HAWAIIAN ISLANDS
NATIONAL WILDLIFE REFUGE

MASTER PLAN/ENVIRONMENTAL IMPACT STATEMENT

TECHNICAL APPENDICES

Department of the Interior
U.S. Fish and Wildlife Service Region One

1986

TECHNICAL APPENDIX

This Technical Appendix consists of Locational Criteria and Output Summaries which support the findings and recommendations in the Hawaiian Islands National Wildlife Refuge (HINWR) Master Plan/Environmental Impact Statement (EIS). Locational Criteria are information which describe the resource conditions necessary for the production or maintenance of a given output on the Refuge. Output Summaries provide information concerning an output's background, potential, demand, and the degree to which it would conflict with another output. Locational Criteria and Output Summaries were prepared prior to developing the management alternatives in Section VI of the HINWR Master Plan/EIS in order to fully understand all of the important factors and relationships of each output considered.

Locational Criteria and Output Summaries were prepared for all outputs considered in the planning process. For various reasons, not all of these outputs have been incorporated as objectives in the final Master Plan/EIS. Some outputs were dropped from further consideration due to conflict with other higher priority outputs. Others were dismissed due to low demand or a lack of resources to support the output. Additionally, certain outputs have been grouped together in the Master Plan/EIS (because of similar resource needs, demands, and potential) in order to reduce repetition and streamline the planning process. Other outputs have been renamed to better reflect their true meaning. The following chart provides a cross-reference between outputs as originally described in the Locational Criteria or Output Summaries and the final listing in the Refuge Output List (Master Plan/EIS, page 5.2) and the objective statements (Master Plan/EIS, pages 5.7-5.9).

Output Reference in Locational Criteria and Output Summaries		Output Reference in Refuge Output List and Objectives Statements
Hawaiian Monk Seal	=	Monk Seal
Laysan Duck	=	Laysan Duck
Laysan Finch, Nihoa Finch, Nihoa Millerbird	=	Endemic Finches and Millerbird
Sea Turtle	=	Sea Turtle
Sensitive Species	=	Sensitive Species (Sooty Storm Petrel)
Cultural Resource Protection	=	Cultural Resource Protection
Wilderness	=	Wilderness
Research Natural Area	=	Research Natural Area
Other Protective Status	=	Other Protective Status

State of Hawaii Land Uses	=	Other Protective Status
Black Footed Albatross, Laysan Albatross, Bonin Petrel, Bulwer's Petrel, Wedge-Tailed Shearwater, Christmas Shearwater, Red-Tailed Tropicbird, Masked Booby, Brown Booby, Red-Footed Booby, Great Frigatebird, Gray Backed Tern, Sooty Tern, Brown Noddy, Black Noddy, Blue-Gray Noddy, White Tern	=	Marine Birds
Other Migratory Birds	=	Other Migratory Birds
Native Terrestrial Plants and Invertebrates	=	Terrestrial Endemic and Native Species
Marine Reef Species	=	Marine Reef Species
Ecological Monitoring	=	Research Studies
Studies and Publications	=	Research Studies
Cooperative Programs	=	Research Studies
Species Transplantation	=	Not Included
Environmental Education	=	Environmental Education
Interpretation	=	Interpretation
Nature Tours	=	Interpretation
Wildlife/Wildlands Observation	=	Interpretation
Photography/Journalism/Art	=	Photography/Journalism/Art
Other Recreation	=	Other Compatible Public and Economic Uses
Ahi Fishing, Aku Fishing, Albacore Fishing, Baitfishing, Bottomfishing, Trap Fishing, Recreational Fishing, Consumptive Recreation, Other Commercial Consumptive Uses, Aquarium Specimen Collecting, Other Consumptive Uses	=	Not included within the Refuge. Support for Commercial Fishing Off-Refuge included in Objective for "Other Compatible Public and Economic Uses".

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LOCATIONAL CRITERIA

OUTPUT: HAWAIIAN MONK SEAL PRODUCTION/MAINTENANCE

DESCRIPTION: Production and maintenance of monk seals (Monachus schauindslandi) requires adequate haul-out areas for pupping, nursing and resting, food, minimized exposure to disease and predators, and freedom from harassment by people, boats, fishing nets, etc.

ECOLOGICAL RELATIONSHIPS: The Hawaiian monk seal is found throughout the Northwestern Hawaiian Islands and rarely around the main Hawaiian Islands or other Pacific atolls. Major congregation areas are Pearl and Hermes Reef, Lisianski Islands, Laysan Island, French Frigate Shoals, Necker Island and Nihoa Island within the Refuge and Kure Atoll and Midway Islands at the north end of the NWHI.

Haul-out areas for pupping, nursing, and resting are primarily sandy beaches, but hard substrate bench areas and exposed reef are used as well (Gilmartin 1983). Vegetation behind beaches is sometimes used for shelter from wind and rain. Protected shallow water adjacent to the haul-out areas is important for the young animals. The nearshore areas, inside the reef are extensively used by weaned pups learning to feed (Johnson and Johnson 1978). During the breeding season, adults commonly feed in the nearshore areas, most often in waters less than 20 fathoms (DeLong et.al. in press).

Foods include spiny lobster, octopi, eels, and various reef fishes. Foods are located in coral communities, over extensive offshore banks surrounding the islands and on the precipitous bank slopes. Monk seals will use suitable feeding areas around the NWHI even without emergent lands nearby for hauling out.

Population counts have been made almost every year throughout the NWHI since the late 1950s. Counts indicate declines on all atolls except French Frigate Shoals (Gilmartin 1983). Counts over the last 7 years have averaged more than 500 animals, about half of what was counted in the late 50's (Gilmartin 1983). The proportion of the total population included in the count is unknown. Population estimating techniques used by Johnson and Johnson (1981) for Laysan Island suggest the Laysan population was about three times the daily beach count.

Various human activities are the major factors limiting monk seal production. Extended human activity on beaches causes monk seals to abandon haul-out areas. The seals are also vulnerable to entanglement in various fishing gear, especially nets. Monk seals are subject to ciguatera poisoning although the extent of mortality is not known. Predation by sharks is also a mortality factor of unknown proportions.

Extensive changes in population structure have been noted since monk seal monitoring began. Skewed age and sex ratios and mortality of juveniles and subadults are major current problems. Attacks by adult males on weaned pups and adult females are an additional problem possibly resulting from the current anomalous population structure.

OUTPUT: HAWAIIAN MONK SEAL PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Haul-out areas	X	Sandy beaches hard substrate benches, exposed reefs	Same	Same
Inner reef waters	X	Abundant food source, no limitations from competition, no predators, balanced age/sex structure	Adequate food source, minimized competition, minimum effect of predators, balanced age/sex structure	Same
Food	X	Spiny lobsters, octopi, eels, various reef fishes	Same	Same
Predators/ mortality disease	X	Minimize predation by sharks, no mortality from intraspecific interactions, no disease problems	Prevent predation from affecting population levels, no mortality from interspecific interactions, no diesease problems	Prevent predation from affecting population levels, minimize mortality from interspecific interactions, disease not affecting population levels
Human-related disturbance	X	No mortality caused by people or their tools (e.g. fishing nets), no disturbance of haul-out or feeding areas	Mortality minimized to that which cannot be avoided (under controlled use of resources by people), minimal disturbance of haul-out and feeding areas which does not affect long term population status	Same

OUTPUT: LAYSAN DUCK PRODUCTION/MAINTENANCE

DESCRIPTION: Production and maintenance of Laysan ducks (Anas laysanenis) requires nesting substrate, food and lack of contact with exotic organisms including disease, and human disturbance.

ECOLOGICAL RELATIONSHIPS: Laysan ducks are endemic, permanent residents of Laysan Island. These ducks are terrestrial but will fly short distances when disturbed (Ely and Clapp 1973). During crepuscular and nocturnal hours, Laysan ducks appear to be active in the lagoon, in low vegetation zones around the lagoon and in other patches of vegetation (Sincock and Kridler 1977, FWS 1983). During daylight, particularly in warm weather, they seek cover and rest in dense stands of Pluchea sp., Ipomoea sp., and Sicyos sp., where they tend to remain until early evening. Their nest is a shallow depression on the ground concealed in vegetation, usually Eragrostis, Cyperus sp., Chenopodium or Scaevola sp. (Ely and Clapp 1973).

Laysan ducks are primarily insectivorous. They frequently feed on brine flies (Neoscatella sexmaculata) along the damp edge of the lagoon, and brine shrimp (Artemia sp) in the lagoon during nocturnal hours. Other invertebrates including larval and pupae flies of moths, beetles, crustaceans and other littoral forms around the lagoon and small potholes are also known to be taken by these birds.

The Laysan duck population was reduced to less than 20 birds during the early part of this century when vegetation on the island was destroyed by introduced rabbits. Since the island recovered, the Laysan duck population has increased substantially. Census data between 1957 to 1980 vary between 25 and 688. The carrying capacity of the island for Laysan ducks is estimated to be 500 to 600 based on population present in 1979-80 (FWS 1982).

A number of factors may potentially affect the Laysan Duck, although at present the population appears secure. The major threats involve the stability of the habitat. Action was taken in the fall of 1984 to stabilize a substrate of windblown sand in a devegetated area on the windward side of the lagoon at Laysan Island. Aerial photographs had revealed a decrease in the surface area of the lagoon due to the sandfill. The dynamics and natural succession of the lagoon system and the surrounding patches of vegetation are not thoroughly understood. Abrupt or widespread changes in these areas could have detrimental affects on Laysan ducks. Exotic organisms are the main threat to the stability of these systems. Past effects of exotics may still be influencing these systems (e.g. soil blowing into lagoon). Exotic organisms such as rats or diseases can directly threaten the duck. Human disturbance can effect this fragile system directly and indirectly.

OUTPUT: LAYSAN DUCK PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nest habitat	X	Partially open stands of vegetation (e.g. Cuperus sp., Chenopodium sp., Scaevola) which provide some shelter	Same	Same
Food	X	Brine flies (e.g. Neoscatella sexmaculata), brine shrimp (Artemia sp.); larvae and pupae of various moths, flies, beetles; small aquatic crustaceans.	Same	Same
Introduced species	X	Prevent the introduction of exotic plants, invertebrates and vertebrates to Laysan Island	Same	Same
Human-related disturbance		No disturbance	Infrequent human disturbance at (certain) distance	Infrequent human disturbance at (closer) distance

OUTPUT: LAYSAN FINCH PRODUCTION/MAINTENANCE

DESCRIPTION: Laysan finch (Telospiza cantans) production and maintenance requires nesting substrate, food and lack of human disturbance and contact with exotic organisms including disease.

ECOLOGICAL RELATIONSHIP: Laysan finches historically were endemic to Laysan Island, although additional populations have been established on several islands on Pearl and Hermes Reef. Laysan finches are found in almost all plant associations on the 400 hectare island, although they appear to favor the Eragrostis sp. (bunch grass) association. Clumps of the Eragrostis sp. are the primary nesting substrates for this bird.

Laysan finches are omnivorous. They appear to use almost any kind of food available including leaves, flowers and seeds of many types of plants, various invertebrates, eggs of seabirds and carrion (seabirds) (Sincock and Kridler 1977, Ely and Clapp 1973). They have been observed probing at the base of Eragrostis clumps, presumably for water. Apparently they require fresh water, they have also been observed drinking from the hypersaline lagoon (Sincock and Kridler 1977).

Population estimates from censuses conducted over the last 15 years average at about 10,000 birds on Laysan Island, although in some years population estimates have ranged from less than 7,000 to over 20,000 birds (FWS 1983). the average carrying capacity for the island is approximately 10,000 birds.

A population of about 500 birds has been established on Southeast Island of Pearl and Hermes Reef. Birds have apparently spread to nearby islands: North, Grass, and Seal-Kittery Islands. These islands contain small populations of up to 50 birds or more.

The Laysan finch populations appear to be maintaining themselves in an essentially pristine environment, free of any significant influences of people. The major threats to the present conditions include the potential of harmful exotic organisms becoming established on Nihoa, avian disease being introduced into the finch population, human disturbance of various kinds, and major natural disasters such as tsunamis.

OUTPUT: LAYSAN FINCH PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTORS	OPTIMUM	ACCEPTABLE	MINIMUM
Nest habitat	X	Clumps of Eragrostis sp. (bunch grass)	Same	Same
Food	X	Parts of native plants (seeds, flower heads, etc.) native invertebrates, some seabird eggs, seabird carrion	Same	Same
Exotic organisms	X	Prevent the introducation of exotic plants, invertebrates, or vertebrates to Laysan Island and Pearl Hermes Reef.	Same	Same
Human-related disturbance		No disturbance	Infrequent human disturbance at 500 feet	Infrequent human disturbance at 300 feet.

OUTPUT: NIHOA FINCH PRODUCTION/MAINTENANCE

DESCRIPTION: Nihoa finch (Telospiza ultima) production and maintenance requires nesting substrate food, and lack of contact with exotic organisms including disease and human disturbance.

ECOLOGICAL RELATIONSHIP: Nihoa Finches are endemic to Nihoa Island and occupy virtually the entire 62 hectare island including the valleys, slopes and rocky outcroppings. They appear to prefer the open areas covered by stands of low shrubs dominated by Sida fallax, or Chenopodium oahuense and Solanum nelsoni (Conant 1983). This vegetation type covers much of the sides and floors of the valleys. Small holes in rocky outcroppings are apparently the preferred nesting sites.

Nihoa finches are omnivorous, eating a wide variety of plant material (seeds, flower heads, ect.), invertebrates, and sometimes bird eggs. These birds also tend to congregate at the few seeps or pools of water on the island (Clapp et.al. 1977). Apparently they require a source of fresh water.

The popultion appears to fluctuate between 1,000 and 5,000 birds, based on census data over the last 20 years (FWS 1983). Despite any population fluctuations, Nihoa finches appear to be maintaining their population in what is essentially a pristine environment. The major threats to the present conditions include the potential of harmful exotic organisms becoming established on Nihoa, avian disease being introduced, harmful exotic organisms becoming established on Nihoa, human disturbance of various kinds, and major natural disasters such as tsunamis.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nest habitat	X	Stands of native low shrubs in valleys Sida, Chenopodium, Solanum, with rocky outcroppings	Same	Same
Food	X	Parts of native plants (e.g. seeds, flower heads etc.), various native invertebrates, some seabird eggs	Same	Same
Exotic organisms	X	Prevent introduction of exotic plants, invertebrates, or vertebrates to Nihoa Island	Same	Same

OUTPUT: NIHOA MILLERBIRD PRODUCTION/MAINTENANCE

DESCRIPTION: Nihoa millerbird (Acrocephalus familaris kingi) production and maintenance requires nesting substrate, food and lack of contact with exotic organisms including disease and human disturbance.

ECOLOGICAL RELATIONSHIP: Nihoa millerbirds are endemic to and generally distributed throughout the 62 hectare Nihoa Island. They are found primarily in the dense shrubs of Sida fallax and Chenopodium oahuense where they tend to forage and place their nests (Clapp et al. 1977, Sincock and Kridler 1977). This preferred habitat occupies about 40 hectares.

Densities are relatively low for this species. The population appears to vary between 200 and 600 birds. Millerbirds are apparently quite sedentary, occupying territories between 0.2 and 0.4 hectares (Conant 1983). Movements and territory size are probably related to distribution and abundance of vegetation and terrestrial arthropods (their primary food source) which result in low densities.

Populations appear to remain around the carrying capacity of the habitat on Nihoa Island. The island remains in a relatively pristine condition with no perceptible effects of people evident on the Millerbird population. The major threats to the present conditions on Nihoa Island include the potential of harmful exotic organisms becomming established, the introduction of avian disease and major natural disasters such as fire.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nest habitat	X	Native shrubs, (Sida, Chenopodium in dense stands	Same	Same
Food	X	Invertebrate fauna, primarily arthropods	Same	Same
Exotic organisms	X	Prevent introduction of exotic plants, invertebrates or vertebrates to Nihoa island	Same	Same
Human-related disturbance		No disturbance	Infrequent human disturbance at (certain distance) 500 feet	Infrequent human disturbance at 300 feet

OUTPUT: SEA TURTLE PRODUCTION/MAINTENANCE

DESCRIPTION: Production and maintenance of the Hawaiian population of green sea turtles (Chelonia mydas), requires adequate nesting sites, food, a certain level of protection from natural predators, and freedom from exotic predators.

ECOLOGICAL RELATIONSHIPS: The Hawaiian population of the green sea turtle was historically distributed throughout the 2,450km long Hawaiian Archipelago. The current distribution of adults is a function primarily of the availability of acceptable breeding, feeding, and nesting habitat (Balazs 1980). Feeding and nesting areas are located in coastal waters of both the main islands and the NWHI. Feeding "pastures" used by adults are usually less than 10m deep, and frequently not more than 3m deep (Balazs 1980). Resting sites are usually nearby feeding areas, normally at less than 20 meters. Suitable sites include coral recesses, undersides of ledges, sand bottom areas, or other sites relatively free from strong currents and disturbances from predators and people (Balazs 1980). Surface basking in the water and on the shoreline is also done.

The only appreciable amount of nesting still known to occur is at French Frigate Shoals, on several islands most notably East and Whale-Skate. Successful nesting requires a sloping beach platform and moist but well drained, friable sand substrate which can easily be excavated by the female (FWS 1980).

Green sea turtles of all age classes feed on a variety of algae species. Adults appear to feed mostly nearshore on a small number of algae species. They graze off calcarious reef structures, rocks, or they take floating material (Balazs 1980). Juvenile and subadults are known to also feed on various invertebrates. Younger turtles (<35cm) living in pelagic waters presumably feed on various invertebrate forms, although data are lacking (Balazs 1980).

In the NWHI, resident aggregations of adults are known to occur at Necker Island, French Frigate Shoals, Lisianski Island, Pearl and Hermes Reef, and to a lesser extent, Laysan, Midway, and Kure Atoll. An average of about 200 females nest annually at French Frigate Shoals and less than 20 at Laysan, Lisianski Islands and Pearl and Hermes Reef (Balazs 1980). The number of females nesting annually since 1973 has fluctuated substantially. Total population size in unknown.

The major limiting factor is predation. Adult turtles are vulnerable to predation by tiger sharks, which can reach apparently significant levels in certain areas such as the NWHI. Hatchlings are vulnerable to ghost crabs and to a lesser extent, various carnivorous fishes. Illegal and accidental taking by people and human disturbance of turtles while on land are an additional concern.

Four other species of marine turtles are known to occur in Hawaii. The hawksbill (Eretmochelys imbricata) and the Leatherback (Dermochelys coriaces) are currently listed as endangered species. The hawksbill has been recorded nesting in small numbers in the southern end of the Archipelago. Leatherbacks are seen regularly in the pelagic zone surrounding Hawaii, yet are not known to nest in Hawaii. Both the loggerhead (Caretta caretta)and the olive ridley turtle(Lepidonchelys olivaces) occur only as rare vagrants.

OUTPUT: SEA TURTLE PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTUR	OPTIMUM	ACCEPTABLE	MINIMUM
Nest habitat	X	Moist, well-drained substrate which can be excavated by female. Must be readily accessible beach from open ocean	Same	Same
Food	X	Adults, subadults - primarily various species of algae usually in near shore area including adjacent to nest sites subadults, juveniles - also take various invertebrates in coastal areas, hatchlings feed on a variety of invertebrates near the surface in pelagic waters	Same	Same
Predators	X	Protect hatchlings, control ghost crabs when excessive predation as needed, control sharks if excessive predation of adults	Same	No management
Human-related	X	No moratality caused by people or their tools (e.g. fishing nets), no disturbance of nesting beaches	Mortality minimized to that which is un-avoidable (under controlled use of resources by people), minimal disturbance of nesting beaches which has no long term affect on population status	Same

OUTPUT: WILDERNESS AREAS

DESCRIPTION: The 1964 Wilderness Act (16 U.S.C. Sec. 1131-1136) defines "Wilderness" and provides for its designation and use. A Wilderness is recognized as an area of the earth and its community of life that is untrammeled by humans, where people themselves are visitors who do not remain. It is an area of land retaining its primeval character and influence, without permanent improvements or human habitation, and which is protected and managed so as to preserve its natural conditions. Furthermore, wilderness: 1) generally appears to have been affected primarily by the forces of nature with unnoticable human imprint; 2) has outstanding opportunities for solitude or primative recreation; 3) has at least 5000 acres or is of sufficient size as to make practicable its preservation in unimpaired condition; and 4) may also contain ecological, geological, or other features of scientific, educational scenic or historical value. The HINWR was proposed as a Wilderness Area by the FWS in 1967.

ECOLOGICAL RELATIONSHIPS: To preserve the Wilderness quality of units within the National Wildlife Refuge System it is necessary to manage so as to maintain the Wilderness character of the biological and physical features of the area; to manage the resource so as to maintain the wilderness quality for future benefit and enjoyment; to provide opportunities for research, solitude and permitted recreational uses; to retain the area in the same condition as in its pre-wilderness designation; and to insure that human works remain substantially unnoticeable.

BASIC ASSUMPTIONS: Although not yet designated Wilderness, the FWS currently manages the refuge as such. Wilderness areas may be closed to specific uses if they are determined to be incompatible with refuge objectives. The use of motorized equipment is prohibited except in emergency search and rescue missions, where essential to the refuge objectives, and when boat and aircraft use is an established practice prior to wilderness designation. All vehicle use must meet 'minimum tool' criteria. The use of aircraft is permitted over Wilderness Areas.

Source: Refuge Manual
Tern Island Study
Committee on Merchant Marine and Fisheries. 1967. A Compilation of Federal Laws Relating to Conservation and Development of Our Nation's Fish and Wildlife Resources, Environmental Quality, and Oceanography. Serial No. 95-B. U.S. Government Printing Office, Washington, D.C.

OUTPUT: WILDERNESS AREAS

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Site Condition	X	Free from evidence of human manipulation. Contains significant ecological, historic, scientific values	Relatively free from human manipulation	Same
Natural Diversity	X	Varied and pristine ecological communities	Same	Same
Wildlife		Areas with excellent wildlife habitat	Same	Same
Access		Available to recreationists by charter plane and boat.	Same w/charter plane	Same

OUTPUT: RESEARCH NATURAL AREA

DESCRIPTION: Research Natural Areas (RNAs) are part of a national network of reserved areas under various ownerships. RNAs are intended to present the full array of North American ecosystems, biological communities, habitats, and phenomena, geological and hydrological formation and conditions. They are areas where natural processes are allowed to predominate without human intervention. However, under certain circumstances, deliberate manipulation is used to maintain unique features that the RNA was established to protect. (Refuge Manual)

Public Use Natural Areas (PUNAs) are designed to assure the preservation of a variety of significant natural areas for public use which, when considered together, illustrate the diversity of natural environments and preserve those environments that are essentially unaltered by humans for future use.

The key distinction between RNAs and PUNAs is that the latter allows public access for recreation compatible with maintenance of resource integrity.

ECOLOGICAL RELATIONSHIPS: HINWR was designated a RNA in 1967 because of important populations of seabirds and seals and other attributes including: a significant ecological community illustrating characteristics of a coral atoll in sub-tropical waters; biota of relative stability maintaining itself under prevailing natural conditions; an ecological community significantly illustratingthe process towarda climax community; habitat supporting vanishing, rare and restricted species; relic flora and fauna persisting from an earlier period, and seasonal haven for concentrations of native animals.

BASIC ASSUMPTIONS: Activities limited to colleges and other scientific agencies for research, observation, monitoring and educational activities. Minimal disruptive procedures may be permitted provided activities do not impair or threaten the area. Non-research education will be permitted when it does not conflict with research use. No permanent physical improvements are permitted in RNAs. Management practices are used only when necessary (e.g. feral animal control). Use of RNAs will be governed by management plan compatible with refuge objectives detailing protection, management and practices. Disestablishment procedures are initiated if an area is no longer useful for its established purposes.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Wildlife	X	Areas with excellent wildlife viewing possibilities without disturbance	Areas with good wildlife viewing w/out disturbance	Areas with fair viewing w/out disturbance
Natural Diversity	X	10 or more micro-habitats available for study	7 or more micro-habitats available	5 or more micro-habitats available
Site Condition	X	Free from evidence of human manipulation Endangered species population present	Relatively free from human manipulation Threatened species population present	Same Sensitive species population present
Access		Available to scientist w/ charter plane and boat	Available to scientist w/ charter plane, FWS boat	Same

OUTPUT: OTHER PROTECTIVE STATUS

Critical Habitat for the Hawaiian Monk Seal

The FWS will support critical habitat designation by the National Marine Fisheries Service. This protection will overlay existing protection offered by the Research Natural Area and by the current boundaries of the HINWR. However, critical habitat will offer more inclusive protection to the waters surrounding Lisianski, Necker and Nihoa Islands, and will standardize the protection zone around all the islands of the Northwestern Hawaiian Islands (NWHI).

Marine Sanctuary Proposal

The intent of this proposal is to unify fragmented jurisdictional management to present an ecologically comprehensive perspective while allowing multiple use to be granted by permit. The boundaries include all lands and waters enclosed by the 12 mile radius drawn around all NWHIs. The sancturary is designed to preserve coastal areas and fisheries, provide regulations for planning and management, provide protection where gaps exist in laws, and ensure balance in multiple use. This proposed sanctuary would be managed by NOAA as a unit in a series of existing Marine Sanctuaries in the U.S.

Both Critical Habitat and Marine Sanctuary proposals would enhance protection of unique wildlife resources of the NWHI not currently and/or comprehensively protected e.g. monk seal feeding areas and tuna schools. Both proposals would be enforced by NOAA. Both are overlain to some degree by existing protective status.

World Heritage Site

The International Convention concerning the Protection of the World Cultural and Natural Heritage (UNESCO 1972) provides for the designation of areas of "outstanding universal value" as World Heritage Sites. These exceptional areas must be recommended by the signatory nation responsible for the site for declaration by the International World Heritage Committee. The sites will undoubtedly include many previously designated protected areas.

The primary objective is to protect the natural features for which the area was considered to be of world heritage quality. Also important is to provide publications of information for worldwide public enlightenment as well as to provide for research and environmental monitoring.

Management of these sites will stress the maintenance of the heritage values, the continuation of legal protection, and will promote each site as to its significance to each country, its people and the world.

All sites will have to have strict legal protection and will be owned by government or a non-profit corporation or trust for the long term. While recreation and on-site interpretation will generally be developed, some sites may be of such significance that public use will either be strictly controlled or prohibited.

Boundary Review

Seek to resolve conflicts with the State of Hawaii concerning the extent of the Refuge boundaries. Seek to expand boundaries to the edge of the reef on islands not currently protected e.g., Lisianski. Seek to hold boundaries on Maro Reef, Laysan, French Frigate Shoals, Pearl and Hermes Reef. Seek to expand boundaries at Necker and Nihoa to a specific fathom line. This will offer a more inclusive area of aquatic habitat, and will enhance and standardize jurisdictional management.

Midway Overlay

Seek and include islands at Midway as areas under the protective agencies of the FWS. Coordinate with U.S. Navy to manage islands consistent with the FWS objectives concerning migratory birds, endangered species and predator control and contingency plans.

National Landmark/Historic Sites

Seek to include Nihoa and Necker as archeological sites suitable for Historic Site recognition. Review status and history of other islands in the NWHI as potential Historic site. Seek National Landmark status of appropriate islands.

Source: Marine Sanctuary Proposal, C. Harrison 1983
Recovery Plan for the Hawaiian Monk Seal, W. Gilmartin 1983

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Site Location	X	All Hawaiian waters	NWHI waters	HINWR waters
Access	X	Access with special use permit	Access with permit	Same
	First line is Critical Habitat for seals Second line is Marine Sanctuary Proposal			
Site Location	X	Boundary out to 20 f. Boundary out to 12 mi.	Boundary out to 3 m.. Boundary out to 7 mi.	Boundary out to 10 f. Boundary out to 3 mi.
Access	X	Area closed w/out permit	Area closed w/out permit	Same
		Area open to public use with permission	Same	Same

OUTPUT: BLACK-FOOTED ALBATROSS PRODUCTION/MAINTENANCE

DESCRIPTION: Black-footed albatross (Diomedia nigripes) production and maintenance requires substrate, food and freedom from introduced diseases, predators and human disturbance.

ECOLOGICAL RELATIONSHIPS: Black-footed albatross use all NWHI except Gardner Pinnacles from October through June or July. They are colonial ground nesters, preferring open areas, and will feed offshore. This species is particularly vulnerable to food shortages during its breeding season. One of the predominant causes of natural mortality in chicks is starvation, which occurs when parent birds are unable to secure enough food to keep growing young alive. This species migrates away from the NWHI after breeding.

The occurrence of avian pox and possible lead poisoning on Midway Islands, predation by rats (Kepler 1967) on Midway Islands and Kure Atoll, and control programs on islands where people and birds coexist (especially Midway) are all causes of reduced breeding or mortality in black-footed albatross.

In the NWHI, black-footed albatross populations have largely recovered from the depredations of feather hunters and the results of devegetation. With introductions of soil and exotic vegetation on Sand Island, Midway, numbers of breeding birds have increased there. Population numbers during the past several years appear to have been fairly constant, or perhaps increasing slightly.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: BLACK-FOOTED ALBATROSS PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Large, open sand beaches above storm tide line. Exotic vegetation lacking.	High, sandy ridges; open, sandy areas running inland from the beach between vegetation, especially Scaevola and Eragrostis Exotic vegetation lacking.	Flat, rocky strata with little vegetation.
Disease	X	Avian pox absent.	Pox incidence decreased.	Pox incidence decreased from present levels
Predators	X	Rats absent.	Rats absent.	Where they now occur, rats decreased.
Isolation		People absent from colonies during breeding season.	Slight human impact during breeding season.	Light human impact.
Food		By percent volume in diet: Exocoetidae 44.2 Ommastrephidae 29.2 Fish 5.4 Crustacea 4.3 Other squid 2.6	Same	Same

OUTPUT: LAYSAN ALBATROSS PRODUCTION/MAINTENANCE

DESCRIPTION: Laysan albatross (Diomedia immutabilis) production and maintenance requires nesting nesting substrate, food and freedom from introduced diseases, predators and human disturbance.

ECOLOGICAL RELATIONSHIPS: Laysan albatross breed on all NWHI, generally from October through July. They are ground nesters and tend to select nest sites closer to vegetation than the black-footed albatross (Fisher 1972). Individual pairs return with the same mate to the same nest site annually.

This species feeds offshore during the breeding season and is vulnerable to food shortages during this time. Most natural chick mortality can probably be attributed to starvation although shark predation occurs to an unknown extent.

Additional causes of mortality include rats (Kepler 1967), avian pox and possible lead poisoning on Midway Islands, and control programs in breeding colonies by humans.

Feather hunting in the late 19th and early 20th centuries resulted in the loss of several important Laysan albatross colonies worldwide. In the NWHI, the decline of this species was exacerbated by the devegetation of Laysan and Lisianski Islands earlier this century; but the population apparently recovered throughout the refuge and may be increasing on several islands, most notably Midway Islands. This is due to the introduction of exotic flora and soil on Sand Island which created additional nesting habitat.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: LAYSAN ALBATROSS PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting	X	Flat, interior plains close to vegetation and protected from blowing sand and high water. Exotic plants absent.	Interior areas covered by Lepturus and Tribulus. Beach perimeters.	Rocky areas with little vegetation; slopes; open beaches or dense vegetation.
Disease		No avian pox.	Same	Pox controlled.
Predators		Rats absent.	Rats absent.	Decreased populations where they presently occur.
Isolation		No human disturbance.	Same	Slight human disturbance.
Food		By percent volume in diet: Ommastrephidae and other squids 64.8 crustacea 8.6 Velellidae 4.0 Exocoetidae ova 3.6 Molidae 2.8 Fish 2.4 Jamthinidae ova 1.8	Same	Same

OUTPUT: BONIN PETREL PRODUCTION/MAINTENANCE

DESCRIPTION: Bonin petrel, (Pterodroma hypoleuca) production and maintenance requires nesting substrate, food, freedom from excessive competition and predation and isolation from human presence.

ECOLOGICAL RELATIONSHIPS: Bonin petrels are present on all NWHI except Nihoa, Necker and Gardner Pinnacles. They nest in burrows, breeding from January or February through June or July. However, birds have been recorded during all months. Bonins probably feed pelagically, occasionally in association with other species. The non-breeding distribution of this species is not well-known.

The two principal causes of mortality of Bonin petrels in the NWHI are rat predation and shearwater attack. Rat predation has been documented at Kure Atoll and Miday Islands. Both Rattus rattus and R. exulans are involved. Studies by Woodward (1972) and Grant et al. (1981) have documented that rat predation, in the absence of effective control programs, can virtually eliminate successful fledging of young birds and could eventually lead to local extirpation. The significance of chick mortality by wedge-tailed shearwaters to the NWHI breeding population of Bonin petrels is uncertain, but it is clear that impact on localized colonies can be severe. Late nesting petrels are particulary vulnerable, as chicks are less able to defend themselves against shearwaters. Petrel mortality may result from direct attach or as a result of starvation caused by separation from parents when young are evicted from burrows. In addition, on Laysan Island, the Laysan finch preys on eggs of this species.

Burrows are also often destroyed inadvertently by persons walking through nesting colonies. Even prior to egg laying, such destruction of habitat may cause prospective nesting birds to abandon the area and not nest during the season in which disturbance occurs.

Although it appears that populations on Refuge islands are stable, population trends are hard to document due to the nesting habits and pattern of nocturnal activity in Bonin petrets. However, a drastic population decline has occured on Midway Island due to black rat predation (Grant et al. 1981).

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: BONIN PETREL PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Sandy soil overlain by *Eragrostis* and shrubby vegetation.	Sandy soil covered with grass, *Eragrostis* and *Ipomoea* or *Scaevola*.	On surface under dense vegetation.
Predation	X	No human presence in colonies during breeding season.	Minimal disturbance during breeding.	Same
Competition		Wedge-tailed shearwaters absent.	Wedge-tailed shearwaters present in low numbers.	Wedge-tailed shearwaters present in moderate numbers.
Food		By percent volume in diet: Myctophidae 24.3 Ommastrephidae 17.4 Sternoptychidae 11.5 Crustacea 6.8 Mullidae 4.2 Gonostomatidae 2.8 Other squid 3.6 Fish 2.7 Synodontidae 2.3	Same	Same

OUTPUT: BULWER'S PETREL PRODUCTION/MAINTENANCE

DESCRIPTION: Nest habitat, food isolation and freedom from predators are required for the production and maintenance of Bulwer's petrels. (Bulweria bulwerii)

ECOLOGICAL RELATIONSHIPS: Bulwer's petrels breed on all NWHI except Midway and Kure Atoll. They are ground nesters, using the islands from late March to October. At these times they feed within 80 km of their colonies (King 1970). This species is not particularly reliant on predatory fishes to drive prey to the surface. Winter feeding and dispersal patterns are unknown.

Natural egg predators include Nihoa and Laysan finches and crabs (Grapsus sp.). Crabs may also consume small chicks, but the extent of this loss is uncertain. Egg predation is exacerbated by human disturbance that causes incubating adults to temporarily abandon their eggs. On rat infested islands, rat predation of Bulwer's petrels can be severe. In the NWHI, Midway Islands and Kure Atoll are the only islands with rats; no Bulwer's petrel colonies exist on these islands.

There are insufficient data from any of the Hawaiian Island nesting colonies to document population trends, with the exception of Midway Islands, where Bulwer's petrels were once "abundant" (Munroe 1944) and no longer exist.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	Rocky areas and ledges affording holes and crevices. Sicyos absent.	Under human-related structures. Under dense vegetation on the surface of the ground.	Abandoned wedge-tailed shearwater burrows.
Predators	X	Absence of cats or rats.	Absence of cats or rats.	Controlled predators where now present.
Isolation	X	Absence of people in colonies during breeding season.	Little human disturbance in colonies during breeding season.	Same
Food		By percent volume in diet: Myctophidae 30.5 Sternoptychidae 29.3 Ommastrephidae 20.7 Crustacea 3.9 Fish 3.6 Exocoetidae 3.2 alobates sericeus 2.6	Same	Same

OUTPUT: WEDGE-TAILED SHEARWATER PRODUCTION/MAINTENANCE

DESCRIPTION: Wedge-tailed shearwater (Puffinus pacificus) producation and maintenance requires nesting substrate, food, isolation and freedom from introduced predators.

ECOLOGICAL RELATIONSHIPS: Wedge-tailed shearwaters breed on all NWHIs. They are burrow nesters, using the islands from March through December. During this time, they feed within 80 km of their breeding grounds, often in association with tuna schools.

Human-related causes of mortality include historic depredation by Hawaiians and burrow destruction by intruders. Disturbance to nesting birds can cause abandonment of eggs and young with resulting mortality, as well as increased predation on unattended eggs by Nihoa and Laysan finches on these islands. Many young wedge-tailed shearwaters, particularly those from islands offshore of Oahu, perish when attracted to onshore street and automobile lights when they fledge.

Dogs, cats, rats, mongooses, owls and mynas are known to predate wedge-tailed shearwater nests.

Inconsistent censusing methods make the interpretation of historic population trends difficult. It is known, however, that dramatic population declines have occured on Midway in recent years, probably due to rats introducted in 1943. Main Island populations, including those on off-shore islets, have probably fluctuated radically because of Hawaiian hunting pressures, military activities and rats. It is thought that much of the historical breeding range of this species in the Main Islands has been reduced.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: WEDGE-TAILED SHEARWATER PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Soil overlain by *Eragrostis*, *Scaevola* and *Ipomoea*, dense *Solanum Sicyos*, or grasses.	Loose sand under rocks. Soil under hardpan.	Rocky areas with deep crevices and holes. Surface nesting on sand overlain with scant vegetation.
Predators	x	Exotic plants absent. Rats, dogs, cats, mongooses and mynas absent.	Same	Some predators present but controlled.
Isolation	X	Colonies free of human presence. Street, auto and other lights not visible from colony.	Same	Minimal human presence; lights shaded and distant.
Food		By percent volume in diet: Ommastrephidae 28.2 Carangidae 27.6 Mullidae 19.3 Myctophidae 4.2 Exocoetidae 4.2 Monacanthidae 4.1 Fish 3.2 Nomeidae 1.8 Gobiidae 1.5 Crustacea 1.1	Same	Same

OUTPUT: CHRISTMAS SHEARWATER PRODUCTION/MAINTENANCE

DESCRIPTION: The production and maintenance of Christmas shearwaters (Puffinius nativitatis) requires nest cover, food, isolation and freedom from excessive predation and competition.

ECOLOGICAL RELATIONSHIPS: Christmas shearwaters breed on all NWHI except Gardner Pinnacles and Necker Island. They nest on the surface of the ground under various types of cover. Birds use the islands from January through November, during which time they feed offshore. They are well-known to associate with tuna schools.

This shearwater is quite skittish, and when disturbed the bird will often leave the nest. On Laysan Island and Nihoa Island, resident finches eat unattended eggs; this is the most common cause of egg loss on these islands.

Interspecific competition is also responsible for loss of both eggs and chicks. Red-tailed tropicbirds and brown noddies, which nest in similar sites, will occasionally chase Christmas shearwaters off eggs or kill the chicks.

Christmas shearwater populations declined drastically on Laysan Island (Ely and Clapp 1973) and Lisianski Island (Clapp and Wirtz 1975) during the era of feather hunting, and after the extensive destruction of habitat by introduced rabbits in the early twentieth century. It is probable that the Christmas shearwater has never fully regained its former numbers on these colonies, by far the most important colonies in the NWHI. The original vegetation of these islands may have been different from that which occurs today, and this change may have adversely affected recovery. Present numbers seem to have been stable for the past several years, except for the Midway Islands population, which is probably low because of the introduction of the black rat in 1943. (Fisher and Baldwin 1946).

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which result in decreased availability of food for birds, especially during the reproductive season.

OUTPUT: CHRISTMAS SHEARWATER PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting	X	Dense Scaeola, rocky outcrops at perimeter of island. In shallow trenches under boards, other vegetation, or rocks. Exotic vegetation absent.	Sheltering debris such as boards, sheets of tin, etc.; may be in conjunction with Eragrostis-Ipomoea Boerhavia association. In interior within Ipomoea.	Tournefortia, Scaevola and Chenopodium.
Predation		Nihoa finches absent.	Small number of finches present.	Moderate number of finches present.
Competition		Red-tailed tropicbirds and brown noddies absent.	Red-tailed tropicbirds and brown noddies present in small numbers.	Red-tailed tropicbirds and brown noddies present in moderate numbers.
Food		By percent volume in diet: Ommastrephidae 47.4 Mullidae 14.9 Carangidae 13.5 Exocoetidae 10.3 Fish 4.8 Nomeidae 2.5 Holocentridae 2.4 Gonostomatidae 1.5	Same	Same

OUTPUT: SOOTY STORM-PETREL PRODUCTION/MAINTENANCE

DESCRIPTION: Sooty storm-petrel (Oceanodroma tristrami) production and maintenance requires nesting habitats, food, and freedom from excessive competition and predation.

ECOLOGICAL RELATIONSHIPS: Sooty storm-petrels are present from October through May and nest on all NWHI except Gardner Pinnacles and Midway Islands. Their presence on Lisianski Island and Kure Atoll is suspected, although not confirmed. They nest in a variety of habitats, depending on availability, though they are generally found in subsurface burrows, under vegetation or in cavities. Sooty storm-petrels probably feed offshore while using the islands.

On Laysan Island, wedge-tailed shearwaters peck and kill late-fledging storm-petrel chicks, forcibly removing them from their burrows. It is likely that the presence of the black rat on Midway Islands accounts for its absence there, and undoubtedly Polynesian rats on Kure Atoll kill adults, young or eggs.

Our knowledge of this species consists largely of colony locations and basic natural history. Reliable information concerning population trends is not available. Ely and Clapp (1973) ventured a guess that populations on Laysan Island are probably roughly equal to estimates at the beginning of this century. However, Hasegawa (1978) noted that the "breeding population appears to have greatly decreased recently" on Torishima Island in the Izus.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Inaccessible recesses in talus slides. Exotic vegetation absent. Burrows under Eragrostis and Ipomoea.	Burrows under Ipomoea and hardpan. Also within Ipomoea cavities and cavities in guano piles. Burrows in soil under Cynodon.	Under Eragrostis and Boerhavia; also in open rubble.
Predators		Cats and rats absent.	Cats and rats absent.	Cats and rats present but controlled.
Competition		Wedge-tailed shearwaters absent.	Wedge-tailed shearwaters in small numbers.	Wedge-tailed shearwaters in moderate numbers.
Food		By percent volume in diet: Unidentified squid 28.8 Stepnoptychidae 23.0 Velellidae 11.9 Argasidae 10.0 Crustacea 5.0 Halobates Sericeus 1.1		

OUTPUT: RED-TAILED TROPICBIRD PRODUCTION/MAINTENANCE

DESCRIPTION: Red-tailed tropicbird (Phaethon rubricauda) production and maintenance requires nesting cover, food and freedom from introduced predators and diseases.

ECOLOGICAL RELATIONSHIPS: Red-tailed tropicbirds breed on all NWHI, generally from January through October. They are surface nesters requiring shelter from the sun. This species rarely feeds in association with predatory fishes; instead, it is usually a solitary (Gould 1971) pelagic feeder (Diamond 1975).

Red-tailed tropicbirds are highly vulnerable to rat predation. Egg and nesting loss due to rats have been documented on Kure Atoll (Woodward 1972) and on Midway Islands (Ludwig et. al. 1979). At Johnston Atoll, dogs, cats and ants all affect nesting success to some degree. Avian pox has been found on tropicbirds on Midway Islands.

Current populations of red-tailed tropicbirds are probably fairly stable, but historically they have undergone dramatic fluctuations. On Laysan Island (Ely and Clapp 1973) and Lisianski Island (Clapp and Wirtz 1975), populations crashed after rabbits devegetated the islands in the early part of this century. The birds had been extirpated as a breeding species from Lisianski Island by 1923, when Wetmore visited the island in May and found only two birds and no nests (Clapp and Wirtz 1975). Today, the vegetation has recovered and the birds have repopulated these islands. On Midway Islands, human alteration of the islands is probably the main reason for increased populations. Wetmore (in Fisher 1946) estimated 20 birds in April 1923 on Midway Islands. By 1946, 19,000 birds (10,000 on Sand Island; 9,000 on eastern Island) were estimated for both islands. Today, as estimated 10,000 birds nest there. This decline since 1945 may be due to rat predation. Tropicbird populations have also increased on Kure Atoll (Woodward 1972) and Tern Island (French Frigate Shoals) (Amerson 1971) where there is permanent human habitation. Similar to Midway Islands, increased tropicbird populations on these two islands are probably a result of increased nesting habitat created by structures and introduced vegetation.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: RED-TAILED TROPICBIRD PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Cover	X	Large, dense Scaevola stands on island perimeter. Exotic plants absent.	In Tournefortia, human debris, Pluchea, and holes and crevices in rock. Also in Eragrostis, Casuarina and Solanum. Lower, less dense Scaevola on island perimeter or Ipomoea over low Scaevola interiors.	Around rock piles; within and beneath human-made structures. Small caves, overhangs, crevices and holes.
Disease	X	Pox absent.	Same	Pox present but controlled.
Predators	X	Rats, dogs, cats, and ants absent.	Same	Where now present, predators controlled.
Food	X	By percent volume in diet: Exocoetidae 33.5 Ommastrephidae 17.3 Carangidae 14.3 Coryphaenidae 9.7 Molidae 5.0 Scomberesocidae 4.3 Tetradontidae 4.0 Scombridae 3.6 Fish 3.3 Hemiramphidae 2.5 Xiphiidae 1.6 Other squid 0.5	Same	Same

OUTPUT: MASKED BOOBY PRODUCTION/MAINTENANCE

DESCRIPTION: Masked booby (Sula dactylatra) production and maintenance requires suitable nesting substrate, roosting areas and food.

ECOLOGICAL RELATIONSHIPS: Although immatures range widely, adult masked boobies are year-round residents and breed on all NWHI. Most breeding occurs from February through October. Nesting is on the surface, usually in open areas. Breeders and non-breeders roost on the islands in large aggregations or clubs.

Feeding is pelagic, up to 150 km from land (Palmer 1962). Masked boobies rarely associate with one another when feeding, but frequently occur in mixed species foraging flocks (Gould 1971). Generally these feeding flocks occur when skipjack or yellowfin tunas drive smaller prey to the surface. Populations of the masked boody appear to be fairly stable throughout the NWHI, both in recent and historical times, except for an apparent decrease on Necker Island (Clapp and Kridler 1977) for unknown reasons. Generally, this easily counted species seems to have fairly large fluctuations in breeding populations. During the early part of the twentieth century, this species declined severely on Laysan Island (Ely and Clapp 1973) and Lisianski island (Clapp and Wirtz 1975) due to feather hunting. The introduction of rabbits and the devegetation that followed were probably only secondary factors affecting numbers of this ground-nesting species.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which result in decreased availability of food for birds, especially during reporductive season.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting	X	Sand of upper beaches; exotic vegetation absent.	Open, sandy areas in island interiors among Tribulus, Lepturus and Scaevola. Flat, sandy beaches. High, open slopes, ridges and summits of high islands.	High, level rocky substrate or lower rocky areas.
Roosting Areas		Open beaches seperate from breeding areas.	Same	Same
Food		By percent volume in diet: Exocoetidae 58.0 Carangidae 29.0 Coryphaedidae 2.8 Hemiramphidae 2.8 Ommastrephiae 2.6 Scombridae 2.2 Fish 2.2	Same	Same

OUTPUT: BROWN BOOBY PRODUCTION/MAINTENANCE

DESCRIPTION: Brown booby (Sula leucogaster) production and maintenance requires nesting habitat, nest material, food and freedom from introduced predators.

ECOLOGICAL RELATIONSHIPS: Brown boobies breed on all NWHI except Midway Islands. They breed in all months, with a definite peak in spring and summer. Nesting is on the ground in rocky, cliffy areas. In sandy areas, brown boobies breed amoung vegetation, contructing substantial nests. Birds feed inshore year around (Diamond 1978), most within 80 km of the breeding island (King 1970).

Rats are suspected to be a problems on several islands, but definitive information on their effect on brown boobies is lacking. However, Polynesian rats have been observed attacking and killing incubating Laysan albatrosses (Kepler 1969). Therefore, it is believed that brown boobies would also be vulnerable.

Populations of the brown booby appear to be fairly stable throughout the NWHI, both in recent and in historical times, except on Midway Islands. In the late 1930s, it was the most common booby (Hadden 1941). Today, single birds occasionally roost on the island; but none breed. Counts of this conspicuous bird make population esimates on a given visit to a breeding island relatively accurate. However, asynchronous nesting cycles make it impossibe to estimate all nesting attempts during that year from a single visit. Severe vegetation losses on Laysan Island (Ely and Clapp 1973) and Lisianski Island (Clapp and Wirtz 1975), caused by the introduction of European rabbits in the early twentieth century, did not seem to affect the populations of this ground nesting species.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproduction season.

OUTPUT: BROWN BOOBY PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Rocky strata on slopes or ridges overlooking sharp elevational drops. Inland on grassy, Sesuvium or Chenopodium areas. Exotic vegetation absent.	Open areas within Scaevola. Exotic vegetation absent.	Small, rocky ledges or bare areas of coral rubble. Exotic vegetation absent.
Nesting Material		Vegetation such as grass, twigs, etc. in sandy areas. nothing in rocky areas.	Vegetation.	Material absent.
Predators		Cats and rats absent.	Same	Where they presently occur, cats and rats in reduced numbers.
Food		By precent volume in diet: Carangidae 27.9 Exocoetidae 26.4 Mullidae 15.7 Hemiramphidae 9.9 Ommastrephidae 4.8 Belonidae 4.6 Fish 3.9 Kyphosidae 3.7 Scomberesocidae 2.7	Same	Same

OUTPUT: RED-FOOTED BOOBY PRODUCTION/MAINTENANCE

DESCRIPTION: Red-footed booby (Sula sula) production and maintenance requires suitable nesting substrate, nest material, isolation, food and freedom from introduced predators.

ECOLOGICAL RELATIONSHIPS: Red-footed boobies nest on all NWHI except Gardner Pinnacles. Birds may be found on the islands at all times during the year, although breeding is concentrated in the spring and summer. These boobies are shrub nesters and build nest platforms with a variety of plants. A significant number of immature birds roost on the isands (Woodward 1972).

Birds forage pelagically (Diamond 1978), frequently in feeding flocks which occur when yellowfin or skipjack tunas drive smaller prey to the surface. They probably remain in NWHI waters throughout the year.

Theft of eggs, young and/or nest material from red-footed booby nests by frigatebirds is common, especially when boobies are disturbed from their nests. Rats prey on booby eggs, young and adults on Kure Atoll (Kepler 1967) and Midway islands (Ludwig et al. 1979).

Red-footed booby populations seem to have remained steady over the last century, with the exceptions of declines in breeding birds on Laysan/Lisianski in the 1920's (Ely and Clapp 1973; Clapp and Wirtz 1975). However, the Laysan and Lisianski colonies have recovered and populations on Tern Island (French Frigate Shoals) may have increased recently.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease availability of food for birds, especially during the reproductive season.

OUTPUT: RED-FOOTED BOOBY PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	Mid and lower elevations of higher islands; in low Chenopodium, Sida and Sesbania 3-4' above the ground. Also in Scaevola. Exotic vegetation absent	In Tournefortia and Chenopodium, rubble from humans. In Prichardia on Nihoa. Scaevola-Pluchea in island interirors. Exotic vegetation absent.	Matted Solanum, Tribulus, Sicyos Scant low-growing Scaevola and Solanum. Exotic vegetation absent.
Nesting Material		Scaevola branches and twigs, Tribulus and/or Sicyos, Boerhavia	Data not available.	Solanum, Tribulus, Sicyos or Boerhavia
Predators		Rats and cats absent.	Rats and cats absent.	Predators controlled where they presently occur.
Food		By percent volume in diet: Exocoetidae 46.3 Ommastrephidae 27.2 Carangidae 10.6 Scombersocidae 4.3 Scombridae 3.1 Fish 2.7 Hemiramphidae 2.1 Molidae 1.8 Mullidae 1.6	Same	Same

OUTPUT: GREAT FRIGATEBIRD PRODUCTION/MAINTENANCE

DESCRIPTION: Great frigatebird (Fregata minor) production and maintenance requires nesting habitat, nest material food, isolation and freedom from introduced predators.

ECOLOGICAL RELATIONSHIPS: Great frigatebirds nest on all NWHI except Gardner Pinnacles. Although some birds are on the islands in all months, the breeding season lasts from March to November, during which time twig nests are constructed on vegetation. Feeding usually occurs within 80 km of the breeding or roosting grounds. Juveniles wander, however, adult birds remain in NWHI waters all year (Diamond 1978).

Egg and chick loss among great frigatebirds is often due to disturbance by other frigates pillaging nest material or unmated males attempting to set up breeding colonies within existing ones. This problem can be seriously exacerbated by human intruders in a colony, which cause parent birds to flush from eggs and young, allowing neighboring frigatebirds to raid the nests.

Attacks of black rats (Rattus rattus) on incubating red-footed boobies on Eastern Island, Midway (Ludwig et al 1979) suggest that similar problems may also exist for the great frigatebirds which nest in the same area.

Most populations of great frigatebirds in the NWHI appear to have been reasonably stable based on historical records, but there are two important exceptions. The populations of this shrub-nesting species plummetted during the early twentieth century on Laysan Island (Ely and Clapp 1973) and Lisianski Island (Clapp and Wirtz 1975), when introduced rabbits destroyed most of the native vegetation on those islands. It seems that the population on Lisianski Island has recovered, but that on Laysan Island has still not achieved its former levels. The populations on Nihoa Island and Necker Island, where large colonies are scattered along cliff slopes, are particularly difficult to census and consequently only gross changes in nesting populations can be observed. On Tern Island (French Frigate Shoals) the first nesting of this species was attempted in 1982.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: GREAT FRIGATEBIRD PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	Dense Chenopodium and Sesbania or large clumps of low, thick Chenopodium and Sida. higher elevations of canyon and valley walls. High, thick Scaevola.	Scattered Chenopodium and Sida. Low Scaevola, Chenopodium Tribulus and Solanum.	Low, thick Tribulus and Tournefortia Jutting rock crags.
Nesting Material	X	Data Not available.	Tribulus stems, Boerhavia and Solanum.	Tournefortia twigs.
Predators	X	Rats Absent.	Same	Rats controlled.
Food	X	By percent volume in diet: Exocoetidae 61.9 Ommastrephidae 13.6 Carangidae 9.2 Hemiramphidae 4.6 Fish 3.3 Coryphaenidae 1.8 Monacanthidae 1.8 Scombersocidae 1.3 Scombridae 1.2	Same	Same

OUTPUT: GRAY-BACKED TERN PRODUCTION/MAINTENANCE

DESCRIPTION: Gray-backed tern (Sterna lunata) production and maintenance requires nesting habitat, food, isolation and freedom from predation and excessive competition.

ECOLOGICAL RELATIONSHIPS: Gray-backed terns return annually to colonies on all the NWHI to breed, arriving as early as December and departing in September. They nest on the ground, often in association with sooty terns, and feed inshore during this time. Cowfish, (Lactoria fornasini) (Ostraciontidae), are especially important in the diet, regardless of season or island. After breeding, gray-backed terns migrate to unknown areas.

If disturbed, this species will leave the nest, exposing the egg or chick to predators, especially finches on Laysan and Nihoa. Rats will also predate gray-backed terns. Sooty terns are known to kill gray-backed chicks, and may compete with adults for nesting sites, as well.

Little pre-20th century mention is made of gray-backed terns. However, it is known that breeding populations declined on Laysan and Lisianski Islands in the 1910's and 1920's following the introduction of rabbits. These populations are believed to have recovered. On Midway Islands, this species is thought to have declined much from pre-World War II levels (Fisher 1946) and has probably not yet recovered.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: GRAY-BACKED TERN PRODUCTION/MAINTENANCE

LOCTIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	Under *Scaevola*, *Eragrostis* and other vegetation. Around perimeters of sooty tern colonies. On sparsely vegetated rocky ledges and ridges within canyons and gulches. Exotic vegetation absent.	Rocky strata ledges and ridges. Broken coral and rubble, high on beach outside sooty tern colony.	Under scattered beach vegetation and along the perimeter of beaches. Open sand on beaches; within sooty tern colony.
Predators		Rats absent.	Same	Rats controlled on islands where they presently occur.
Competition		Sooty terns absent.	Few sooties.	Moderate numbers of sooty terns.
Isolation		Human disturbance in breeding colonies absent.	Same	Minimal
Food		By persent volume in diet: Ostraciontidae 43.0 Exocoetidae 9.7 Fish 7.7 Mullidae 7.6 Clupeidae 5.6 Coryphaenidae 3.9 Ommastrephidae 3.8 Nomeidae 3.5 Crustacea 3.2 Pegasidae 2.4 Caragidae 2.0 Balistidae 1.7 Cheilodactylidae 1.4 Gonorhynchidae 1.1 Chaunacidae 1.0 Istiophoridae 1.0	Same	Same

OUTPUT: SOOTY TERN PRODUCTION/MAINTENANCE

DESCRIPTION: Sooty tern production and maintenance requires appropriate nesting substrate, food, freedom from introduced predators and human disturbance.

DESCRIPTION: Sooty terns (Sterna fuscata) are ground nesting birds with breeding colonies on all NWHI, including Midway Islands and Kure Atoll, from December through September. Although they are pelagic feeders (Diamond 1978; King 1967), feeding concentrations occur around colonies during the breeding season, depending on predatory tunas to drive prey to the surface. Non-breeding birds may stay on the wing for months.

As ground nesters, sooty terns are quite vulnerable to predators. Rats take eggs, young and adults on Midway Islands and Kure Atoll. Great frigatebirds take sooty tern chicks throughout the NWHI. Adult sooty terns will peck and kill neighboring chicks which wander into their territory. Ruddy turnstones (Arenaria interpres) will take eggs (Feare 1976; Dinsmore 1971). On Laysen Island and Nihoa Island, the endemic finches eat unattended eggs and are the prime cause of egg loss. Cattle egrets (Bubulcus ibis) have been observed taking sooty tern chicks at French Frigate Shoals, where they are a vagrant species. Ant infestation also commonly causes egg and chick loss (Brown 1973).

Historically, sooty tern populations appear to have been stable and not significantly different from present levels, with the possible exception of Midway Islands.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	In Eragrostis in island interiors.	At edges and within dense Scaevola clumps. Also in areas vegetated with Tribulus, Boerhavia, Lepidium.	High rocky ledges.
Predators		Finches, cattle egrets, rats and ants absent. Finches present.	Same	Cattle egrets, rats and ants controlled where they now exist.
Food		By present volume in diet: Ommastrephidae 53.4 Mullidae 14.5 Exocoetidae 8.8 Carangidae 6.9 Nomeidae 3.1 Gempylidae 3.0 Fish 2.8 Scombridae 2.5 Monacanthidae 1.9 Holocentribae 1.6 Molidae 1.0	Same	Same

OUTPUT: BROWN NODDY PRODUCTION/MAINTENANCE

DESCRIPTION: Brown noddy (Anous stolidus) production and maintenance requires appropriate nesting habitat, nest material, food and an absence of predators.

ECOLOGICAL RELATIONSHIPS: Brown noddies breed on all NWHI between March and October, nesting both on the ground and in vegetation. Nest material includes vegetation. During this time, birds feed pelagically (Diamond 1978) in association with tuna schools (Gould 1971), usually within 50 miles of land (King 1967). Brown noddies are absent from NWHI waters in the winter.

Because of nesting habitat, this species is quite vulnerable to mammalian predators. Among those animals knows to predate brown noddies in Hawaii and elsewhere, are rats (Kepler 1967), rabbits (Brown 1974) and cats (Dorward and Ashmole 1963).

Based on historical records, populations appear to be stable, with several exceptions. Declines occurred on French Frigate Shoals due to Coast Guard disturbance in the 1960's (Amerson 1971) after rabbits were released in the 1920's. Midway populations have declined since the introduction of the black rat (Fisher 1946). With the exception of Midway Islands, all these populations have recovered.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

OUTPUT: BROWN NODDY PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	On ground in ravines. May be under thick Chenopodium or on rock outcroppings and ledges. Also in shallow holes in cliffs. On ground under vegetation, such as dense Scaevola-Ipomoea or thick Eragrostus.	In Scaevola bush from 1-3' off ground or on ground in association with Tribulus, boerhavia and Solanum.	Bare rock under Eragrostis, Scaevola-Eragrostis or Ipomoea
Nesting Material		Bones, feathers, pebbles, sticks, weed stems, straws.	Scaevola, Eragrostis, bones.	Feathers, Portulaca.
Predators		Rats and other exotic mammals absent.	Rats absent.	Predators controlled where they now exist.
Food		By percent volume in diet: Ommastrephidae 32.8 Mullidae 24.0 Carangidae 10.3 Exocoetidae 9.1 Synodontidae 6.0 Fish 6.0 Gempylidae 2.8 Holocentridae 2.0 Monacanthidae 1.0	Same	Same

OUTPUT: BLACK NODDY PRODUCTION/MAINTENANCE

DESCRIPTION: Black noddy (Anous tenuirostris) production and maintenance requires nesting substrate, nest material, roosting sites, food and freedom from exotic predators.

ECOLOGICAL RELATIONSHIPS: Black noddies breed in winter and spring on all Refuge islands and on Midway. Although exact breeding months vary widely from year to year, generally, eggs are laid as early as November; and chicks may fledge as late as July. The nests themselves, built on cliff ledges or on vegetation, contain some plant material in them. A substantial portion of the population is non-breeding and uses the islands to roost. Both breeding and non-breeding black noddies are inshore feeders (Diamond 1978; King 1967), depending on tuna and nearshore fish such as ulua to drive their prey to the surface.

Black noddies are not particularly vulnerable to introduced mammalian predators. However, avian predators are known, i.e., Mynas.

Historically, populations of these birds have been stable in the NWHI, except for Laysan Island (Ely and Clapp 1973). The devegetation of that island caused depressed populations in the 1920's, although numbers have now returned to previous levels. On Midway Islands, numbers have increased since the beginning of the century due to increased nesting habitat provided by introduced Casuarina litoria.

Other outputs that are potentially conflicting include human activities resulting in disturbance or habitat alteration of breeding islands, and competing activities which lead to decreased availability of food for birds, especially during the breeding season.

OUTPUT: BLACK NODDY PRODUCTION/MAINTENANCE

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Habitat	X	On high islands, ledges on steep cliff faces; Scaevola, Casuarina, Tournefortia, Pluchea, Cocos.	Ledges, Pluchea, Eragrostis or Scaevola.	Rocks, ledges, small growth forms of Scaevola, artificial structures, Eragrostis clumps, Solanum.
Roosting Sites	X	Rocks, Cocos. Tournefortia, Eragrostis, Casuarina	Chenopodium or Brassica.	Beaches, small growth forms of Scaevola, artificial structures.
Predators	X	Mynas absent.	Same	Mynas controlled.
Food	X	By percent of volume in diet: Mullidae 32.7 Synodontidae 21.7 Clupeidae 10.7 Exocoetidae 8.6 Ommastrephidae 6.7 Other fish 5.8 Gobiidae 2.9 Gempylidae 2.3 Gonorhynchidae 1.9 Atherinidae 1.9 Holocentridae 1.5		

OUTPUT: BLUE-GRAY NODDY PRODUCTION/MAINTENANCE

DESCRIPTION: Blue-gray noddy (Procelsterna cerulea) production and maintenance requires nesting substrate, food and isolation from human disturbance when incubating eggs.

ECOLOGICAL RELATIONSHIPS: In the NWHI, blue-gray noddies breed on Nihoa and Necker Islands, on La Perouse Pinnacle in French Frigate Shoals, and on Gardner Pinnacles. While present all year, they breed primarily in winter and spring. They nest on cliffs and feed inshore year-round. However, food requirements are most critical from December to June.

Predation by finches probably occurs on Nihoa if adults are flushed from nests.

Blue-gray noddy populations appear to be stable. However, the Kaula Island population has decreased; and total loss of the colony may have occurred.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of breeding islands and competing activities which decrease the availability of food for birds, especially during the reproductive season.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Recesses and hollows on steep cliffs, often just above shoreline.	Rock faces and ledges along valley sides and ridge tops.	Same
Isolation	X	Colonies free from human disturbance during nesting season.	Minimal disturbance of colonies during breeding season.	Same
Food	X	By percent volume in diet: Synodontidae 19.9 Halobates 18.8 Seruceys 17.9 Crustacea 14.8 Exocoetidae 14.2 Mullidae 7.8 Misc. fish 2.0 Gempylidae 1.8 Bothidae 1.5 Ommastrephidae	Same	Same

OUTPUT: WHITE TERN PRODUCTION/MAINTENANCE

DESCRIPTION: White tern (Gygus alba) production and maintenance requires adequate nesting substrate, food and freedom from introduced predators.

ECOLOGICAL RELATIONSHIPS: White terns breed on all NWHI. Although breeding occurs throughout the year, it peaks in spring and summer on islands where phenology is known. Eggs are laid on a variety of substrates, depending on availability; nests are not constructed. During this time, approximately March through August, food needs are especially critical in colony waters: non-breeding birds feed far offshore. White terns feed in association with predatory tunas.

Aside from Nihoa and Necker Islands, where estimates are unavailable, populations in the NWHI seem to be fairly stable. However, there was a severe decline on Laysan Island (Ely and Clapp 1973) and Lisianski Island (Clapp and Wirtz 1975) when rabbits were introduced. Populations on these two islands have regained their former levels. The population on Midway has greatly increased during the past 50 years, possibly due to the introduction of Casuarina litorea (Fisher and Baldwin 1946). Present numbers on Midway are probably stable, but may still be growing slowly.

Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration on breeding islands, especially during the reproductive season, and competing activities which result in decreased availability of food for birds.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Nesting Substrate	X	Ledges on sheer cliffs from 50' to 250' above the sea on high islands. Rocks and ledges along the periphery of islands, elevated at least several inches above the ground.	In vegetation such as Scaevola, Casuarina, Cocos and Eragrostis.	Coral Rubble on open beach. Ground under Scaevola or Eragrostis
Predators	X	Rats, mynas and ants absent.	Same	Predators controlled where they now occur.
Food	X	Readily available within feeding grounds. By percent volume in diet: Exocoetidae 22.7 Mullidae 19.5 Ommastrephidae 11.6 Misc. fish 6.1 Hemiramphidae 4.6 Coryphaenidae 4.4 Belonidae 4.0	Same	Same

OUTPUT: ECOLOGICAL MONITORING

DESCRIPTION: Ecological monitoring includes studies, publications and banding. It is used to sample and assess population levels and trends and the causative factors for the observed trends in an effort to maintain seabird and other elements of HINWR at optimum levels. Research which is conducted by responsible scientists, educators and cooperating organizations is encouraged, providing such activities will not threaten or impair a species or area. Collection of scientific specimens is with permit only.

ECOLOGICAL RELATIONSHIPS: Techniques used to monitor populations include various methods to sample and measure breeding populations, reproductive success, chick growth rates, egg sizes, adult weights, estimates of feeding intervals of chicks and incubation shift lengths. In addition to monitoring seabird growth rates, these data may be useful in monitoring fish stocks and environmental pollution.

BASIC ASSUMPTIONS: Parameters used in monitoring must be accurately measurable in the field, should be related to detectable causes such as food shortages or pollution levels, should be limited to as little interpretation as possible. Data must be directly comparable when collected by different researchers, must be relatively non-disturbing to birds and other wildlife/wildland elements, must have natural variability that is significantly less than the variation cuased by external factors, must be biologically feasible and relevant. Research will be according to FWS established policies: non-disturbing without permit, permitted take only, conducted away from monk seals, sea turtles, subject to periodic checks by Refuge personnel and results made known to HINWR for future planning.

HINWR has allowed research which is compatable with Refuge objectives to be conducted. In 1981, as a participant in the Tripartite Study, FWS hosted 26 research projects in the HINWR. Research has occured in cooperation with other federal organizations i.e. NMFS, FWS-Research; State organizations, i.e. DLNR, U.H. Sea Grant Program, HIG, Inst. Marine Biology; other Universities, i.e. UCLA, UC-Davis; and private organizations such as Bishop Museum.

SITE LOCATION: Three methods are described based on site access: 1) short-duration population assessment will be conducted on short visits (5-10 days) on periodically planned and otherwise opportunistic visits to NWHI; 2) long-duration population assessment used especially for asynchronic breeders will be used in conjunction with other field camps when possible and/or at least one every five years; and 3) continous study of populations on Tern Island, French Frigate Shoals.

Sources: FWS Draft Report of Monitoring Manual of Seabirds of the NWHI. Unpubl.
HINWR 1983.
HINWR Narrative Report, 1981-1982
Fefer, et.al. 1983.

OUTPUT: ECOLOGICAL MONITORINGS

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Monitoring, studies and site locations	X	Plan 1. Short visits every 1-2 years to all islands	Visits every 5 years to key lands	Same
		Plan 2. Long visit every 2-3 years	Every 5 years	Every 6 years
		Plan 3. Continious study	Same	Same
Site Restricitons	X	Work will not occur within 1000' of E/T species	Work will not occur within 500' of E/T species	Within 300' of E/T species
Banding Site Location	X	Able to band birds on all islands	Able to band birds on 2/3 of all islands	Able to band on 1/2 of of islands
Recovery	X	Able to recover bands on all islands	Able to recover bands on 2/3 of the islands	Able to recover on 1/2 of islands
Access		Access once a year band site	Access every 2-3 years to band site	Access every 5 years to band site

OUTPUT: ENVIRONMENTAL EDUCATION

DESCRIPTION: Students and teachers involved in formal environmental education (EE) programs with a school district or college in which refuge lands, resources and facilities provide a place to actively study and learn about ecology and environmental relationships and enhance environmental awareness, understanding and appreciation.

ECOLOGICAL MONITORING: Environmental Study Areas are places where students and teachers can become involved in an organized environmental education program. Locational criteria are not aimed at specific studies but suggest locations where marine and terrestrial ecosystems interact.

Because of the possibility of disturbing and disrupting seabird nesting and sea turtle/monk seal haul-out behavior, EE sites must be located on specific sites. Shelters and work benches/tables would be included as support facilities.

The areas should provide places for students to enrich their course of study as presented by their teacher. Areas also provide locations where the refuge staff could conduct EE workshops. For the most part, refuge managers and staff serve as coordinators, consultants and resource persons. The maximum number of people using the area at one time would be 20.

BASIC ASSUMPTIONS: Activities will occur year-round. Sites should be away from hazards, nesting and endangered species.

SITE LOCATION: Kilauea Point Wildlife Administrative Site is the existing EE site on Kauai. It is easily reached by local, regional and national educators and is the closest existing site to the remote NWHI. No other EE sites on Oahu are currently being considered.

Sources: Grays Lake NWR Master Plan

OUTPUT: ENVIRONMENTAL EDUCATION

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
DIVERSITY		3 or more habitat types adjacent to discussion area	2 or more habitat types	Same
HAZARDS		Within fenced-in area from cliffs, deep water, sharks, nesting species	Same	Same
ACCESS		Area within 300' of parking area	Area within 100'	Within 2000'
SLOPE		0-2%	2-5%	5-10%
FACILITIES		Within 1/4 mi. of restrooms, drinking water, shade	Within 1/2 mi. of same	Within 1/2 mi. of same
NESTING SPECIES		2 or more nesting sp. within 300'	1 or more sp. within 400'	1 or more sp. within 500'
SEASON		Suitable for use year-round	Suitable for 9 months	Suitable for 6 months
LAND USE		Over 1/2 mi. from other activities	Infrequent interuption	Same
VEGETATION		Within grass or sand area	Within sand area	Same

OUTPUT: INTERPRETATION

DESCRIPTION: Interpretation is an educational activity aimed at revealing ecological relationships, examining systems through conducted nature tours, underwater tours, etc. On-site interpretation is preferred but not always possible. However, the use of audiovisual media, exhibits and presentations by experienced personnel is highly desirable and a necessary component to off-site programs. More people may be reached and exposed to the ecological and human relationships through these media.

ECOLOGICAL RELATIONSHIPS: Due to the sensitive nature of island ecosystems, endangered species and difficult logistics, off-site interpretive centers will reach more people. The use of quality audiovisual material will enhance the interpretive experience and address priority and regional topics in a more comprehensive manner for more people than would on-site interpretation. Consequently, less environmental impact to fragile ecosystems would result. Conducted tours and talks will usually start or center at the Refuge Headquarters when possible, with access from there being by foot. Tour routes will include sites of public interest, scenic vistas, locations with informative signs and structures. The quality of the experience is the most important factor, hence, sites with important ecological components and diversity will be emphasised without disturbing the wildlife. The maximum number of people should be less than 20.

BASIC ASSUMPTIONS: Interest exists in populations limited by financial and time constraints. Programs will be conducted by those with direct experience with the Northwestern Hawaiian Islands. Tour areas will be placed well away from unprotected sensitive areas, areas frequented by endangered species, areas of potential hazard and refuge work or storage areas.

Interpretive tours will be led by personnel familiar with refuge policy regarding sensitive areas.

SITE LOCATIONS: Kilauea Point Wildlife Administrative Site is the closest interpretive site that is easily reached by local, regional and national groups.

Tern Island is a staffed refuge field station located at French Frigate Shoals. Special airplane charters are necessary to reach this site. On-site interpretive programs are not currently available there.

Source: Refuge Manual
Kern and Pixley NWR Master Plan, Locational Criteria Forms

INTERPRETIVE CENTER (OFF-SITE)

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Off-site Location	X	Within large urban center	Within large rural district	Same
On-site Location		Greater than 1000' from endangered species, hazards	Greater than 500' from endangered species, hazards	Same
Access	X	Reachable by public transport	Reachable by private transportation	Same
Points of Interest	X	Several multimedia events	One or more media events	Same
Area		Seating for at least 60	Seating for 40	Seating for 20

OUTPUT: PHOTOGRAPHY/JOURNALISM/ART

DESCRIPTION: On-site visitors engaged in wildlife-oriented photography, journalism and art. Includes both on-site activities and at Kilauea Point.

ECOLOGICAL RELATIONSHIPS: Diversity of habitat and existing wildlife concentrations, peak nesting seasons and proximity to vistas are key locational criteria. Other considerations are accessibility, avoidance of hazards and conflicts, quality of viewing sites, proximity of blinds to nesting species, ease of monitoring activities of recreationists, lack or disturbance to environment and wildlife but with close enough proximity to wildlife/wildlands for full appreciation.

Photographic opportunities are best in early morning and evening, when light is less intense. Photo opportunities are available at any point on the Refuge but may be optimized by the use of blinds. This would concentrate useage to specific areas for ease in monitoring effects.

BASIC ASSUMPTIONS: Refuge personnel will be available to monitor non-consumptive land uses on an opportunistic basis. Design of blinds should be considerate of surrounding landscape. Other considerations should include handicapped access, vandalism, maintenance and construction methods. Users will avoid critical nesting grounds, sensitive sites and proximity to endangered species. Users will be required to file for special use permits. Size of groups will be limited. Group tours will be responsible for their own food; lodging will be provided on Tern Island for a fee.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Wildlife	X	Areas with excellent wildlife viewing/ photographing without disturbance	Areas with good wildlife viewing/ photographing without disturbance	Areas with fair wildlife viewing/ photographing with out disturbance
Natural Diversity (Habitat)		4 or more natural features nearby	3 or more natural features nearby	One or more natural features nearby
Access (On-site)	X	Charter boat and airplane	Charter airplane, refuge boat	Space available FWS flight. Refuge boat
Visual		High-quality visual elements in view, no human development in sight	Quality elements in view, little human development in sight	No negative elements in view

OUTPUT: OTHER RECREATION

DESCRIPTION: Limited recreational opportunity in designated areas for authorized personnel. Includes swimming, snorkelling, scuba, jogging and volleyball.

ECOLOGICAL RELATIONSHIPS: Such activities will be limited to designed areas on Tern Island and will be managed in ways which will avoid disturbance to wildlife and/or other habitats.

BASIC ASSUMPTIONS: Non-wildlife oriented recreation will be limited to authorized personnel: those stationed on Tern Island with FWS or other researchers with Special Use Permits. Also may include commercial fishermen stationed on motherships, fishing vessels, service vessels, aircraft, etc. at Tern Island for extended periods.

SITE LOCATIONS: Limited solely to designated area of Tern Island.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Wildlife	X	Not within sight or earshot of E/T animals.	Within 500' of E/T animals.	Same
Facilities	X	Existing runway.	Same	Same

OUTPUT: COMMERCIAL FISHING

DESCRIPTION: Commercial use of a renewable fishery resource outside Refuge boundaries by rod and reel, baited lines, various nets, traps and spearguns. This includes mothership and commercial charter boat fishing.

ECOLOGICAL RELATIONSHIPS: Maintaining and enchancing existing resource potentials are priorities of HINWR. NWHI seabirds consume an estimated 410,000 metric tons of fish. Their nesting islands and atolls are vulnerable to human disturbances such as pollution and the introduction of exotic or alien organisms. If it could be demonstrated that commercial fishing would not lead to a significant decline in both fish and wildlife stocks, fishing might be permissible within the Refuge on a limited entry, seasonally determined basis. Only permitees who have demonstrated a willingness to follow guidelines and objectives of HINWR would be seasonally renewed.

BASIC ASSUMPTIONS: The HINWR, via Tern Island, will allow and/or provide radio communication, emergency flights, limited transport of parts and people to those involved with the industry.

An emergency buoy inside Refuge boundaries will be available for use in emergencies.

SOURCES:

Fefer et al. 1982.

Okamoto and Kanenaka. Preliminary Report on the Nearshore Fishery Resource Assessment of the NWHI, 1977-1982. In proceedings of the Second Symposium on Resource Investigations in the NWHI, Volume 1, R.W. Grigg and K.Y. Tanone, ed. pp. 123-143.

DLNR. 1979.

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Site Locations	X	Areas manageable by on-site personnel	Areas manageable by off-site personnel	Same
Access	X	Charter boat and plane (people and supplies)	Charter boat	Same
Wildlife	X	Activity conducted 1000' from endangered species	Activity conducted 500' from endangered species	Same

1978 LANDINGS AND POTENTIAL SUSTAINABLE YIELDS IN THE HAWAIIAN REGION (MODIFIED FROM HAWAII FISHERIES DEVELOPMENT PLAN, 1979)

SERIES/GROUP	1978 LANDINGS		ADDITIONAL POTENTIAL*		TOTAL POTENTIAL*	
	1 ST	2 MT	ST	MT	ST	MT
SKIPJACK (AKU)	3,397	3.082	10,000	9,072	13,400	12,156
ALBACORE TUNA (SURFACE)	285	258	5,000	4,536	5,285	4,794
ALBACORE (SUB-SURFACE)	63	57	3,000	2,722	3,063	2,779
BIGEYE TUNA (AHI)	230	209	5,000	4,536	5,230	4,745
YELLOWFIN TUNA (AHI)	1,061	963	500	454	1,561	1,417
BOTTOM FISH (INSHORE)	522	474	450	408	972	882
BOTTOM FISH (DEEP SEA)	385	349	500	454	885	803
SEAMOUNT/ GROUNDFISH	0	0	2,000	1,814	2,000	1,814
AKULE	208	188	225	204	432	392
OPELU	150	136	500	454	650	590
SHARKS	11	10	300	272	311	282
BILLFISH	371	336	500	454	871	790
SPINY LOBSTER	17	15	350	318	367	333
SHRIMP (DEEP SEA)	1	"1	2,000	1,814	2,000	1,815
KONA CRAB	14	13	25	23	39	36
TOTAL	6,712	6,089	30,350	27,533	33,622	

* - UTILIZING THE CONSERVATIVE (MINIMUM) VALUES GIVEN IN HAWAII FISHERIES DEVELOPMENT PLAN (1979), TABLE III-1.

1 - ST = SHORT TONS (2000 LB) = 0.9072 x METRIC TONS
2 - MT = METRIC TONS (2205 LB) = 1.102 x SHORT TONS

OUTPUT: RECREATIONAL FISHING

DESCRIPTION: Noncommercial, consumptive or nonconsumptive use of a renewable fishery resource by rod and reel and/or speargun. This activity provides the public with high quality, wildlife oriented recreation in a pristine setting with relatively unexploited fish stock.

ECOLOGICAL RELATIONSHIPS: All fishing programs will be reviewed to determine if they affect, adversely or beneficially, endangered species or their habitats. See Non-consumptive commercial use (charter SCUBA diving).

BASIC ASSUMPTIONS: Pending further analysis:

See Non-consumptive commercial use (charter SCUBA diving)
All safety requirements must be met.
Fishing only in designated areas.
No fish may be sold.
Catch and release fishing will be favored,
Fishing plan proposed to regional Office will be adopted.

Sources: Tern Island Report
Refuge Planning Manual

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Site Locations	X	Areas off-refuge supported by on-site personnel	Areas off-refuge manageable by off-site personnel	Same
Access		Charter boat and airplane	Charter plane	Same
Wildlife	X	Areas with excellent fishing potential	Areas with good fishing potential	Areas with fair potential

OUTPUT: OTHER CONSUMPTIVE USES

DESCRIPTION: Consumptive use is taken here to include but not limited to salvage for glassballs, shells, bottles and other historical artifacts including war paraphernlia, ship salvage, precious and nonprecious coral harvest.

ECOLOGICAL RELATIONSHIPS: Such activities will be managed in ways which will avoid serious disturbance to wildlife and/or plant communities. Such activities will be subject to state and federal laws. All activities will be reviewed to determine if they affect, adversely or benefically, endangered species (Section 7 consultation) or their habitats.

BASIC ASSUMPTIONS: Special-use permits will be issued for all activities. Activities will occur in designated areas. The use of metal locators will not be allowed because of potential conflicts with antiquities legislation and habitat disturbance. Consumptive use will be in accordance with Refuge objectives. Said useage will be subject to state and federal laws including taxation.

SITE LOCATION: Various activities will be located in specific areas.

Source: Refuge Planning Manual

OUTPUT: OTHER CONSUMPTIVE USES

LOCATIONAL FACTORS	IMPORTANT FACTOR	OPTIMUM	ACCEPTABLE	MINIMUM
Site Locations	X	Areas manageable by on-site personnel	Areas manageable by off-site personnel	Same
Access	X	Charter boat and plane	Charter boat	Same
Wildlife	X	Activity conducted 1000' from endangered species	Activity conducted 500' from endangered species	Same

OUTPUT SUMMARIES

VULNERABLE SPECIES
OUTPUT: HAWAIIAN MONK SEAL PRODUCTION/MAINTENANCE

1. Description: Species in danger of extinction deriving special protection and management emphasis pursuant to the Endangered Species Act of 1973, as amended.

2. Existing Levels/Distribution: Aerial and beach counts of monk seals in the NWHI have declined from approximately 1,200 animals in 1958 to 550-600 animals in 1982. Studies involving identification of known animals at Laysan and Lisianski Islands indicate beach counts represent approximately 1/3 of the total island population, leading to the conclusion that the NWHI population is currently between 1,500-1,800 animals. The 1982 counts (typical of recent years) of seals at various NWHI are as follows:

Nihoa Island	8
Necker Island	24
French Frigate Shoals	297
Gardner Pinnacles	6
Laysan Island	90
Lisianski Island	81
Pearl and Hermes Reef	29
Midway Islands	2
Kure Atoll	24
Total 1982 Count	561

3. Locational Criteria: Monk seals haul out and pup on lava benches and sandy beaches. Feeding occurs in shallow nearshore waters and to depths exceeding 30 fathoms. (See Locational Criteria Form.)

4. Potential for Continued/Increased Production and Maintenance: Documented population decline appears attributed to the combination of natural and human-related factors including disturbance to hauling beaches, shark predation, mobbing by overly aggressive males and disease. Decline is particularly dramatic on western atolls and islands. Mortality of pups and adult females is particularly serious. Skewed sex ratios (more males) in western atolls inhibits potential for population stabilization or recovery. There appears to be little that can be done to enhance hauling or feeding habitat. Recovery is dependent upon control of limiting factors and reestablishment of balanced age and sex ratios in each of the different subpopulations. Major population manipulation (shark control, culling males, transplantation) is possible if decline continues.

OUTPUT: HAWAIIAN MONK SEAL PRODUCTION/MAINTENANCE (Continued)

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/Policies: Endangered Species Act (Federal/State), Marine Mammal Protection Act, NWRS Administration Act, Research Natural Area and Monk Seal Recovery Plan.

   b. Historic/projected public use demand: Principal demand has focused on research value. Historic harvest, resulting in near extinction, was terminated near the turn of the century. Research interest is likely to continue/expand as species remain in jeopardy. Biological characteristics of this unique tropical seal are also of research and educational interest. Considerable latent demand for observation opportunity might be expected if access was made available.

   c. Potential/projected economic return: Current mandates prevent harvest for economic use. Research/educational interest generate substantial project funding (principally federal government funds).

6. Conflict with Other Outputs: Principal conflicts occur with outputs that create disturbance to seals on hauling/pupping beaches and harassment or potential mortality threats within feeding habitats. Certain fishery outputs may conflict through direct or indirect impacts on food supply/habitat. Certain recreational and perhaps scientific/educational outputs may conflict by causing excessive harassment on haul-out areas.

7. Objective/Strategies: The intermediate goals stated in the Recovery Plan direct management/research efforts to 1) stop the downward trend in numbers of monk seals in the central and western portions of the species' range; 2) take action to develop positive growth rates at most or all islands; 3) take action to identify or prevent human activities that could result in degradation or destruction of vital habitats; and 4) determine the population level which will result in maximum net productivity.

   Basic strategies to deal with these problems include 1) identify and mitigate natural factors contributing to decreased survival and productivity; 2) characterize marine and terrestrial habitat requirements; 3) monitor population trends; 4) document and where possible, mitigate the direct

   and indirect effects of human activities on monk seals; and 5) implement programs leading to conservation and recovery.

VULNERABLE SPECIES
OUTPUT: GREEN SEA TURTLE PRODUCTION/MAINTENANCE

1. Description: (See definition of endangered species production/maintenance).

2. Existing Levels/Distribution: The Hawaiian population of green sea turtles was historically distributed throughout the 2,450 km Hawaiian Archipelago. Taking of sea turtles for food, oil and shell products persisted throughout the era of Polynesians and increased with the influx of people from other parts of the world.

   Severely reduced populations remain today with over 90% of the extant breeding population found at French Frigate Shoals (about 300 breeding females). Because all mature females do not breed each year, the total mature female population at French Frigate Shoals is probably about 750 (Weatherall 1983). An estimated total of not more than 20 females nest annually at Laysan and Lisianski Islands and Pearl and Hermes Reef.

3. Locational Criteria: Nesting green sea turtles require suitable beaches (sloped with well-drained sand) free from exotic and excessive numbers of natural predators. Major food resources are various species of algae found at inshore areas. The main island areas have larger standing crop densities of the preferred algae species. Basking areas (sand beaches, beach rock slabs and sand bars) are important also. (See Locational Criteria Form).

4. Potential for Continued/Increased Production and Maintenance: Continued production and maintenance will require continued protection of the habitats on the NWHI and the nearshore areas of these and the main Hawaiian Islands and enforcement of regulations protecting the turtles. There are opportunities to increase nesting populations on many of the NWHI, however restoration of major nesting colonies on the main islands appear unlikely. A potential exists for increasing the number of turtles nesting at Laysan and Laysan and Lisianski Islands and Pearl and Hermes Reef. This may require artificial stocking, "headstarting" (raising hatchlings in captivity to a juvenile size), some predator control, and continued enforcement and educational efforts and restricting human access/disturbance.

OUTPUT: GREEN SEA TURTLE PRODUCTION/MAINTENANCE (Continued)

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/Policies: Endangered Species Act (Federal/State), NWRS Administration Act, Research Natural Area, Green Sea Turtle Regulations (State).

   b. Historic/projected public use demand: The exploitation of green sea turtles was a traditional use, strictly regulated for the nobility and priests of native Hawaiians. Turtles were captured by hand, or with spears or nets. The populations around the main islands were taken. Traditional controlled take gave way in the mid-1800's to more intensive and commercial take, including around the NWHI. Regulation to protect the remaining population was adopted in 1974 by the State of Hawaii and in 1978 by the Federal Government A small amount of interest in renewing harvest of turtles persists. Some people would like to see subsistence catch regulations developed to meet traditional native Hawaiian demands. Research interest has been ongoing and promises to continue. There may be some demand for observation opportunities if access can be made available.

   c. Potential/projected economic return: Current mandates prevent harvest for economic use. There could be a potential for a small economic return from harvesting a sustained yield from a non-endangered population. Research/educational interest generates some project funding (principally federal government funds).

6. Conflicts with Other Outputs: Principal conflicts involve outputs that could interfere with nearshore feeding or create disturbance to nesting or basking turtles or the nests. These include bait fishing, nature tours and sport fishing. Certain fishery outputs may conflict through threat of entanglement in nets. Any output which potentially presents threat of exotic predators becoming established on the islands may conflict.

7. Objectives/Strategies: No Recovery Plan has yet been prepared for the Pacific populations of green sea turtles. Thus, management objectives at this point are directed at first maintaining existing populations, particularly the viable breeding/nesting population at French Frigate Shoals. In addition, efforts will be made to encourage or actively restore nesting populations at other major atolls in the NWHI.

OUTPUT: GREEN SEA TURTLE PRODUCTION/MAINTENANCE (Continued)

Strategies to achieve these objectives will start with protection of all the atolls with current or historic nesting use. Additional management efforts may include artificial stocking in suitable but unused or underused habitat, predator control, manipulation of hatchlings, etc.

VULNERABLE SPECIES
OUTPUT: LAYSAN DUCK PRODUCTION/MAINTENANCE

1. Description: Species in danger of extinction deriving special protection and management emphasis pursuant to the Endangered Species Act of 1973, as amended.

2. Existing levels/Distribution: Laysan ducks are endemic to Laysan Islands. These birds are vitally linked to the lagoon ecosystem and its surrounding mud/sand flats and vegetation. The Laysan duck population has been severely threatened by a number of factors since the late 1800's. Following the prohibition on hunting, establishment of a sanctuary and rehabilitation of the habitat, the Laysan duck population increased to several hundred. Population estimates fluctuate some but the population appears to be relatively stable.

3. Locational Criteria: The lagoon system, including much of its invertebrate fauna, is vital to the survival of the duck. Feeding occurs in the lagoon and along the shoreline. These birds also depend on the shrub and grass vegetation surrounding the lagoon for cover. (See Locational Criteria Form.)

4. Potential for Continued/Increased Production and Maintenance: Relatively stable populations appear to approach or meet the carrying capacity of the available habitat for Laysan ducks. The chief concern is not to increase populations but to assure continued existence of the duck population through maintenance of a viable lagoon system. The lagoon system must be thoroughly understood so unnatural changes can be recognized and trends in deteriorating habitat conditions can be prevented.

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/Policies: Endangered Species Act (Federal/State), NWRS Administration Act, Research Natural Area, Laysan Duck Recovery Plan and Migratory Bird Treaty Act.

   b. Historic/projected public use demand: Historic use has been limited to a very few people. Laysan ducks were killed for food and sport by members of the early guano operations and feather traders. Since that era, use has been confined to research, an interest which is likely to continue at sporadic intervals. A limited amount of interest may exist for observation

opportunities if access to Laysan Island is available. Various zoological gardens or similar institutions are interested in maintaining or obtaining collections of these birds.

c. Potential/projected economic return: Current mandates prevent consumptive use; in addition, there are no current demands for such use. Research/educational interest generates some project project funding (principally federal government funds).

6. Conflicts with Other Outputs: Principal conflicts occur with outputs that require frequent human access to Laysan Island or modification of the island. Additional conflicts arise with outputs which result in additional threats of harmful exotic organisms becoming established on the island.

7. Objectives/Strategies: Because of the unique nature of the threats to this species, the Recovery Plan objectives focus on two points. The maximum population of 500-600 does fluctuate some but management efforts will simply attempt to maintain this natural population. To achieve this, efforts will be directed at preventing exotic influences from disturbing the delicate environment, particularly the lagoon system. In addition, captive breeding stock will be maintained as a backup in the event a disaster hits the population.

The thrust of recovery management will be an intensive program to prevent introductions of exotics and effects of people coupled with careful preparation to eliminate exotics if they do colonize the island. In addition, the physical/chemical and biological conditions of the lagoon will be monitored in relation to conditions for the Laysan duck. Population monitoring techniques will be developed and scheduled surveys conducted.

VULNERABLE SPECIES
OUTPUT: LAYSAN FINCH PRODUCTION/MAINTENANCE

1. Description: Species in danger of extinction deriving special protection and management emphasis pursuant to the Endangered Species Act of 1973, as amended.

2. Existing Levels/Distribution: Twelve line transect censuses from 1966 to 1976 yielded population estimates between 6,764 and 20,802 (average 10,087). More recent counts (1983) have resulted in similar population estimates (11,047). Roughly 10,000 appears to be the carrying capacity of the habitat on Laysan Island. These birds are distributed throughout the terrestrial portions of the island.

   One hundred and eight Laysan finches were introduced to Southeast Island, Pearl and Hermes Reef, in 1967. This population increased and appears to have stabilized at about 500 birds. Individual birds have emigrated to neighboring islands in Pearl and Hermes Reef. There are now small populations of about 50 birds each on North, Grass, Seal and Kittery islands.

3. Locational Criteria: Laysan finches nest primarily in clumps of bunch grass (Eragrostis sp.), although they will use other vegetation types. They feed on many parts (seeds, tender shoots, flower heads) of various plants, invertebrates, and sometimes seabird eggs and carrion. (See Locational Criteria Form.)

4. Potential for Continued/Increased Production and Maintenance: All populations appear to be at the full carrying capacity of the habitat. Populations also appear to be relatively stable over the long term, despite some fluctuation from year to year. Recovery plan objectives aim towards maintaining current distribution and abundance. There are no plans for increasing production and maintenance.

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/policies: Endangered Species Act (Federal/State), NWRS Administration Act and Research Natural Area.

   b. Historic/projected public use demand: There are no historic uses other than limited scientific investigations (population censuses, specimens collected, life history observation). Scientific

interest is likely to continue, to assist as needed, with management of this endangered species. There could be some small demand for observation opportunities, depending on access availability.

c. Potential/projected economic return: There are no known consumptive uses of this species. This species is a potential attraction for commercial nature tours. Research/educational also interest generates some project funding (principally federal government funds.)

6. Conflicts with Other Outputs: Principal conflicts occur with outputs which involve either frequent or illegal human access to Laysan Island or the potential of harmful exotic organisms becoming established on the islands.

7. Objective/Strategies: Because of the unique nature of the threats to this species, the Recovery Plan objectives simply require that the existing habitat and population be maintained at current levels. The key component of the recovery objective is to guarantee to the extent possible, that exotic influences (organisms, effects of people) are not allowed to change the nature of Nihoa Island. An intensive program to prevent introductions of exotics and effects of people, coupled with careful preparation to be able to eliminate exotics in the event they do colonize the island, will be the prime strategy for recovery.

VULNERABLE SPECIES
OUTPUT: NIHOA FINCH PRODUCTION/MAINTENANCE

1. Description: Species in danger of extinction deriving special protection and management emphasis pursuant to the Endangered Species Act of 1973, as amended.

2. Existing Levels/Distribution: Line transect censuses, conducted between 1964 and 1975, generated population estimates of Nihoa finches from 1,318 to 6,686. The only census since then, conducted in 1981, provided a population estimate of 1,608 birds. The total population probably fluctuates between 2,000 and 4,000 birds.

3. Locational Criteria: Nihoa finches appear to nest most often in holes of cliffs or rocky outcroppings. Foods include seeds, tender shoots, and flower heads of plants, invertebrates, and also seabird eggs. (See Locational Criteria Form.)

4. Potential for Continued/Increased Production and Maintenance: Nihoa finches appear to be fully occupying all suitable habitat on Nihoa Island. The population also appears to be relatively stable over the long term, although census data from different years indicate that the population may fluctuate quite a bit. Recovery Plan objectives aim toward maintaining the current population level. There are no plans for increasing production and maintenance on the refuge (with the potential exception of transplanting birds to another island).

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/policies: Endangered Species Act (Federal/State), NWRS Administration Act and Research Natural Area.

   b. Historic/projected public use demand: No historic use other than very limited scientific investigations (population censuses, a few specimens collected, life history observation). Scientific interest is likely to continue, assisting as needed, with management of this endangered species. There is a possibility of a small demand for observation opportunities; however, access to Nihoa Island is difficult and relatively dangerous.

OUTPUT: NIHOA FINCH PRODUCTION/MAINTENANCE (Continued)

c. Potential/projected economic return: There are no consumptive uses of this species; in any case consumptive uses of endangered species are illegal. This species could potentially be one attraction for commercial nature tours of various kinds, although access to Nihoa Island is difficult and relatively dangerous. Research/educational interest generates a small amount of project funding (principally federal government funds).

6. Conflicts with Other Outputs: Principal conflicts occur with outputs which involve either frequent or illegal human access to Nihoa Island or the potential of harmful exotic organisms becoming established on the island.

7. Objectives/Strategies: Because of the unique nature of the threats to this species, the Recovery Plan objectives simply require that the existing habitat and population be maintained at current levels. The key component of the recovery objective is to guarantee, to the extent possible, that exotic influences (organisms, effects of people) are not allowed to change the nature of Nihoa Island. An intensive program to prevent introductions of exotics and effects of people, coupled with careful preparation to be able to eliminate exotics in the event they do colonize the island, will be the prime strategy for recovery.

VULNERABLE SPECIES
OUTPUT: NIHOA MILLERBIRD PRODUCTION/MAINTENANCE

1. Description: (See definition of endangered species production/maintenance.)

2. Existing levels/Distribution: Line transect censuses between 1964 and 1973 produced population estimates from 41 to 625. A more recent census (1981) indicates an estimated population of about 338 birds. Apparently a more or less stable population of between 200 and 500 birds occupies the island. They appear to be confined mostly to the dense, shrubby vegetation which occupies about 40 hectares (64%) of the islands.

3. Locational Criteria: Nihoa millerbirds are associated with dense stands of Sida sp. and Chenopodium sp. shrubs. They place their nests within the densest portion of the plants. Millerbirds forage within the shrubs, in the leaf litter and on the soil surface, taking various insects and other invertebrates. (See Locational Criteria Form for further detail.)

4. Potential for Continued/Increased Production and Maintenance: Nihoa millerbirds are endemic to Nihoa Island and appear to be fully occupying available habitat on the Island. The population may fluctuate some but it appears to be stable over the long term at around the carrying capacity of the island for millerbirds. The Recovery Plan for the Nihoa millerbird focuses on assuring the continued existence of this population. Expansion of the population is not a primary need except for the possibility of establishing buffer populations. The option will be kept open to move the millerbird to Laysan Island where a closely related subspecies once occurred.

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/policies: Endangered Species Act (Federal/State), NWRS Administration Act, Research Natural Area.

   b. Historic/projected public use demand: No historic use other than very limited scientific investigations (population censuses, a few specimens collected, life history observation). Scientific interest is likely to continue, assisting, as needed, with management of this endangered species. There is a possibility of a small demand for opportunities to observe this species, however access to Nihoa Island is difficult and relatively dangerous.

OUTPUT: NIHOA MILLERBIRD PRODUCTION/MAINTENANCE

6. Conflicts: Principal conflicts occur with outputs that involve either frequent or illegal (unregulated) human access to Nihoa Island or the potential increased risk of introduced organisms becoming established on Nihoa.

7. Objectives and Strategies: Because of the unique nature of the threats to this species, the Recovery Plan objectives simply require that the existing habitat and populations be maintained at current levels. The key component of the recovery objective is to guarantee to the extent possible that exotic influences (organisms, effects of people) are not allowed to change the nature of Nihoa Island. An intensive program to prevent introductions and the effects of people, combined with careful preparation to be able to eliminate exotics in the event they do colonize the island, will be the prime strategy for recovery.

OUTPUT: SENSITIVE SPECIES (SOOTY STORM-PETREL) PRODUCTION/ MAINTENANCE

1. Description: Species, subspecies or distinct populations that could become federally listed as endangered or threatened in the forseeable future throughout all or in a significant portion of the ranges without active management or removal of threats. Currently, the sooty storm-petrel is the only NWHI species designated as sensitive.

2. Existing Levels/Distribution: Sooty storm-petrels are restricted to the North Pacific Ocean, with breeding colonies in the NWHI and in Japan, on the Volcano, Izu and possibly Bonin Islands. Storm-petrels are difficult to census accurately, and both existing and historical estimates are very approximate. For this reason, reliable information on population trends is not available. However, breeding populations on Torishima Island (Izu Islands) have greatly decreased recently. Estimates of breeding populations in the NWHI (1979-1982) are as follows:

Nihoa	2000-3000 pairs
Necker	+
French Frigate Shoals	+
Gardner Pinnacles	0
Laysan	500-2500 pairs
Lisianski	?
Pearl and Hermes Reef	1000-2000 pairs
Midway	0
Kure	?
Total	3500-7500 pairs

3. Locational Criteria: Sooty storm-petrels are present on the islands only during the breeding season. They nest in a variety of habitats including subsurface burrows, under vegetation and in natural rock crevices. They probably feed offshore while associated with the islands.

4. Potential for Continued/Increased Production and Maintenance: Continued production and maintenance will require continued protection of the breeding habitats in the NWHI. Sooty storm-petrels have been recorded on Kure Atoll, but no nesting has been documented. Their absence there and on Midway Islands is probably due to rats, which kill adults, chicks and eggs. Predator eradication and/or control programs are necessary to encourage breeding on these islands.

OUTPUT: SENSITIVE SPECIES (SOOTY STORM-PETREL) PRODUCTION/ MAINTENANCE (Continued)

5. Demand/Justification for Continued/Increased Production and Maintenance: Breeding populations of sooty storm-petrels are small and limited to a few localities. The small colonies in the NWHI probably comprise a significant proportion of the world population. Protection of existing nesting habitat and efforts to increase the limited distribution are necessary to prevent this species from becoming threatened or endangered.

6. Conflicts with other Outputs: Principal conflicts occur with outputs that harass birds on the nesting islands or destroy nesting habitat. Certain fishery outputs may conflict by affecting food availability and accidentally introducing predators.

7. Objectives and Strategies: Present breeding populations should be protected by restricting access to colonies during the reproductive season. Expansion of these populations should be encouraged by urging the institution of persistent rat control measures at Midway Islands.

ENVIRONMENT
OUTPUT: CULTURAL RESOURCE PROTECTION

1. Description: This output involves preservation of Polynesian archaeological sites and artifacts, as well as historic artifacts. Religious use of sites is also an aspect of their protection.

2. Locational Criteria: House sites, terraces, burial caves and ceremonial structures are found on Nihoa; Necker has numerous maraes (temples). Evidence of past commercial and military use may exist on all NWHI.

3. Existing Levels/Distribution: The Bishop Museum is assessing archaeological sites on Nihoa and Necker; no on-site visitation by nonresearchers has been allowed. Historical artifacts on other NWHI have not been cataloged, nor has their collection been allowed.

4. Potential for Continued/Increased Production and Maintenance: Bishop Museum archaeologists could complete assessments for all NWHI. Hawaiian sites would be available, when logistically feasible, to the public for religious purposes.

5. Demand/Justification for Continued /Increased Production and Maintenance: Groups have requested access to religious sites on Nihoa and Necker. Approval of these would likely lead to more requests for visitation.

6. Conflict: Nesting seabirds and endangered land birds are most likely to be affected by human visitation to islands. Seals and turtles also may be disturbed by landings and departures. On and off-loading can be extremely hazardous or impossible on Necker and Nihoa; the steeply sloping, rubbly terrain is an additional hazard. Costs, which must be born by the visitors, may be quite high. A FWS employee must accompany all groups.

7. Objectives and Strategies: Specific archaeological aims for sites on Nihoa and Necker will be established using Bishop Museum recommendations when that study concludes in early 1985. The remaining refuge islands will be assessed and, where appropriate, nominated to state and national registers. Groups desiring access to archaeological sites will be accommodated whenever possible. Such visits will be scheduled to minimize wildlife conflicts.

RESOURCE MANAGEMENT
OUTPUT: WILDERNESS

1. Description: An area of federal land in excess of 5000 acres and lacking permanent improvements or human habitation which is designated by Congress. The minimum size requirement makes practical the land's preservation in an unimpaired condition. Compatible uses are allowed with specific restrictions.

2. Locational Criteria: The proposed Hawaiian Islands Wilderness was first suggested after a review of all federal lands in excess of 5000 acres. The first proposal included a total of 303,936 acres out of a tentative total of 304,203 acres of HINWR lands and waters. This recognized that Tern Island was not of wilderness quality. After public hearings on this proposal, it was amended to include 255,878 acres, reflecting a new refuge boundary agreement between the State of Hawaii and the Department of the Interior. Hawaii later was dropped from House Bill 1907 with the formal recommendation that only 1,742 acres of emergent lands be considered as wilderness on the initial designation and at such time as the actual boundaries are resolved with the state of Hawaii, the additional submerged lands be adopted.

3. Existing Status: Because of the unresolved boundary dispute, the proposal was not presented to Congress in spite of support from both Senators from Hawaii.

4. Potential for Enactment: So long as the boundary dispute remains unresolved, it is unlikely that wilderness status will be granted. It appears that the refuge has been dropped from consideration. FWS policy is to manage all emergent lands, excluding Tern Island, as de facto wilderness.

5. Demands for Output: The demand for wilderness status has declined somewhat since the initial proposal and depends on the outcome of the boundary dispute.

6. Conflicts: In the face of other legislation such as Research Natural Area Status, the need for Wilderness classification of refuge lands may not be as great. Wilderness status may prevent the execution of some proposed refuge activities, including such fishery support as small boat traffic and vessel mooring. However, Tern Island, the proposed site for most of the activity including tours, photography, environmental education, etc., has been excluded from wilderness consideration. The use of motorized boats and generators for management purposes, already an established practice and necessary to accomplish refuge goals, could continue if the HINWR is granted Wilderness status.

OUTPUT: WILDERNESS (Continued)

7. Objectives and Strategies: With resolution of the boundary dispute and clarification of permitted activities as prerequisites, the emergent lands and, if feasible, HINWR waters will be nominated for wilderness status. As before, Tern Island would be excluded from this consideration. This would ensure consistent long-range management goals for the refuge. Pending a decision on the boundary dispute, the refuge will be managed as de facto wilderness, as is FWS policy.

ENVIRONMENT
OUTPUT: RESEARCH NATURAL AREA

1. Description: In a research natural area, natural processes are allowed to procede unhampered, providing baseline ecological data, research and educational opportunities for advanced students, scientists and managers.

2. Locational Criteria: The seven large islands and atolls in the HINWR are designated RNAs: Nihoa, Necker, French Frigate Shoals, Gardner Pinnacles, Laysan, Lisianski and Pearl and Hermes Reef.

3. Existing Levels/Distribution: The FWS carries out continuous seabird monitoring at French Frigate Shoals, primarily on Tern Island. Both the Service and NMFS conduct spring and summer field camps on several of the other large islands and atolls of the refuge. Shorter visits are also scheduled or occur opportunistically or when necessary for management.

4. Potential for Continued Status: Graduate students and researchers regularly submit research proposals for projects in the HINWR. Increased fishing in NWHI waters will necessitate close seabird monitoring. Monk seal and green sea turtle research will continue.

5. Demand/Justification for Continued Status: Baseline data collection for seabirds nesting within the refuge began in the five year Tripartite Study, which concluded last fall. To be of management value, data collection must continue, especially as use of the refuge and surrounding waters increases.

6. Conflicts: RNA status limits nonresearch activities on most of the emergent refuge land. It also precludes activities interfering with naturally-occurring processes on the designated islands and atolls. Educational uses of RNAs may interfere with refuge goals for wildlife.

7. Objectives and Strategies: The FWS will continue to conduct research and monitoring on HINWR lands. Outside research proposals will be evaluated individually, especially with respect to management applicability and effect on wildlife. Limited educational opportunities will be available to educators (see Environmental Education).

ENVIRONMENT
OUTPUT: OTHER PROTECTIVE STATUS

1. Description: Potential designations of areas in the HINWR include critical habitat for all threatened and endangered species, marine sanctuary, refuge overlay status for Midway, world heritage site, biosphere reserve and national natural landmark.

2. Locational Criteria:

Critical Habitat: Areas that may be proposed for the monk seal include beaches and lava benches inland to 100' beyond the vegetation line, submerged land, lagoon waters and all waters from the low low water mark out a yet undecided depth. Sea turtle, land bird and waterbird habitat has not yet been proposed.

Marine Sanctuary Proposal: This would encompass all land and waters within a 12 mile radius of all NWHI.

Midway Refuge Overlay: This plan seeks to include the islands of Midway in the NWR system as an overlay refuge.

World Heritage Site: Such a plan could include the entire refuge.

Biosphere Reserve: Potentially, the entire HINWR could be included.

National Natural Landmark: In a 1981 evaluation of possible state areas to be designated landmarks, the NWHI from Nihoa to Kure were ranked first.

3. Existing Levels/Distribution:

Critical habitat: Designation of critical habitat for the monk seal was deferred until after the recovery plan. The plan was recently (1983) completed and it included a recommendation for critical habitat by the recovery team. No formal proposal by National Marine Fisheries Service (NMFS) has been made yet. A formal proposal by NMFS for the green sea turtle has been deferred until completion of the recovery plan. Critical habitat for land birds has not been designated.

Marine Sanctuary Proposal: A proposal has been submitted to NOAA. It has not yet been acted upon.

OUTPUT: OTHER PROTECTIVE STATUS (Continued)

Midway Refuge Overlay: The FWS presented a proposal to the U.S. Navy and negotiations are now underway.

World Heritage Site: No formal proposal to designate all or part of the HINWR a world heritage site has been made.

Biosphere Reserve: No proposal has been made.

National Natural Landmark: No proposal has been made.

4. Potential for Continued/Increased Protection:

Critical Habitat: This designation, as described in the recovery plan, would enlarge the protective area for monk seals by including waters around Nihoa, Necker and Lisianski; other areas of monk seal critical habitat would overlay current refuge boundaries. Exact boundaries of green sea turtle critical habitat have not yet been delineated. Critical habitat for the land and water birds would overlay present refuge boundaries.

Marine Sanctuary: This status would overlay management areas currently protected to varying degrees by state and federal agencies. This overlay is proposed to ameliorate the potential conflicts between these organizations' different management perspectives.

Midway Refuge Overlay: This plan would enhance the wildlife management programs at Midway by increasing FWS effectiveness.

World Heritage Site: Designation of HINWR as a heritage site may provide additional protection for natural features in the refuge, as well as encouraging publication of informative material for the general public.

Biosphere Reserve: This designation, which specifies that the site should provide research and educational opportunities, provides production and maintenance guidelines similar to RNA status.

National Natural Landmark: This status may offer additional protection for refuge resources.

5. Justification for Continued/Increased Protection:

Critical Habitat: Recent monk seal population declines, although not yet completely understood, indicate the need for maximum protective efforts. Protection and recovery

will be enhanced by critical habitat designation for all endangered and threatened species in the refuge.

Marine Sanctuary: This comprehensive management plan is designed to enhance the management of the waters surrounding the NWHI.

Midway Refuge Overlay: These islands contain the largest NWHI breeding colonies of three seabird species, as well as producing a small number of monk seal pups annually. Green sea turtles frequent adjacent waters. The coexisting human population makes Midway's wildlife management situation unique. Production and maintenance of wildlife could be increased if the FWS was able to enact more consistent and sustained research and control projects than are now possible.

World Heritage Site: There is no present demand to nominate HINWR for this status. The possible additional protection and support of refuge goals justifies investigating this designation for the refuge.

Biosphere Reserve: RNA designation may make nomination of the HINWR unnecessary; however, the possibility should be explored before this designation is dropped from consideration.

National Natural Landmark: Although there is no present demand to nominate HINWR for landmark status, this designation should also be considered.

6. Conflicts:

Critical Habitat: Permits will be required for activities within critical habitat; this may hamper some research projects. Inclusion of waters not within the HINWR may restrict fishing and traffic.

Marine Sanctuary: Parties now claiming jurisdiction over potential sanctuary lands and waters must negotiate. NOAA would manage the sanctuary, allowing use of it by permit. This may restrict some refuge programs.

Midway Refuge Overlay: Refuge overlay status for Midway Islands may require the Navy to increase consultation with the FWS concerning projects potentially affecting seabirds and other wildlife. This addition to the refuge system would increase FWS responsibilities, perhaps necessitating additional staff and funds.

OUTPUT: OTHER PROTECTIVE STATUS (Continued)

World Heritage Site: Heritage sites generally provide recreation and on-site interpretation which would likely conflict with refuge management goals. However, sites of outstanding significance may have much more limited public access.

Biosphere Reserve: The educational stipulation of biosphere reserve status may conflict with research and management goals.

National Natural Landmark: Inclusion of Midway and Kure with refuge islands may restrict current uses of those two atolls.

7. Objectives and Strategies:

Critical Habitat: Designate appropriate critical habitats for all threatened and endangered species.

Marine Sanctuary: With all involved parties, thoroughly investigate the submitted proposal.

Midway Refuge Overlay: Continue dialog with the Navy concerning the FWS proposal.

World Heritage Site: Investigate the possibility of nominating all or part of the HINWR as a world heritage site. If appropriate, nomination will follow.

Biosphere Reserve: Evaluate the consequences of biosphere reserve status for the HINWR; nomination would be contingent upon recommendation.

National Natural Landmark: Evaluate the effect of this designation on the refuge. Implement nomination procedures if appropriate.

ENVIRONMENT
OUTPUT: STATE OF HAWAII LAND USES

1. Conservation Land Use District:
Lands within the various counties bounded by conservation district lines as established by Act 187, SHL 1961, and Act 205, SHL 1963, or future amendments. There are five established subzones;

A. Protective (P) Subzone is designed "to protect valuable resources in such designated areas as restricted watersheds, marine, plant, and wildlife sanctuaries, significant historic, archaeological, geological and volcanological features and sites; and other designated unique areas. The boundaries of the (P) subzone shall encompass: All lands encompassing the NWHI except Midway Island."
B. Limited (L) Subzone is to limit uses where natural conditions suggest constraints on human activities i.e., lands subject to floods, tsunamis, volcanoes, erosion, etc.
C. Resource (R) Subzone is to develop, with proper management, areas to ensure sustained use of natural resources of those areas. These areas include offshore islands of the state unless placed in a (P) or (L) subzone; Lands and territorial waters below the upper reaches of the wash of waves, usually evidenced by the edge of vegetation, unless placed in a (P) or (L) subzone.
D. General (G) Subzone is designated open space where specific conservation uses may not be defined, but where urban use would be premature.
E. Special (EE) Subzone possessing unique developmental qualities which compliment the natural resources of the area.

The (P) and (R) subzones are delineated in the NWHI. The following uses are permitted with the (P) subzone: Research; recreational and educational use which require no physical facilities; establishment of marine, plant, and wildlife sanctuaries and refuges, wilderness and scenic areas including habitat improvements, maintenance of desired vegetation, removal of dead or noxious plants; programs for control of animal, plant, and marine populations, to include fishing and hunting; monitoring, observing and measuring natural resources. Governmental use not enumerated herein where public benefit outweighs any impact on the conservation district will be implemented. The (R) subzone will include all uses of the (P) subzone and aquaculture, artificial reefs and commercial fishing operations.

OUTPUT: STATE OF HAWAII LAND USES (Continued)

Conflicts: The designation of (P) and (R) subzones provides superficial protection to the resources of the NWHI. The (P) subzone applies to all lands in the NWHI except Midway. The regulation can be interpreted to read that no structures can be built on lands in the subzone. The definition includes the control of marine populations by fishing and the final clause could invalidate all conservation measures inherent in the regulations for the benefit of the public. The (R) subzone includes commercial fishing and aquaculture development. It appears these subzones are not adequate to ensure continued and comprehensive protection for resources in the HINWR.

2. Marine Life Conservation Area:
Special area designation of unique marine resources. All marine waters of the State of Hawaii are designated a marine life conservation area to be administered by the Department of Land and Natural Resources. No persons shall take any fish, crustacea, squid or other marine animal within any conservation district except in accordance with specific regulations. These may be limited area and species taken, manner of take, seasons and closures.

3. Coastal Zone Management Act:
State of Hawaii authorizes Department of Planning and Economic Development to manage CZM complying with federal CZMA of 1972: to apply when development significantly affects coast zone or for a project whose market value exceeds $25,000.

4. Special Management Area:
Classification of special marine areas extending not less than 300 feet inland and including the waters themselves. No development will be permitted that will have an adverse environmental and ecological effect on the area except if it is outweighed by public health and safety concerns.

5. Shoreline Management Area:
Classification by City and County which follows state ordinance. Requires special management use permit. City jurisdiction in urban areas only. This classification overlaps the conservation land use status of the NWHI.

6. Definition of shoreline:
Upper reaches of the wash of the waves evidenced by vegetation line, or if not vegetation, then by debris line on beach.

OUTPUT: STATE OF HAWAII LAND USES (Continued)

7. Natural Area Reserve System:
Preservation of unique natural resources. Preserves, sanctuaries, refuges must be strengthened and additional areas of land and shoreline suitable for preservation should be set aside and administered solely and specifically for the aforesaid purpose. This is a state-wide system established to preserve in perpetuity specific land and water areas supporting natural flora and fauna native to Hawaii in a condition as unmodified as possible.

8. State Endangered Species Act:
Follows federal lead but recognizes that a threatened species on the federal list may be an endangered species on the state list. Provides regulations pertaining to the conservation of such species.
   a. Hawaiian monk seal - protected species by HRS 195-D. It is unlawful to molest, kill, capture, possess, except with permit, the Hawaiian seal.

9. Wildlife Sanctuary/Refuge:
Designated area of land or water to preserve, protect, conserve and manage wildlife, where hunting and other activities may be restricted.

10. Wilderness Preserve:
Relatively large designated areas with diversity and abundance of native flora and fauna and geological formations, largely undisturbed by people or their influences, in which the introduction of exotic plants, animals or construction of structures is prohibited.

11. Scenic Reserve:
Designated areas possessing natural, scenic, wildland qualities which in total or individually outweigh all other values the area may possess, when evaluated in the long run for public interest.

12. Historic Site:
Specifically defined location, site or area designated on the national or state register of historic places and identified with... the indigenous culture of the state.

OTHER FISH AND WILDLIFE
OUTPUT: MARINE BIRD PRODUCTION AND MAINTENANCE

1. Description: All bird species (except waterfowl), which move seasonally from one place to another and return, or are included in the terms of International Convention and the Migratory Bird Treaty Act.

2. Existing Levels/Distribution: Five million seabirds of 18 species breed each year in the NWHI. Several million additional shorebirds return to the islands each year, but do not breed (see Other Migratory Bird Maintenance). With few exceptions, recent surveys (1978-1982) indicate the magnitude and distribution of seabird breeding populations and shorebird wintering populations in the HINWR are not significantly different from populations surveyed in the 1960's (Tables 1 & 2).

3. Locational Criteria: Migratory birds nest, feed and roost on all islands of the HINWR.

4. Potential for Continued/Increased Production and Maintenance: Documented declines in the NWHI have occurred at Midway Island and Kure Atoll where rats were introduced. Historical declines were documented on Laysan and Lisianski Islands when introduced rabbits devegetated the islands. Continued production and maintenance of seabird populations are dependent upon 1) maintenance of predator free nesting islands with suitable vegetation to provide nesting habitat and 2) maintenance of available good resources in the waters surrounding the islands.

5. Demand/Justification for Continued/Increased Production and Maintenance: It is the policy of the USFWS to manage refuges and to maintain migratory bird populations at a level consistent with their role in the environment. The migratory birds are protected by provisions of the Migratory Bird Treaty Act (1916), Migratory Bird Conservation Act (1929) and NWRS Administration Act (1966).

6. Conflicts with other Outputs: Principal conflicts occur with outputs which create disturbance to birds on nesting islands and outputs which could potentially cause mortality in feeding areas. Certain fishing outputs may conflict through direct or indirect competition for food supply or habitat. Certain recreational and perhaps scientific or educational outputs may conflict by causing excessive harassment on nesting islands. Conflicts can occur with outputs which have the potential of introducing harmful organisms to the islands.

OUTPUTS: MARINE BIRD PRODUCTION/MAINTENANCE (Continued)

7. Objectives and Strategies: Migratory bird populations must be maintained or enhanced according to FWS policies. Populations should be monitored to detect declines when they occur. In the event of declines, follow up investigations are needed to determine the cause. The health of the bird populations in the HINWR should be considered when regulating other outputs (i.e. fishing, recreating, etc.), which may conflict. Enforcement of regulations restricting access to the islands and a monitoring program to prevent accidental introduction of non-native species are essential.

OTHER FISH AND WILDLIFE
OUTPUT: OTHER MIGRATORY BIRD MAINTENANCE

1. Description: All bird species which move seasonally from one place to another and return, and/or are included in the terms of international convention and the Migratory Bird Treaty Act. This consists primarily of shorebirds.

2. Locational Criteria: Shorebirds are present in the HINWR throughout the year, although populations decline significantly in the late spring and summer. Over 35 species of shorebirds have been recorded in the NWHI.

3. Existing Levels and Distribution: The most abundant species are ruddy turnstones, lesser golden plovers, sanderlings, wandering tattlers and bristle-thighed curlews. Highest estimates presented below are derived from the 1960s and recent surveys (1979-1982). Birds are found in a variety of habitats on the different islands; but the largest concentrations of all species are found on Laysan Island, where the interior lake provides mudflat habitat. Both ruddy turnstones and bristle-thighed curlews have been recorded eating seabird eggs.

High total for HINWR (1979-1982)

Golden plover	1,807
Ruddy turnstone	11,758
Sanderling	56
Wandering tattler	634
Bristle-thighed curlew	384

4. Potential for Continued/Increased Production and Maintenance: Maintaining the integrity of the hypersaline lake on Laysan Island is the key to maintaining populations.

5. Demand/Justification for Continued/Increased Production and Maintenance: The Migratory Bird Treaty Act is the prime regulatory motivation to maintain numbers of shorebirds. Aside from their role in the terrestrial and marine ecosystems of Hawaii, they play a relatively important role in arctic ecology.

6. Conflicts: Potentially conflicting outputs are those which include activities resulting in disturbance or habitat alteration of islands, especially the interior lake of Laysan. Feeding habits of shorebirds at Laysan have not been studied sufficiently, but they appear to eat crustacea and brine flies and their larvae. Any disturbance to these foods would directly affect the shorebirds.

OUTPUT: OTHER MIGRATORY BIRD MAINTENANCE (Continued)

7. Objectives and Strategies: Maintain the integrity of the island ecosystems by limiting boat traffic and human intrusion on the islands.

OTHER FISH AND WILDLIFE
OUTPUT: NATIVE TERRESTRIAL PLANTS AND INVERTEBRATES PRODUCTION AND MAINTENANCE

1. Description: The Northwestern Hawaiian Islands (NWHI) have many endemic, rare or unique species of terrestrial plants and invertebrates associated with them. Some taxa are endemic to single or several islands, while many are indigenous to the NWHI. Undoubtedly a number of forms are yet unknown or undescribed.

2. Existing Levels/Distribution: Inventory of plant taxa for the various island groups is fairly complete.

3. Locational Criteria: The following is a summary of the number of endemic/indigenous plant taxa on the HINWR:

Island Group	Endemic Taxa	Indigenous Taxa
Nihoa Island	4	17
Necker Island	-	5
French Frigate Shoals	1	11
Gardner Pinnacles	-	1
Laysan Island	6	23
Lisianski Island	1	13
Pearl and Hermes Reef	3	12

A total of 15 taxa are endemic and 82 are indigenous.

An additional 133 taxa are known from the HINWR which are exotic in origin. Of these, 55 have become naturalized on the island. The endemic and indigenous species represent 25 different families.

Laysan and Nihoa Islands support the most diverse array of indigenous and endemic species. This is due largely to the more diverse habitats found on these islands. Laysan also has a number of naturalized exotic species, as does French Frigate Shoals.

Information on endemic or indigenous terrestrial invertebrates on the HINWR is very sketchy. Only limited effort has been made to inventory these animals. It is anticipated that many forms are yet to be described. Recently on Nihoa Island, limited surveys have been done for terrestrial arthropods and land mollusks. Some rarely collected or undescribed taxa have been discovered. A number of endemic taxa are known. Surveys have also been conducted on Laysan Island. Much still remains to be learned.

OUTPUT: NATIVE TERRESTRIAL PLANTS AND INVERTEBRATES PRODUCTION/MAINTENANCE (Continued)

4. Potential for Continued/Increased Production and Maintenance: Continued production and maintenance of native terrestrial plants and invertebrates depend on maintaining an intact ecosystem. Factors, primarily exotic organisms, which can upset the ecological balance of these island systems are the chief threat. Actions to protect the endangered terrestrial birds should adequately protect Laysan and Nihoa Islands. The other islands will need to be protected similarly.

5. Demand/Justification for Continued/Increased Production and Maintenance:

   a. Mandates policies: NWRS Administration Act and Research Natural Area.

   b. Historic/projected public use demand: A limited amount of research interest from all over the world has been and will continue to be focused on these taxa and their evolutionary history. The rare, specially adapted forms found on these islands pose interesting ecological questions regarding dispersal mechanisms, genetics of small populations, evolution of distinct forms, etc.

   c. Potential / projected economic return: Research/ educational interest may generate a small amount of project funding (principally research grants).

6. Conflicts with other Outputs: Outputs which involve human use of the islands or near shore use by a substantial number of vessels present a potential threat through the possible introduction of exotic organisms. Disruption of the fragile terrestrial ecosystem is the chief concern.

7. Objectives/Strategies: The objective for this output is to simply maintain the distribution and abundance of native flora and fauna through maintenance of the ecosystem. Actions prescribed to accomplish this for the endangered terrestrial birds on Laysan and Nihoa Islands will simultaneously conserve the terrestrial plants and invertebrates. Similar strategies can be applied to maintain native plants and invertebrates on the other islands. Fourteen of these taxa are considered candidates for listing as threatened or endangered.

OTHER FISH AND WILDLIFE
OUTPUT: MARINE REEF SPECIES

1. Description: Organisms inhabiting the reef ecosystem.

2. Locational Criteria: Surveys have been conducted throughout the NWHI to assess nearshore marine species. Detailed studies were conducted at French Frigate Shoals.

3. Existing Levels/Distribution: Data were collected during the Tripartite Study by the Department of Land and Natural Resources and the FWS Cooperative Fishery Research Unit throughout the NWHI to provide baseline population levels of nearshore marine species.

4. Potential for Continued/Increased Production and Maintenance: Enhancing marine reef populations requires reef manipulation, creation of artificial habitat, expansion of existing reef habitat and microclimate manipulation. Maintaining populations requires non-disturbance. Even then, some species may not respond. Evidence from Pearl and Hermes Reef indicates that the Black-lipped Oyster has not recovered from overexploitation early in this century. Fishing for sharks may enhance the survival of some species of fish at the expense of the balanced ecosystem. Fishing for select species will require specific monitoring programs to determine population fluctuations.

5. Demand/Justification for Continued Maintenance and Production: HINWR exercises jurisdiction over certain nearshore waters, i.e., Laysan Island, Maro and Pearl and Hermes Reefs, French Frigate Shoals. Inside these waters, marine organisms are closed to fishing. Waters adjacent to Necker and Nihoa are fished primarily for lobster. Lisianski Island waters are not fished but are considered state waters and susceptible to increased fishing. The state of Hawaii strongly contests FWS jurisdiction in the NWHI.

6. Conflicts with other Outputs: As mentioned above the state of Hawaii contests the ownership/control of waters of the HINWR. In part, this is due to a potential conflict of marine reef species management goals, especially lobster and baitfish. While it is possible to fish for these organisms without disrupting marine ecosystems, the presence of fishermen and equipment in inshore waters could adversely affect threatened and endangered species. Currently the state and county have designated the island waters as a resource subzone suitable for development of aquaculture and commercial fishing. Settlement of the boundary dispute in favor of the FWS will add protection to these species.

OUTPUT: MARINE REEF SPECIES (continued)

7. Objectives/Strategies: Continued surveys of the reef community are essential to monitor changes in the relative abundance of specific species if harvest and sport fishing are instigated. The Cooperative Fishery Research Unit conducted trophic level studies as part of the Tripartite Study. Fishing will disrupt future studies unless specially designated areas are set aside. FWS should attempt to develop in-house expertise in marine ecosystems.

SCIENTIFIC AND PROFESSIONAL SERVICES
OUTPUT: ECOLOGICAL MONITORING

1. Description: Formalized programs to monitor the natural environment on a recurring basis at a number of sites specifically to detect changes in the population of sea birds, sea turtles, monk seals and vegetation cover.

2. Locational Criteria: This activity is carried out on all islands of the HINWR.

3. Existing Levels/Distribution: The recent completion of the Draft Ecological Monitoring Manual for NWHI Seabirds commences a program to measure changes in the biota in the face of increased competition from commercial fisheries. From 1979-1982, food habits and aspects of the breeding ecology of NWHI seabirds were studied. The objectives of this research were to 1) provide baseline data on populations, food habits, pollutant levels and breeding biology and to document natural variation; 2) assess the use of specific measures for monitoring seabirds and design practical, standard methodologies for long-term monitoring. Hawaiian monk seal surveys have been conducted annually since 1972. These surveys involve annual visitation to each island group to monitor population changes. Field camps have been established on Laysan, Lisianski, Pearl and Hermes Atoll and Nihoa Islands for the past several years to gather seabird, monk seal and sea turtle data. Vegetation on Laysan Island is being mapped and compared with previous years' records.

4. Potential for Continued/Increased Production and Maintenance: The following were determined to have monitoring technique potential for certain NWHI seabirds:

Table 1. Parameters of seabirds that were considered for use as monitoring techniques.

number of breeding pairs	laying synchrony
number of eggs laid	age at first breeding
number of chicks	relaying behavior
number of chicks fledged	time between laying
number of non-breeding birds	length of incubation
number of immature birds	length of chick rearing
age composition	weight at fledging
sex composition	adult weights
number of nests	egg size(includes egg volume, weight, length & breadth)
density of nests	
area of colony	
percent nest occupancy	egg shape
mortality	egg composition
hatching rate	fledging rate
breeding success rate	food (volume, composition)
recruitment	
growth rate	pollutant levels
feeding intervals of chicks	organ/body weight
incubation shift length	blood lipid levels

5. Demand/Justification: Under the Tripartite agreement, the FWS was obligated to study the onshore biota. As a result, the ecological monitoring manual was produced. The initial stimulation for monitoring is still present: to develop a means of gauging the environmental impacts of an expanded commercial fishery in the NWHI. The FWS has the responsibility to maintain present numbers of seabirds and to maintain and enhance monk seal numbers in the HINWR. The demand takes the form of legal mandates.

6. Conflicts: The ecological monitoring output is designed to reduce or eliminate conflicts which result from incompatible uses of the HINWR as well as areas outside the refuge. Potential conflicts could result when adverse trends in bird or seal populations are noted and the causative factors are unknown. Disruptive agents may be identified, yet remain unresponsive to change. Inherent in the monitoring must be an enforcement capacity. Also inherent in the monitoring is the potential to conflict with other high priority outputs through (human) disturbance, introduction of exotic plants.

7. Objectives and Strategies: Ongoing studies must continue to be able to interpret periodic fluctuation in seabird populations. Annual seal counts are necessary to monitor population declines in specific island groups. However, the FWS must use a means of determining the effect and effectiveness of the monitoring programs. The inadvertent adverse effects of researchers on their subjects is a very real concern of the HINWR.

SCIENTIFIC AND PROFESSIONAL SERVICES
OUTPUT: STUDIES AND PUBLICATIONS

1. Description: All studies carried out at least in part on-site, for which results have not been published in a technical journal. It includes studies active throughout the fiscal year, whether completed or not, and studies which may or may not yield information valuable for more effective refuge management. Also included are articles published in a technical journal or other equivalent publications which are aimed at others in the professional community.

2. Locational Criteria: Under the existing status as a Research Natural Area, HINWR has hosted many studies which have resulted in publications.

3. Existing Levels/Distribution: In 1981-82, as a participant in the Tripartite Study, FWS hosted 26 research projects in the HINWR in cooperation with other federal and state organizations: National Marine Fisheries Service, FWS Research, Dept. of Land and Natural Resources, University of Hawaii, Hawaiian Institute of Geophysics, Institute of Marine Biology, Bishop Museum.

4. Potential for Continued/Increased Production and Maintenance: Ongoing studies at Tern Island, Laysan Island and Nihoa will provide data for future publications. The termination of the Tripartite Study has initially decreased the amount of research in the HINWR, however, it is expected that the number of studies will increase as a result of the ecological monitoring project and the Hawaiian monk seal program.

5. Demand/Justification for Continued Production and Maintenance: At least two surveys at different times of the year would be required to inventory numerous vertebrate population levels in order to fulfill the data requirements for accurate ecological monitoring. Various FWS objectives including Migratory Bird Treaty Act, Endangered Species Act, etc., demand enhancement of specific population levels. Measuring these levels is mandated. Vegetation mapping, aerial photography, reef surveys, fish stock census, etc., are all studies with potential publications that are justified on the basis of using the Research Natural Area to its full capacity.

6. Conflict: Due to the limited accommodations at Tern island, only a small number of researchers can be present at one time. Conflicts over FWS priorities and projects can develop. The limited transportation options prevent extensive projects from being conducted in the field. Studies requiring heavy equipment will have difficulty getting into the HINWR. Periodic surveys throughout the

archipelago are limited by the availability of research vessels, both government-owned and charter. The possible conflict between various research projects must be supervised by FWS personnel, i.e. monk seal surveys and seabird research are compatible so long as seals are not disturbed in any way.

7. Objectives/Strategies: Studies and publications have been and will continue to be important outputs of the HINWR. It is an objective of the FWS to increase the number of studies on the HIWNR without adversely affecting the study subjects. Ongoing ecological monitoring will continue to provide data suitable for publication in the future. Making available the accommodations at Tern island will enhance research opportunities. Periodic cruises into the HINWR should address a variety of research questions not currently investigated.

PROFESSIONAL SERVICES
OUTPUT: COOPERATIVE PROGRAMS

1. Description: Programs in which the Refuge participates by making available real estate, facilities and/or provides technical assistance or operational services to other agencies and individuals both within the Service and outside of it.

2. Locational Criteria: Cooperative programs occur throughout the HINWR.

3. Existing Levels/Distribution: Cooperative programs occur on an opportunistic basis in the HINWR. The policy and mandates of the FWS are designed to ensure research and land use cooperation with individuals and organizations with compatible interest. However, due to the sensitive nature of the biotic resource in the HINWR, the use of facilities and real estate is limited.

4. Potential for Continued/Increased Production and Maintenance: Cooperative programs will continue at the current level. Due to the high possibility of disturbing threatened and endangered species, cooperative use is likely to be limited to use of specific areas of Tern Island and waters outside of the HINWR boundaries. Continued support will be provided to vessels in need and emergency use of the Tern Island facilities will be available. This may include radio contact, air charter service, emergency evacuation, food and lodging.

5. Demand/Justification: There is a high demand for the use of facilities at Tern island for a fishery support station. The justification is based on the State of Hawaii contention that the facilities are within state jurisdiction and necessary to make commercial fishing economically feasible.

6. Conflict: The increased use of the HINWR is likely to cause disturbance to the endangered monk seal and threatened green sea turtle. Additional adverse affects are possible through the use of Tern Island and the rest of the HINWR if the programs are not compatible. Compatible uses include meteorological stations, technical assistance not previously mentioned in other outputs and other similar activities.

7. Objectives/Strategies: Cooperative programs will continue on an opportunistic basis except when uses are not compatible with FWS objectives. As requests are received, they will be assessed for any adverse impacts they might impose. If there are means to mitigate the adverse affects, then the use may be permitted.

RESOURCE MANAGEMENT
OUTPUT: SPECIES TRANSPLANTATION

1. Description: Certain species formed on the HINWR may require transplantation to historical and/or unoccupied habitat elsewhere on the Refuge to meet desired levels for those respective outputs. Transplanting may involve actually moving a group of individuals from one island to another, or it could involve taking captive individuals to an unoccupied island. Such activities would have to be done with the proper approval and permits.

2. Existing levels/Distribution: Very few transplants of organisms, native to the NWHI, to other islands has been attempted. There is little reason to move most endangered species and there are significant environmental risks associated with transplanting. The only transplanting of species done so far has been with species for which there is concern for their survival. The Laysan finch was transplanted to Southeast Island in Pearl and Hermes Reef in 1967. It has since become well established on several islands in Pearl and Hermes Reef. Nihoa finches were transplanted to Tern Island and East Island in French Frigate Shoals in 1967 but neither population survived. The National Marine Fisheries Service has transplanted monk seals. Other transplantations of native species have apparently occurred accidentally, plant species have been moved from one island to another by people. Of course there have also been some exotic species brought to the NWHI accidentally.

3. Locational Criteria: Any of the islands could be selected as a site for transplanting a species. It depends on which species need to be transplanted and what the objectives and constraints will be for such a transplant.

4. Potential for Continued/Increased Production and Maintenance: Further transplants of species will be done only after careful scrutiny of objectives and anticipated impacts. There are several threatened or endangered species which may require transplantation of individuals as part of the recovery program. For other species it is highly unlikely that this will be done.

5. Demands/Justification for Continued/Increased Production and Maintenance:

   a. Mandates/policies: The Endangered Species Act directs agencies of the federal government to use their authorities in furtherance of the purposes of the Act. Recovery programs for certain endangered species may involve transplanting individuals to areas outside their present range.

   b. Historic/projected public use demand: A small portion of the public has varying opinions regarding transplantation of birds from one area to another. The issue revolves around the validity of moving a species outside is presumed historic range.

   c. Potential/projected economic return: No economic return will be generated by such actions, however some funding (principally government) will be needed if any transplanting is conducted.

6. Conflicts with Other Outputs: Transplanting species may create conflicts. Adding a species to an environment in which it is not native can potentially effect indigenous species of that environment. Careful evaluation must be made of all anticipated impacts on indigenous species, particularly invertebrates and plants.

   Introduction of a species, particularly an endangered one, into a new environment will also subject that area to restrictions which associated with conservation of that species.

7. Objectives/Strategies: Transplanting species will be pursued only as it serves the needs of other outputs, in the order of their priority. It is anticipated that very few transplants will be necessary under these conditions and they will be primarily or exclusively for endangered species. Recovery plans will guide this effort.

EDUCATION/INTERPRETATION
OUTPUT: ENVIRONMENTAL EDUCATION

1. Description: Structured educational activities within an approved course of study aimed at 'hands-on' experience concerning the natural environment and people's role in it.

2. Locational Criteria: In order to obtain "hands-on" experience, this activity must occur within the HINWR or at other ecologically similar sites. Within the refuge, only Tern Island can be easily reached via boat or air transportation. In the main islands, Kilauea Point National Wildlife Refuge is appropriate for environmental education (EE).

3. Existing Levels/Distribution: Environmental education does not currently occur within HINWR lands.

4. Potential for Continued/Increased Production and Maintenance: Environmental education programs could be developed for Kilauea Point by the Kauai Community College to take advantage of the proximity to elements found in the HINWR. Special field trips could be made to Tern Island, French Frigate Shoals, if funds were available to defer transportation costs.

5. Demand/Justification for Continued/Increased Production and Maintenance: At present there is low-level demand for EE among educators in Hawaii. The FWS could develop a program to stimulate interest in including EE in school curriculums.

6. Conflicts: Conflicts described in the Interpretation output summary apply to this output as well. Funds needed to visit HINWR could be better spent on local field trips or trips to Kilauea where similar elements occur nearer population centers.

7. Objectives and Strategies: Develop a program suitable for Kilauea Point based on the elements common to HINWR and Kilauea. Outreach programs into schools with lectures, films and specimens can supplement this, although they cannot offer hands-on experience. Limited EE tours to Tern Island will be permitted for educators. Restrictions on these trips are similar to those imposed on other tour groups (see Interpretation, Conducted).

EDUCATION/INTERPRETATION
OUTPUT: INTERPRETATION OFF-SITE

1. Description: Educational and recreational activity conducted away from HINWR (off-site) at various interpretive centers using exhibits, displays, and other media and personnel.

2. Locational Criteria: The nearest site to HINWR that is suitable for interpretation is Kilauea Point Wildlife Administrative Site on Kauai. Interpretation is conducted in Honolulu at FWS offices and outreach programs for schools, conservation groups, etc.

3. Existing levels/Distribution: Interpretative displays are set up at Kilauea Point. A relatively high volume of people are exposed to the center on a daily basis. Interpretation in Honolulu is sporadic and responsive to demand. The recently-completed film for the Tripartite Study has been successful and is well-received. Currently, as part of the Master Planning Process, an outreach program to educate potential users is being conducted.

4. Potential for Continued/Increased Production and Maintenance: Plans call for an expansion of the Kilauea facilities to increase off-site interpretation. This is advantageous because Kilauea is easily reached by tourists on Kauai, and available to other groups off Kauai as well. The natural landscape of the Point is very similar to the high islands of the HINWR. The seabird species that can be readily seen there represent most species found in HINWR. The recent attraction of Laysan albatrosses to the Point added a good measure of the uniqueness of the HINWR. Interpretation in Honolulu is limited by space. If additional space were available, displays, films, slides and personnel could be used to systematically conduct interpretation sessions. The completion of the Tripartite film has enhanced the outreach program.

5. Demand/Justification for Continued/Increased Production and Maintenance: The low level demand for interpretation is currently being met in Honolulu by members of the refuge staff on an opportunistic basis. Additional demand is being created with the showing of the films and slides. The display at Kilauea answers questions raised during tourist exposure to the wildlife resources. However, demands to get into the HINWR for interpretation are often created through the use of these displays. The interest is to interact with the native biota at close range in a near-pristine setting.

OUTPUT: INTERPRETATION OFF-SITE (Continued)

6. Conflict: Interpretation programs pose the potential to disturb the subject of study. Conducted tours and display maintenance require additional work by Service staff. At Kure, tours may conflict with the monk seal program and LORAN station operation.

7. Objectives and Strategies: The continued development of Kilauea Point interpretive facilities and exploration of an Oahu site will be pursued. These will provide exposure to the unique HIMWR without incurring the associated disturbance to sensitive wildlife species. Outreach programs by refuge staff will continue to reach interested groups.

   The state of Hawaii and the Navy will be contacted about the development of interpretive displays at Kure and Midway.

EDUCATION/INTERPRETATION
OUTPUT: INTERPRETATION CONDUCTED

1. Description: An educational activity aimed at revealing species relationships, examining ecosystems and exploring how the natural world and human activities are interrelated.

2. Locational Criteria: The possibility of conducted interpretation in HINWR is greatest at Tern Island.

3. Existing Levels/Distribution: Currently, there is no ongoing interpretation program conducted in the HINWR. (See Interpretation, Off-Site).

4. Potential for Continued/Increased Production and Maintenance: An interpretation program conducted within HINWR is a potential output at Tern Island; all other areas of HINWR are too remote for people to easily reach. Small groups could be flown to Tern Island for periods ranging from several hours to several days. Overnight stays involve use of the sleeping and cooking facilities there.

5. Demand/Justification for Continued/Increased Production and Maintenance: Based on the interest generated in current interpretative programs concerning HINWR, it appears that there is a low level demand for on-site conducted interpretation. Special groups capable of paying transportation costs and with ample time in case of weather changes could be accommodated on an intermittent basis.

6. Conflict: Principal conflict involves potential disturbance of threatened/endangered species of HINWR. Interpretation areas must be discrete from those of research. Interpretation conducted on-site may violate the intent of the Research Natural Area designation and the state and federal endangered species acts. Consequently, seal hauling beaches will be completely off-limits, while access to sea-bird colonies will be restricted; this lessens the quality of the observer's experience. Supervision by refuge staff will be necessary. Transportation and lodging costs may be prohibitive.

7. Objectives and Strategies: Limited on-site interpretation will be permitted at Tern Island. Small (7 people maximum) groups will be accommodated when wildlife conflicts can be minimized. Six to eight such groups, staying no more than three days per trip, will be scheduled annually. Although school groups will not be permitted, educators interested in including information relating to the HINWR in their curriculums will be allowed (see Environmental Education). All groups will be under the direct supervision of refuge staff.

EDUCATION/INTERPRETATION
OUTPUT: NATURE TOURS

1. Description: On-site visitors engaged in wildlife/wildland observation as part of a non-consumptive commercial group led by naturalists committed to enforcing FWS policy. This does not include interpretive or environmental education groups.

2. Locational Criteria: The use of tour ships makes this activity possible throughout the HINWR. Small groups could travel by air to Tern Island, base themselves there and tour by boat.

3. Existing Level/Distribution: Nature Tours are not presently being conducted in the HINWR.

4. Potential for Continued/Increased Production and Maintenance: Several tour agencies of international scope have approached the HINWR for permission to conduct nature tours. Due to the conflict with the Tripartite Project, tours were not allowed into the HINWR.

5. Demand for Continued/Increased Production and Maintenance: Once the tour option is made available, the demand will increase. Several international tour agencies will make this option accessible to the public. The destination of Hawaii as a site for natural history tours is well established. Both local, mainland and international tourists will be drawn to the NWHI since it is a pristine wilderness with abundant wildlife. A parallel between the Galapagoes and the NWHI can be made. Both offer potentials for close viewing of wildlife, unique photographic opportunities and warm, sunny weather.

6. Conflict: Tour groups could disturb threatened/endangered species if not properly supervised. Vessels could only land at designated areas. The use of Tern Island would have to be restricted to avoid interference with FWS objectives. More people in the area means a possibility for conflict with wildlife and cultural resources preservation. Special area designation and the use of photo blinds would help orient traffic on Tern Island. Accommodations are limited.

7. Objectives/Strategies: These are the same as objectives for conducted interpretation. In addition to Tern Island, tours may be possible at Midway, in cooperation with the Navy.

EDUCATION/INTERPRETATION
OUTPUT: WILDLIFE/WILDLANDS OBSERVATION

1. Description: Non-consumptive recreation involving on-site visitors engaged in observation and study of wildlife/ wildlands.

2. Locational Criteria: This output is available throughout the entire HINWR.

3. Existing Levels/Distribution: This output currently exists as a by-product of other activities such as photography, sailing, art etc. by those living or visiting the HINWR.

4. Potential for Continued/Increased Production and Maintenance: Expanding the opportunities for this output require the opening up of Tern Island to users, either as an overnight station or as a port of call for boats and planes. Observation blinds could be constructed to minimize disturbance to wildlife. The potential to disturb threatened/endangered species is high and without these support facilities, unsupervised observation should not be considered an appropriate use of HINWR.

5. Demand/Justification for Continued/Increased Production and Maintenance: The demand for wildlife observation opportunities is linked with other outputs such as photography, and other more specific land uses. As it stands, wildlife observation is a low level activity.

6. Conflicts: Conflicts described in non-commercial photography apply.

7. Objectives and Strategies: The development of facilities to accommodate observation will minimize disturbance to wildlife, especially the construction of blinds and fenced off areas.

EDUCATION/INTERPRETATION
OUTPUT: PHOTOGRAPHY/JOURNALISM/ART COMMERCIAL USE

1. Description: On-site visits to HINWR for the purpose of photography/journalism/art (P/J/A) for commercial markets.

2. Locational Criteria: Opportunities for this output occur throughout the HINWR. Specific areas where certain elements may be viewed exist, i.e., Laysan finches, etc. From a logistical point of view, Tern Island is the most appropriate location.

3. Existing Levels/Distribution: Tern Island has been used as a base for past photo/journalistic productions. Other artistic and journalistic opportunities exist throughout the NWHI, especially at Midway and Kure Islands.

4. Potential for Continued/Increased Production and Maintenance: Expanding the P/J/A base beyond Tern Island will require the use of a charter boat with full berthing facilities (see Nature Tours). The use of Tern Island will continue to be the best, most convenient location for P/J/A operations. The housing facilities can support as many as 11 at one time (not including FWS personnel), provided those spaces are not in use.

5. Demand/Justification for Continued/Increased Production and Maintenance: A moderate level of demand exists for this output and the use of Tern Island as a base of operations. In 1983, at least 3 major stories appeared in national magazines. This exposure of the HINWR justifies the continued activity as a public relations and education effort.

6. Conflicts: P/J/A could disturb threatened and endangered species and migratory birds if not properly supervised. Specific areas need to be set aside for P/J/A opportunities. The use of blinds will decrease the potential for disturbance.

7. Objectives and Strategies: The need to increase exposure of the HINWR while maintaining the integrity of the ecosystems demands special consideration. Accommodating the production of professional articles on the HINWR should be a priority. This may be accomplished by inviting magazines to send out a special staff to take photographs and write stories while on Tern Island. Photo blinds, trail space viewing, etc, can be used to minimize impact on wildlife.

EDUCATION/INTERPRETATION
OUTPUT: PHOTOGRAPHY/ART NON-COMMERCIAL USE

1. Description: Visitors whose primary purpose is to photograph, draw, paint, sculpt, etc., wildlife/wildland subjects for non-profit use.

2. Locational Criteria: Artistic opportunities exist throughout the HINWR. Specific elements may be seen at precise locations, i.e. Bristle-thighed Curlews at Lisianski and Nihoa millerbirds at Nihoa. From a logistical point of view, most bird species can be viewed at Tern Island, French Frigate Shoals. Underwater photographic opportunities are excellent there.

3. Existing Levels/Distribution: Tern Island has been a base for photo expeditions for several years. Other amateur photographers have gone to Kure Atoll and Midway Islands.

4. Potential for Continued/Increased Production and Maintenance: Expanding the photographic and artistic opportunities calls for expanding the capacity of Tern Island to handle increased traffic and use of facilities. In order to minimize disturbance, photo blinds and designated areas should be established. The potential to disturb threatened/endangered species is high; without these support facilities, photography and art cannot be allowed to go unsupervised. If Tern Island was advertised as an available option, usage would increase accordingly.

5. Demand/Justification for Continued/Increased Production and Maintenance: Photography as a recreational activity is highly regarded and pursued; the field of wildlife and wildlands photography is especially popular with amateurs and professionals alike. Wildlife art is a widely practiced hobby. The excellent opportunities within the HINWR to obtain close-up views of seabirds surpasses other areas of the main Hawaiian Islands and the world. Thus, it can be concluded that if accommodations and transportation logistics were manageable, Tern Island use would greatly increase. The results would serve to advertise the unique nature of the HINWR to both the private and public sectors of Hawaii and the world.

6. Conflicts: People desiring close-up views of wildlife may disrupt threatened/endangered species, migratory birds and research. Increased use of air transport could increase the chance of accidents and bird strikes. All activity must be monitored by FWS personnel.

OUTPUT: PHOTOGRAPHY/ART NON-COMMERCIAL USE (Continued)

7. Objectives and Strategies: The development of facilities to accommodate photographers and artists will minimize disturbance to wildlife. Blind construction and fenced off areas should be considered to control the effects of people on threatened/endangered species.

OTHER PUBLIC USES
OUTPUT: OTHER WILDLIFE/WILDLAND RECREATION

1. Description: Non-consumptive recreation including such diverse activities as birding, sailing, art, recreational diving, HAM radio operation, etc.

2. Locational Criteria: These activities could potentially occur on or around most refuge islands or islets.

3. Existing Levels/Distribution: These activities occur at low levels as permitted in HINWR especially at Tern Island, French Frigate Shoals. Limited housing and other facilities make this an acceptable location for such pursuits.

4. Potential for Continued/Increased Production and Maintenance: These outputs have potential to expand since their non-consumptive nature poses little threat so long as the activities are properly monitored and supervised. Special interest groups could be accommodated at Tern Island. Due to the isolation of other islands in HINWR, these outputs would probably be limited to Tern Island. Sailboats could reach other islands in the refuge but since the potential for disturbing threatened/endangered species is high, their activities onshore must be limited to Tern Island.

5. Demand/Justification for Continued/Increased Production and Maintenance: A low-level demand exists for these refuge outputs. If this activity were encouraged, the user level would probably increase. If housing were made available at Tern Island, usage would soon approach maximum levels, provided that transportation was economically feasible.

6. Conflict: Unmonitored activities could adversely affect threatened/endangered species and migratory birds. Introduction of exotic pests could result from unauthorized landings. The potential for great harm exists. Increased ship traffic to the HINWR would increase the possibility of groundings, oil spills, etc. Ongoing research projects could be affected by unsupervised groups. The use of FWS personnel to supervise visitors would detract from the time spent on maintenance work and wildlife management unless additional funds were obtained. Since Tern Island has become a major hauling area for monk seals, strict beach regulations must be obeyed. A fence around off-limits areas may be considered in lieu of enforcement personnel. Transportation costs may be prohibitive for most people.

7. Objectives and Strategies: These activities appear compatible with the outputs and objectives of HINWR so long as they are properly monitored, supervised, and limited. Specifically designated areas of Tern Island should be established for such recreational purposes. Fencing for delineation may be advisable. Visits will be scheduled to minimize conflicts with wildlife. Applicants for special use permits must be familiar with the restrictions before leaving Honolulu. Under the current transportation system, only those able to stay for several hours or weeks of time have been able to go to Tern Island. (See Environmental Education, Interpretation, Other Recreation.)

OTHER PUBLIC USES
OUTPUT: CHARTER SCUBA/SKIN DIVING

1. Description: On-site visitors engaged in extensive underwater wildlife observation, exploration, photography (amateur or professional) using SCUBA or skin diving, charter boats, yachts or skiffs.

2. Locational Criteria: Charter SCUBA diving can occur in relatively shallow waters of HINWR. High island diving may be suitable on limited basis. It is expected that most activity would occur at French Frigate Shoals due to extensive coral growth. In addition to onshore facilities, the marine environment is particularly diverse.

3. Existing Levels/Distribution: Commercial diving is not permitted in the HINWR now.

4. Potential for Continued/Increased Production and Maintenance: French Frigate Shoals (FFS) is a potential areas for this output to occur. Charter boats can reach FFS without excessive travel. Onshore facilities could be utilized. Other islands may be suitable if charter boats carry enough berthing space. It may be desirable to place Refuge employees on board to help interpret, gather data opportunistically and enforce refuge objectives.

5. Demand/Justification for Continued Production and Maintenance: Currently, a low level demand exists. If permits for this activity were available, the demand would probably increase sharply.

6. Conflict: Unauthorized landings could disturb threatened/endangered species and degrade the islands; monitoring by FWS personnel would be necessary. Charter boats must be U.S. Coast Guard approved with appropriate medical facilities. Tern Island evacuation may be used only in emergencies. Commercial diving is not permitted in Research Natural Areas (RNAs).

7. Objectives/Strategies: Commercial diving will not be permitted in the HINWR because of potential conflicts with endangered or threatened species, possible groundings leading to habitat disturbance and the refuge's current classification as a RNA.

OTHER PUBLIC USES
OUTPUT: OTHER RECREATION

1. Description: Limited recreational outlets include swimming, scuba, snorkeling, jogging and volleyball.

2. Locational Criteria: Water sports can be practiced around all refuge islands and islets. The runway will accommodate jogging and volleyball.

3. Existing Levels/Distribution: Personnel and authorized permittees recreate on and around Tern Island. Occasionally, these people snorkel or dive elsewhere within French Frigate Shoals. Field camp staff engage in some limited recreation, mostly swimming.

4. Potential for Continued/Increased Production and Maintenance: People on remote islands will continue to need recreation, especially those stationed at Tern Island for long time periods.

5. Demand/Justification for Continued/Increased Production and Maintenance: Adjustment to life on a small, remote island is facilitated by recreational opportunities. This is especially true for those stationed at Tern Island for long tours of duty (up to 5 months).

6. Conflicts: If poorly scheduled and/or in inappropriate areas, recreation can interfere with endangered and threatened wildlife and seabirds. Around some islands, especially at certain times of the year, sharks make water sports hazardous.

7. Objectives and Strategies: Recreation will be permitted on and in waters adjacent to Tern Island in designated areas. It will be scheduled to minimize conflicts with wildlife. Scuba and snorkeling also will be permitted in designated areas elsewhere in French Frigate Shoals when disturbance to wildlife can be minimized. Recreation on or around other Refuge islands and islets will also be permitted for authorized personnel although its regulation will be by Special Use Permit or the FWS field supervisor.

OTHER PUBLIC USES
OUTPUT: AHI FISHING

1. Description: Yellowfish tuna (Thunnus albacares) and Bigeye (Ahi) (T. obesus) fishery occurring in deep water (50-150 fm) using long-line and deep-sea hand lines.

2. Locational criteria: Fishing occurs around the main islands to a small degree. The primary fishing grounds are in the north and central Pacific.

3. Existing Levels/Distribution: Bigeye was the second most important commercial species fished in Hawaii. Yellowfin tuna is now more commercially valuable. In 1978, 209 metric tons were landed. Landings fluctuate yearly.

4. Potential for Continued/Increased Production and Maintenance: Fishing output reflects historic Hawaiian trends: high in the late 1940's after the war, low in the 60's, upturn in the 70's with increased effort and technology, with a steady increase to present. However, ahi landings have steadily decreased since the peak in 1952. Ahi landings could be increased by exploiting new grounds to the north, west and south of the Hawaiian Islands.

5. Demand/Justification for Continued/Increased Production and Maintenance: Ahi demands continues to be high since it is the desired fish for sashimi in Hawaii and Japan. Prices have steadily climbed in spite of an unstable supply.

6. Conflicts: Principal conflicts are same as in aku fishery.

7. Objectives/Strategies: Same as those for albacore.

OTHER PUBLIC USES
OUTPUT: AKU FISHING

1. Description: Skipjack tuna (Katsuwonus pelamis) fishery using pole and line vessels and baitfish or purse seiners. On and nearshore facilities necessary.

2. Existing levels/Distribution: Based on 1978 data, 3082 metric tons were landed from 14 Aku fishing boats. The fishery is the mainstay of the Hawaiian fleet. Fishing occurs around the main islands and Midway.

3. Locational Criteria: Aku is a pantropical tuna whose migratory movement brings it into the Hawaiian archipelago seasonally. It is believed there are 3 distinct stocks of Aku having different movements. Landings extend from April to September.

4. Potential for Continued/Increased Production and Maintenance: Skipjack or Aku is the most valuable Hawaiian commercial fishery in terms of landing and values. Catches have ranged from 2267-7256 metric tons. It is estimated that the fishery could yield 12,156 metric tons, a 75% increase, if expanded. Currently, 75% of the catch is made within 20 miles of the main islands. In 1977, fish aggregating devices were placed near Oahu and Lanai. Catches near these sites constituted a significant portion of the landings. In addition to fishing, Aku boats spend much time obtaining live bait. Competition from Japanese boats has a negative effect on the amounts of Aku reaching the Hawaiian market. To expand the existing fishery, aggregating device deployment should be increased, the north and west fishing grounds should be harvested and overall efficiency must be increased. Reliable sources of baitfish need to be maintained. If the local cannery remains closed, an aku fishery in the NWHI is unlikely.

5. Demand/Justification for Continued/Increased Production and Maintenance: Due to a growing Aku fleet, good fishing years, and a market slump in 1980-82, the demand and price for Aku has decreased. Cannery prices for frozen Aku do not provide much economic incentive for fishery expansion. The existing fleet relies on local markets for fresh fish at relatively high prices. The limited shelf life for fresh Aku prohibits the movement of fish from NWHI to local markets in Honolulu via air shipment. However, if cannery prices for light meat tuna improve, and if suitable long-distance pole and line boats and baitfish are available, a NWHI base could be utilized for transshipment of frozen Aku to the cannery. Additionally, the Aku resources of NWHI may be harvested by U.S. purse seiners that would not need storage or shipment out of Tern Island.

Infrastructure necessary to expand the existing aku fishery in NWHI requires the deployment of no more than 5 fish aggregating devices between Necker and Maro Reef. This would greatly save on fuel for exploratory fishing. Conceivably, the fish caught could be transported to Tern Island where a mothership may be anchored. Frozen fish would then be moved to the market site periodically. If the market could bear an additional cost increase, fresh fish could be flown out of Tern Island (an additional $1.00/lb). However, this appears doubtful. The mothership/barge could store water, fuel, supplies, baitfish, etc. If baitfish are obtained at French Frigate Shoals, then small boats and nets would be necessary. The crews of barge and catcher boats could use Tern Island for recreation and personnel changes and emergency evacuation. Radio contact with HINWR staff would be necessary.

6. Conflicts: Principal conflicts result from use of the Tern Island facilities and French Frigate Shoals as a base. Frequent travel to the Shoals increases the likelihood of accidental groundings. Six recent groundings have occurred in 5 years. The placement of a mothership at moorings south of Tern Island implies an increase in small boat use of the Shoals. Activities such as fuel transfer pose risks of potential spillage and other accidents. Recreation of the fishing crew could conflict with policies established for migratory bird, monk seal and sea turtle production and maintenance. Seals and turtles could be adversely impacted through continual disturbance from small boats and bait-fishing nets within French Frigate Shoals. The use of nets nearshore could further jeopardize seals: accidental and purposeful entanglement has occurred. In addition, the pursuit of inshore fish could disturb food supplies to those seabirds that rely on tuna to drive prey to the surface. Thus, both birds and fishermen, who use seabirds to locate tuna schools, may be adversely affected. Increased pollution, i.e., oil and trash, may lower the integrity of the atoll.

7. Objectives/Strategies: Close seabird monitoring in the NWHI is necessary to detect any population change which may be caused by the depletion of Aku stocks. Regulated use of the emergency buoy within the atoll by fishing vessels will be permitted for resupply of Tern Island or in emergencies. A leeward mooring buoy outside the refuge is possible. Regulated Tern Island access from moored fishing vessels via small boat will be permitted for limited equipment storage, recreation and emergency evacuations. Cooperation with the tuna industry to minimize the risks inherent in increased atoll traffic is suggested.

OTHER PUBLIC USES
OUTPUT: ALBACORE FISHING

1. Description: Albacore (Thunnus alalunga) is a cosmopolitan tuna species found in warm and temperate waters but occurring at greater depths in lower latitudes. This species supports a fishery using long-line, trolling and ika-shibi (squid-tuna).

2. Existing levels/distribution: Hawaiian catch pre-1979 was incidental to other long-lined species, representing 1% of the total landings (73,000 tons). Considerable fluctuation occurs from year to year. Data suggests that the mean size of fish and the real abundance decreased between 1955 to 1968. After 1973, the catch per unit effort began a rise with the initiation of a ika-shibi method. In 1979, an experimental station was established at Midway in order to exploit fishing grounds previously fished solely by the Japanese. A purse-seine mothership and 26 trollers fished the waters north of Midway for about 5 months and landed 1609 short tons. In 1982, 75 trollers worked the area with out the mothership present. Fifty-five trollers did likewise in 1983. Catches were smaller than in 1979.

   Albacore are highly migratory across the north central Pacific. The cycle apparently begins in April off the Japanese coast. Fish move east as the summer progresses. The Hawaiian fishery peaks in the June-August period as the fish are approximately due north of the NWHI. Good catches have been made through December. The fishery out of Midway is apparently most successful in early summer. After that, the center of the stock moves east by north, closer to other ports for offloading. The fish return west and apparently spawn near land in the western Pacific.

3. Locational Criteria: Albacore fishing in Hawaii occurs throughout the year in the northern waters, peaking from June to August. Use of Midway Island as a fishery support station is desired by much of the fishing community to facilitate delivery, reduce transit time, recreate, etc.

4. Potential for Continued/Increased Production and Maintenance: The relatively new ika-shibi fishery has increased landings of albacore. The North Pacific trolling fishery has greatly expanded landings. If the fleet is expanded to 100 vessels, annual catch rates of 5,000-12,000 short tons might be expected. Recent (1983) maximum sustainable yield estimates range from 99,000 to 165,000 short tons. Some suggest the fishery can withstand an additional catch of 10-20% without significantly affecting the stock.

OUTPUT: ALBACORE FISHING (Continued)

5. Demand/Justification for Continued/Increased Production and Maintenance: During the past 20 years, a shift from pole-and-line fishing which targets albacore, aku and ahi to purse seining which targets only aku and ahi has occurred. This shift has recently reached the Central and Western Pacific. This emphasis on seining is expected to increase competition and increase world supply of light-meat tuna i.e., aku, ahi. Since 50% of the Pacific albacore catches are pole and line, this trend may lower albacore catch and create a stronger demand for domestic white-meat (albacore). During 1980-82, U. S. light-meat demand dropped by 15% due to competition by poultry and meat prices (Rule of thumb: 1% drop in meat prices = 5.7% drop in tuna consumption). However, white-meat demand is steady for 3 reasons: 1) it is consumed by higher income brackets, so it is less susceptible to inflation and price fluctuation; 2) tuna can be 'stretched' more easily due to its firmness; 3) and it is used by institutions and restaurants steadily. Overall market slump will affect harvesters' ability to move to Midway without a support station. A shift in cannery procurement processes from long-term supply contracts with boats to open market purchases has caused more disruptions among harvesters, directly affecting the number of vessels financially able to enter the Midway albacore market in Honolulu.

6. Conflicts: The albacore fishery in the north central Pacific poses potential conflicts with high priority HINWR objectives. The development of a support station at Midway in the proposed form of a mothership with associated vessels could adversely impact endangered and threatened species. It is estimated that between 400 and 600 transits through the reef during one 5 month season would occur. This traffic increases the associated risks of atoll navigation. Since most of the captains would be unfamiliar with such navigation, the potential of accidental grounding, loss of human life, oil spills, fires and introduction of exotic organisms is very real. The incidence of groundings in the NWHI over the last 5 years provides some index of the potential, especially in light of the grounding in May 1982 at the entrance to the Midway harbor. The traffic and oil leakage could adversely affect the struggling monk seal and sea turtle populations in the area. Off-duty, recreating crew members could further affect seals while they look for glass balls and shells, jog on the beach, etc. Currently, fishermen are restricted to their boats by the commanding officer at Midway. The development of a station at Midway would encourage diversification of fishing throughout the NWHI. This could have direct effects on the biotic resources. Increased fishing nearshore enhances the possibility of conflict with wildlife species. Accidental or purposeful discharge of bilge oil could wash ashore;

unauthorized landings could occur, resulting in the introduction of rats, cats, insects, and plants not currently present.

Direct conflicts could result from the competition for food fish used by birds. Baitfish, opelu and akule all are utilized by seabirds during each season. Secondary effects are possible through the decrease of tunas. Tunas are responsible for driving bird prey species to the surface, thereby making food available. Albacore fishing, however, should have little effect since the fish are deep and seabirds rarely occur with albacore schools. Aku and Ahi fishing could have an effect.

7. Objectives/Strategies: Objectives are similar to Aku fishery development. The use of Tern Island as a multispecies fishery support base is not recommended. However, placement of a mooring buoy outside refuge boundaries is a possible alternative. Cooperation with the industry to minimize the risks inherent in increased atoll movement is suggested.

OTHER PUBLIC USES
OUTPUT: BAITFISHING

1. Description: Resource harvesting of inshore baitfish including nehu (Stolepherous buccaneeri), juvenile opelu (Decapterus sp.) and akule (Selar crumenopthalmus) using surround nets and hook and line.

2. Locational Criteria: Fishery restricted to main islands but extensive schools found in HINWR lagoon waters.

3. Existing Levels/Distribution: Akule ranks third in landings and fourth in value of commercial Hawaiian fishes. The highest recorded landing was about 1 million pounds, decreasing to 700,000 pounds by 1978. The majority of the catch occurs within 2 miles of shore. The Kauai portion of the catch is considered the major source. Opelu ranks fourth in landings, fifth in value. Landings have fluctuated between 150,000 and 525,000 pounds, averaging 257,000 pounds. Both species show periodic population fluctuation. Nehu populations in Kaneohe Bay provide the bulk of the baitfish for the Aku fishery. The population is overexploited at present.

4. Potential for Continued/Increased Production and Maintenance: Baitfishing in the main islands could with stand additional fishing. Although the resource potential may exceed an additional 2 million pounds, including fish from the HINWR, expansion of the fishery seems to be restricted by consumer demand. Upwards to an additional 2 million pounds of each species could be harvested from the NWHI, if logistically possible. Currently, in the main island fishery, spotter planes and trailable boats are used to fish. Specific adaptations would have to be in place in order to fish the NWHI.

5. Demand/Justification for Continued/Increased Production and Maintenance: Currently, live fish are used as bait for Aku fishing. The need for sustainable live bait is critical to the potential expansion of the tuna fishery. Experimental use of tilapia and mollies has not been as successful as hoped. Thus, the industry relies on live traditional baitfish. The use of these fish for personal consumption is limited to fresh fish. The market for frozen fish is poorly developed and also unlikely to expand significantly. An expansion of the fishery would have to entail an aggressive marketing approach to sell the vast increase in products.

6. Conflicts: The harvest of shoaling baitfish in the HINWR could have a direct, immediate and significant effect on the seabird populations. These fishes are important foods for most species. Approximately 39,000 metric tons of baitfish are consumed annually by NWHI seabirds including 390 metric tons of nehu, 135 metric tons of akule and 16,000 metric tons of opelu. In addition to direct competition for food, this fishery could have an adverse effect on wildlife through net entanglement of sea turtles and monk seals, the latter having shown curiosity about nets in its environment. Onshore facilities to process, handle and transport the resource would have similar environmental impacts to the albacore or aku fishing support stations. The synergistic effects of bait and aku fishing could hold disastrous results for some species of seabirds. Depriving birds of the predatory fish which drive prey to the surface, then removing the prey itself, could leave certain species with no alternative food sources. Of all public use outputs, inshore baitfishing holds the greatest potential threat to the marine and terrestrial resources of HINWR.

7. Objectives/Strategies: The potential magnitude of the effects of landings, groundings, human activities associated with nearshore fishing, commercial development and environmental pollution by oil, heavy metals and organochlorine will increase with use. Thus, inshore baitfishing must be prohibited from HINWR waters.

OTHER PUBLIC USES
OUTPUT: BOTTOMFISHING

1. Description: A fishery conducted in deep offshore waters using baited hook and line gear which is hauled in by hand or by mechanical line-haulers. A complex of species, especially snappers, jacks and groupers, are harvested.

2. Existing Levels/Distribution: Bottomfish stocks near the main islands are being fully fished, and in some cases, overexploited, primarily by small-boat fisheries. The fishery peaked after WWII at approximately one million pounds. Since 1978, catches and fishing effort have increased markedly around the main islands. Reduced catch rates are attributed to a combination of increased fishing effort, displacement of native bottomfish by the introduced ta'ape, and aberrations in normal current patterns. Results from stock assessments in NWHI indicate that resources between Nihoa and Gardner Pinnacles have been noticeably affected by fishing. Areas to the north have not been so.

3. Locational Criteria: The area of capture is centered around offshore terraces and slopes to depths of approximately 200 fathoms. The potential habitat for bottomfish is very limited. Because handline gear is the principal method of capture, the fishery is extremely localized. The relative abundance of individual species changes with latitude.

4. Potential for Continued/Increased Production and Maintenance: Substantial increases in the distant-water bottomfish catch cannot presently be accommodated without adverse effects on market stability and price. Long travel times to the Honolulu market from the NWHI and the limited life of iced fish have placed a limit on commercial fishing. Fresh fish need better refrigeration and handling. A market for rapid frozen fish needs to be developed. Fishing success is highly dependent upon ocean conditions in the frequently turbulent NWHI waters. If a support station is developed at Tern or Midway Island, the prospects of overfishing bottom fish stocks would be of greater concern. Traditional fishing grounds near the main islands are currently fished to their sustainable limit.

5. Demand/Justification for Continued/Increased Production and Maintenance: Bottomfish demands from restaurants will cause bottomfishing efforts to remain at high levels or even increase. The fishery will have to continually expand its range of operation to sustain catch rates. In addition to restaurants, the new markets needed for frozen fish and the

uncertain economic feasibility of the distant water fishery suggest that rapid-freezing is not likely to become widely accepted. Thus only a fresh fish market will exist. This precludes an extensive distant water fishery since the transit time is prohibitive. A NWHI support station needs a thorough assessment of market constraints and economics before being implemented.

6. Conflicts: If a support station is considered, then the potential conflicts identified in the review of albacore and aku fishing apply. Although this fishery does not compete either directly or indirectly for seabird or seal foods, onshore infrastructures could adversely impact the fauna. Seals have been observed stealing fish and with bottomfishing hooks imbedded in their mouths.

7. Objectives/Strategies: A fishery for bottomfishes could have some secondary enhancing effects on the populations of seabird food species through reduced consumption of mutual prey. Limited development of support facilities would have minimum impact on wildlife species. Since bottomfish are quickly depleted and slow to recover, even a temporary fishery might have long-lasting effects.

OTHER PUBLIC USES
OUTPUT: TRAP FISHING

1. Description: Fishery which primarily uses traps to capture fish, lobster, shrimp and crabs in waters outside the HINWR.

2. Existing Levels/Distribution: Lobster fishing occurs in the main and NWHI. In 1977, 70,000 pounds were landed; in 1978, the catch totaled 31,000 pounds. Although there are several species of deepwater shrimp in Hawaiian waters, the caridean shrimp Heterocarpus laevigatus appears to be by far the largest and possibly the most abundant species. Estimated abundance of H. laevigatus in the Hawaiian archipelago is 2,500-5,000 metric tons. The total landings may only be speculated; as much as 25,000 pounds have been landed through 1978. Kona crab landings also fluctuate, ranging from 15,000 to 45,000 lbs per year. The record catch is 71,000 pounds in 1972.

3. Locational Criteria: Lobster fishing occurs over 1600 nm^2 in the main islands and surrounding Necker and Nihoa Islands of the HINWR. Shrimping is conducted in specific areas around all main islands. Within the optimum depth range of 75-400 fm, several species of shrimp have continuous distribution throughout the Hawaiian Islands. The Kona crab occurs in greatest abundance in localized areas of the main Hawaiian Islands.

4. Potential for Continued/Increased Production and Maintenance: Hawaii Fishery Development Plans projected in 1979 that 100,000 to 150,000 lbs of lobster could be landed if all grounds were fished. This includes 3500 nm^2 of NWHI grounds with 1600 nm^2 main island grounds. The Fishery Management Council has concluded that the best available information supports a tentative determination that maximum sustainable yield is in the range of 15,000 to 30,000 lobsters, approximately one pound each, for the main Hawaiian Islands. Catch data for the NWHI fishery is extremely limited. Council estimates indicate the fishery grew from 72,000 lbs in 1977 to 200,000-400,000 lbs in 1980. Estimates of fishing effort are unavailable. The NWHI fishery represents a fundamental transformation in Hawaii's commercial lobster fishery. There are insufficient data to estimate catches and MSY's for slipper lobster, Kona crabs and shrimp.

OUTPUT: TRAP FISHING (Continued)

5. Demand/Justification for Continued/Increased Production and Maintenance: Spiny Lobsters are a relatively small part of the Hawaiian Islands commercial fisheries. Virtually all are processed to frozen tails for the restaurant market. In recent years, the world price for frozen lobster tails has been increasing about 18% per year. The current wholesale price is about $3.00/lb. for whole lobster. The NWHI lobster fishery has developed outside the confines of the local fish market by opening up export markets in frozen tails. Increased landings will not lower the price. The fishery remains volatile due to fluctuating catch rates. It is currently estimated that 1-2,000,000 lb. of shrimp might be economically harvested. Kona crabs may sustain a fishery capable of removing 60,000 - 100,000 lb. in the main islands and another 50,000-75,000 lbs. from the NWHI. Major investments have recently been made in the Hawaiian deepwater shrimp fishery by a local shrimp fishing company. In addition, numerous vessel owners in Alaska and the Pacific Northwest have expressed an interest in entering the fishery.

6. Conflicts: The presence of fishing vessels, the placement of fishing gear and the alteration of the lobster populations will modify the proposed critical habitat of the monk seal. There is insufficient information to fully assess the potential conflicts inherent in these environmental modifications. The potential impacts of trap fishing are disturbance, incidental mortality and reduction of known food resources, accidental groundings and oil spills.

7. Objectives: Collection of information on incidental mortality and disturbance is of high priority. Seal and turtle food habit studies need to be continued. Activities which are likely to jeopardize the continued existence of endangered or threatened species should be thoroughly evaluated.

OTHER PUBLIC USES
OUTPUT: RECREATIONAL FISHING

1. Description: Consumptive recreation involving renewable fish resources and charter boats in and around HINWR waters and lands, possible use of Tern Island facilities, radio contact with Tern Island and air transport facilities.

2. Locational Criteria: Onshore, offshore and lagoon waters of HINWR have potential for sport fishing.

3. Existing Levels/Distribution: Sport fishing is not now permitted in HINWR waters. Distance to HINWR prohibits most fishermen from reaching the virgin fishing grounds. In addition to distance, expense and regulations are prohibitive.

4. Potential for Continued/Increased Production and Maintenance: Virgin fishing grounds exist in the NWHI, particularly in the HINWR. However, refuge waters are closed to commercial or recreational fishing. If air and boat charters were available, increased use would be expected. Continuous fishing pressure would soon result in maximum sustainable yields.

5. Demand/Justification for Continued/Increased Production and Maintenance: Occasional requests are received for fishing groups to go into HINWR. If Tern Island were opened to fishing, usage would increase accordingly.

6. Conflict: Onshore and nearshore fishing are not recommended because of the potential disturbance to monk seals and sea turtles and the introduction of exotic or alien organisms to refuge islands. Offshore consumptive fish harvest also may conflict with turtle and monk seal refuge management goals since both animals range widely. Nearshore feeding seabirds such as black noddies depend on predatory fish in and outside the reef to drive their prey to the surface. They may be impacted during their breeding season by competition with humans.

   Increased boat traffic will in turn increase the possibility of accidental spills and groundings; it also necessitates monitoring by FWS personnel, both by radio and visually. Certain reef fish contain ciguatoxin in quantities great enough to affect people; these species would have to be avoided entirely. If commercial fishing is permitted, less fish will be available to sport fishers.

7. Objectives and Strategies: Because of the increased risk of disturbance to threatened and endangered species, possible competition with feeding seabirds and potential habitat damage from accidental groundings and spills, consumptive recreational fishing will not be allowed within the HINWR.

OTHER PUBLIC USES
OUTPUT: CONSUMPTIVE RECREATION

1. Description: Collection of glass balls, bottles, sea shells, war mementos, personal salvage, etc. for non-commercial use.

2. Locational Criteria: Could occur throughout NWHI, however, most easily accessible at Tern Island, Midway and Kure Islands.

3. Existing Levels/Distribution: These activities are conducted to a small degree by people stationed at or visiting the NWHI for recreation.

4. Potential for Continued/Increased Production and Maintenance: The collection of renewable items such as shells, glass balls, bottles, etc. could continue and increase as supply lasts. Collection of items for personal salvage could continue to be conducted opportunistically. Private collection of war mementos on federal land is forbidden by the Antiquities Act of 1906.

5. Demand/Justification for Continued/Increased Production and Maintenance: Demand for recreation is high among those stationed or visiting NWHI and HINWR. If more people were stationed there, demand for these activities would increase. Work conditions in the NWHI can become unbearable if confined to a boat, work site or campsite for prolonged periods. The desire to get away from the facilities is legitimate.

6. Conflict: The collection of renewable items may disturb threatened or endangered species. It is probable that the collection of glass balls and shells at Midway and Kure have played a significant role in the reduction of monk seal numbers there. Since the U.S. Coast Guard's departure from Tern Island and limitation of beach access, seal numbers have increased radically to an average of about 40 per day. Both state and federal regulations prohibit the disturbance of threatened/endangered species and seabirds.

7. Objectives and Strategies: Since most beaches in HINWR are frequented by monk seals and turtles, collecting cannot be permitted on the refuge. The potential for disturbance is too great to justify the activity. In spite of the high demand for glass balls, beaches will remain off limits to those without legitimate research purposes.

OTHER PUBLIC USES
OUTPUT: OTHER COMMERCIAL CONSUMPTIVE USE

1. Description: Consumptive commercial use is assumed to include but is not limited to salvage for glass balls, shells, bottles, and other historical artifacts including war paraphernalia, ship salvage, nonprecious coral harvest and aquarium specimen collection.

2. Locational Criteria: Salvage operations occur opportunistically when ships run aground. Glass balls occur on all islands of HINWR. Non-precious corals are harvested at Kure, Midway and perhaps other NWHI periodically, but probably not commercially. Collecting for commercial use is not currently pursued or permitted in HINWR.

4. Potential for Continued/Increased Production and Maintenance: Ship salvage will continue as necessary either by the ship insurance companies or opportunistically by other salvagers. Glass ball collecting is a renewable resource that could bring sustained money to the collectors. Low level use to date for historic and other salvage will not change. Depending on demand, nonprecious coral harvest could become a viable industry.

5. Demand/Justification for Continued/Increased Production and Maintenance: Demands for salvage permits occur periodically. These are not expected to increase in the future. Glass ball collecting is a very popular recreational activity. If fishing is allowed to take place on the HINWR, then requests for glass ball harvesting will probably increase. Off-duty fisherman are likely to engage in this activity. Collection of these and other items (shells, bottles, etc.) could develop into a commercial endeavor. Interest exists at low levels for aquarium specimen collection; allowing collection would probably precipitate increased demands for this activity.

OUTPUT: OTHER COMMERCIAL CONSUMPTIVE USE (Continued)

6. Conflicts: Sea shells, glass balls and coral occur on the beaches and/or in nearshore waters. Collecting these renewable resources is likely to disturb sea turtles and monk seals. Continued disturbance to these threatened/endangered species is illegal (Section 7 Endangered Species Act). The pursuit of these activities at Midway is suspected to have helped cause the decline of seals there. The collection of historic artifacts by individuals on federal land is illegal according to the Antiquities Act. Periodic ship salvage is the only suitable consumptive commercial activity likely to occur on HINWR lands and waters. The potential for conflict with preservation of cultural resources is high. Ship salvage will be mandated to remove vessels if possible and to prevent oil pollution and escape of exotic organisms. Aquarium specimen collection is not permitted in Research Natural Areas.

7. Objectives/Strategies: All grounded ships will be removed from HINWR property as soon as possible to prevent pollution, introduction of exotic organisms, and remove rusted iron. Glass ball, shell, coral and other beach collecting will not be permitted due to seal and turtle disturbance. Commercial collection of historical artifacts cannot legally occur. Likewise, aquarium specimen collection is not permissible within the refuge.

[NOTE: This output summary has been incorporated into "Other Commercial Consumption Use"]
PUBLIC USE MANAGEMENT
OUTPUT: AQUARIUM SPECIMEN COLLECTING

1. Description: The collection of marine specimens in HINWR waters by commercial operators for resale.

2. Locational Criteria: This activity could occur inside HINWR boundaries near inshore reefs, especially at Tern Island.

3. Existing Levels/Distribution: Specimens have been collected through HINWR as part of the Tripartite Study for scientific purposes. Collecting for commercial use is not currently pursued or permitted in HINWR.

4. Potential for Continued/Increased Production and Maintenance: Specimens could be collected in specially designated areas on a rotational basis. Current research areas must not be disturbed by collectors. FWS marine researchers could best identify areas suitable for collecting on a one-time basis initially. New areas would subsequently need to be identified to avoid overfishing. Specimens could be air transported from Tern Island to insure high survival. Consequently, French Frigate Shoals would be the best collecting site.

5. Demand/Justification for Continued/Increased Production and Maintenance: Interest currently exists at a low level. Interest and demand is expected to rise sharply if permits are allowed. Under the existing protection rendered by the Research Natural Area, collecting is not permitted.

6. Conflict: French Frigate Shoals is unique in Hawaiian waters since it has the only extensive beds of Acropora coral. Associated biota is thus restricted in range. Collection of these resources should be strictly monitored, if permitted at all. As mentioned in 5 above, collecting is not permitted under the Research Natural Area jurisdiction. Changes in the legal overlay would have to be made. If changed, collecting activities would have to be closely monitored to be sure they did not interfere with threatened and endangered species. No unauthorized landings on islets and islands will be permitted except during emergencies.

OUTPUT: AQUARIUM SPECIMEN COLLECTING (Continued)

7. Objectives/Strategies: When incorporated into Other Commercial Consumptive Use, the output Aquarium Specimen Collecting was modified. Other Commercial Consumptive Uses became Other Compatible and Economic Uses in the final refuge output list (Section V in the MP/EIS). These changes reflect the evolution of the final MP/EIS from its earliest inventory stage to the final synthesis (Section II). In the final document, aquarium specimen collecting is prohibited. Limited entry collecting shall be permitted on a rotational basis so long as activities do not conflict with HINWR objectives and mandates.