaiian monk seals, and (2) the effects of lobster fishing on the availability of important monk seal prey resources.

On 7-8 December 1999 the Hawaiian Monk Seal Recovery Team met to review information and developments concerning the species' recovery. During the meeting, new information was provided on the results of studies to assess prey preferences based on analyses of prey fatty acid signatures in monk seal blubber samples. Preliminary results presented at the meeting revealed that lobsters probably constitute a significant percentage of the diet of most juvenile and adult female monk seals at French Frigate Shoals, but only a small proportion of the diet of adult male monk seals. As of the end of 1999 the recovery team had not yet provided the Service with recommendations based on this new information, but it was the Commission's understanding that it was considering recommendations similar to those of the Commission (*i.e.*, closing all breeding atolls to lobster fishing).

Longline Fishing

In 1990 there were reports of interactions between Hawaiian monk seals and a rapidly expanding pelagic longline fishery for swordfish that had begun operating near major monk seal breeding atolls. Several monk seals were soon found with longline hooks imbedded in their mouths and skin. In response, the National Marine Fisheries Service, at the recommendation of the Western Pacific Regional Fisheries Management Council, and with support from the Marine Mammal Commission and the Fish and Wildlife Service, established a protected species management zone around the Northwestern Hawaiian Islands. Under the measure, pelagic longline fishing was prohibited anywhere within 50 nmi of the Northwestern Hawaiian Islands. Since that time, no seals have been found with longline hooks imbedded in them.

In 1999 a single vessel began fishing for sharks in shallow reef areas of the Northwestern Hawaiian Islands using a bottom longline with approximately 400 baited hooks. Although the Western Pacific Regional Fisheries Management Council was advised early in 1999 of plans to start the fishery, the Council had no fishery management plan in place for shark bottom longline fishing, and management measures adopted for the pelagic longline fishery did not apply because shark longlines are not set at the surface. As a result, the vessel left port to begin fishing in the summer of 1999 with no measures in place to limit its catch or prevent possible effects on protected species. When the vessel returned to port after fishing at French Frigate Shoals, the National Marine Fisheries Service placed an observer aboard the vessel, which then began fishing at Gardner Pinnacles. No interactions with Hawaiian monk seals were reported while the observer was aboard.

At the Marine Mammal Commission's 19-21 October 1999 annual meeting, a representative of

the Service advised the Commission of this situation. He also noted that the Service believed it was likely that monk seals would be hooked if the bottom longline shark fishery continued, and that the Western Pacific Regional Fisheries Management Council was expected to consider action to close the fishery in 2000. The Commission also was concerned about the likelihood of monk seals getting caught or entangled in shark longlines. Therefore, in its letter of 23 November 1999 to the Service, it recommended that the Service prohibit longline fishing for sharks within 50 nmi of the Northwestern Hawaiian Islands pending development and review of a fishery management plan for sharks.

To ensure that other new fisheries possibly affecting monk seals do not begin without careful prior assessment of management needs, the Commission also recommended that the Service establish a rule prohibiting all commercial fishing within 50 nmi of the Northwestern Hawaiian Islands unless and until an applicable fishery management plan has been developed and reviewed for potential impacts on monk seals pursuant to consultation provisions of section 7 of the Endangered Species Act.

Enhancing Survival of Pups Born at French Frigate Shoals

As noted above, the French Frigate Shoals monk seal colony began a sharp decline in the late-1980s due to poor juvenile survival thought to be caused by limited prey availability. To enhance survival of weaned pups and rebuild the colony at Kure Atoll where there was no evidence of prey limitations, the National Marine Fisheries Service began a program in 1984 to rescue underweight pups from French Frigate Shoals, rehabilitate them at facilities on Oahu, and release them at Kure Atoll. The effort has helped to speed the recovery of the Kure Atoll colony; many animals moved to Kure and some of their offspring are now producing pups.

Translocations to Midway Atoll — When the Navy announced plans to close its Naval Air Station at Midway Atoll and began steps to transfer the atoll to the Fish and Wildlife Service, the Marine Mammal Commission and the recovery team recommended that the release site for seals rescued from French Frigate Shoals be switched from Kure Atoll to the Midway Islands to help reestablish a colony there. This was done in late 1992 and early 1993, but most translocated animals soon disappeared or were found dead. Further releases at Midway were therefore suspended pending a review of the translocation effort at that site and captured seals were again released at Kure Atoll.

The review suggested that the different release procedures used at Midway, prompted in part by limited funding, had contributed to the high mortality. Handling protocols were therefore changed and plans for moving seals to Midway resumed in 1995 when 12 pups were captured. Before they could be released at Midway, however, most of the seals developed a previously unobserved eye problem, and translocation work was again suspended. The eye problem persisted, resulting in blindness in most animals, which prevented their release. In 1999 the seals captured in 1995 were transferred to Sea World in Texas where they will be kept permanently for research and public education purposes.

At the recommendation of the Commission and the recovery team, another attempt to capture and translocate seals was planned for 1998. To minimize risks of similar health problems, it was decided to hold and fatten the seals in pens in the field and then move them directly to Midway, rather than moving them to facilities on Oahu for rehabilitation. Before work could begin, however, health and disease studies carried out in anticipation of the translocation revealed the possible presence of antibodies to morbillivirus in three of the seals tested from French Frigate Shoals; no signs of the antibodies were found in seals from other atolls.

Given the possible exposure of seals at French Frigate Shoals to morbillivirus and the risk of spreading the virus from one colony to another, the Commission, by letter of 31 December 1998, and the Hawaiian Monk Seal Recovery Team recommended postponing planned translocation work until further studies to confirm evidence of past exposure to the virus could be completed. In its letter, the Commission also recommended that if translocation work were suspended, funds allocated to the translocation work should be redirected to a headstart program similar to one successfully carried out at Kure Atoll in the 1980s. In that program, weaned pups were maintained during the first months after weaning in an enclosure built at the atoll to increase their first-year survival prospects.

In 1999 no translocation work was undertaken and more than 100 monk seals were sampled to resolve uncertainties about the possible past exposure of seals to morbillivirus. Among the sampled seals were two of the three animals that tested positive in 1998. The results revealed no signs of morbillivirus antibodies in any of the tested animals. The involved veterinarians therefore concluded that the 1998 test results were caused by false positives, and that the virus was not present at French Frigate Shoals or other colonies. In light of these findings, the Service began developing plans to renew the translocation of young seals from French Frigate Shoals to the Midway Islands in 2000. At the end of 1999, however, the Service suspended plans in this regard. It did so because first-year survival rates for seals born at French Frigate Shoals in 1998 had increased from about 15 to 50 percent and because the Service planned to further enhance juvenile survival at French Frigate Shoals in 2000 by reducing shark predation (see below) at the atoll. With regard to the Commission's recommendation that funds for translocation work in 1998 be redirected to a headstart program at French Frigate Shoals, no action was taken because the funds were instead used for the health assessment work and assessing juvenile survival.

Adult male aggression — Although reduced prey availability appears to have been the principal factor underlying poor juvenile survival at French Frigate Shoals, several other factors have contributed to juvenile mortality at this site, including attacks on pups by adult males. In 1997 Service researchers observed a high number of incidents involving adult male aggression toward pups, most of which were caused by two identified animals. After the same animals again began attacking pups early in 1998, both were captured and moved to Johnston Atoll, about 1,125 km south of French Frigate Shoals. Since their removal in June 1998, evidence of male aggression toward pups at French Frigate Shoals has decreased substantially, and neither male has been resighted at the atoll.

Shark predation — Shark predation is another factor affecting juvenile survival. Pups, which have not yet learned to avoid sharks, are particularly vulnerable, and the frequency of shark predation at French Frigate Shoals appears to have increased in recent years. At its 19-21 October 1999 annual meeting, the Commission received information from the Service indicating that perhaps 30 percent of pup mortality at French Frigate Shoals in 1998 was due to sharks. This high level of predation may be partly related to a change in pupping sites brought about by erosion at Whaleskate Island, which until recently has been one of the most important pupping sites at the atoll. Over the past few years, however, erosion has left the island awash most of the time and seals formerly using the island have moved to other islands at the atoll, particularly Trig Island, where incidents of shark predation, as well as aggressive male behavior, have been high. Most shark attacks observed in 1998 and 1999 involved Galapagos sharks patrolling the Trig Island shoreline (Fig. 4). The number of such sharks observed near the pupping beaches appears to have increased substantially in recent years.

Figure 4. Sharks patrolling the shoreline along Trig Island, a Hawaiian monk seal pupping beach at French Frigate Shoals. (Photograph by Mitch Craig, courtesy National Marine Fisheries Service)

From tags placed on sharks around the island in 1999, Service researchers determined that at least 14 sharks, and perhaps many more, were patrolling the island's shoreline.

Given information presented at its meeting, the Commission shared the Service's concern that shark predation had become a significant threat to the recovery of the French Frigate Shoals monk seal colony and concluded that steps were urgently needed to reduce the number of Galapagos sharks patrolling waters near Trig Island. The Commission was not supportive of a large-scale shark reduction program at the atoll because of the importance of shark predation in the atoll's marine ecosystem. However, recognizing the possibility that increased shark predation was caused by a relatively small number of Galapagos sharks that had recently learned to prey on juvenile monk seals, it seemed possible that shark predation on monk seals could be significantly reduced without disrupting the atoll's shark population by eliminating those few sharks. Therefore, in its 23 November 1999 letter, the Commission recommended that the Service consult with staff of the Fish and Wildlife Service's Hawaiian Islands National Wildlife Refuge to identify and undertake methods to selectively cull Galapagos sharks patrolling waters off Trig Island using methods that were unlikely to incidentally catch monk seals.

Marine Debris

Another factor affecting juvenile monk seal mortality at French Frigate Shoals and other atolls is entanglement in lost and discarded fishing gear, particularly derelict fishing nets. Since the early 1980s National Marine Fisheries Service field crews have observed more than 150 entangled monk seals. Although some seals were able to free themselves, researchers have found it necessary to intervene and remove the attached material in most cases. In 1999, 25 entangled monk seals were

seen during field visits to most major breeding sites. The period of observation ranged from about two to nine months except at Midway Atoll, which was occupied all year. Six entangled seals were able to free themselves and 19 were freed by researchers. Young monk seals are far more prone to entanglement than adults. Of the 25 monk seals entangled in 1999, 10 were pups, 2 were juveniles, 4 were subadults, and 9 were adults. In recent years, the number of observed entanglements has increased, although this may reflect an increase in time spent on the atolls by researchers.

As noted in past annual reports, early in the 1980s the Marine Mammal Commission was instrumental in expanding awareness of the global extent of marine debris pollution and its effects on many species of wildlife. The Commission's initial concern in this regard stemmed in part from reports of entangled Hawaiian monk seals. Although most of the reports involved animals seen hauling out on beaches entangled in relatively small pieces of debris, the Commission was (and remains) concerned that a far greater number of unobserved seals may be caught and drowned at sea in debris too large to allow animals to swim ashore.

To help assess this possibility for Hawaiian monk seals, the National Marine Fisheries Service conducted a diver survey of marine debris caught in reefs at French Frigate Shoals during the winter of 1996-1997. The survey found that the number of net fragments snagged on coral heads and reef rubble was far greater than expected. From the small areas sampled, it was estimated that there were up to 94 net fragments per square kilometer, and more than 29,000 net fragments in waters less than 10 m deep at French Frigate Shoals alone. Most of the netting appeared to be trawl webbing. Although its origin is unclear, no trawl or gillnet fishing occurs in the Northwestern Hawaiian Islands, and it is assumed that virtually all of the debris has been transported by ocean currents from fishing grounds around the rim of the North Pacific Ocean. In addition to posing entanglement risks for monk seals, sea turtles, and other species, the derelict nets damaged and caught tons of coral.

Despite the daunting task of collecting this debris, the National Marine Fisheries Service took steps to organize cooperative diver clean-up efforts in both 1998 and 1999. Agencies and groups contributing divers, boats, services, or other assistance included (in alphabetical order) BFI Industries, the Center for Marine Conservation, the City and County of Honolulu, the Coast Guard, the Fish and Wildlife Service, the Hawai'i Wildlife Fund, the Navy, the State of Hawaii, the University of Hawaii Sea Grant College Program, and the University of Alaska Marine Advisory Program. In both years, grants to help fund the work were provided to the Service by the National Fish and Wildlife Foundation. In both years the Commission commented to the Foundation in support of the grants.

In 1998 during six days of clean-up work at French Frigate Shoals, divers removed approximately six tons (5,500 kg) of debris from 1.5 square kilometers of reef near major pupping beaches. In 1999 clean-up efforts were expanded and shifted to reefs near pupping beaches on Lisianski Island, where the largest numbers of entangled monk seals have been recorded, and Pearl and Hermes Reef. In 1999 about 25 tons of debris were removed from the two sites combined (Fig. 5). For 2000 the Service plans to substantially increase its funding for the cooperative clean-up efforts in order to increase both the number of divers and the duration of their clean-up visits.

In the course of the offshore clean-up work, divers have encountered several seals badly entangled in large derelict net fragments hung up on coral heads. Two seals were found during the initial survey in 1997 (one drowned and the other was released alive). In addition monk seal field crews found and released four seals entangled in debris caught in reefs in 1999. The results suggest that, in at least some cases, both the amounts and effects of hazardous marine debris at sea

have been greatly underestimated and that entanglement can be a far more serious source of mortality for marine species than generally recognized.

Although the origin of net debris in the Northwestern Hawaiian Islands is uncertain, most net fragments are thought to come from distant fisheries located around the North Pacific rim. This is suggested in part by the presence of glass floats used in Asian net fisheries. To focus international attention on the need to minimize marine debris in the North Pacific, in June 1999 the Department of State, in consultation with the National Marine Fisheries Service, the Marine Mammal Commission, and other federal agencies, cabled its embassies and posts in Russia, China, Japan, Korea, the Philippines, and Taiwan. The cable asked that the issue of marine debris be

Figure 5. Derelict netting being removed from the reefs at Pearl and Hermes Reef, October 1999. (Photograph by Mark Sranek, courtesy National Marine Fisheries Service)

raised with appropriate officials of the host governments. In particular, the cable asked that local officials be advised of the problems created by marine debris in the North Pacific, particularly net debris in the Northwestern Hawaiian Islands, and that they be asked about (1) their willingness to participate in an international workshop to be hosted by the United States in 2000 on marine debris issues in the North Pacific, and (2) efforts being taken by their governments to implement Annex V of the International Convention for the Prevention of Pollution from Ships. As discussed in previous annual reports, Annex V became effective in 1988 and includes provisions prohibiting the intentional discard of all plastics from ships at sea, including old nets and net scraps generated during net repairs.

In addition, the Department of State submitted an information paper for a meeting of the International Maritime Organization's (IMO) Marine Environment Protection Committee scheduled for March 2000. The IMO oversees matters pertaining to Annex V. The paper describes

the impacts of marine debris on monk seals as well as other marine species in the North Pacific and U.S. efforts to enforce provisions of Annex V. Noting that debris problems have continued despite adoption of the Annex by 92 nations, the paper urges IMO members to increase enforcement efforts related to Annex V.

Funding

During the past five years, the National Marine Fisheries Service has significantly increased funding levels for the Hawaiian monk seal recovery program. In 1999 nearly $1.5 million was allocated for recovery work, only about half of which was programmed in the Service's base-level funding request for the program. For 2000 the Service's initial budget request included a $2 million increase in the base level funding request in recognition of the Hawaiian monk seal program's long-term funding needs. The requested increase, however, was subsequently reduced and for fiscal year 2000 the Service's appropriation included no increase for work on Hawaiian monk seals. As a result, there remains a severe funding shortfall for activities planned during 2000 to assess monk seal foraging needs, clean up derelict nets entangling monk seals, enhance survival of pups born at French Frigate Shoals, and continue health and disease studies.

Given its understanding of the above developments, the Commission wrote to the National Marine Fisheries Service on 14 December 1999. In its letter, the Commission recommended that the Service take steps to reallocate resources, seek supplemental funds, and restructure out-year budget requests so as to meet the needs that prompted the initial fiscal year 2000 increase in base-level funding for the Hawaiian monk seal recovery program.