

NATURAL RESOURCES MANAGEMENT PLAN
FOR
NAVAL AIR FACILITY, MIDWAY ISLAND

January 1991

Prepared by:

U.S. Fish and Wildlife Service
Hawaiian Islands National Wildlife Refuge
Honolulu, Hawaii

COMPREHENSIVE NATURAL RESOURCES MANAGEMENT PLAN
FOR
NAVAL AIR FACILITY, MIDWAY ISLAND

Prepared by: Natural Resources Management Branch

Approving Officials:

Installation Commander

Date

Pacific Division
Naval Facilities Engineering Command

Date

Assistant Regional Director
Refuges & Wildlife Resources, Region 1
U. S. Fish & Wildlife Service

Date

Date of Annual Review/Update

Name and Title of Reviewer(s)

TABLE OF CONTENTS

I. Executive Summary

A. Summary of Findings and Recommendations	I-1
B. Potential Management Options	I-2
C. Implementation	I-5

II. Basic Section

A. Introduction	II-1
B. Installation Description	II-2
C. Existing Plans and Policies	II-6
D. Manmade Environment	II-6
E. Natural Environment	II-13
F. Constraints and Opportunities	II-23
G. References	II-25

III. Land Management Section

A. Introduction	III-1
B. Policies and Programs	III-1
C. Existing Conditions	III-4
D. Management Recommendations	III-11
E. Implementation	III-17
F. References	III-19

IV. Fish and Wildlife Section

A. Introduction	IV-1
B. Policies and Programs	IV-4
C. Fish and Wildlife Goals and Objectives	IV-6
D. Fish and Wildlife Resource Inventory	IV-9
E. Existing Management and Use Characteristics of Resources	IV-30
F. Fish and Wildlife Resources versus Base/Mission Conflicts	IV-30
G. Existing land Use Plans Affecting Fish and Wildlife Resources	IV-32
H. Opportunities and Constraints	IV-32
I. Habitat Management Needs	IV-32
J. Species Management Needs	IV-33
K. Management Recommendations	IV-35
L. Proposed Management, Protection, and Conservation Programs	IV-38
M. Implementation Costs and Schedule	IV-44
N. References	IV-44

V. Outdoor Recreation Section

A. Introduction	V-1
B. Policies and Programs	V-1
C. Objectives	V-1
D. Resource Analysis	V-2
E. Existing and Potential Recreation Activities	V-3
F. Project Recommendations	V-4
G. Implementation Costs and Schedules	V-8
H. References	V-8

ACRONYMS

Definitions of abbreviations and acronyms used in this document:

ASL - above sea level
ASO - Aviation Safety Officer
BASH - Bird-Aircraft Strike Hazard
BOS - Base Operations Services
CIP - Capital Improvements Plan
COMNAVBASE - Commander Naval Base
DERP - Defense Environmental Resoration Program
DOA - Department of Agriculture
DOD - Department of Defense
DODINST - Department of Defense Instruction
DOI - Department of Interior
EFD - Engineering Field Division
ESA - Endangered Species Act
FWS - U.S. Fish and Wildlife Service
MAC - Military Air Command
MILCON - Military Construction
MWR - Morale, Welfare, and Recreation
NAF Midway - Naval Air Facility, Midway Island
NAS Barbers Point - Naval Air Station, Barbers Point
NAVFAC - Naval Facility
NMFS - National Marine Fisheries Service
NOPF - Naval Ocean Processing Facility
NWR - National Wildlife Refuge
OIC - Officer-in-Charge
OPNAVINST - Naval Operations Instruction
PACDIVNAVFACENGCOCOM - Pacific Division, Naval Facilities Engineering
Command
SECNAV - Secretary of the Navy
UST - underground storage tanks

Executive Summary

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

A. Summary of Findings and Recommendations	I-1
B. Potential Management Options	I-2
1. Criteria for evaluation	I-2
2. Ranking of recommended options	I-3
a. Protection and conservation of natural resources	I-3
b. Reduction of bird-aircraft strike hazard (BASH)	I-4
c. Land management	I-4
d. Natural resource use and outdoor recreation	I-5
C. Implementation	I-5
1. Development costs	I-5
2. Revenue changes	I-5
3. Ten year schedule of natural resource projects	I-5

Tables

I-1	Project costs - Land Management	I-7
I-2	Project costs - Fish and Wildlife Management	I-9
I-3	Project costs - Outdoor Recreation	I-13
I-4	Ten year schedule of natural resource projects	I-15

Plates

I-1a	Endangered Hawaiian monk seals, Eastern Island
I-1b	Albatross nesting colony, Eastern Island

I. EXECUTIVE SUMMARY

A. Summary of Findings and Recommendations

The Natural Resources Management Plan for the Naval Air Facility, Midway Island (NAF Midway) provides a multiple-use program for the management, conservation, and protection of renewable natural resources including vegetation, shorelines, fish, wildlife, water, and natural areas. The plan includes a bird-aircraft strike hazard (BASH) section with recommendations for reducing bird-aircraft collisions. It also identifies opportunities for outdoor recreation compatible with the military mission of the facility and in conformance with natural resources laws, regulations, and policies.

Midway Atoll is a unique ecosystem of special interest. Eastern Island is a Navy Wildlife Refuge and the entire atoll is part of the National Wildlife Refuge System. There are many natural resources of special interest at NAF Midway including the endangered Hawaiian monk seal (*Monachus schauinslandi*; Plate I-1a), threatened Hawaiian green sea turtle (*Chelonia mydas*), 15 breeding species of migratory seabirds, a variety of native plants, reef fishes and invertebrates, and many significant habitats including coral reefs, beaches, sand dunes, stands of native shrubs, fields, and ironwood forests. More than one million seabirds nest on Midway Atoll. At certain times of the year, the islands are virtually covered with seabirds (Plate I-1b). Because of the atoll's limited land area, native animals and plants are especially vulnerable to disturbance. Impacts to wildlife are potentially more drastic at Midway than on larger land masses.

Many opportunities exist at NAF Midway to increase the protection for its unique wildlife and habitats. Most of these opportunities relate to mitigation of conflicts between humans and their activities and wildlife for the limited space available. Identified within this plan are several areas of existing or potential conflict. These include the following:

- hazards to wildlife due to construction, renovation, or repair of buildings, roads, and other facilities
- new development in existing or potential wildlife habitat
- disturbance of wildlife during daily operations and recreation activities
- presence of hazards to wildlife including abandoned structures and debris, uncovered pits, fenced enclosures, antennas, overhead utility wires, lighting, deteriorating seawalls, and nets entangled in piers
- conflicts between wildlife and vehicular traffic
- potential hazards to wildlife related to storage or spillage of petroleum products, contaminants, or hazardous wastes
- bird aircraft strike hazards.

Besides conflicts, opportunities abound to maximize natural resource potential and provide opportunities for wildlife oriented outdoor recreation. These include the following:

- orientation of all personnel arriving at Midway with respect to wildlife regulations
- enforcement of wildlife and fisheries regulations

- regulation of wildlife researchers, writers, photographers, and cinematographers
- promotion of wildlife interpretation for base personnel
- control of predation by introduced rats on indigenous seabirds and native vegetation
- preservation and enhancement of coastal strand and beach habitat
- prevention of future introduction of alien and pest species
- restoration and enhancement of Eastern Island
- preservation of populations of lobster and other species harvested recreationally
- preservation of dwindling populations of Hawaiian monk seals and green sea turtles.

Included within this plan are recommendations to minimize conflicts and take advantage of opportunities to provide a balance between natural resources and man at NAF Midway. Implementation of this plan will take advantage of the cooperative efforts of the U.S. Navy, U.S. Fish and Wildlife Service, base contractor, volunteers, and researchers. Although this plan is divided into several management areas, because of NAF Midway's small size and density of wildlife resources, most of the specific management recommendations are interrelated and are thus difficult to lump into one area. For example, in order to reduce bird aircraft strike hazards, cleared areas near the airfield should be replanted with native shrubs to provide less desirable habitat for albatross nesting. In order to encourage these plants, herbivorous rodents and competing introduced plants must be controlled.

It is recognized that, in the future, the proposed natural resources management program may conflict with new or changing military mission and security requirements at the installation and modifications to this plan may be necessary if and when conflicts occur.

B. Potential Management Options

✓ 1. *Criteria for evaluation*

There are several criteria for evaluating and ranking options that apply to NAF Midway. These include:

Legal requirements. Examples are the protection of endangered and threatened species and migratory birds, and compliance with historic preservation requirements.

Interference with military mission. For any proposed action, not required by law, the most important criterion is the degree to which the proposed recommendation would interfere with the military mission of the station. If a non-mandated option would seriously constrain military operations it will not be considered. However, if the proposed action would only result in an inconvenience, it will be considered.

Promotion of Refuge objectives. As NAF Midway has been designated as an overlay National Wildlife Refuge managed by the U.S. Fish and Wildlife Service (FWS), actions that promote Refuge objectives but do not interfere with the military mission will be considered.



Plate I-1a. Endangered Hawaiian monk seals, Eastern Island



Plate I-1b. Albatross nesting colony, Eastern Island

Actions which promote the military mission and promote wildlife objectives would be given priority consideration.

Costs of proposed action. Costs must be reasonable so that the option has a strong probability of being funded and implemented. As Midway is a Naval Facility and a National Wildlife Refuge, programs to be conducted on Midway may be funded by either agency. Programs that are considered to be Navy responsibility are considered as Navy costs and programs considered to meet Refuge objectives but not necessarily military objectives are considered as Fish and Wildlife Service costs.

Benefits. For people-oriented proposals, such as improved recreational facilities, first priority will be given to those projects that provide base personnel with a better understanding of the wildlife of Midway. By informing people about the wildlife resources at Midway, regulations concerning wildlife protection will be better understood and people would have an appreciation for the unique environment of Midway. This could result in higher morale and reduced wildlife enforcement problems.

2. Ranking of recommended options

✓ a. Protection and conservation of natural resources

1. Threatened and endangered species preservation. Recommendations designed to preserve and enhance populations of endangered monk seals, threatened sea turtles, and other endangered species should be implemented. These include reducing human visitation to Eastern and Spit islands, enhancing beach habitat, reducing human disturbance, elimination of hazards, and introduction of seals from other colonies.
2. Pest control. In order to eliminate predation on seabirds and herbivory on native plants, by introduced rats, a comprehensive program of rat control should be initiated following the guidance of reports by Murphy and Tyler (1988) and Reidinger (1982). Initial control efforts should focus on native vegetation communities and burrow colonies on Sand Island, and the whole of Eastern and Spit islands.
3. Native plants. In order to maintain or enhance the existing diversity of wildlife habitat, control erosion, and reduce the bird-aircraft strike hazard, the recovery and reestablishment of native plants should be promoted as part of an integrated program of vegetation management. Growth of beach naupaka and other dune-building species should be encouraged, especially along shorelines and in open areas not constrained by airfield clearances. Existing stands of native strand vegetation should be cleared of introduced plants, especially ironwood and golden crown-beard.
4. Hazards. Mortality and injury to wildlife resulting from human activities, structures, or debris should be minimized. Abandoned structures and debris, such as uncovered pits, utility lines, and fences, that represent potential hazards to wildlife, should be eliminated. Entanglement hazards, such as fishing nets and monofilament line, should be cleared from shorelines and pier pilings. Toxic substances, such as waste oil and lead paint from demolished buildings, should be collected, stored, and removed from the atoll. Construction of new hazards, such as fences and above-ground wires, should be minimized. A program to reduce conflicts between wildlife and vehicular traffic should be developed and implemented.
5. Orientation. All incoming personnel (except returning residents), military and civilian, arriving by aircraft or vessel, should receive an orientation briefing, in which wildlife regulations and the importance of preventing the introduction of alien or domestic species are explained.

6. Consultation. A protocol should be established for coordination and consultation between the FWS, the Navy, and any civilian contractor, in order to mitigate conflicts between wildlife and military and civilian activities, including construction, renovation, operations, and recreation.
7. Restoration of Eastern Island. In order to provide wildlife habitat and, potentially, to reduce BASH, Eastern Island should be restored to a natural condition. Restoration should include the cleanup of abandoned runways, structures, and debris and the control of rats and introduced plants (especially ironwoods). The availability of Defense Environmental Restoration Program (DERP) and other funds should be investigated.
8. Sanctuaries. On Sand Island, sanctuaries for especially rare or sensitive species or habitats should be established and clearly posted.
9. Monitoring. In order to evaluate ongoing management programs and assess additional management needs, it is recommended that the health and status of selected wildlife be monitored.

✓ b. **Reduction of bird-aircraft strike hazard (BASH)**

1. BASH plan. In order to reduce the bird-aircraft strike hazard (BASH), a comprehensive BASH plan should be prepared and implemented. This plan should include the collection of detailed information on bird-aircraft collisions.

✓ c. **Land management**

1. Vegetation management. In order to protect structures, reduce erosion, decrease the bird-aircraft strike hazard, and maximize the diversity of wildlife habitat, the proposed integrated vegetation management program should be developed and implemented. The general, overriding objectives of this program are to control the spread of ironwood trees, especially along shorelines, near structures, and in stands of native vegetation and to promote the recovery and reestablishment of native plants, primarily beach naupaka and other dune-building species, especially along shorelines and in open areas not constrained by airfield clearances. Existing stands of native strand vegetation should be cleared of introduced plants, especially ironwood and golden crown-beard.
2. Coastal zone management. In order to control coastal erosion while maintaining beach accessibility for endangered monk seal habitat and recreational use, nonrestrictive erosion control methods (e.g., vegetation management, revetment) should be used whenever possible instead of bulkhead or riprap.
3. Water supply. In order to prevent contamination of groundwater aquifers and, secondarily, of humans and wildlife, MILCON Project P-288 should be implemented to contain spills, and abandoned fuel storage tanks should be located, drained, and demolished. The availability of clean-up funds through the Navy Installation Restoration Program or the Defense Environmental Restoration Program should be investigated.
4. Noxious weed and pest control. In order to control rodents in inhabited areas, the current level of effort must be maintained or possibly increased. It is recommended that control efforts be extended to outlying and abandoned areas, with the ultimate goal of eliminating rats from the atoll. Efforts to control golden crown-beard and other noxious weeds should be extended to abandoned and unimproved areas, in order to control populations of flies and mosquitos and to encourage growth of native plants.

5. Soil stabilization and erosion control. In order to prevent soil erosion and accumulation of windblown sand on runways, existing dunes and dune vegetation should be protected and areas cleared for airfield or other operations should be replanted with native shrubs.

d. Natural resource use and outdoor recreation

1. Wildlife interpretation. In order to provide opportunities for public use of fish and wildlife resources, a program of environmental education and wildlife interpretation program should be initiated. This program should include interpretive displays of photographs and information on the atoll's wildlife, an informational brochure, nature walks, and slide presentations.
2. Research and journalism. The use of fish and wildlife resources by scientific researchers, writers, photographers, and film-makers should be encouraged. These activities should be regulated by the FWS in cooperation with COMNAVBASE and the OIC-NAF Midway.
3. Recreational fishing. The proposed set of regulations should be implemented to ensure the continued viability of the recreational harvest of fishes, lobsters, coral, and other invertebrates. These regulations should be clearly posted and re-evaluated periodically by the FWS and the OIC-NAFMIDWAY.
4. Scuba diving. In order to enhance opportunities for this unique recreational activity, rental dive equipment should be made available through NAF Midway Morale, Welfare, and Recreation (MWR).

C. Implementation

1. Development costs

Development costs are summarized in Tables I-1 through I-3. The total projected cost for natural resources and outdoor recreation projects is \$1,311,000: \$263,500 is allocated for land management, \$908,500 is allocated for fish and wildlife management and \$139,000 is allocated for outdoor recreation projects. Funding for these projects will be shared by the Navy and the FWS, as follows: \$596,000 (Navy) and \$715,000 (FWS).

2. Revenue changes

No revenue sources (e.g., fishing licenses, commercial outleases), *per se*, exist at NAF Midway. The annual Navy and FWS budgets for Midway will vary depending on approved projects.

3. Ten year schedule of natural resource projects

A year by year schedule of natural resource projects and associated costs is presented in Table I-4. Year 1 of this schedule is considered to be the first funding year following acceptance of this plan. The schedule includes anticipated annual cost increases for projects continuing over several years.

TABLE I-1

Project Costs - Land Management

PROJECT	FUNDING	
	Navy	FWS
Watershed		
• Investigate UST cleanup through various funding sources	3,000	
Vegetation Management		
Sand Island		
<i>Improved Lands</i>		
• Remove, top, or trim ironwoods as required to protect structures	20,000	
<i>Shorelines</i>		
• Eliminate ironwoods from Area 7 native plant revegetation plot (40,000 sq. ft.)	36,000	
• Evaluate revegetation of native plants in the above plot and remove newly sprouted ironwood saplings	21,000	8,000
• Remove ironwoods and replant native vegetation in high erosion area test plot (1000 sq. ft.)	5,000	
• Evaluate revegetation in high erosion area test plot, remove new ironwood sprouts; expand efforts to other areas if successful	9,000	
• Clear exotic plants (e.g., ironwood, golden crown-beard) from stands of native vegetation:		
- Frigate Point	8,000	
- Southwest shoreline (near NOPF)	8,000	
<i>Airfield clearances</i>		
• Scarify or pave required clearance areas as designated	36,000	
• Revegetate designated areas with low-growing native shrubs	4,000	
<i>Open fields and lawns</i>		
• Establish native plant revegetation test plot (1000 sq. ft.)	3,000	
• Evaluate success of native plant revegetation test plot		1,000

TABLE I-1 (cont'd)
Project Costs - Land Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Vegetation Management (cont'd)</u>		
• If successful, continue native plant revegetation of open areas	17,500	
<i>Area 7</i>		
• Scarify or pave required clearances	30,000	
<i>Cultivation</i>		
• Establish greenhouse/nursery		15,000
• Cultivate native plants		24,000
Eastern Island		
• Remove ironwood saplings after major habitat restoration		15,000
SECTION TOTAL	200,500	63,000

TABLE I-2

Project Costs - Fish and Wildlife Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Orientation</u>		
• Develop orientation sheet		500
• Produce and distribute orientation sheet; review and update yearly	9,000	
• Initiate in-person orientation		15,000
• Produce, duplicate, and distribute orientation video		1,000
<u>Monk Seals</u>		
• Evaluate effects of disturbance on monk seals		20,000
• Introduce "Headstart Program" seals to Eastern Island		16,000
• Develop, produce, and post information signs at beach access points		21,000
• Implement permitting process for Eastern and Spit islands		10,000
<u>Wildlife Hazards</u>		
• Remove nets, ropes, and other beachcast hazards from atoll beaches	37,000	30,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor, e.g., Dive Club
• Install and maintain covering or other avian exclusion devices on open pits and sub-surface control chambers	9,000	1,000
• Install and maintain avian exclusion or escape devices on fenced enclosures, such as tennis courts, storage yards, fuel storage tanks, etc.	13,000	1,000

TABLE I-2 (cont'd)

Project Costs - Fish and Wildlife Management

<u>PROJECT</u>	<u>FUNDING</u>	
	Navy	FWS
<u>Wildlife Hazards</u> (cont'd)		
• Evaluate base lighting needs in relation to potential wildlife hazards		1,000
• Modify base lighting to minimize wildlife impacts	15,000	
• Install ramps in water treatment ponds to provide escapeways for birds	3,000	
<u>Wildlife Sanctuaries</u>		
• Establish, post, and maintain sanctuaries in harbor dunes and Frigate Point areas		3,000
<u>Vehicular Traffic</u>		
• Develop, install, and maintain barrier system to prevent albatross chicks from wandering onto major roadways	18,000	
• Implement vehicular traffic reduction recommendations	5,000	
• Close to 4-wheeled traffic, roads not required for normal vehicle circulation	5,000	
• Institute recommended enforcement system for vehicle-related albatross mortality incidents	500	
<u>Project Consultation and Conflict Mitigation</u>		
• Institute proposed protocol	6,500	6,500
<u>Rat Control</u>		
• Continue rat control (including dead bird pickup) in inhabited areas and at the dump	132,000	

TABLE I-2 (cont'd)
Project Costs - Fish and Wildlife Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Rat Control</u> (cont'd)		
• Increase control efforts to include known burrow nesting seabird areas and remnant beach naupaka stands on Sand Island		60,000
• Pursue funding sources to increase rat control efforts throughout Sand Island		2,000
• Pursue funding sources to eradicate rats from Eastern/Spit islands		2,000
• Implement increased rat control measures on Sand and Eastern/Spit islands		230,000
<u>Eastern Island Restoration</u>		
• Pursue alternatives for debris removal and habitat restoration	3,000	3,000
<u>Public Use</u>		
• Initiate special use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		20,000
<u>Monitoring</u>		
• Aerial photographic survey of vegetation	25,000 (flight time)	5,000
• Monitor migratory bird resources:		
-Populations		40,000
-Reproductive parameters		30,000
-Contaminants		36,000
• Monitor monk seal populations		10,000
• Monitor green sea turtle populations		10,000

TABLE I-2 (cont'd)

Project Costs - Fish and Wildlife Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>BASH</u>		
<i>Aircraft Operational Procedures</i>		
• Implement procedures	8,000	
<i>Wildlife Management</i>		
• Conduct study of albatross flight patterns with respect to vegetation	40,000	
<i>Monitoring</i>		
• Implement data collection methods	5,500	
SECTION SUBTOTAL	334,500	574,000

TABLE I-3

Project Costs - Outdoor Recreation

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Interpretive Display</u>		
• Develop, produce, and install interim display		12,000
• Evaluate location for permanent display		500
• Develop plans for permanent interpretive display <u>structure</u>		2,000
• Acquire materials and construct display structure	15,000	
• Develop, produce, and install permanent display		20,000
<u>Interpretive Brochure</u>		
• Develop refuge brochure		15,000
• Review and determine printing requirements for brochure		2,000
• Print and distribute refuge brochure	8,000	
• Revise and reprint brochure as needed	8,000	2,000
<u>Interpretive Slide Shows and Tours</u>		
• Provide quarterly presentations relating to island wildlife		9,500
• Conduct bi-monthly nature tours		10,000
<u>Scuba Diving</u>		
• Facilitate the availability of equipment for scuba and skin diving	20,000	
<u>Recreational Fishing</u>		
• Establish and enforce regulations for taking of fish, shellfish, and corals	10,000	1,000

TABLE I-3 (cont'd)
Project Costs - Outdoor Recreation

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Recreational Fishing (cont'd)</u>		
• Review and revise regulations		4,000
	_____	_____
SECTION TOTAL	61,000	78,000

TABLE I-4

Ten year schedule of natural resource projects

	Funding Agency	
	Navy	FWS
<u>Year 1</u>		
• Investigate cleanup of underground storage tanks (UST) through various funding sources	1,000	
• Remove, top, or trim ironwoods as needed to protect structures	2,000	
• Scarify or pave required clearance areas near airfield and Area 7 as designated	8,000	
✓ • Develop orientation sheet for all personnel visiting Midway Atoll		500
• Initiate and conduct in-person orientation		1,500
• Initiate evaluation of effects of disturbance on monk seals		2,000
• Implement permitting process for Eastern and Spit islands		1,000
• Initiate removal of nets, ropes, and other beachcast hazards from atoll beaches	3,000	2,000
• Initiate removal of entanglement hazards from underwater structures such as pilings	Volunteer labor--Dive Club	
• Establish, post, and maintain wildlife sanctuaries as designated		1,000
• Institute recommended enforcement system for vehicle-related albatross mortality incidents	500	
• Implement proposed protocol for project consultation and conflict mitigation	2,000	2,000
• Control rats in housing areas, work places, and dump (including dead bird pickup)	12,000	
• Investigate options for debris removal and habitat restoration on Eastern Island	1,000	1,000
• Initiate special-use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Initiate migratory bird resources monitoring: populations, reproductive parameters, and contaminants		7,000
• Initiate monk seal population monitoring		1,000
• Initiate BASH data collection	1,000	
• Develop, produce, and install an interim interpretive display		12,000

	Funding Agency	
	Navy	FWS
<u>Year 1 (cont'd)</u>		
• Facilitate the availability of equipment for scuba and skin diving	5,000	
• Establish and enforce regulations for taking of fish, shellfish, and corals	1,000	1,000
YEAR 1 TOTAL	36,500	34,000

Year 2

• Investigate UST cleanup through various funding sources	1,000	
• Remove, top, or trim ironwoods as needed to protect structures	2,000	
• Initiate clearance of exotic plants (e.g., ironwood, golden-crown beard) from stands of native plants at Frigate Point	2,000	
• Scarify or pave required clearance areas near airfield and Area 7	8,000	
• Produce and distribute orientation sheet; review and update yearly	1,000	
• Conduct in-person orientation		1,500
• Produce, duplicate, and distribute orientation video		1,000
• Evaluate effects of disturbance on monk seals		2,000
• Develop, produce, and post monk seal information signs at beach access points		11,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,000	2,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Develop and install covers or other avian exclusion devices on open pits and sub-surface control chambers	5,000	1,000
• Evaluate base lighting needs in relation to potential wildlife hazards		1,000
• Develop barrier system to prevent albatross chicks from walking onto major roadways	1,000	1,000
• Close roads not required for normal vehicle circulation to four-wheeled traffic	1,000	

	Funding Agency	
	Navy	FWS
<u>Year 2 (cont'd)</u>		
• Implement vehicular traffic reduction recommendations	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	12,000	
• Initiate rat control efforts in known burrow-nesting seabird colony areas and beach naupaka stands on Sand Island		20,000
• Investigate funding sources to increase rat control efforts throughout the atoll		1,500
• Pursue alternatives for debris removal and habitat restoration on Eastern Island	1,000	1,000
• Continue project consultation protocol	500	500
• Conduct special use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Initiate vegetation monitoring via aerial photography	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		17,000
• Monitor monk seal populations		1,000
• Initiate green sea turtle population monitoring		1,000
• Collect BASH data	500	
• Evaluate location for permanent interpretive display		500
• Develop refuge interpretive brochure		15,000
• Review and develop printing requirements for refuge interpretive brochure		2,000
• Initiate bi-monthly nature interpretation tours		500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
TOTAL YEAR 2	45,000	84,500

Year 3

• Investigate UST cleanup through various funding sources	1,000
• Remove, top, or trim ironwoods as required to protect structures	2,000
• Eliminate ironwoods from Area 7 native plant revegetation plot (40,000 sq ft)	10,000

	Funding Agency	
	Navy	FWS
<u>Year 3 (cont'd)</u>		
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	5,000	
• Scarify or pave required clearance areas around airfield and Area 7 as designated	8,000	
• Establish greenhouse nursery		15,000
• Initiate cultivation of native plants		3,000
• Produce and distribute orientation sheet ; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	2,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Develop and install avian exclusion or escape devices on all enclosures, such as tennis courts, fenced compounds, or similar smaller hazards	10,000	1,000
• Modify base lighting to minimize wildlife impacts	15,000	
• Install ramps in water treatment ponds to provide escapeways for birds	3,000	
• Install barrier system to prevent albatross chicks from wandering onto major roadways	10,000	
• Implement vehicular traffic reduction recommendations and maintain closure of non-essential roads	1,000	
• Control rats in housing areas, work areas, and dump (including dead bird pickup)	12,000	
• Continue rat control efforts in known burrow-nesting seabird areas and naupaka stands on Sand Island		20,000
• Investigate funding sources to increase rat control efforts throughout the atoll		1,000

	Funding Agency	
	Navy	FWS
<u>Year 3 (cont'd)</u>		
• Pursue alternatives for debris removal and habitat restoration on Eastern Island	1,000	1,000
• Continue project consultation protocol	500	500
• Conduct special use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		17,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Implement recommended BASH aircraft operational procedures	1,000	
• Initiate study of albatross flight patterns	20,000	
• Collect BASH data	500	
• Develop plans for permanent interpretive display structure		2,000
• Print and distribute refuge interpretive brochure	8,000	
• Initiate quarterly presentations relating to island wildlife		500
• Conduct bi-monthly nature tours		500
• Facilitate the availability of equipment for scuba and skin diving	5,000	
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Review and revise above regulations		1,000
YEAR 3 TOTAL	118,500	75,500

Year 4

• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in native plant revegetation plot and remove newly sprouted saplings	2,000	1,000
• Remove ironwoods and replant native vegetation in high erosion area test plot (1000 sq ft)	5,000	
• Remove exotic plants from stands of native vegetation at Frigate Point	1,000	

	Funding Agency	
	Navy	FWS
<u>Year 4 (cont'd)</u>		
• Scarify or pave required clearance areas as designated	6,000	
• Cultivate native plants		3,000
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	2,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and maintain closure of non-essential roads	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	12,000	
• Continue rat control efforts in known burrow-nesting seabird areas and naupaka stands on Sand Island		20,000
• Implement increased rat control measures on Sand Island		40,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		17,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	

	Funding Agency	
	Navy	FWS
<u>Year 4 (cont'd)</u>		
• Continue study of albatross flight patterns	20,000	
• Collect BASH data	500	
• Acquire materials and construct permanent interpretive display structure	15,000	
• Develop, produce, and install display materials		20,000
• Provide quarterly presentations relating to island wildlife		1,000
• Conduct bi-monthly nature tours		1,000
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 4 TOTAL	78,500	117,500

Year 5

• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area	2,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Establish native plant revegetation test plot (1,000 sq ft)	3,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,000
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000

	Funding Agency	
	Navy	FWS
<u>Year 5 (cont'd)</u>		
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	3,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain avian exclusion or escape devices on all enclosures	1,000	
• Maintain wildlife sanctuary signs		1,000
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and maintain closure of non-essential roads	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Implement rat control measures on Eastern and Spit islands; continue efforts on Sand Island		70,000
• Continue project consultaion protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography and journalism		2,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
• Provide quarterly presentations relating to island wildlife		1,000
• Conduct bi-monthly nature tours		1,000
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Review and revise above regulations		1,000
TOTAL YEAR	40,000	101,000

	Funding Agency	
	Navy	FWS
Year 6		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Eliminate ironwoods from second section of Area 7 native plant revegetation plot (40,000 sq ft)	12,000	
• Evaluate revegetation in shoreline revegetation area and remove ironwood saplings	3,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Evaluate success of native plant revegetation test plot		1,000
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,000
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beach cast hazards from atoll beaches	3,500	3,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		40,000
• Continue project consultation protocol	500	500

	Funding Agency	
	Navy	FWS
<u>Year 6 (cont'd)</u>		
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations and and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
• Review and update refuge interpretive brochure as required	8,000	2,000
• Provide quarterly presentations relating to island wildlife		1,000
• Conduct bi-monthly nature tours		1,000
• Facilitate availability of scuba diving equipment	5,000	
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 6 TOTAL	68,000	73,000

Year 7

• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area; remove new ironwood sprouts	3,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if test plot is successful	5,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,500
• Produce and distribute orientation sheet; review and update	1,000	

	Funding Agency	
	Navy	FWS
Year 7 (cont'd)		
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Refurbish or replace and post monk seal information signs at beach access points		10,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	4,000	3,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain avian exclusion or escape devices on all enclosures	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Review and revise above regulations		1,000
YEAR 7 TOTAL	43,500	62,000

	Funding Agency	
	Navy	FWS
<u>Year 8</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area; remove new ironwood sprouts	3,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting, if necessary	1,500	
• Clear exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if successful	5,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,500
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beach cast hazards from atoll beaches	4,000	3,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000

	Funding Agency	
	Navy	FWS
<u>Year 8 (cont'd)</u>		
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		13,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 8 TOTAL	48,500	58,000
<u>Year 9</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Eliminate ironwoods from last section of Area 7 native plant shoreline revegetation area(40,000 sq ft)	14,000	
• Evaluate revegetation in shoreline revegetation area and remove ironwood saplings	4,000	1,500
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if successful	5,500	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		3,000
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000

	Funding Agency	
	Navy	FWS
<u>Year 9 (cont'd)</u>		
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	4,500	4,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain avian exclusion or escape devices on all enclosures	1,000	
• Maintain wildlife sanctuary signs		1,000
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures four-wheeled traffic	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Facilitate availability of scuba diving equipment	5,000	
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Evaluate the above regulations		1,000
YEAR 9 TOTAL	64,500	54,000

	Funding Agency	
	Navy	FWS
<u>Year 10</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area	4,000	1,500
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if successful	6,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		3,000
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beach cast hazards from atoll beaches	4,500	4,000
• Remove entanglement hazards from underwater structures		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures four-wheeled traffic	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000

	Funding Agency	
	Navy	FWS
Year 10 (cont'd)		
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 10 TOTAL	51,000	53,500

Basic Section

TABLE OF CONTENTS

II. BASIC SECTION

A. Introduction	II-1
1. Purpose and objectives of the plan	II-1
2. Scope of the plan	II-1
3. Duration of the plan	II-2
4. Regulatory basis	II-2
5. Modifications	II-2
B. Installation Description	II-2
1. Location and land area	II-2
2. Military mission	II-5
3. History	II-5
C. Existing Plans and Policies	II-6
D. Manmade Environment	II-6
1. Existing land uses	II-6
a. Developed grounds	II-6
b. Undeveloped grounds	II-6
c. Land use and facility plans	II-6
d. Circulation	II-6
e. Infrastructure	II-13
2. Cultural and historical resource	II-13
E. Natural Environment	II-13
1. Climate	II-13
2. Topography	II-19
3. Geology	II-19
4. Soils	II-19
5. Hydrology	II-19
6. Vegetation	II-20
7. Wildlife	II-20
8. Wetlands	II-23
9. Floodplains	II-23

TABLE OF CONTENTS (cont'd)

F. Constraints and Opportunities	II-23
1. Conflicts between programs	II-23
2. Special resource areas	II-23

G. References	II-25
---------------	-------

Figures

II-1	Hawaiian Island Chain	II-3
II-2	Midway Atoll	II-4
II-3	Land Use - NAF Midway	II-11
II-4	Circulation	II-12
II-5	Fresh water collection and distribution	II-14
II-6	Ground-water wells	II-15
II-7	Sewage and drainage lines	II-16
II-8	Fuel tanks and hazardous waste dumps	II-17
II-9	Historical sites	II-18
II-10	Vegetation, Sand Island	II-21
II-11	Vegetation, Eastern Island	II-22
II-12	Critical habitat - endangered Hawaiian monk seal	II-24

Tables

II-1	Programs and Policies Affecting Natural Resources at NAF Midway	II-7
------	---	------

Plates

II-1a	NAF Midway airfield, Sand Island
II-1b	Mature ironwood trees, Sand Island

II. BASIC SECTION

A. Introduction

1. Purpose and objectives of the plan

In consonance with federal programs for the management, protection, and conservation of natural resources, it is the policy of the Navy to restore, improve, preserve, and properly utilize natural and cultural resources on Navy lands whenever practicable.

The purpose of the Natural Resources Management Plan for the Naval Air Facility - Midway Island (NAF Midway) is to provide multiple use programs for the management, conservation, and protection of renewable natural resources including forests, fish, wildlife, soil, water, and historical and natural areas. The plan also addresses opportunities for outdoor recreation, where compatible with the military mission and wildlife refuge regulations. All recommended programs in this plan conform to existing laws, regulations, and policies governing natural resources.

The basic sources for the information presented in this plan are the following: the NAF Midway Island Master Plan (Appendix B in the NAS Barbers Point Master Plan) prepared by the Facilities Planning Department of the Pacific Division, Naval Facilities Engineering Command, dated September 1985; the Natural Resources Management Plan for NAS Barbers Point, dated January 1988; the Hawaiian Islands National Wildlife Refuge Master Plan/Environmental Impact Statement, dated May 1986; and the flora and fauna resource surveys and publications of the Pacific Islands Office, U.S. Fish and Wildlife Service. All documents used in the writing of this plan are identified in the list of references at the end of each section of the plan.

2. Scope of the plan

The plan comprises four sections and the executive summary, as follows:

Executive Summary. In the executive summary, the management options recommended in each of the other sections are summarized, evaluated, and ranked as to importance. Schedules and costs associated with implementation of these options are presented in this section.

Basic Section. This section provides a general overview of the format and purpose of the Natural Resources Management Plan and it identifies the existing regulations and policies that affect all aspects of natural resource management. A complete description of the facility and adjacent areas is included in this section.

Land Management Section. Following the guidance of NAVFAC P-73 Navy Real Estate Operations and Natural Resources Management Procedural Manual, Volumes I and II, and NAVFAC MO-100.1, this section of the plan identifies land management issues and objectives and provides recommendations for multiple use programs. Specific issues addressed include coastal erosion, pest and noxious weed control, vegetation management, protection and improvement of the natural landscape, and conservation and enhancement of wildlife habitat.

Fish and Wildlife Section. Following the guidance of NAVFAC P-73, Volume II, and NAVFAC MO-100.3, this section of the plan provides an inventory of the facility's fish and wildlife resources (including threatened and endangered species) and identifies and addresses the key issues for conservation and management of these resources. Specific management objectives and recommended actions dealing with wildlife and wildlife habitat are presented in this section.

Outdoor Recreation Section. Following the guidance of NAVFAC P-73, Volume II, and NAVFAC MO-100.4, this section of the plan provides an inventory of existing and potential outdoor recreation areas and activities, including fishing, sailing, other water sports, and nature photography and interpretation. Issues such as consumptive and non-consumptive uses of natural resources, establishment and protection of nature areas, and management of recreational areas are also addressed.

3. Duration of the plan

The plan is designed to be in effect for ten years. Management recommendations, including implementation costs, are described and prioritized for the ten year period; the implementation schedule is presented in one year increments.

4. Regulatory basis

The plan format is consistent with the directions provided in the following documents: OPNAV-INST 5090.1, Environmental and Natural Resources Protection Manual, Chapter 15; NAVFAC P-73 Navy Real Estate Operations and Natural Resources Management Procedural Manual, Volume I, Chapter 19 - Outleasing, and Volume II, Natural Resources Management; NAVFAC MOs 100.1, 100.2, 100.3, and 100.4. A brief statement of the relevance of each document is presented in Table II-1.

5. Modifications

It is recognized that the proposed natural resources management programs may, in the future, conflict with new or changing military mission or security requirements at the facility. If and when such conflicts occur, it may become necessary to modify this plan.

B. Installation Description

1. Location and land area

Midway Atoll is situated at the northwest end of the Hawaiian Island chain, at 28° N latitude and 177° W longitude, approximately 1150 linear miles from Honolulu, Hawaii (Figure II-1). The nearest emergent land, Kure Atoll, lies 60 miles to the west.

The atoll comprises two larger islands, Sand Island and Eastern Island, and one smaller islet enclosed within a reef approximately five miles in diameter (Figure II-2). Sand Island is about 1.8 miles long by 1.2 miles wide, comprising 1200 acres, and with a maximum elevation of 43 feet ASL. Eastern Island, located one mile east of Sand Island, covers about 800 acres and has a maximum elevation of 35 feet ASL. The smaller islet, Spit Island, is somewhat ephemeral and the area and orientation of its emergent land vary considerably from year to year.

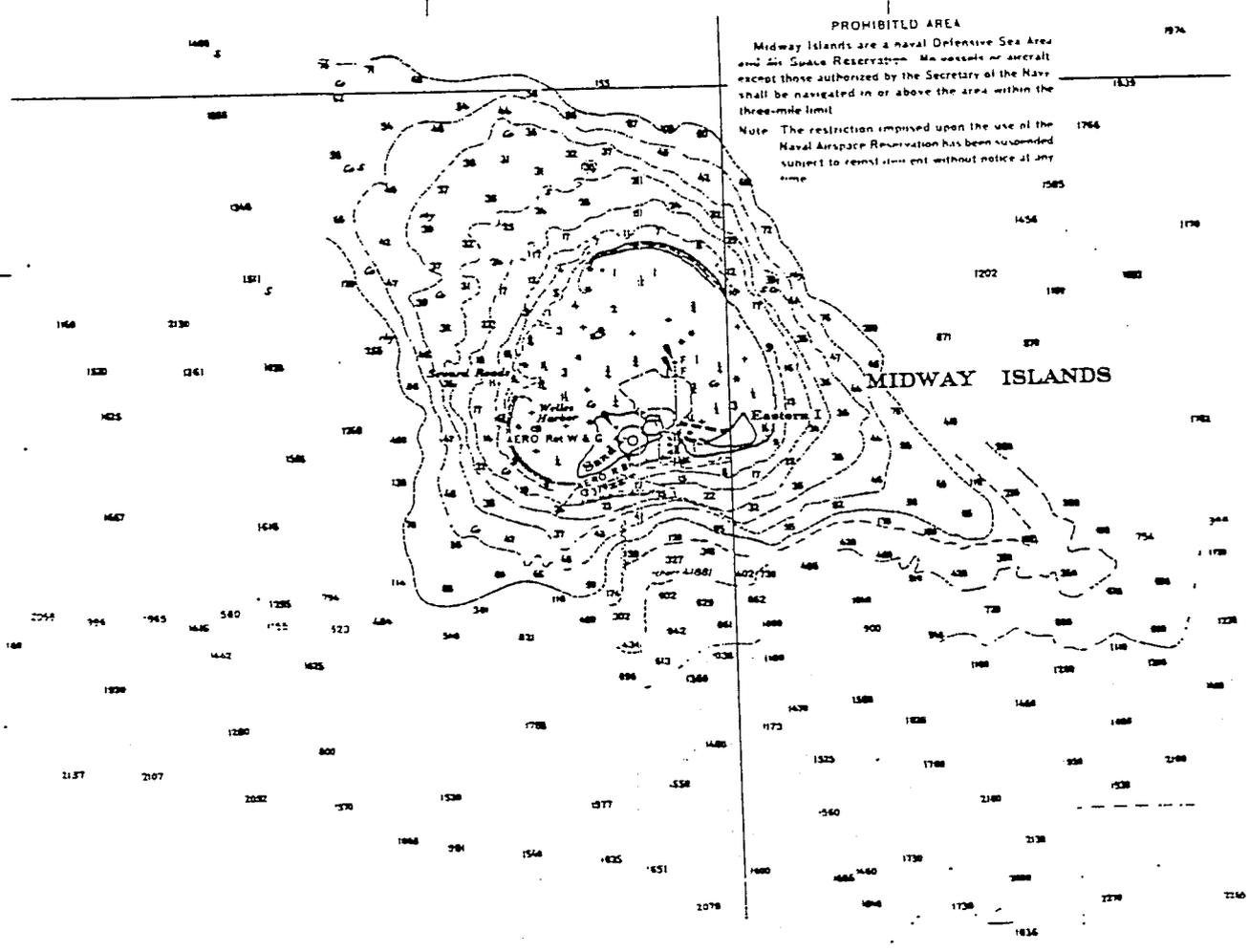
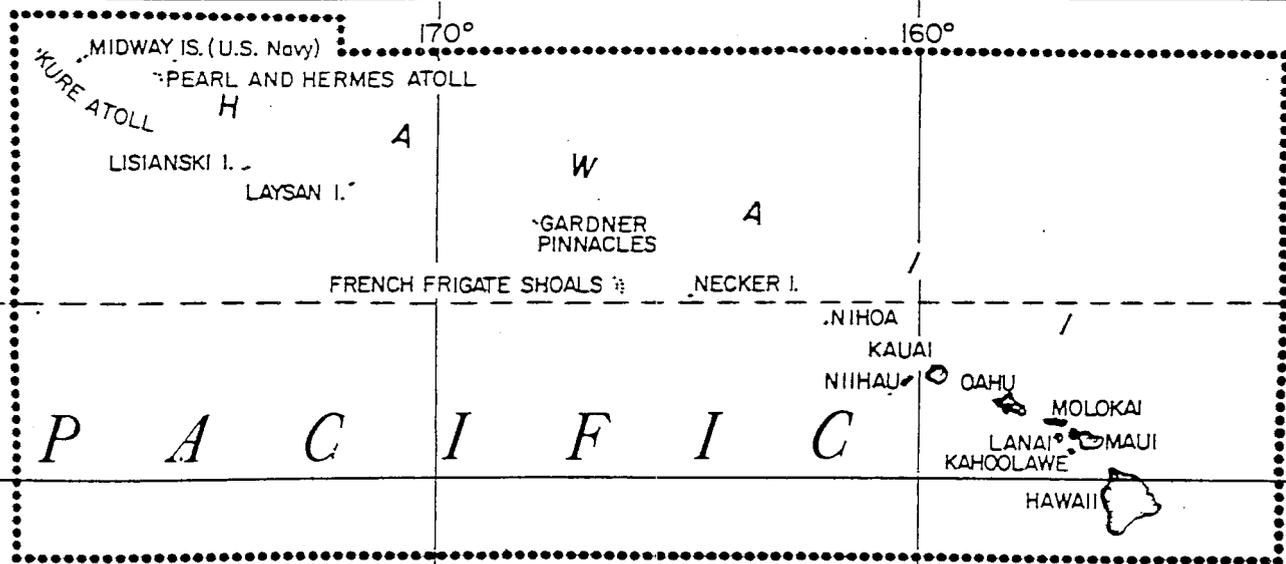
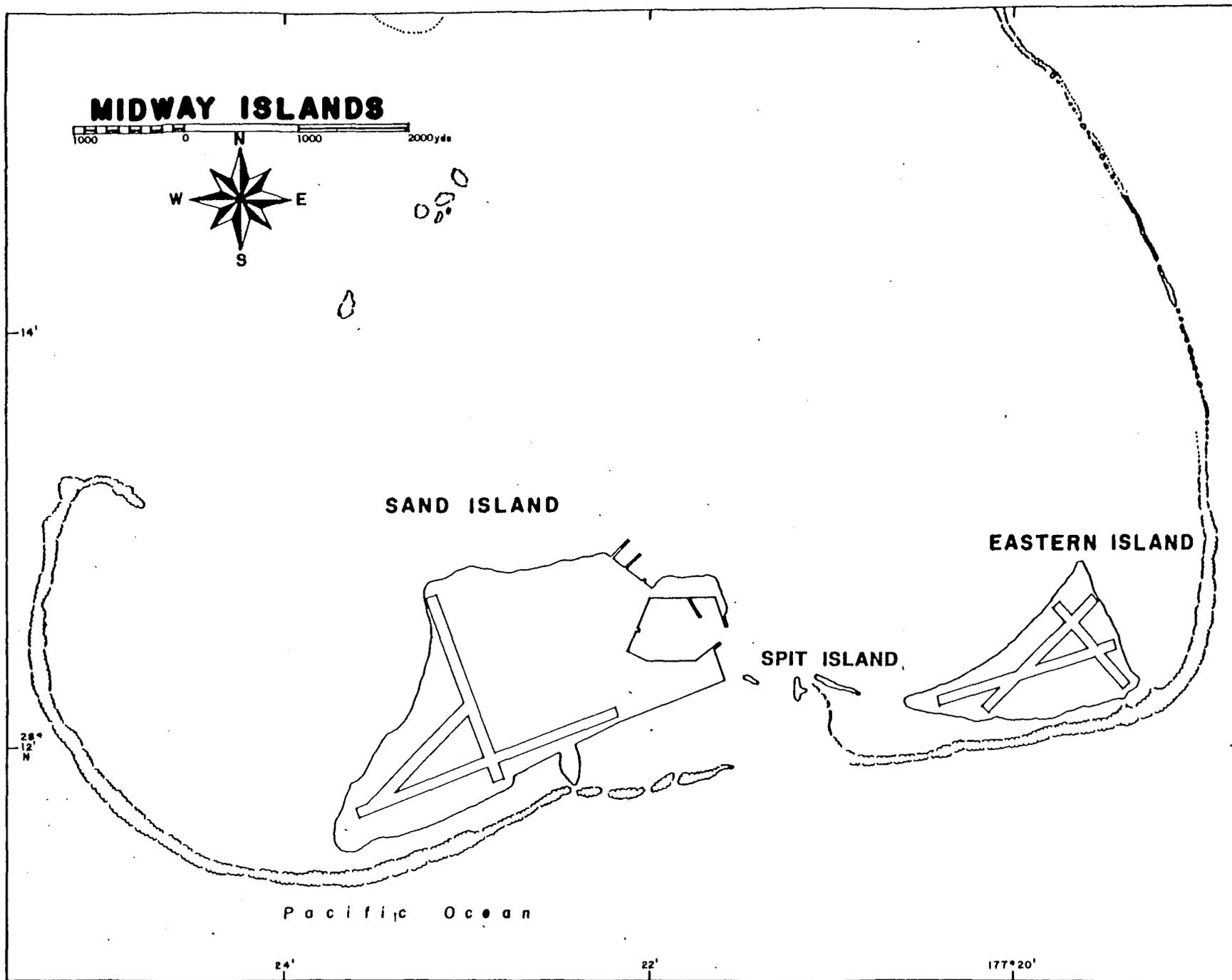


Figure II-1. Hawaiian Island Chain



II-4

Figure II-2. Midway Atoll

2. Military mission

The mission of NAF Midway is to maintain and operate facilities and provide services and material to support operations of aviation activities and units of the operating forces of the Navy and other activities and units, as designated by the Chief of Naval Operations.

The Naval Ocean Processing Detachment Midway Island is a remote detachment of the Naval Ocean Processing Facility, Ford Island, Hawaii and a tenant of NAF Midway. The mission of this detachment is to conduct oceanographic observations to provide the Navy with operational information in selected areas.

3. History

The Midway Islands were formally claimed by the United States on 28 August 1867, by Captain William Reynolds, USN, commanding the USS *Lackawana*. In 1903, by Executive Order of President Theodore Roosevelt, the jurisdiction and control of the Hawaiian Islands (including Midway) was assigned to the Department of the Navy. At that time, the Pacific Cable Company established a permanent station on Sand Island to support operation of the transpacific cable. By 1921, the U.S. Navy had begun using the island as a rendezvous station for naval vessels, and in 1935 an advance base was established. Commercial airline flights were initiated by Pan American World Airways in 1936. In 1940, a U.S. Naval Station was established and subsequently, in June of 1942, Midway became famous as the site of an important World War II battle. During the war, nearly 10,000 people inhabited the atoll, but shortly thereafter the atoll was virtually abandoned. From 1947 through 1952, the airfield facilities were operated by the Civil Aeronautics Administration. In 1950, the base was temporarily reactivated for the Korean airlift. In 1957, a major rebuilding program was initiated at Midway to create a Pacific early warning base. In October of 1978, U.S. Naval Station, Midway Island was redesignated Naval Air Facility Midway Island. Beginning in 1981, base operations were outleased to a civilian contractor. Currently, the population is fewer than 500 residents, the majority of which are civilians.

The Organic Act of 1900 (which established the Hawaiian Islands as a United States Territory) and the Statehood Act of 1959, both specifically excluded the Midway Islands. Thus, Midway is not part of the state of Hawaii and state laws and courts have no jurisdiction.

All federal laws and Executive Orders which apply to military or naval installations apply to Midway Island (including appurtenant reefs and territorial waters). Presidential Executive Order #199-A, dated 20 January 1903, placed the Midway Islands under the jurisdiction and control of the U.S. Navy. Executive Order # 8682, as amended by Executive Order # 8729, established the Naval Defensive Sea Area and Airspace Reservation at Midway and other islands. These orders remain in effect. Executive Order # 11048, dated 4 September 1962, authorized the Secretary of the Navy to be responsible for the civil administration of Midway Island, and granted judicial authority, other than that contained in the act of 15 June 1950, as amended (48 U.S.C. 644a). Jurisdiction and control as assigned by Executive Order # 199-A were continued and 199-A superseded.

On 22 April 1988, Midway Atoll was designated an overlay National Wildlife Refuge, a unit of the Hawaiian and Pacific Islands National Wildlife Refuge Complex. Within the limits of the military mission, all regulations applicable to national wildlife refuges apply also to the Midway Islands.

C. Existing Plans and Policies

Federal, Department of Defense (DOD), and Navy policies and programs that affect natural resources management at NAF Midway are summarized in Table II-1. Navy policy on natural resources management is set forth explicitly in OPNAVINST 5090.1, as follows:

In consonance with federal programs for the management and conservation of natural resources, it is the policy of the Navy to restore, improve, preserve, and properly utilize natural resources on Navy administered lands.

All Navy installations shall be managed in consonance with the Naval mission assigned so as to provide for multiple-use management of natural resources to:

1. Protect, conserve, and manage the watersheds and natural landscapes, the soil, the beneficial forest and timber growth, fish and wildlife, and other natural resources, as vital elements of an optimal natural resources program
2. Utilize and care for natural resources in the combination best serving the present and future needs of the United States and its people
3. Provide for the optimum development of land and water areas and access thereto while maintaining ecological integrity.

D. Manmade Environment

1. Existing land uses

- a. **Developed grounds.** About 40% of emergent lands on Sand Island are ascribed to base operations and support, while the remainder consists of recreation/conservation, abandoned/undeveloped, and open space constrained by airfield activities and antennas (Plate II-1a). Existing land use practices are presented in Figure II-3. All emergent lands on Eastern Island are considered abandoned/unimproved.
- b. **Undeveloped grounds.** Approximately 1000 acres are considered unimproved property, but virtually all of Midway Atoll has been used for some type of military activity in the past. Abandoned lands, including all of Eastern Island and parts of Sand Island, feature extensive areas of runway and other pavement and some abandoned structures.
- c. **Land use and facility plans.** The subject of land use is addressed in the NAF Midway Island Master Plan. Approved in September of 1985, this plan "provides guidelines for land use and facility development for the mid-range (five to eight years)" for the facility. Existing and proposed land uses for the facility are set forth in Master Plan Figure BB-4 which constitutes the Land Use Plan for NAF Midway. A modified version of Figure BB-4 is presented here as Figure II-3.

Two other plans relating to land use are the Facilities Requirements Plan (dated 26 April 1985) which identifies facility assets and deficits, and the Capital Improvements Plan (CIP), which provides a link between the long term Land Use Plan and the proposed construction and repair projects anticipated in the near future.

- d. **Circulation.** The existing roadway network for NAF Midway is shown in Figure II-4.

TABLE II-1

Programs and Policies Affecting Natural Resources at NAF Midway

Federal Laws

Public Law 74-461: Soil Conservation.

Provides for application of soil conservation practices on federal lands.

Public Law 86-797: Sikes Act, as amended.

Requires each military department to ensure services are provided which are necessary for management of fish and wildlife resources on each installation, to provide their personnel with professional training in fish and wildlife management, and to give priority to contracting work with federal and state agencies having responsibility for conservation or management of fish and wildlife.

Public Law 93-0205: Endangered Species Act, as amended.

Provides that all federal agencies ensure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of habitat of such species which is determined to be critical.

Public Law 91-190: National Environmental Policy Act.

Requires that agencies of the Federal Government shall prepare an environmental impact statement for, among other things, "major federal actions significantly affecting the quality of the human environment."

Public Law 65-186: Migratory Bird Treaty Act, as amended.

Implements and provides for enforcement of regulations to protect migratory birds and their nests and eggs.

Public Law 92-522: Marine Mammal Protection Act.

Provides for enforcement of regulations to protect cetaceans and pinnipeds.

Public Law 89-669: National Wildlife Refuge System Administration Act of 1966.

Establishes policies and directives for administration and management of all areas in the National Wildlife Refuge System.

Public Law 85-624: Fish and Wildlife Coordination Act, as amended.

Specifies a process of coordination between the Fish and Wildlife Service and other federal agencies engaged in water resource projects that may affect fish and wildlife resources.

Public Law 87-714: Refuge Recreation Act.

Authorizes the administration of refuges for recreational use, when such uses do not interfere with the refuge's primary use.

Public Law 100-653: Refuge Trespass Act of 1909.

Makes it unlawful to hunt, trap, capture, willfully disturb, or kill any bird or wild animal on a refuge, unless authorized by specific regulations.

Public Law 96-366: Fish and Wildlife Conservation Act (Non-game Act), as amended.

TABLE II-1 (cont'd)

Programs and Policies Affecting Natural Resources at NAF Midway

16 USC 470: National Historic Preservation Act.

Requires federal, federally assisted, and federally licensed undertakings affecting properties included in the National Register of Historic Places be submitted to the Advisory Council on Historic Preservation for review and comment prior to the approval of any such undertaking by a federal agency.

Title 33 USC 1311: Clean Water Act.

Prohibits various activities which may result in the discharge of pollutants into navigable waters, unless an appropriate permit is first obtained. Section 404 prohibits discharge of dredged or filled material into waters of the United States, including wetlands, without first obtaining a permit from the U.S. Army Corps of Engineers.

Public Law 90-583: Noxious Plant Control.

Provides for the control of noxious plants on lands under control or jurisdiction of the Federal Government.

Public Law 93-629: Federal Noxious Weed Act of 1974.

Provides for the control and eradication of noxious weeds and their regulation in foreign commerce.

Public Law 97-321: Leases: Non-excess Property.

Provides for the outleasing of public lands.

Title 50, Code of Federal Regulations.

Sets forth regulations concerning wildlife and administration of wildlife refuges.

16 USC 670a-670f: Conservation Program on Military Reservations.

10 USC 2671: Military Reservations and facilities: Hunting and trapping.

Regulates hunting, fishing and trapping on military reservations and facilities.

Title 10 USC 2667(d): Leases: Non-excess property.

Provides for the outleasing of military lands.

Natural Landmarks Program.

Program administered by the Heritage Conservation and Recreation Service (HCRS) for the purpose of preserving nationally significant areas of ecological, biological, and geological importance.

TABLE II-1 (cont'd)

Programs and Policies Affecting Natural Resources at NAF Midway

Executive Orders

Executive Order 1019, as amended: Hawaiian Islands National Wildlife Refuge.

Sets aside the islands and reefs of the northwestern Hawaiian Island chain for the preservation of native birds and their breeding grounds. Presidential proclamation No. 2466 directed the incorporation of these islands and reefs into the National Wildlife Refuge System.

Executive Order 11514: Protection and Enhancement of Environmental Quality.

Directs issuance of instructions and guidelines relative to preparation of environmental impact statements.

Executive Order 11593: Protection and Enhancement of the Cultural Environment.

States that the federal government shall provide leadership in preserving, restoring and maintaining the historic and cultural environment of the nation.

Executive Order 11988: Floodplain Management.

Requires federal agencies to evaluate effects of actions they take on flood plains.

Executive Order 11989: Off-road Vehicles on Public Lands.

Provides for closing areas to use where soil, wildlife or other resources are adversely affected.

DOD Directives

Directive 4700.4 of January 1989: Natural Resources Conservation and Management (NOTAL).

Establishes fundamental land management policies and procedures for all military lands. Establishes a program for fish and wildlife management. Sets forth the policy of the DOD to permit public access to outdoor recreation resources to the greatest degree possible, consistent with the installation's safety and security requirements and its available manpower and natural resources to support such activities without degradation or impairment of environmental qualities or of military morale, welfare, and recreation programs.

Directive 6050.2 of 19 April 1979 (as amended): Use of Off-road-use Vehicles on DOD lands (NOTAL).

Provides policy for use of off-road vehicles on DOD lands.

Memorandum of Understanding between the Secretaries of Interior and Defense (7 April 1978) for the development of public outdoor recreation resources on military reservations.

Memorandum of Understanding between the Secretaries of Interior and Defense 1978. Conservation of fish and wildlife resources on military reservations.

TABLE II-1 (cont'd)

Programs and Policies Affecting Natural Resources at NAF Midway

Navy

SECNAV Instruction 6240.6E: Department of the Navy Environmental Protection and Natural Resources Management Program.

Assigns responsibility to the Chief of Naval Operations for the development and implementation of natural resources management programs on all land and water areas under the jurisdiction of the Department of the Navy.

NAVFAC P-73, Vol. I: Chapter 19.

Provides direction and guidance for out-leasing of Navy real property.

NAVFAC P-73, Vol. II: Land Management chapter.

Directs each installation which controls at least 30 acres of land unoccupied by structures, facilities, or pavement to implement and maintain a balanced and integrated program for soil and water management, and prepare and implement a land management section of the installation natural resources plan.

NAVFAC P-73, Vol. II: Fish and Wildlife Management chapter.

Sets forth the authority, responsibilities, and procedures for the conservation and management of fish and wildlife resources under the jurisdiction of the Chief of Naval Operations.

NAVFAC P-73, Vol. II: Outdoor Recreation chapter.

OPNAVINST 5090.1.

Requires outdoor recreation management plans for installations which have natural resources that can be managed for outdoor recreation.

OPNAVINST 5090.1, Chapter 15.

Establishes a policy that the Navy will conserve, develop, manage, and maintain land, grounds, and water areas under Navy jurisdiction with proven scientific methods, procedures, and techniques.

NAVFAC MO-100.1.

Provides technical guidance and a sample plan outline for land management.

NAVFAC MO-100.3.

Provides technical guidance for establishing goals and objectives and planning requirements for habitat protection, wildlife inventory and wildlife population management.

NAVFAC MO-100.4. Outdoor Recreation and Cultural Resources.

NAVFACINST 7110.18C.

Provides guidelines on the use of soil conservation and natural resources funds.

NAVFAC P-960: Installation Design.

Sets forth the Navy policy to permit public access to outdoor recreation resources to the greatest degree possible, consistent with the installation's safety and security requirements and its available manpower and natural resources to support such activities without degradation or impairment of environmental qualities.

Memorandum of Agreement between the Naval Facilities Engineering Command and the U.S. Fish and Wildlife Service (13 November 1985).

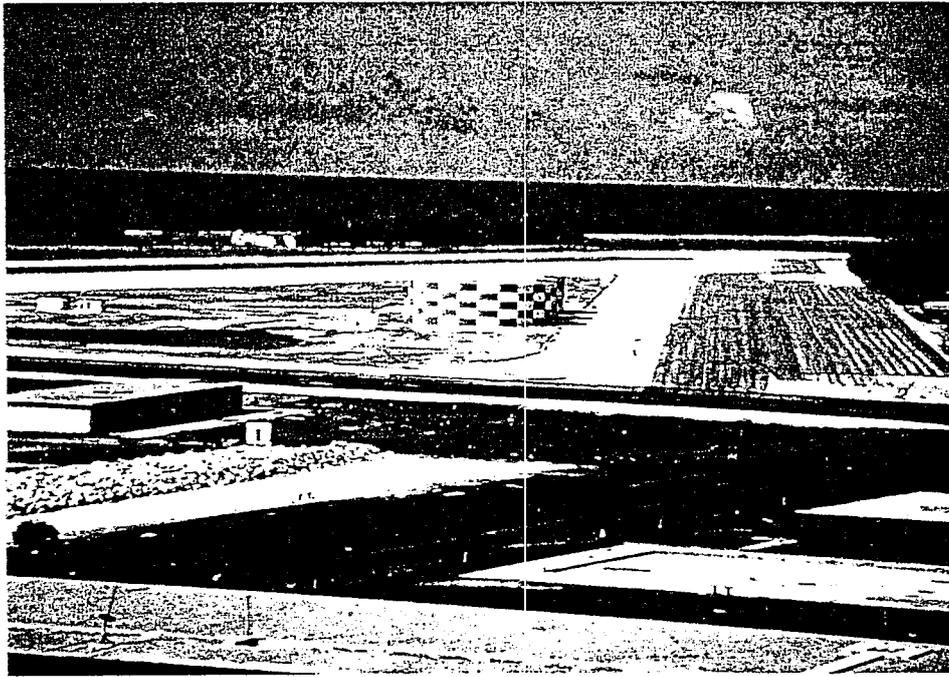
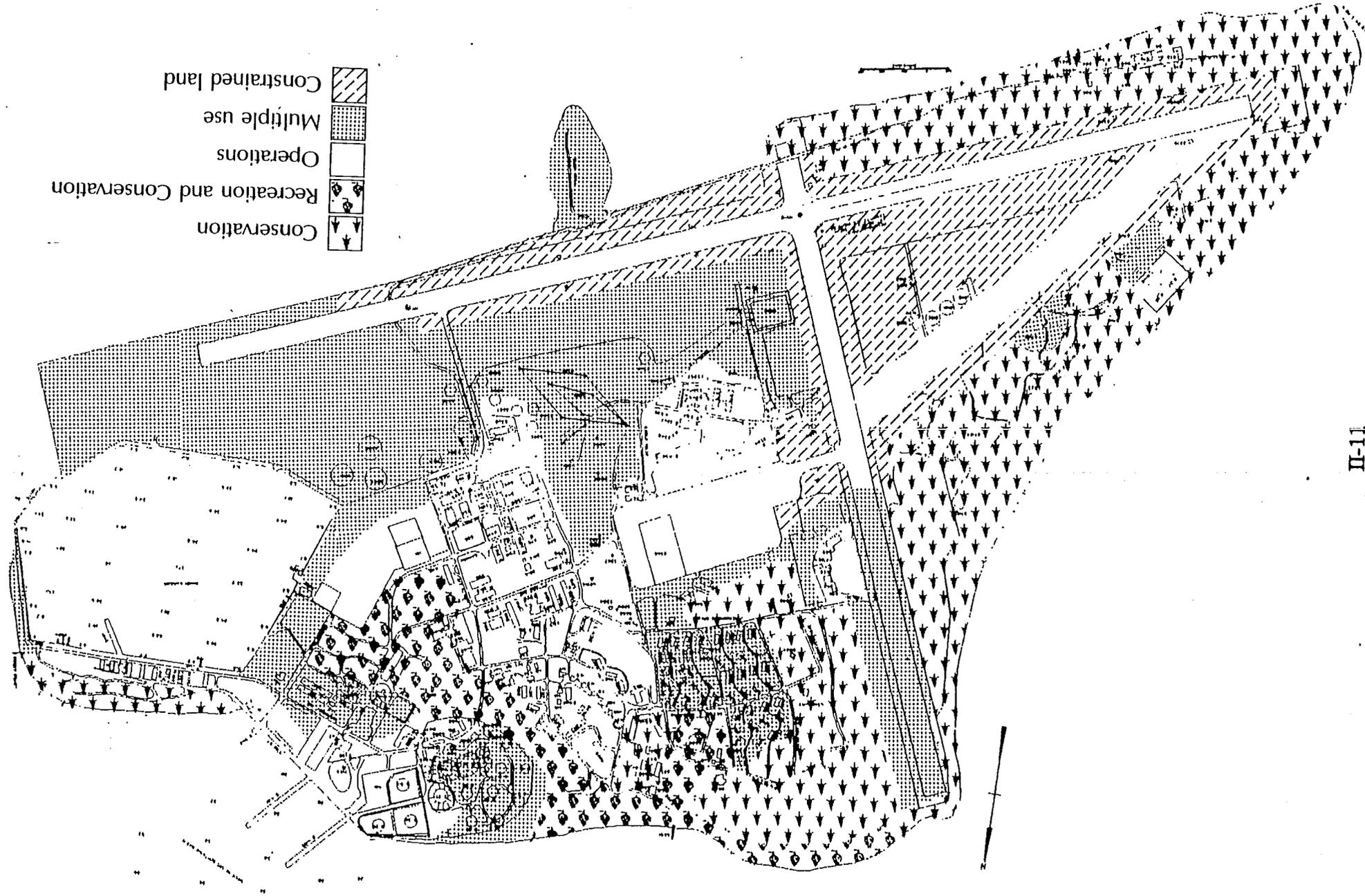


Plate II-1a. NAF Midway airfield, Sand Island



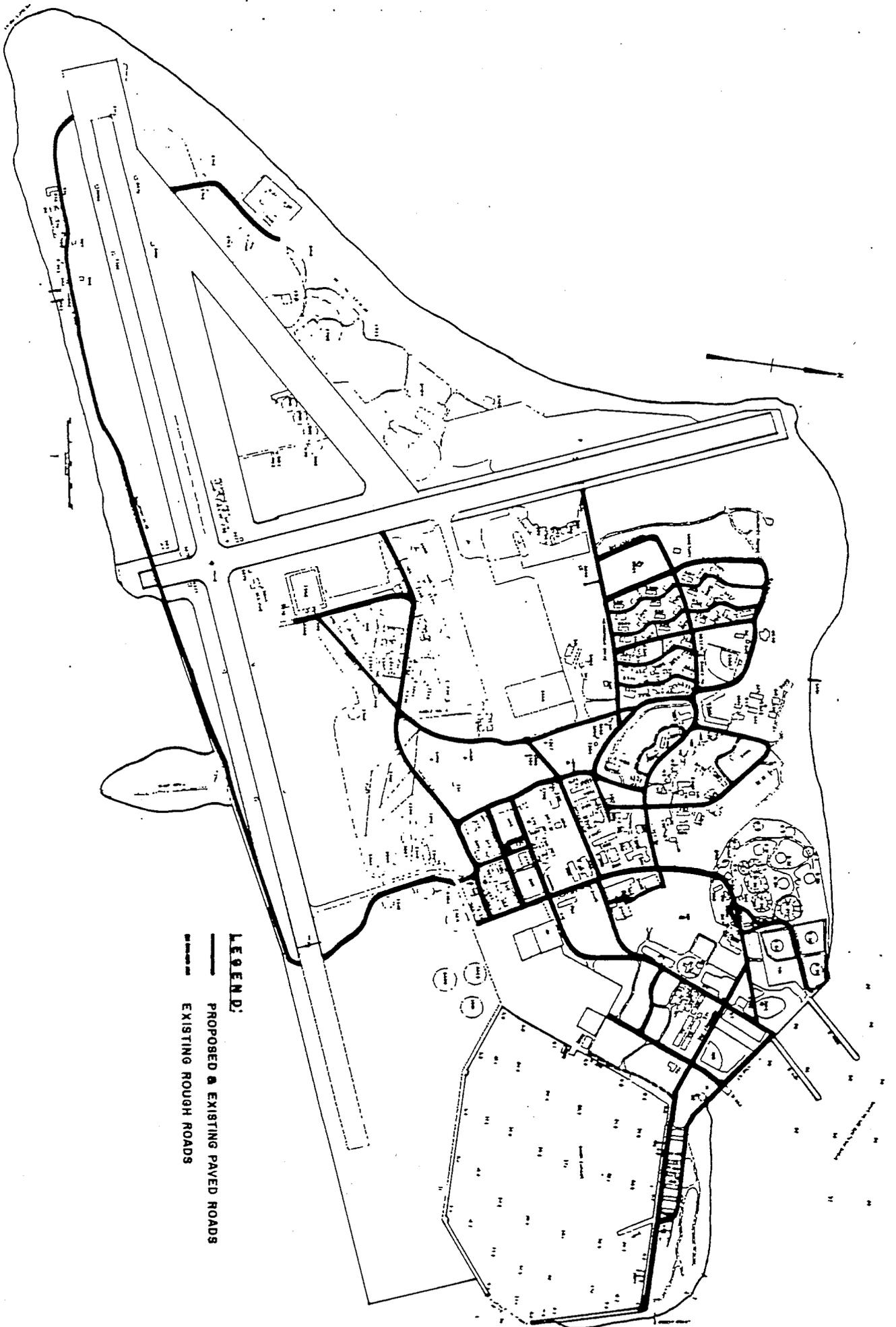
Plate II-1b. Mature ironwood trees, Sand Island

Figure II-3. Land Use - NAF Midway



- Conservation and Conservation
- Recreation and Conservation
- Operations
- Multiple use
- Constrained land

Figure II-4. Circulation



e. Infrastructure

Water Supply. Fresh water supplies on Sand Island are limited to rainwater collected in a 220 acre catchment basin adjacent to runway 6-24 (see Plate II-1a). Raw rainwater is stored in three above ground tanks and then piped to the treatment facility where it is chemically treated, settled, and prechlorinated. It is then pumped through rapid sand filters and stored in two underground tanks prior to distribution. The location of the fresh water collection and distribution system is shown in Figure II-5.

There are eleven shallow ground-water wells on Sand Island, nine of which are active. Well locations are shown in Figure II-6. These wells pump water from the brackish ground water lens. Brackish water is blended with fresh water during periods of low rainfall.

Existing sources of potable water are normally sufficient to support base operations at current levels; however, periods of low rainfall have occasionally led to mandatory water rationing.

Sewage and Drainage. Existing sewage and drainage lines are shown in Figure II-7.

Fuel and Hazardous Waste Storage. Existing and abandoned fuel tanks and hazardous waste dumps are shown in Figure II-8.

2. Cultural and historical resources

There is no known evidence of human occupation of Midway before its discovery by Captain M. C. Brooks in 1859; however, no intensive archaeological survey has been conducted on the atoll. It is possible that a survey would reveal such evidence.

The Commercial Pacific Cable Company Site, which includes five buildings (#619, 623, 626, 628, and 643) on Sand Island has been determined by the Secretary of the Interior to be eligible for inclusion in the National Register of Historic Places. Originally constructed by the Commercial Pacific Cable Company, these buildings are the only remnants of the initial permanent colonization of the Midway Islands.

Several World War II-era military facilities have been designated a national historic landmark. They include: ammunition magazines S-7113, S-7119, S-7121, S-7124, S-7125, and S-6194; the concrete pillbox near S-7125; one and one half emplacements for the three-inch guns of the Third Defense Battalion's Battery D; and two emplacements for the three-inch naval battery.

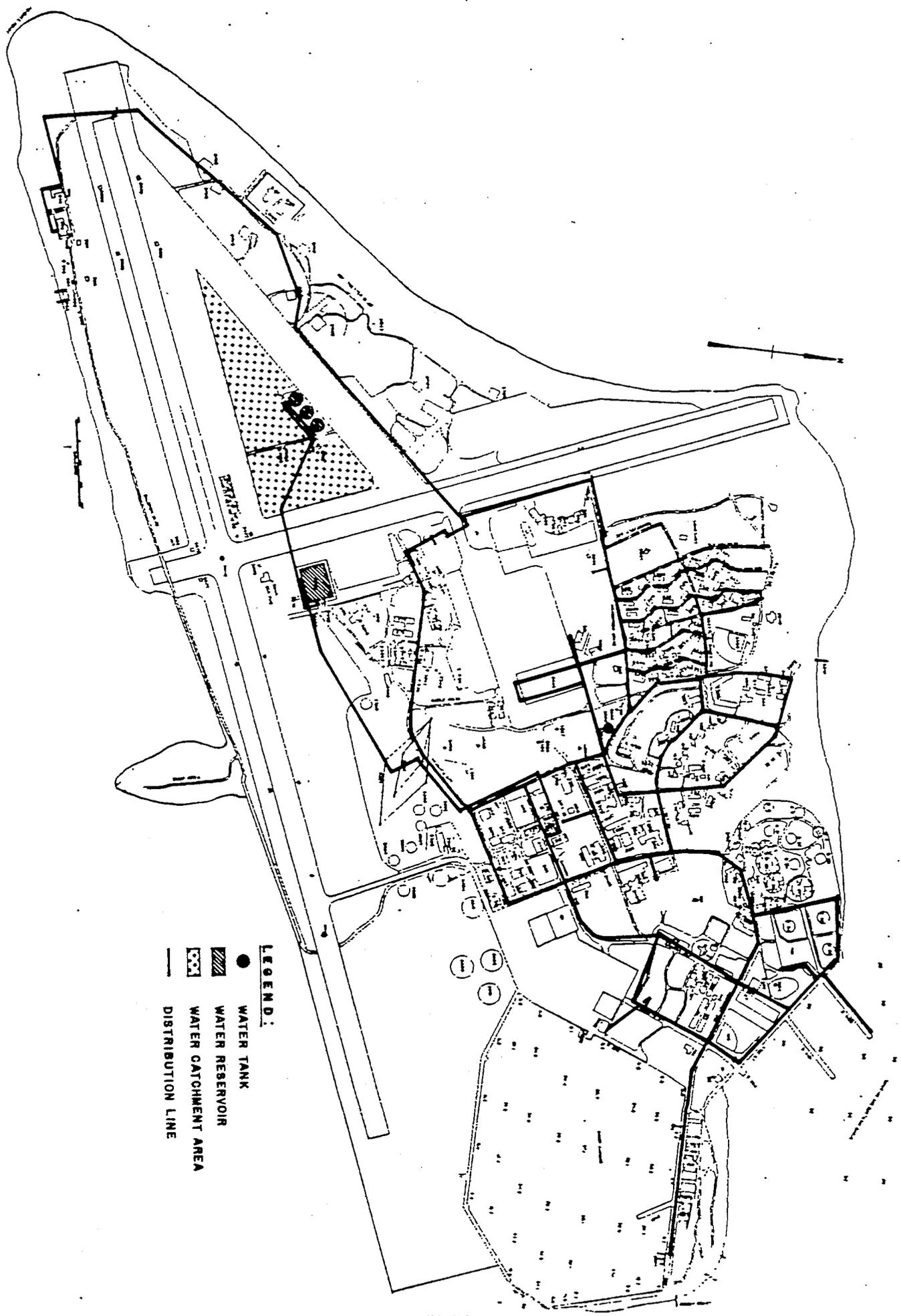
The locations of all structures designated or under consideration for historic status are presented in Figure II-9.

E. Natural Environment

1. Climate

Midway Atoll's small size, low profile, and isolated location result in a climate that is determined primarily by the surrounding oceanic environment. During the summer (May through October), the atoll is surrounded by the warm waters of the North Pacific Gyre, resulting in fair weather, warm temperatures (70° to 90° F), and northeasterly trade winds. During winter (December

Figure II-5. Fresh water collection and distribution



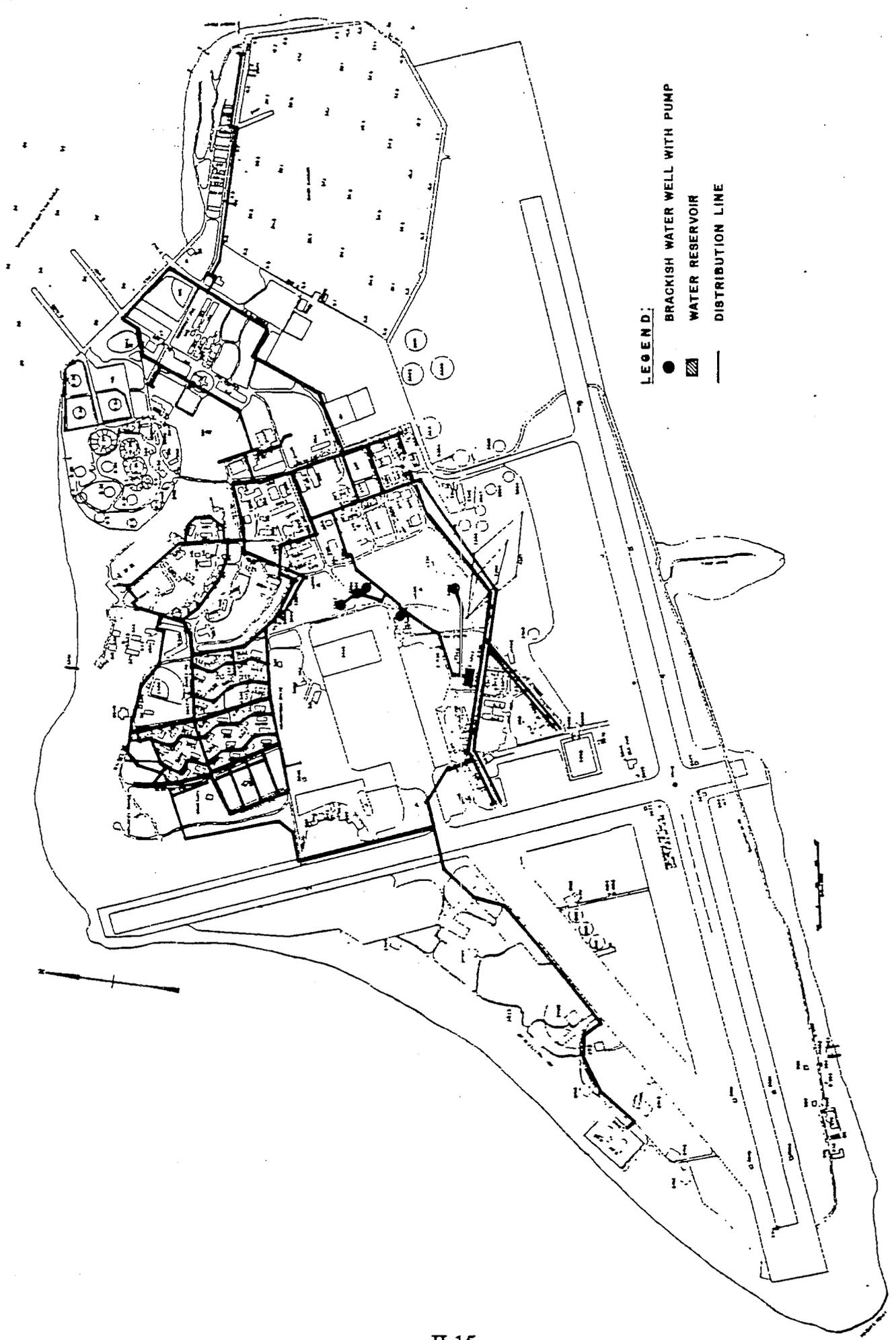
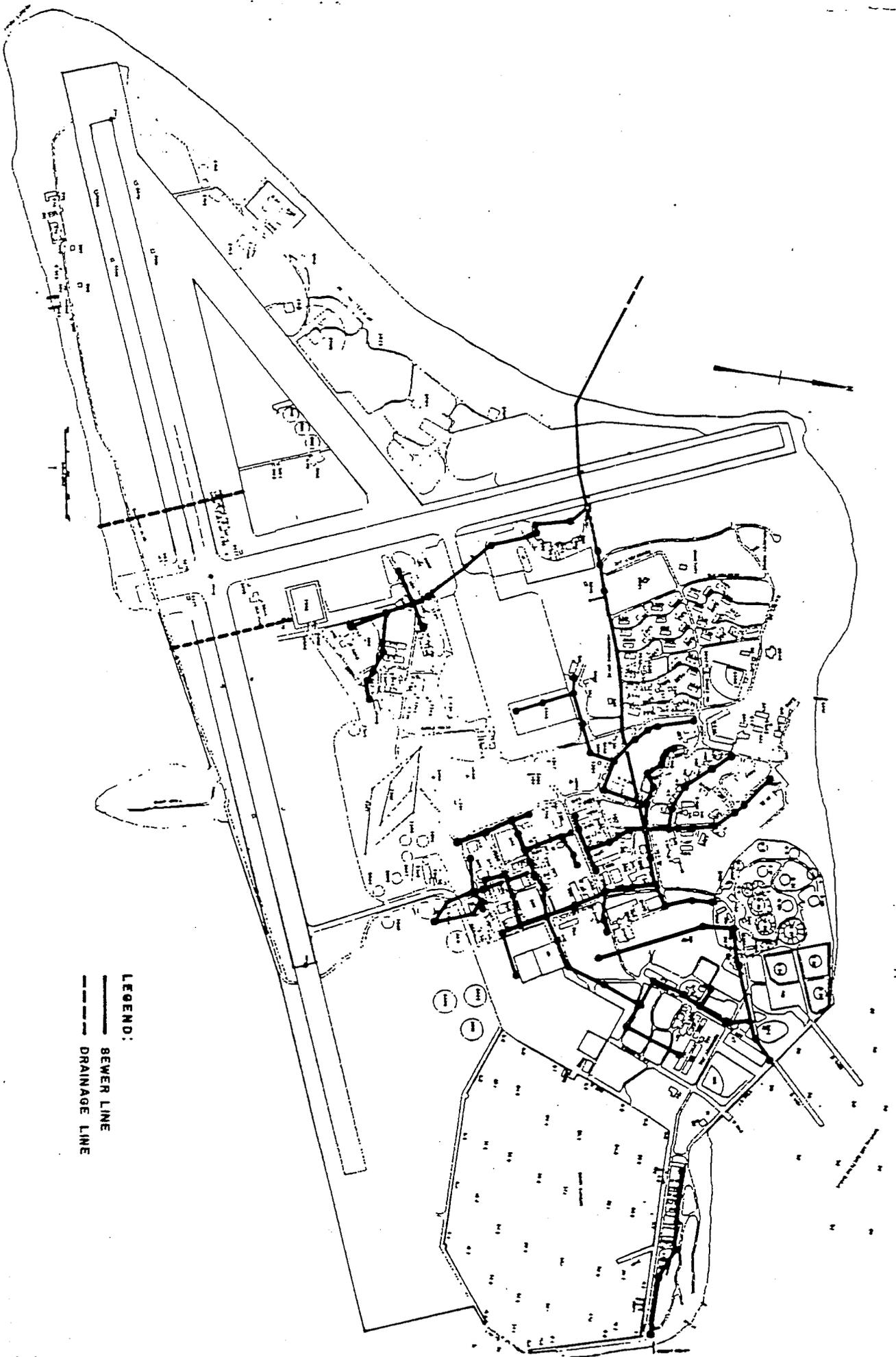
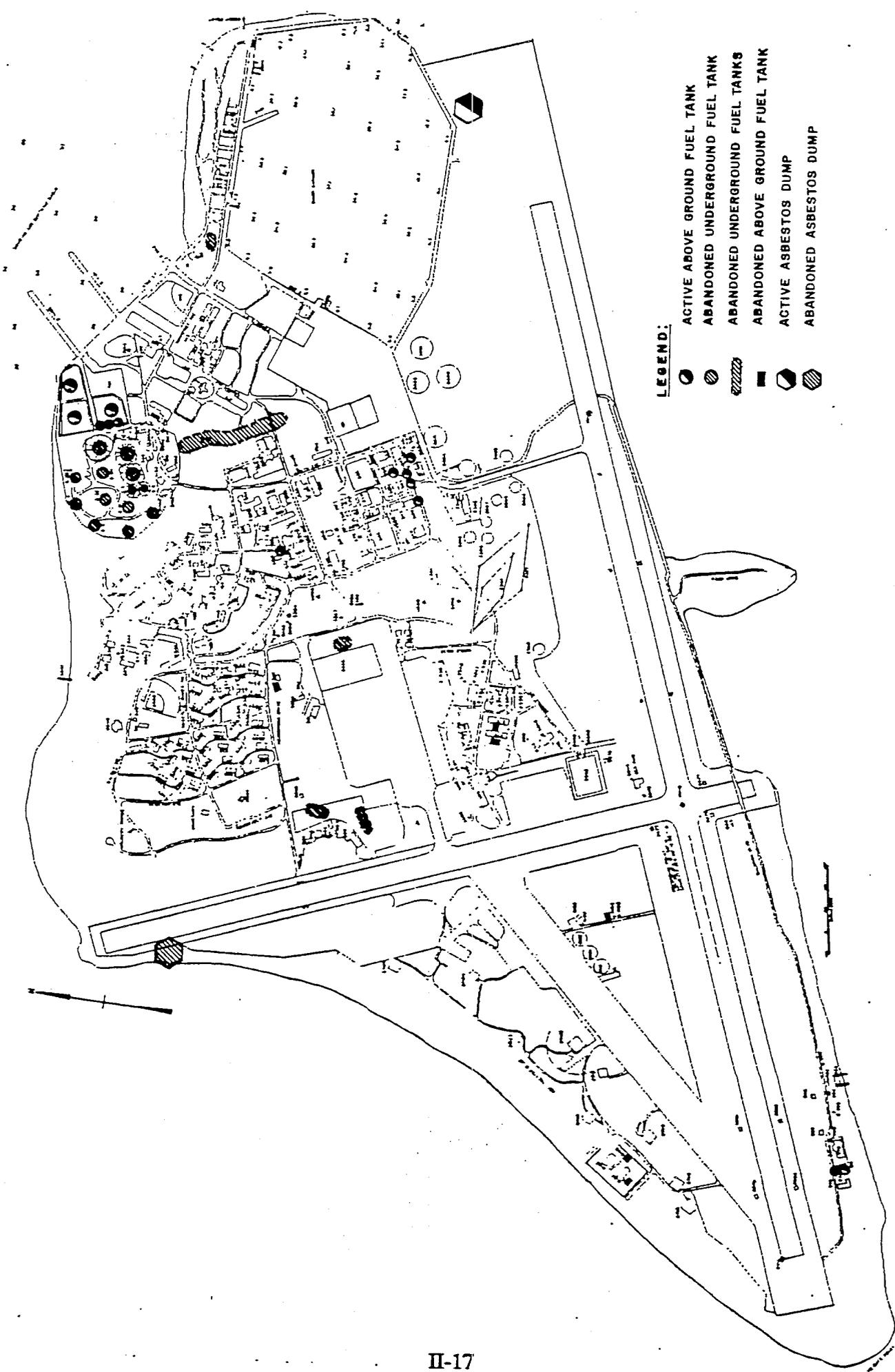


Figure II-6. Ground-water wells

Figure II-7. Sewage and drainage lines

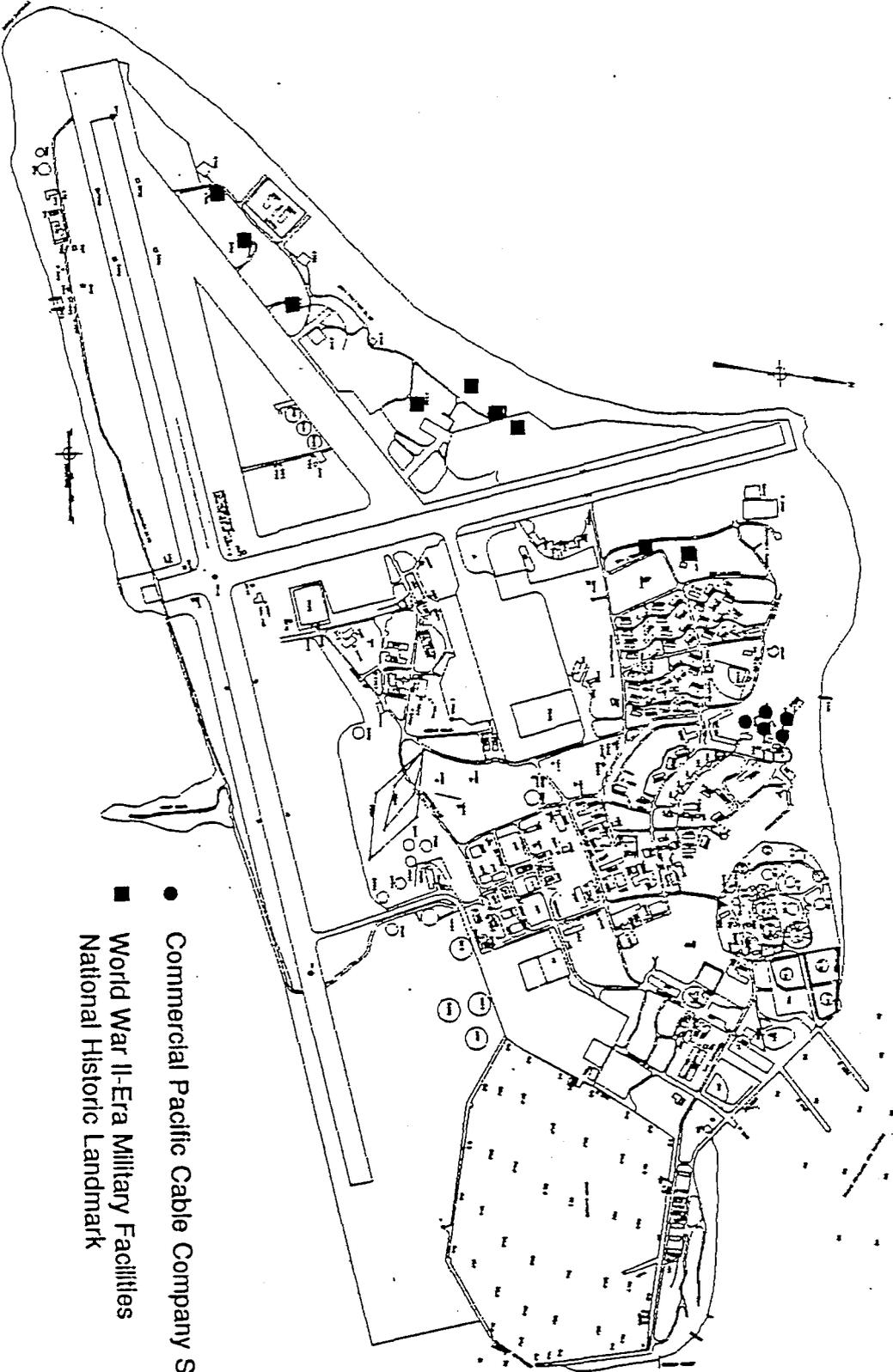




LEGEND:

- ACTIVE ABOVE GROUND FUEL TANK
- ABANDONED UNDERGROUND FUEL TANK
- ▨ ABANDONED UNDERGROUND FUEL TANKS
- ▩ ABANDONED ABOVE GROUND FUEL TANK
- ACTIVE ASBESTOS DUMP
- ▨ ABANDONED ASBESTOS DUMP

Figure II-8. Fuel tanks and hazardous waste dumps



- Commercial Pacific Cable Company Site Building
- World War II-Era Military Facilities
National Historic Landmark

Figure II-9. Historic Properties

through March), colder subarctic waters move nearer the atoll, bringing colder air temperatures (60° to 75° F) and strong southwesterly winds, often accompanied by rainstorms and squalls.

Rainfall occurs at Midway throughout the year, but the average annual total is a modest 42 inches (range: 20 to 69 inches). Historically, the peak months of accumulation have been December through March, but during the past decade January-February and August-September have been the wettest periods. The average relative humidity is 76 percent.

Wind velocity averages about 10 knots, but squalls of up to 30 or 40 knots can occur in any month. Midway has not been struck by a typhoon in recorded history, and the atoll does not lie in a typhoon or tropical storm track. Still, occasional episodes of near-typhoon-force winds (>64 knots) have been reported.

2. Topography

No topographic chart is available for Midway, but the islands are basically flat. The only relief on Sand Island are low hills and dunes, none of which rises more than 50 feet ASL. Eastern Island features a flatter terrain than Sand Island.

3. Geology

Midway is a coral atoll. It originated millions of years ago as a volcano near the present position of the island of Hawaii. After cessation of vulcanism, the island moved gradually northward as part of the Pacific plate to its current location. Erosion and submergence subsequently reduced the original high volcanic peak to a low volcanic island with a fringing coral reef. During the past 15 million years, the calcareous shells of marine plants and animals have accumulated atop the summit of the volcano, producing the atoll that is present today. In 1965, the U.S. Geological Survey determined by drilling that this accumulated material, primarily limestone or "reef rock", was 568 feet thick atop Sand Island and over 1650 feet thick in the lagoon.

The floor of the lagoon, or reef flat, is an irregular collection of coral knolls, composed of actively growing corals and algae, separated by flats covered with a thin sediment layer of coralline and algal debris. The surface layers of the atoll's islands are composed of this debris (e.g., sand, rubble) that winds, waves, and currents have moved from the reef flat and piled atop the reef rock platform. Most of this material is unconsolidated.

4. Soils

No detailed analysis of the island soils has been conducted. The surface layers are composed primarily of coralline and algal debris (e.g., sand, rubble) that has been deposited atop the reef rock platform. Many of the vegetated areas in the interior of Sand Island are covered by a significant soil layer. Over 9000 tons of soil were shipped to Midway from Honolulu in the early 1900s and other shipments may have occurred in more recent times. The increase in vegetation and bird guano during the past 80 years has certainly led to increased surface humus layers.

5. Hydrology

On small islands such as Sand and Eastern, ground water is expected to be in equilibrium with the surrounding sea water. If sufficient rainfall occurs a freshwater lens develops and fresh water dis-

charges into the ocean. If water is pumped out of the aquifer more rapidly than it is replaced by rain, salt water intrusion will result.

Ground water level near the center of Sand or Eastern island is not expected to be more than a few feet above mean sea level. Water level may be much lower during periods of low rainfall and heavy well pumping.

6. Vegetation

Prior to the establishment of permanent human habitations, the islands were nearly devoid of plant life. Today, the larger islands (Sand, Eastern, and Spit) are extensively vegetated, primarily with introduced species, many of which have become naturalized (Plate II-1b).

Introduced in 1903, the ironwood tree (*Casuarina equisetifolia*) has colonized vast areas of all islands and become the predominant plant throughout the atoll. Ironwoods have provided shelter from sun, wind, and wind-driven sand and salt, enabling a wide variety of exotic plant species to become established. The greatest diversity of introduced plants is found in the interior of Sand Island, where mature ironwoods coexist with a variety of cultivated species. In abandoned areas, denser forests of younger ironwoods predominate, while unshaded clearings are overgrown by introduced herbs, such as golden crown-beard (*Verbesina encelioides*) and wild poinsettia (*Euphorbia heterophylla*).

The other distinct plant community consists of the remnant stands of native dune-binding species, primarily beach naupaka (*Scaevola sericea*) and heliotrope (*Tournefortia argentea*). Formerly common along the coastal strand of Sand Island and over much of Eastern Island, these plants have been greatly reduced through shading by ironwoods and herbivory by introduced rats. The only sizeable stand of naupaka on Sand Island is located at Frigate Point.

The distribution of major vegetation zones on Sand Island and Eastern Island, respectively, are presented in Figures II-10 and II-11. For additional details on the vegetation of Midway Atoll, refer to Section IV - Fish and Wildlife.

7. Wildlife

Midway Atoll supports an abundant and diverse wildlife fauna, including migratory seabirds, endangered Hawaiian monk seals, threatened green sea turtles, and a complex community of coral reef fishes and invertebrates.

Indigenous seabirds represent the most conspicuous element of the fauna. Fifteen species, comprising over one million individuals, nest on the atoll each year. Midway features the world's largest colony of Laysan Albatross and the largest colonies of Red-tailed Tropicbirds, Black Noddies, and White Terns within the Hawaiian chain. Small numbers of endangered Short-tailed Albatross visit the atoll each year and the Bristle-thighed Curlew, a candidate endangered species, is commonly seen during migration.

A small population of the endangered Hawaiian monk seal hauls out on atoll beaches throughout the year. In recent years pups have been born in undisturbed areas. Green sea turtles are frequently encountered inside the lagoon and nesting could potentially occur in the future. A small population of protected spinner dolphins rest and raise calves within the lagoon. The coral reef supports over 130 species of fishes, plus lobsters and other invertebrates.

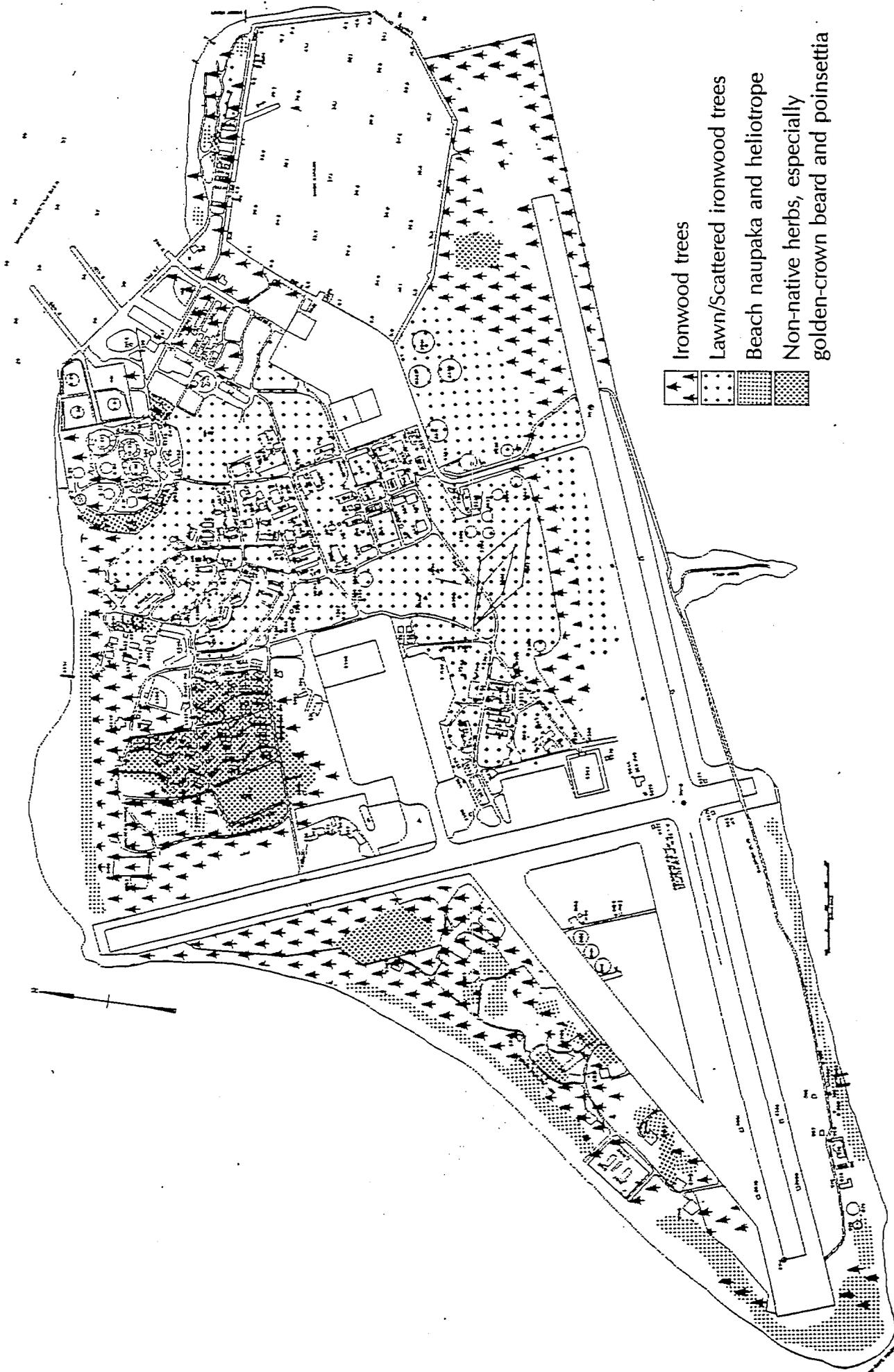
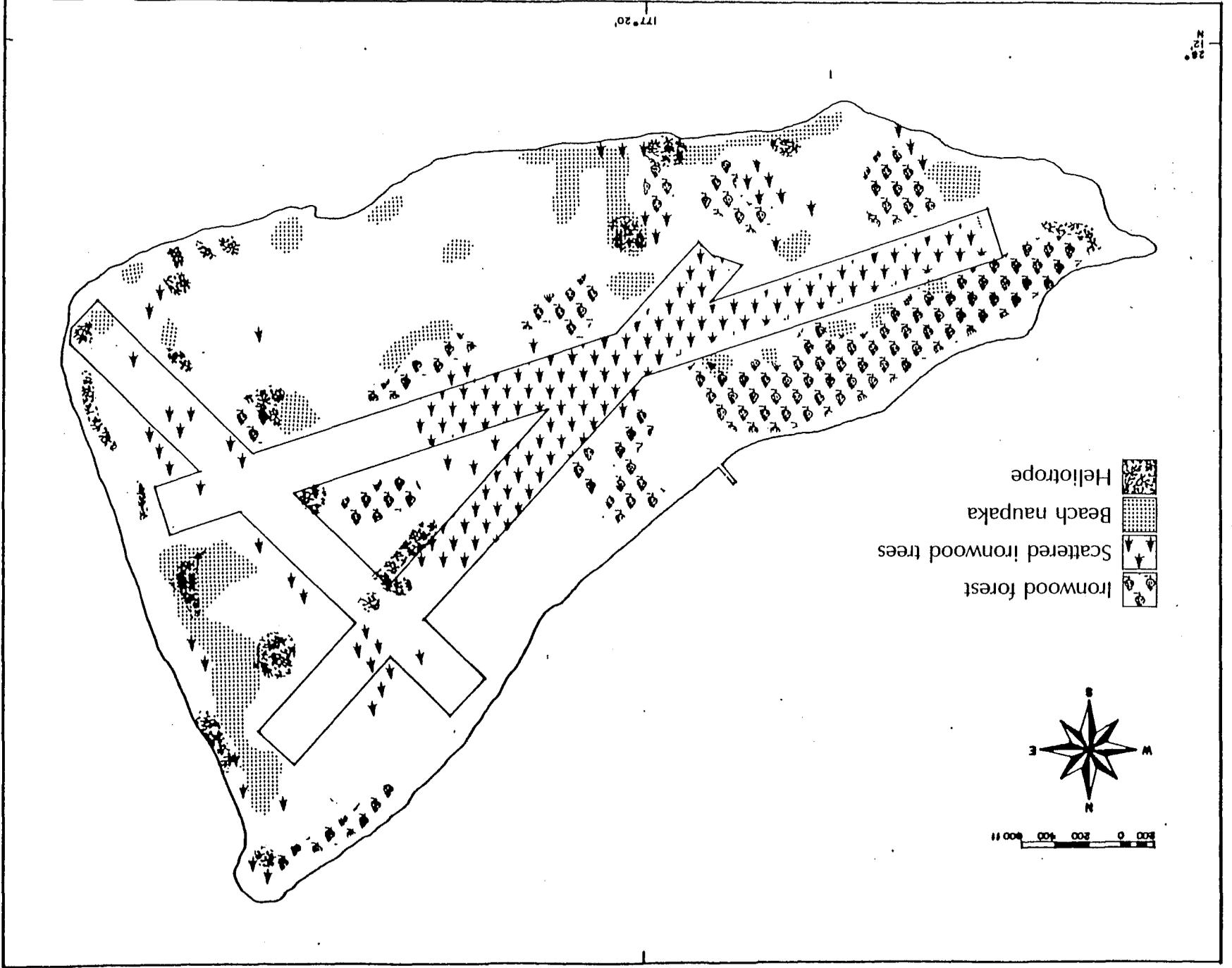


Figure II-10. Vegetation, Sand Island

Figure II-II. Vegetation, Eastern Island



Midway has no indigenous terrestrial wildlife, but several introduced species have become established. Two birds, the Common Myna and Common Canary, are resident. Two rodents, the roof rat and the house mouse, are the only mammals. Several species of lizards and a variety of introduced insects are also present.

For details on the above-mentioned species and other wildlife species, refer to Section IV - Fish and Wildlife.

8. Wetlands

No natural wetlands occur on Midway. The manmade water catchment basin, which periodically is filled with rainwater, is often used by migratory seabirds, waterfowl, and shorebirds.

9. Floodplains

Midway Atoll's low profile makes it potentially vulnerable to inundation by a tsunami; however, no tsunami has hit the atoll in historical times and no official tsunami inundation zone has been delineated.

No natural floodplain exists, but lowlying areas often flood during heavy rainfall. Paving has reduced rates of absorption and abandoned drainages are often backed up.

F. Constraints and Opportunities

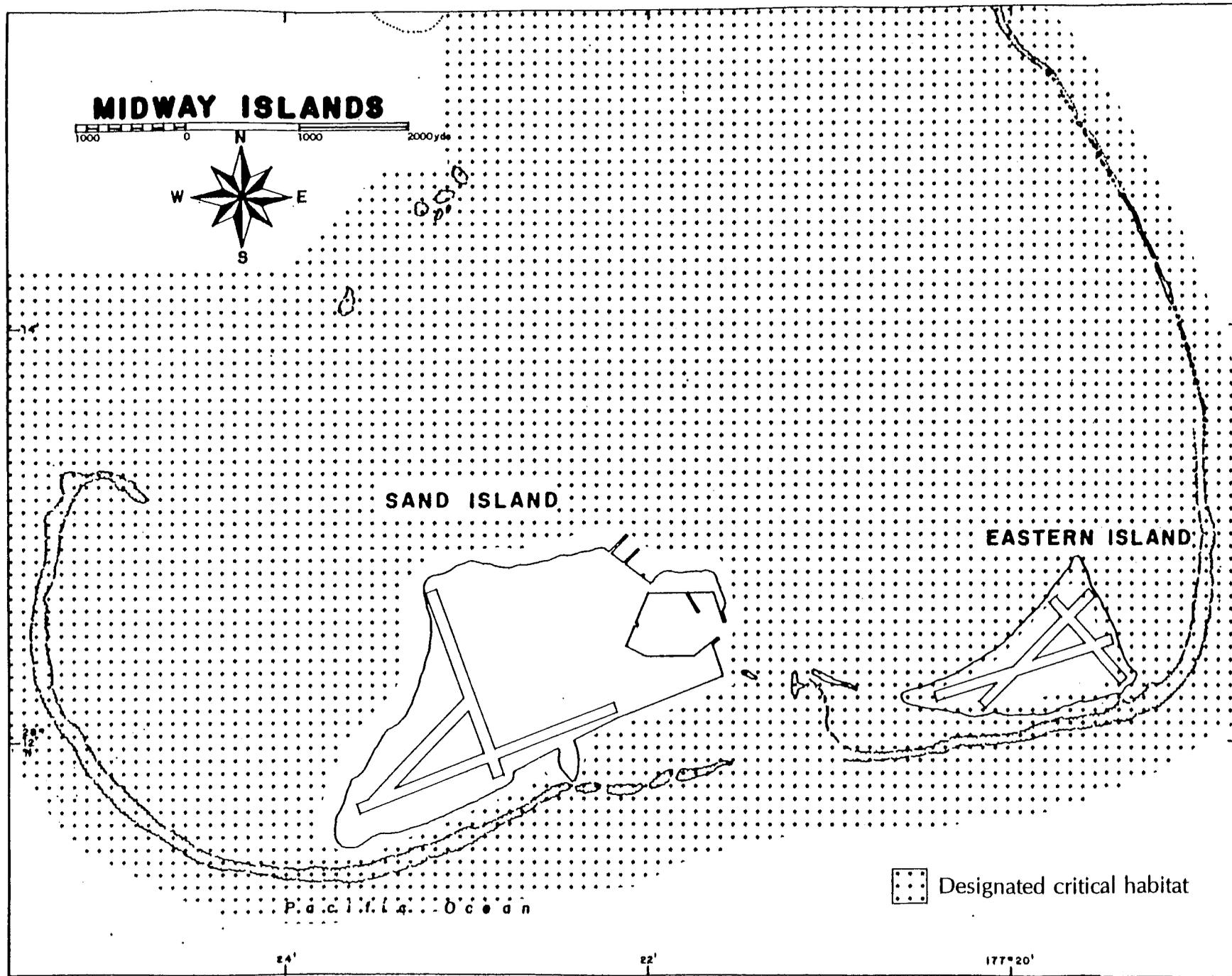
1. Conflicts between programs

The major constraints on potential options for natural resource management will result from conflicts between the requirements of different programs. The military mission will be assigned top priority in resolving such conflicts, but Midway's status as a National Wildlife Refuge requires that wildlife concerns receive the next highest priority, ahead of recreation and other programs.

Certain areas are constrained from vegetation and development due to required clearances for airfield and antenna operations. Clearing of land may result in impacts to wildlife and wildlife habitat, and lead to an increase in the risk of Bird-Aircraft Strike Hazard (see Appendix IV-4).

2. Special resource areas

Midway Atoll, out to a depth of 20 fathoms, except Sand Island and its harbor, has been designated "critical" habitat (Figure II-12) for the Hawaiian monk seal, under the Endangered Species Act (ESA), as codified in 50 CFR 226.1. Human activities are not inherently restricted in areas so-designated; however, activities in these areas that are authorized, funded, or carried out by Federal agencies are subject to Section 7 consultations as required by the ESA. The designation of critical habitat requires Federal agencies to evaluate their activities with respect to the critical habitat and consult with NMFS on any action which may affect the habitat to ensure that it is not likely to result in destruction or adverse modification of the critical habitat.



II-24

Figure II-12. Critical habitat - endangered Hawaiian monk seal

G. References

1. Bryan, E. H. 1978. The Northwestern Hawaiian Islands: An annotated bibliography. U.S. Fish and Wildlife Service. Honolulu, HI.
2. The Travers Group, Inc. 1988. Natural Resources Management Plan: Naval Air Station Barbers Point.
3. U.S. Department of Interior, Environmental Protection Agency. 1988. Preliminary Assessment Report: Naval Air Facility, Midway Island.
4. U.S. Department of Interior, Fish and Wildlife Service, Region One. 1986. Hawaiian Islands National Wildlife Refuge: Master Plan/Environmental Impact Statement.
5. U.S. Navy, Pacific Division, Naval Facilities Engineering Command. 1985. Master Plan NAF Midway Island. Appendix B in Master Plan NAS Barbers Point, Oahu, HI.

Land Management Section

TABLE OF CONTENTS

III. LAND MANAGEMENT SECTION

A. Introduction	III-1
B. Policies and Programs	III-1
1. Federal policies	III-1
2. State and local	III-2
3. Base specific	III-2
4. Land management issues and concerns	III-2
C. Existing Conditions	III-4
1. General base conditions	III-4
2. Land management overview	III-5
a. Goals and objectives	III-5
b. Land suitability and limitations	III-5
3. Wetlands and floodplain management	III-7
4. Coastal zone management	III-7
5. Noxious weed and pest control	III-7
6. Soil stabilization and erosion control	III-10
7. Vegetation management	III-10
D. Management Recommendations	III-11
1. Fish and wildlife management	III-11
2. Outdoor recreation	III-12
3. Watershed management	III-12
4. Coastal zone management	III-12
5. Noxious weed and pest control	III-12
6. Soil stabilization and erosion control	III-13
7. Vegetation management	III-13
a. Improved/inhabited land	III-13
b. Shorelines	III-13
c. Airfield clearances	III-15
d. Antenna fields, lawns, and open lands	III-15
e. Area 7 and other ironwood forests	III-17
f. Cultivation of native plants	III-17
g. Eastern Island	III-17
8. Special management areas	III-17
E. Implementation	III-17
F. References	III-19

TABLE OF CONTENTS (cont'd)

Figures

III-1	Land use suitability	III-6
III-2	Shoreline erosion, Sand Island	III-8
III-3	Shoreline management, Sand Island	III-9
III-4	Proposed vegetation management-shorelines, Sand Island	III-14
III-5	Proposed vegetation management-interior, Sand Island	III-16
III-6	Proposed wildlife sanctuaries	III-18

Tables

III-1	Proposed Development Projects, 1990-1991	III-3
III-2	Project Costs and Implementation Schedule	III-20
III-3	Project Costs - Land Management	III-22

Plates

III-1	Albatrosses nesting colony, Sand Island
III-1b	Abandoned runway, Eastern Island
III-2a	Sheetpile bulkhead, Sand Island
III-2b	Shoreline debris, Eastern Island
III-3a	Deteriorating bulkhead, Eastern Island
III-3b	Riprap at Rusty Bucket, Sand Island
III-4a	Beach erosion, north shore of Sand Island
III-4b	Rodent control baiting station, Sand Island
III-5a	Ironwood trees shading native vegetation
III-5b	Rat herbivory on beach naupaka

III. LAND MANAGEMENT SECTION

A. Introduction

As directed by DODINST 4700.4, OPNAVINST 5090.1, NAVFAC P-73 Navy Real Estate Operations and Natural Resources Management Procedural Manual (Volume I, Chapter 19, and Volume II), and NAVFAC MO-100.1, all Navy commands having responsibility for land, ground, and water areas are required to implement and maintain a balanced and integrated program for soil and water management and have a current land management plan. The objective of this plan is to provide direction to improve real estate values, reduce maintenance, protect wildlife habitats, protect and enhance natural landscapes, enhance the appearance of the installation, and identify areas for agricultural outleasing.

This Land Management Section addresses issues of use and management of all improved and unimproved lands at NAF Midway. Existing programs for soil and water conservation, coastal zone management, erosion control, noxious weed and pest control, management of wildlife habitat, and vegetation management are described. Management objectives and recommendations are delineated and discussed.

Many of the issues addressed here concern competing or conflicting interests in areas which have multiple use potential. In cases where interests conflict, the needs of the military mission are considered to have top priority. The requirements of the National Wildlife Refuge are given priority over recreational and other land uses. It is recognized that appropriate modifications to this plan may be necessary in the future, if changes in the military mission conflict with existing land use practices.

B. Policies and Programs

1. *Federal policies*

Federal laws and policies that affect natural resources management generally and land management specifically are presented in the Basic Section (Table II-1).

Navy policy concerning each of the following important areas of natural resource management is summarized below.

Soil conservation. NAVFAC MO-100.1 provides guidance on water and wind erosion issues. Prevention and correction of erosion serves to protect land forms, conserve soil resources, and reduce scouring and other negative effects of water or airborne soil particles.

Shoreline erosion, referring to the loss of real estate due to water movement, is a natural, dynamic process of waterway meanderings and cyclical beach transport. This process may be significantly altered by shoreline construction. Engineered methods are usually applied to erosion control and shoreline stabilization, but these often create unexpected and undesirable results. Thus, it is recommended that whenever feasible, land activities be planned so as not to be affected by shoreline changes.

Erosion can be prevented or corrected by means of vegetative or engineered solutions. Vegetative methods may require appropriate plant selection, soil preparation, cultivation, irrigation, and subsequent maintenance. Engineered solutions use a variety of materials and techniques; for example,

some methods use permeable surfaces that allow water to filter into the soil, while others rely on impermeable surfaces to contain and transport water.

Water conservation. It is the policy of the Navy to promote and encourage water conservation. When irrigation is required, irrigation systems are expected to optimize water use by assuring quality in design, materials, and construction and by implementation of a careful utilization program. Use of alternative water sources, including non-potable water, is to be considered.

It is expected that most manmade facilities in the Hawaiian Islands will require some irrigation in inhabited areas with introduced plants. Indigenous vegetation may require irrigation if native conditions have been significantly altered. Land use plans should consider that some facilities, such as ballfields and golf courses, require extensive and sophisticated irrigation systems and large quantities of water.

Wetlands and floodplains management. Executive Orders 11990 and 11988 require agencies to actively manage and protect wetlands and floodplains. Section 404 of the Clean Water Act prohibits discharge of dredged or filled material into waters of the United States, without permission from the U.S. Army Corps of Engineers. Section 404(b)(1) guidelines prepared by the Environmental Protection Agency restrict discharges into aquatic areas where environmentally less damaging alternatives exist.

2. State and local

No state or local regulations apply to land management at NAF Midway.

3. Base specific

The subject of land use is addressed in the NAF Midway Island Master Plan, which was prepared by the Pacific Division, Naval Facilities Engineering Command, Facilities Planning Department, as Appendix B of the NAS Barbers Point Master Plan, and approved in September 1985. This Master Plan "provides guidelines for land use and facility development for the mid-range (five to eight years)." Existing and proposed land uses for NAF Midway are set forth in Master Plan Figure BB-4 which constitutes the Land Use Plan for the facility. This Land Use Plan is described as "a long-range planning tool leading to the optimum facility development."

Two other plans relating to land use are the Facilities Requirements Plan (dated 26 April 1985) which identifies facility assets and deficiencies, and the Capital Improvements Plan (CIP) which provides a link between the long range Land Use Plan and the proposed construction and repair projects anticipated in the near future. The CIP is subject to revision as priorities change and it supports the following planning objectives: 1) to ensure that adequate land is available for current mission requirements; 2) to minimize any environmental impact by preserving highly valued natural and cultural resources; and 3) to enhance safety and security at the facility. Construction and repair projects specified in the CIP are categorized on the basis of funding program, primarily MILCON and Special Projects. Proposed development projects for fiscal years 1990 and 1991 are listed in Table III-1.

4. Land management issues and concerns

The land use requirements and practices of man often have conflicted with the needs of indigenous wildlife, especially migratory seabirds. The intensity of such conflicts has increased and declined in proportion to the level of human activity at the facility. The equitable resolution of these con-

TABLE III-1

Proposed Capital Improvement Projects at NAFMIDWAY
for Funding Years 1989-1991

SPECIAL PROJECTS

<u>Title</u>	<u>Project Number</u>
Install Security Fencing and Lighting	C7-84
Resurface Base Roads PH2-5	R11-83
Repair Aircraft Parking Apron PHII	R11-84
Repair Aircraft Taxiway	R12-84
Heat Recovery System, Building 3502	C5-87
Repair Rainwater Catchment	R10-86
Reroof Dining Facility, Building 3502	R2-85
Reroof BEQ C Building 3503	R3-85
Reroof BEQ D Building 3504	R4-85

MILCON PROJECTS

<u>Title</u>	<u>Project Number</u>
Oil Spill Prevention Facilities	P-288
Model E-28 Rotary Hydraulic Arresting Gear Installation	P-300
New BEQ Complex	P-290
Shoreline Protection (NOPF)	P-003

flicts, that is, satisfying the requirements of the military mission while ensuring sufficient habitat for wildlife, is the overriding land management concern at Midway.

Some specific land management issues are the following:

- development of unimproved lands and renovation of abandoned facilities without significant reduction of wildlife habitat, especially for rare and endangered species
- provision of sufficient area for outdoor recreation without significant reduction of wildlife habitat
- control of shoreline erosion without significant reduction of habitat for endangered monk seals
- maintenance of required clearances near runways, antennas, and structures, without increasing the bird-aircraft strike hazard
- management of vegetation to control the spread of ironwoods and preserve and enhance remnant stands of native plants
- control of introduced rats to prevent herbivory on native plants
- restoration of abandoned areas to provide habitat for wildlife
- prevention of contamination of soils and water (and secondarily, humans and wildlife) by petroleum products and hazardous wastes

C. Existing Conditions

1. *General base conditions*

The scale of operations at NAF Midway is currently much reduced from historical levels. Fewer than 40 military and 275 civilians reside at the facility on a permanent basis and operations are restricted to Sand Island. Operational, support, and residential structures are located in the interior of Sand Island. Since 1981, base maintenance and support services have been provided by a civilian contractor (Base Services, Incorporated), and inhabited sections of the base are well maintained. It should be noted, also, that all areas of Midway, including improved lands, are used for nesting by migratory seabirds (Plate III-1a). For a detailed description of the facility, refer to Section II - Basic Section.

Significant portions of Sand Island and all of Eastern and Spit islands are considered abandoned or unimproved lands, though nearly all areas have been used for military purposes at some time in the past. On Sand Island, there are numerous abandoned structures and vacant clearings within and adjacent to developed areas. Outlying areas are overgrown with ironwoods (except where clearances are required for airfield operations), infested with rats, and inhabited by numerous seabirds. On Eastern Island, the runways and structures are severely deteriorated and overgrown by ironwoods, and nesting seabirds are ubiquitous (Plate III-1b).

2. Land management overview

a. Goals and objectives

- to fulfill the facility and development needs of the installation without significant negative impacts to wildlife or wildlife habitat
- to mitigate conflicts between outdoor recreation activities and wildlife in areas designated for multiple use
- to control shoreline erosion without impacting endangered monk seals and other wildlife
- to maintain required airfield clearances, while reducing the risk of BASH
- to manage vegetation so as to control the spread of ironwood trees and promote the recovery of native plants
- to control populations of introduced rats
- to restore Eastern Island and other suitable lands for use as wildlife habitat
- to eliminate the risk of soil or water contamination by spilled oil or other toxic materials

b. Land suitability and limitations

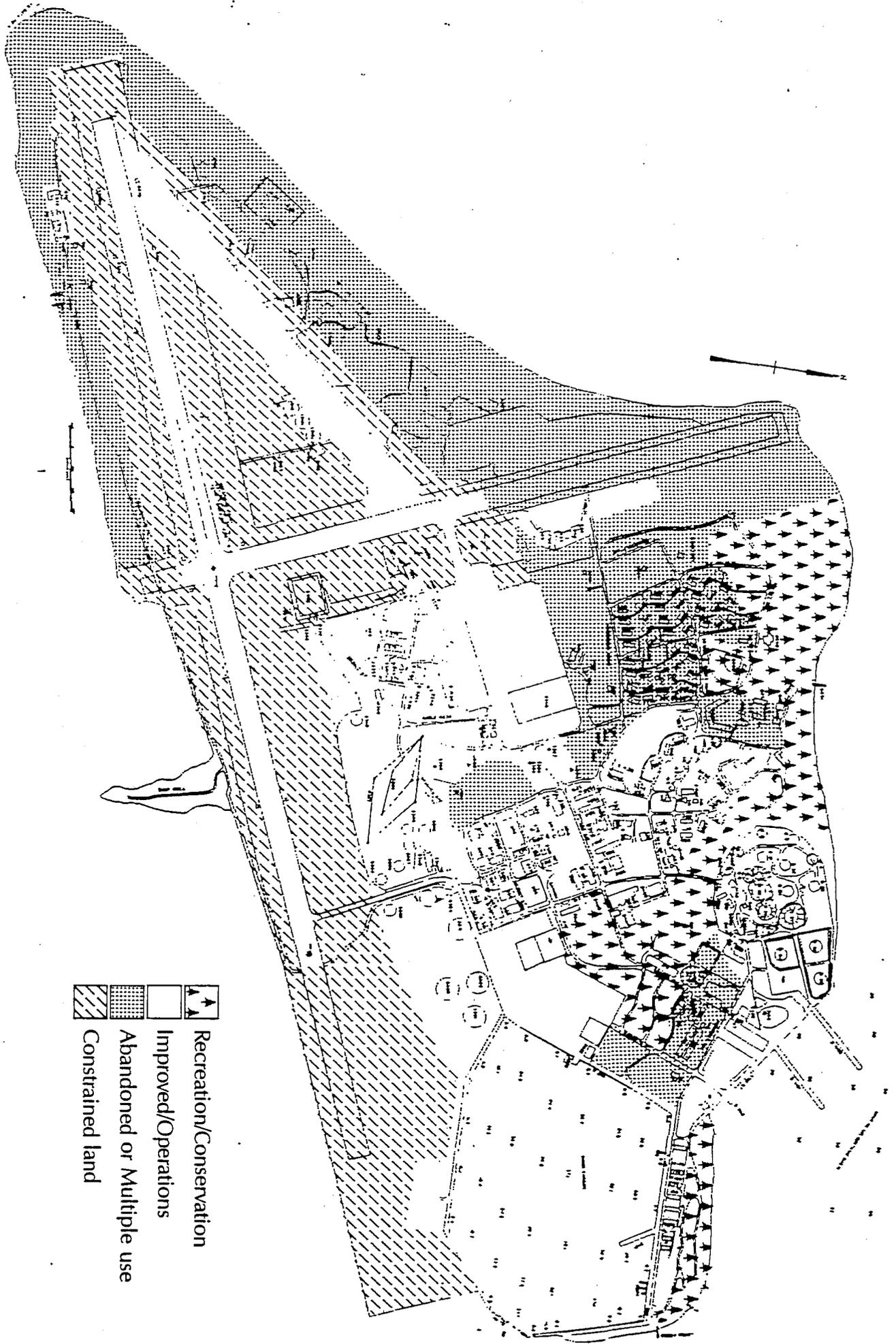
In general, the interior of Sand Island, stabilized by extensive vegetation and accumulated topsoil, is the area best suited to base operations and human habitation. Some land is constrained by mandatory airfield clearances, but sections of abandoned and vacant land within developed areas are sufficient for new construction. Shorelines are subject to erosion and better suited for wildlife habitat and outdoor recreation. Eastern Island features a hard coral substrate and severely deteriorated abandoned facilities and is best suited for restoration as wildlife habitat. A summary of land use suitability is presented in Figure III-1.

Because Midway has been designated a National Wildlife Refuge, all lands not required for the military mission must be considered as potential habitat for wildlife. Outdoor recreation and other land uses may be constrained by the needs of endangered and other wildlife species. Due to wildlife concerns, seasonal shortages of fresh water, poor soil quality, and remoteness from markets, the atoll is not considered suitable for agricultural or other outleases.

Midway Atoll, excluding Sand Island and its harbor, has been designated "critical" habitat for the Hawaiian monk seal, under the Endangered Species Act (ESA). This designation applies to "all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 20 fathoms." Human activities are not inherently restricted in areas so-designated; however, activities in these areas that are authorized, funded, or carried out by Federal agencies are subject to Section 7 consultations as required by the ESA.

No endangered plants are presently thought to occur at Midway; however, the native dune-building species of the coastal strand, especially beach naupaka, are seriously imperiled. These plants reduce beach erosion and provide essential habitat for many seabirds. The few remaining stands of naupaka, such as the one at Frigate Point, should be constrained from development.

Figure III-1. Land use suitability



3. Wetlands and floodplain management

No natural wetland or floodplain exists at Midway. The protection of shorelines from high surf is addressed under coastal zone management.

The ground water table on Sand Island is extremely shallow and thus susceptible to contamination by spillages of oil, hazardous wastes, or toxic substances, such as fumigants. The Preliminary Assessment Report prepared in August 1988 by the Environmental Protection Agency identified two hazardous substances (waste oil and asbestos), but felt that existing contaminated sites were not likely to threaten the brackish water aquifer, the backup water source. Still, there is a chance of seepage from abandoned underground storage tanks or runoff from pesticide fumigation. The backup water system may be important during the anticipated renovation of the water catchment basin.

4. Coastal zone management

The continual reconfiguration of shorelines through deposition and erosion is a natural process inherent to oceanic atolls such as Midway. Sites of pronounced shoreline erosion change from year to year, based on natural events and coastal development. The present locations of actively eroding shores are shown in Figure III-2.

Man-made shoreline is used primarily to protect coastal operations and landfill areas. Shoreline integrity is maintained by sheetpile bulkhead (Plate III- 2a) along most of the eastern half of Sand Island. The small boat harbor, cargo pier, and fuel pier are located in this area of stabilized shoreline. In total, bulkhead covers approximately 42% of the island's 42,000 linear feet of shoreline and an additional 10% is protected by riprap (Figure III-3). The construction of an additional 800 linear feet of bulkhead (CIP project P-003) has been proposed for the shoreline adjacent to the Naval Oceanographic Processing Facility. On Eastern Island, sheetpile bulkhead is limited to a short stretch along the north shore in the vicinity of the abandoned pier. Metal debris piled along the southeastern shore (Plate III-2b) does not appear to be an effective barrier against erosion.

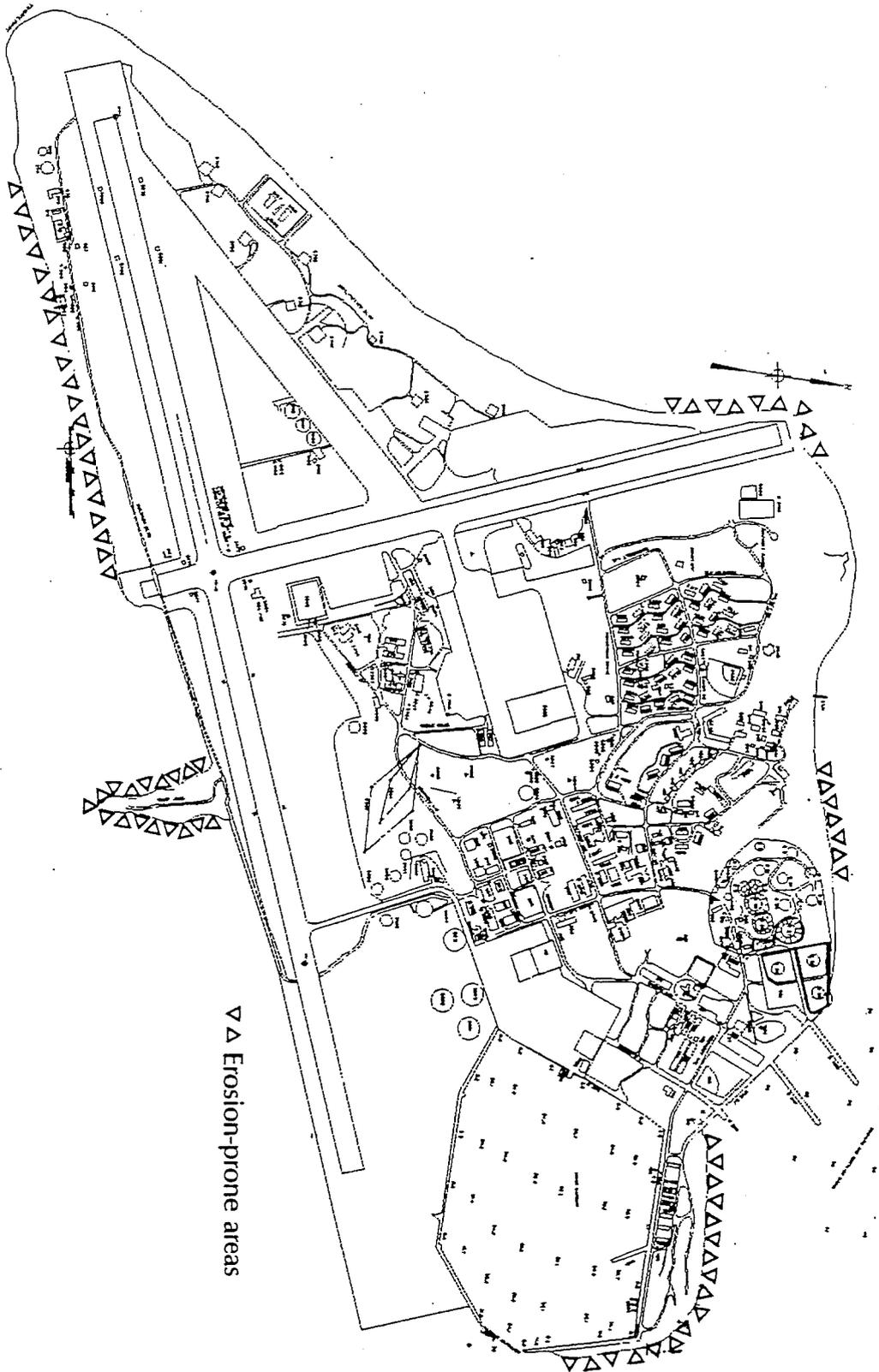
Existing bulkheads serve as a relatively effective barrier against erosion, but they are costly and have a limited expected lifespan. Some sections have begun to deteriorate and suffer from back-side erosion (Plate III-3a). Riprap, consisting of concrete debris from airfield pad demolition, has been partially successful at slowing the rate of erosion in some areas (Plate III-3b). One negative aspect shared by bulkhead and riprap is the reduced beach access for endangered monk seals. Alternative control methods, which do not block beach access, include the use of revetments (as has been recommended for Tern Island) and the planting of native, dune-binding plants, such as beach naupaka. The most stable natural shorelines are those featuring healthy stands of beach naupaka; conversely, erosion is high along shores bordered by ironwood trees (Plate III-4a).

For a coral atoll such as Midway, it is unrealistic to expect any erosion control program to be completely successful. Use and development of the coastal zone will continue to be constrained by the ongoing problem of erosion. Still, vegetation management may be the most economical long term solution for controlling erosion along natural shorelines.

5. Noxious weed and pest control

The current groundskeeping program, as outlined in the Grounds Maintenance Plan of the BOS contract, which relies primarily on mowing, is sufficient to control noxious weeds in inhabited areas. Unshaded, abandoned areas are overgrown by golden crown-beard (*Verbesina encelioides* -

Figure III-2. Shoreline erosion, Sand Island



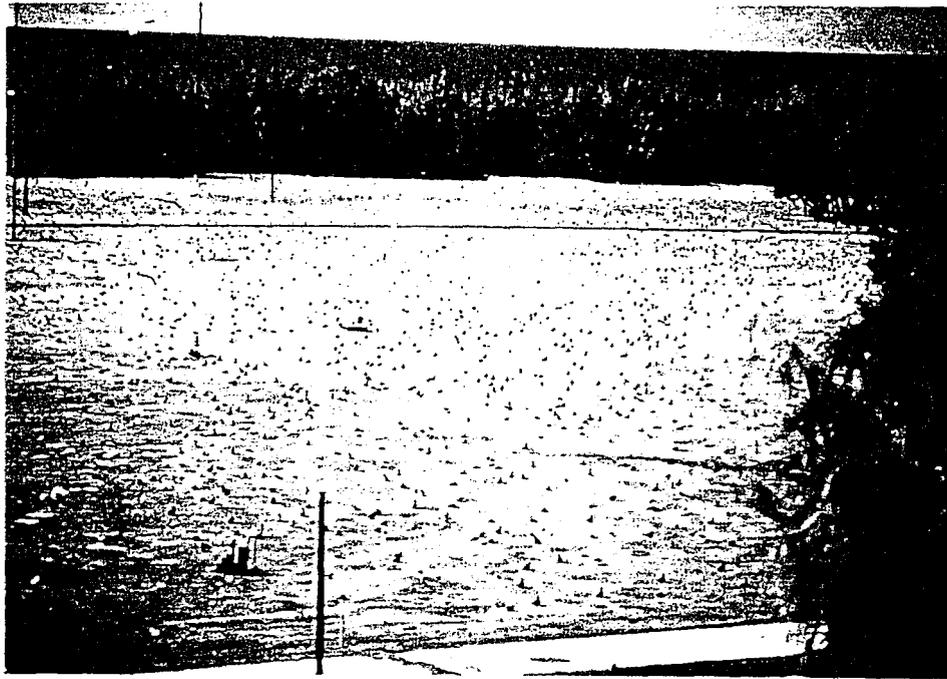


Plate III-1a. Albatross nesting colony, interior Sand Island



Plate III-1b. Abandoned runway, Eastern Island

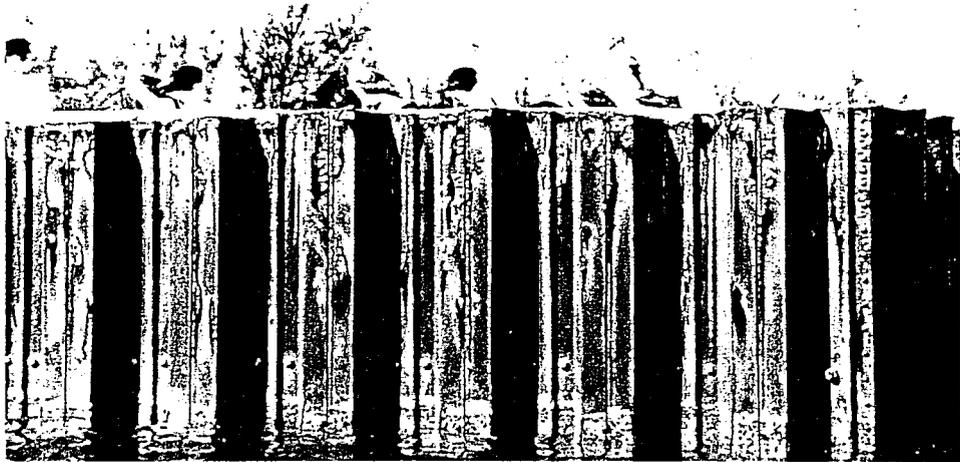


Plate III-2a. Sheetpile bulkhead, Sand Island



Plate III-2b. Shoreline debris, Eastern Island

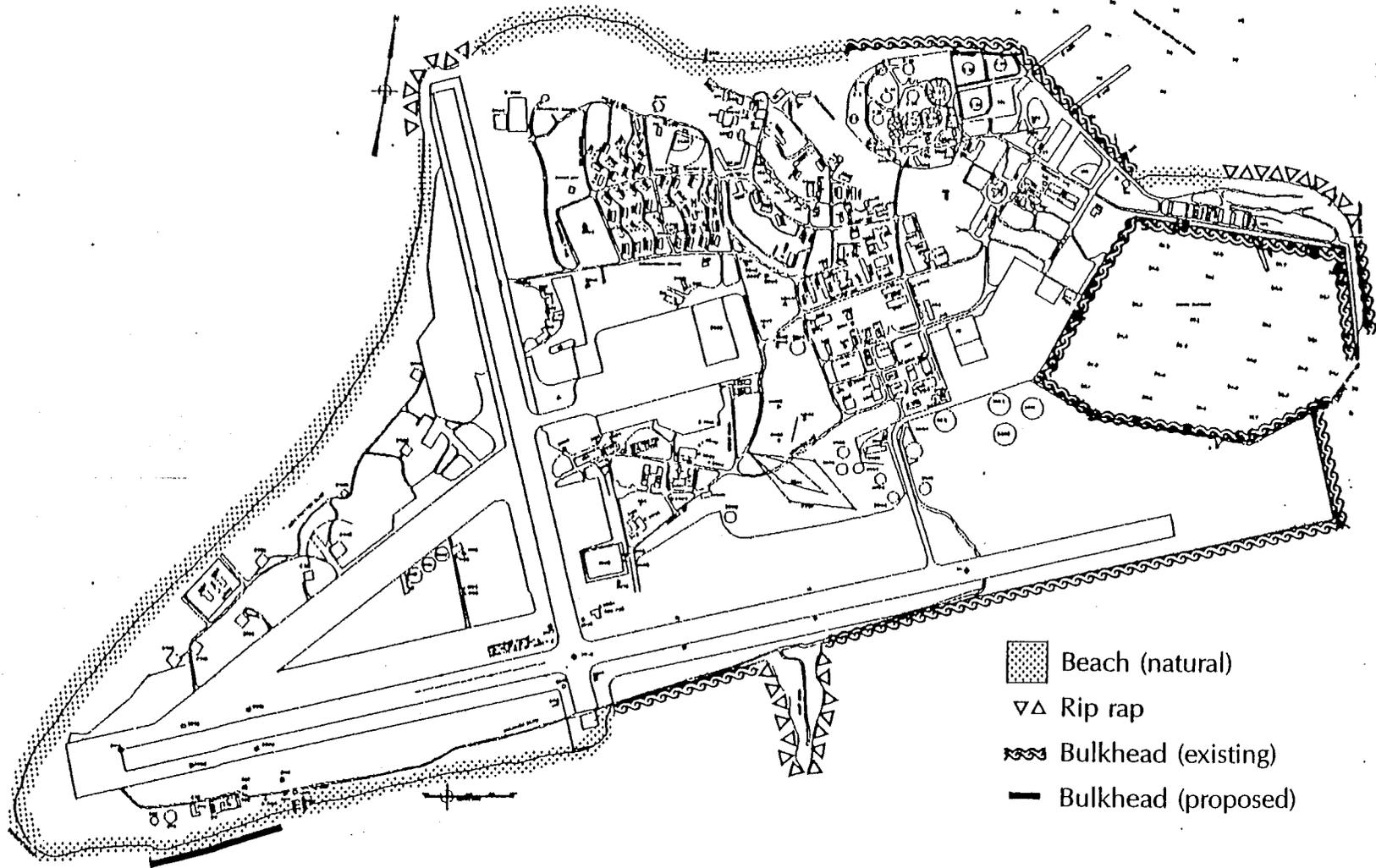


Figure III-3. Shoreline management, Sand Island

des), an introduced herb which represents a threat to native strand plants and habitat for mosquitos and flies.

Limited to inhabited parts of Sand Island, pest control efforts are directed at two rodent species, the roof rat (*Rattus rattus*) and the house mouse (*Mus musculus*), and several types of insects. Details of the pest control program are presented in the Preventive Pest Control Measures section of the BOS contract.

Rodents are controlled by means of bait stations (Plate III-4b) containing a chronic anticoagulant rodenticide (Talon). Currently, fewer than 150 bait stations are in operation (as compared to 350 prior to April 1987) and stations frequently go unbaited during the months when pest control personnel are busy collecting bird carcasses. Current efforts, including the number of operational bait stations and the frequency of re-baiting, are considered to be the minimum necessary to control rats in inhabited areas.

Since the initial infestation in the 1940s, the size of the rat population has varied proportionately with the level of control effort. At present, rats are rarely observed in inhabited areas, but a 1988 study by Animal Damage Control (DOA) showed that rats were numerous elsewhere, even immediately adjacent to inhabited areas. Mice, which are considered a less serious concern, remain abundant in and around structures.

Pestiferous insects include termites, green-bottle flies, mosquitos, and cockroaches. Termites are controlled by fumigation and use of a crushed basaltic rock barrier along the base of all exterior walls to prevent subterranean infestation. Insecticide sprays are used to control roaches in dwellings. Fly populations are minimized by a program of collection and incineration of bird carcasses. Mosquitos are thought to be a vector of avian pox and sometimes they are a problem in inhabited areas, but no control program has been initiated.

For additional information about pest species, refer to Section IV - Fish and Wildlife.

6. Soil stabilization and erosion control

The lush vegetation and accumulated topsoil layer have stabilized the interior of Sand Island and minimized wind-driven erosion. In more exposed areas, dunes and dune-building plants provide a partial barrier against sand transport. However, records from previous decades illustrate that some land use programs can result in erosion problems. During the 1950s and 1960s, the Navy leveled dunes and dune-binding vegetation along runway margins as part of a bird abatement program. The result was the invasion of runways and parking pads by wind-driven, drifting sand, and the need for extensive paving and construction of drift fencing.

Water erosion is not normally a problem in island interiors, but runoff from runways and other paved areas has resulted in erosion in places where adjacent land was not vegetated.

The subject of shoreline erosion is addressed under coastal zone management, earlier in this section.

7. Vegetation management

Most land management programs at NAF Midway affect the existing plant life. Currently, the impact on vegetation is considered on a case by case basis. This approach successfully addresses immediate problems or problem areas, but sometimes results in undesirable side effects. Clearly,

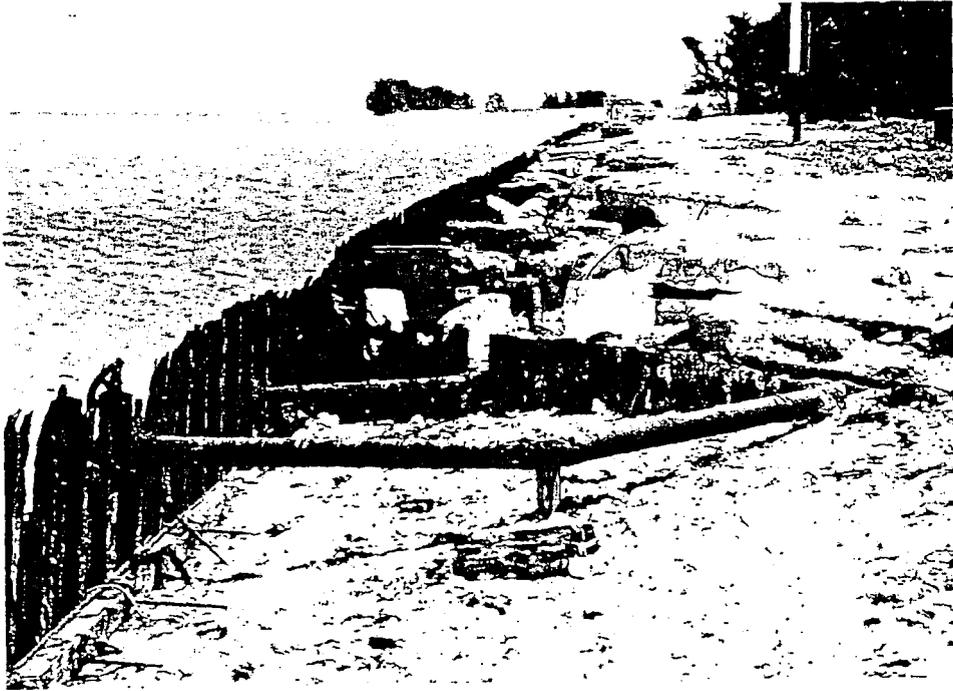


Plate III-3a. Deteriorating bulkhead, Eastern Island

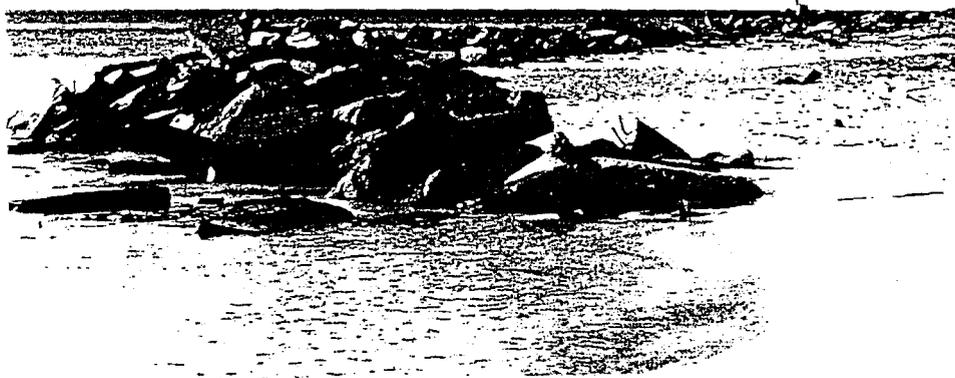


Plate III-3b. Riprap at Rusty Bucket, Sand Island



Plate III-4a. Beach erosion, north shore of Sand Island

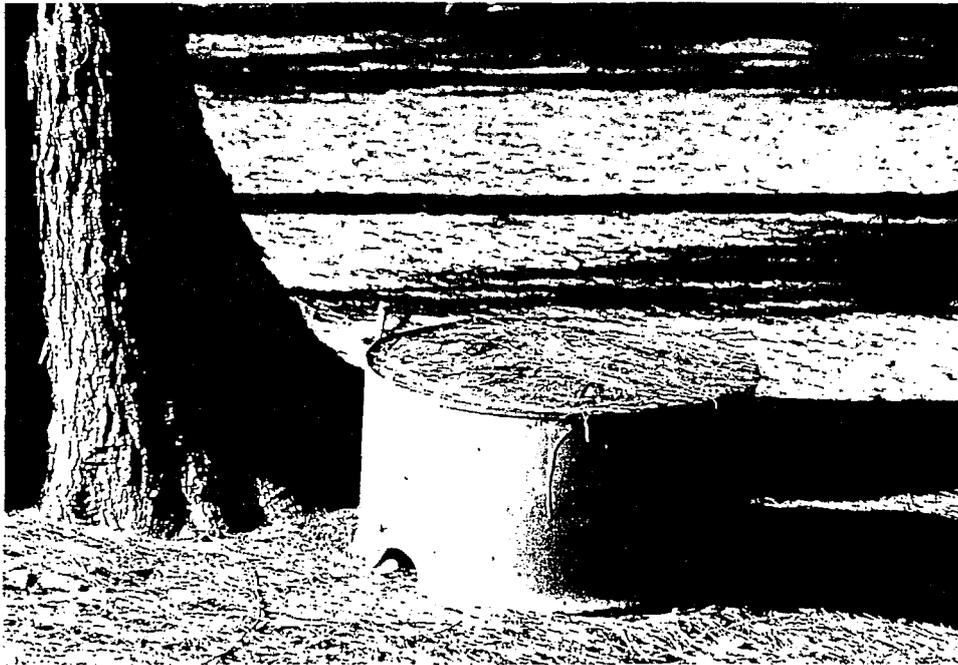


Plate III-4b. Rodent control baiting station, Sand Island



Plate III-5a. Ironwood trees shading native vegetation



Plate III-5b. Rat herbivory on beach naupaka

a comprehensive program of vegetation management is urgently needed. This program should address the following concerns:

- a. Ironwood trees are the predominant feature of the Sand Island landscape and terrestrial ecosystem; their success has been partly beneficial and partly problematic. Ironwoods provide protection from wind, which has led to the establishment of numerous plant species and the stabilization and beautification of island interiors. Mature ironwoods provide habitat for arboreal-nesting seabirds and shade for wildlife and humans alike. On the other hand, ironwoods grow and spread rapidly, recolonizing cleared and abandoned areas, resulting in massive maintenance problems and hazards to airfield operations. Mature trees in improved areas pose a threat to structures during high winds. Along shorelines, ironwoods shade out native dune-building plants (Plate III-5a) leading to increased rates of erosion. Control of ironwoods is an integral part of vegetation management.
- b. Beach naupaka and the other native dune-building plants of the coastal strand community play an important role in the atoll's ecosystem. Thriving in exposed conditions, these plants reduce erosion along shorelines and in interior areas without topsoil, and they provide nesting habitat for many seabird species. Naupaka can also be planted in open areas to prevent nesting by albatrosses. Currently, these plants are imperiled and few healthy stands exist. Herbivory by introduced rats (Plate III-5b) and shading by ironwoods are the primary factors in the decline. The protection and enhancement of these plants should be an integral part of vegetation management decisions.
- c. The proposed plan to reduce bird-aircraft strike hazard (BASH) includes a major land management component, because existing vegetation determines where birds nest and what routes they use to traverse the island. Any area that is not covered by dense vegetation or pavement represents suitable nesting habitat for albatrosses, the primary BASH problem species. Cleared areas proximate to the airfield are the most obvious concern, but antenna fields and other clearances contribute to the problem, too. Flying birds ride updrafts above stands of shrubs and trees, so transit routes to and from the nest sites are often determined by the pattern of vegetation. Roadways and other passages through forests may actually funnel birds toward runways. These topics are addressed in detail in the BASH Plan (Appendix IV-4), but all land management programs should consider potential consequences with respect to BASH.

D. Management Recommendations

1. *Fish and wildlife management*

At Midway, virtually all land management decisions and actions affect wildlife; therefore, it is strongly recommended that the Fish and Wildlife Service be consulted during the planning stage of all land use projects, including new development and construction and renovation of abandoned facilities, in order to minimize hazards to wildlife and loss of wildlife habitat. A proposed consultation protocol is presented in Section IV.

Further recommendations are as follows:

- whenever feasible, construction of new facilities should be restricted to existing developed areas
- to enhance habitat for endangered monk seals, erosion should be controlled by methods which do not deny access to sandy beaches

- the use of Defense Environmental Restoration Program (DERP) funds for the clean up and restoration of Sand and Eastern islands should be investigated.

2. Outdoor recreation

Land management recommendations relating to outdoor recreation are presented in Section V - Outdoor Recreation.

3. Watershed management

In order to protect the brackish water aquifer, it is recommended that MILCON project P-288 be implemented to contain spills and that abandoned tanks be located and drained. It is recommended that the availability of clean up funds through the Navy Installation Restoration (IR) Program or the Defense Environmental Restoration Program (DERP) be investigated.

4. Coastal zone management

In order to prevent and control coastal erosion, while maintaining beach accessibility for endangered monk seal habitat and recreational use, it is recommended that:

- an integrated vegetation management program be implemented (see subsection D7)
- non-restrictive erosion control methods be considered prior to use of bulkhead or riprap.

5. Noxious weed and pest control

Current efforts (i.e., the number of operational bait stations) are considered the minimum necessary to control rats in inhabited areas and further cuts are not advised. It is recommended that stations be checked and re-baited regularly, throughout the year. During months when pest control personnel are busy with carcass retrieval, it may be necessary to add personnel to keep stations baited. It is also recommended that, in the future, the use of baits containing rodenticides known to be least harmful to wildlife should be investigated. Periodic changes in bait type will probably increase control success.

Further, it is recommended that control of roof rats be extended to outlying and abandoned areas, especially near stands of beach naupaka, with the ultimate goal of eliminating rats from the atoll. Rat control is essential for the success of vegetation management measures designed to reduce the risk of BASH. A rat control program is described in detail in Section IV.

Existing levels of effort appear to be sufficient to control golden crown-beard and other noxious weeds in inhabited areas, but it is recommended that control efforts be extended to abandoned and unimproved areas. Dense stands of introduced herbs harbor extensive populations of mosquitos and green-bottle flies; any control program for these insects must begin with habitat reduction. Also, golden crown-beard appears to compete with the already stressed native dune-building plants. Elimination of this species will contribute to the recovery of existing native plants and to replanting efforts. Details of control techniques are presented in the vegetation management subsection.

6. Soil stabilization and erosion control

In order to prevent soil erosion and accumulation of windblown sand on runways, it is recommended that:

- dunes and native vegetation should be maintained, not destroyed, as part of any program of bird abatement or maintenance of airfield clearances
- areas cleared for airfield requirements or other reasons should be replanted immediately with beach naupaka or other native dune-binding plants.

7. Vegetation management

In order to protect structures, reduce erosion, decrease the risk of BASH, and maximize the diversity of wildlife habitat, it is recommended that an integrated vegetation management program be designed and implemented. The general, overriding objectives of this program are as follows:

- to control introduced ironwood trees, wherever they threaten structures, operations, shoreline stability, or native plants, while maintaining sufficient numbers of mature trees to provide shade and habitat for arboreal-nesting seabirds
- to promote the recovery of existing stands of beach naupaka and other native strand plants, especially along shorelines, and to plant these species in cleared lands (including areas where roads, concrete pads, buildings, and debris have been removed) to discourage albatross nesting and reduce the risk of BASH.

As with all land use programs, vegetation management measures should be conducted during seasons and using methods which minimize impacts to wildlife and native plants. It is recommended that the FWS be consulted prior to each phase of this program.

a. Improved/inhabited land

Dead and live mature trees representing a hazard to existing structures should be topped, trimmed, or cut down, as necessary. Other mature trees (including dead trees or "snags") should be maintained for shade and habitat for arboreal nesting seabirds. Cleared areas, including lawns and golf courses, on the northern half of Sand Island will support nesting albatrosses, but should not contribute significantly to BASH, so long as sufficient passageways to northern and eastern shores (away from the airfield) are kept cleared and open.

b. Shorelines

Ironwoods within 100 feet of the beach crown along natural shorelines on Sand Island should be cut down and, when possible, removed, by means which do not result in significant damage to native plants or wildlife. Initial clearing should begin at the fenced compound, where the fairly contiguous stand of naupaka that starts at Frigate Point becomes sparse, and proceed north along the Area 7 beach (Figure III-4). Cutting ironwoods in this area should aid regeneration of naupaka and gradually recreate a continuous stand of this vegetation as far as Rusty Bucket. If this undertaking proves effective in restoration of native strand vegetation, rehabilitation of remaining exposed shorelines should be initiated. Cleared areas must be monitored and newly sprouted ironwood saplings removed annually to prevent re-establishment. If native plants do not recolonize cleared areas naturally, beach crowns should be replanted with native species.

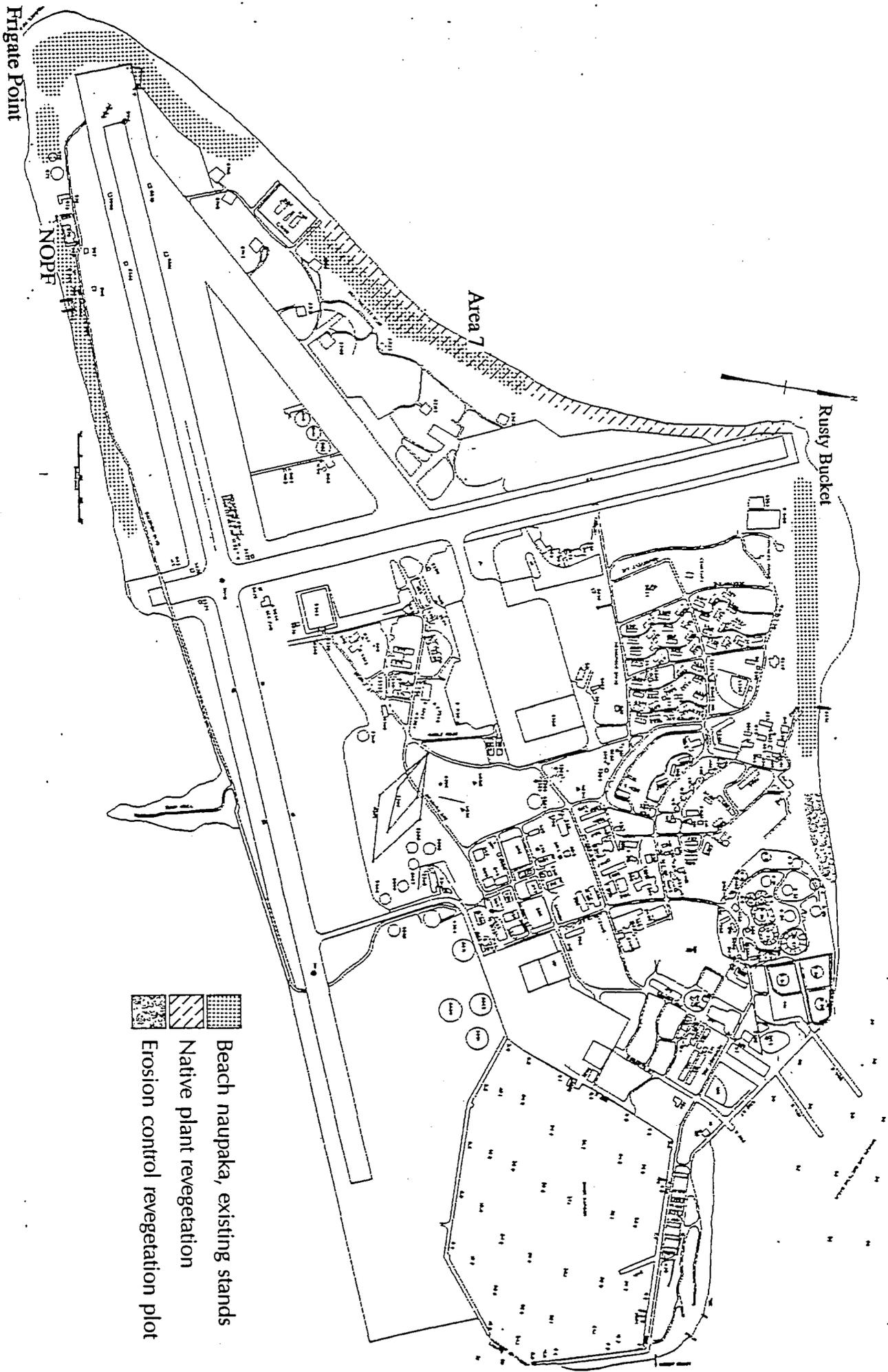


Figure III-4. Proposed vegetation management-shorelines, Sand Island

Shorelines prone to erosion are high priority for reestablishment of native vegetation, but these areas are typically void or only sparsely vegetated with naupaka. Therefore, merely cutting ironwoods in these areas will not be sufficient. One high erosion area should be designated as an experimental native plant revegetation plot, in which trees are cleared and naupaka seedlings are planted. If this technique is effective, other high erosion shores should be revegetated in this way. The northern shoreline of Sand Island, between the Fuel Farm and the beach pavillion (Figure III-4), is recommended for this experimental plot.

Beach naupaka and other native dune-building plants should be protected from disturbance, herbivory by rats, and competition with introduced plants. Existing stands should be cleared of ironwoods (see above) and golden crown-beard. The latter should be pulled by hand, transported to the dump, and burned to prevent reseeding. The stands at Frigate Point and those along the southwest shoreline (near the Naval Ocean Processing Facility) should be considered top priority (Figure III-4).

c. Airfield clearances

All existing and future operational clearances in the vicinity of the airfield, especially those near runways, should be managed to minimize nesting by albatross. Wherever possible, cleared land should be revegetated with ironwoods or naupaka; areas of required clearance should be paved or scarified annually. For a complete discussion of BASH-related vegetation management, refer to Appendix IV-4.

The constrained land north of runway 6 - 24 (Figure III-5) is of primary concern. At the west end, variances should be obtained to allow naupaka from Frigate Point to cover right up to the edge of the paved taxiway (abandoned); alternatively the area should be scarified or scraped annually. The paved triangle that includes the water catchment basin (see Plate II-1a) should be kept clear of vegetation. East of the current taxiway, the existing stand of ironwoods should be maintained to minimize crossing by albatross nesting in the antenna fields; ground between the forest and the paved apron should be scarified or paved. Few albatross nest adjacent to the runway overrun (east end), but if nesting increases, this region should be vegetated or scarified.

The constrained land south of runway 6 - 24 (Figure III-5), including the bulky dump, is not presently as big a problem because birds nesting there usually depart south and do not cross the runway. If necessary in the future, the flat ground immediately adjacent to the paved apron should be scarified or paved and the area south of the road should be revegetated with naupaka.

d. Antenna fields, lawns, and open lands

The open, grass covered lands of the southern half of Sand Island (Figure III-5) support very large numbers of nesting albatross; these birds are the ones most likely to fly across the runway. Wherever possible, these areas should be densely planted with beach naupaka. Birds will continue to nest in clearances required for antennas, but these areas will be less attractive to birds if they are scarified and kept as small as possible.

In order to assess the efficacy of revegetation efforts, it is recommended that a test plot of 1000 square feet be planted with naupaka. If revegetation in the test plot is successful, the operation should be expanded to other open lands.

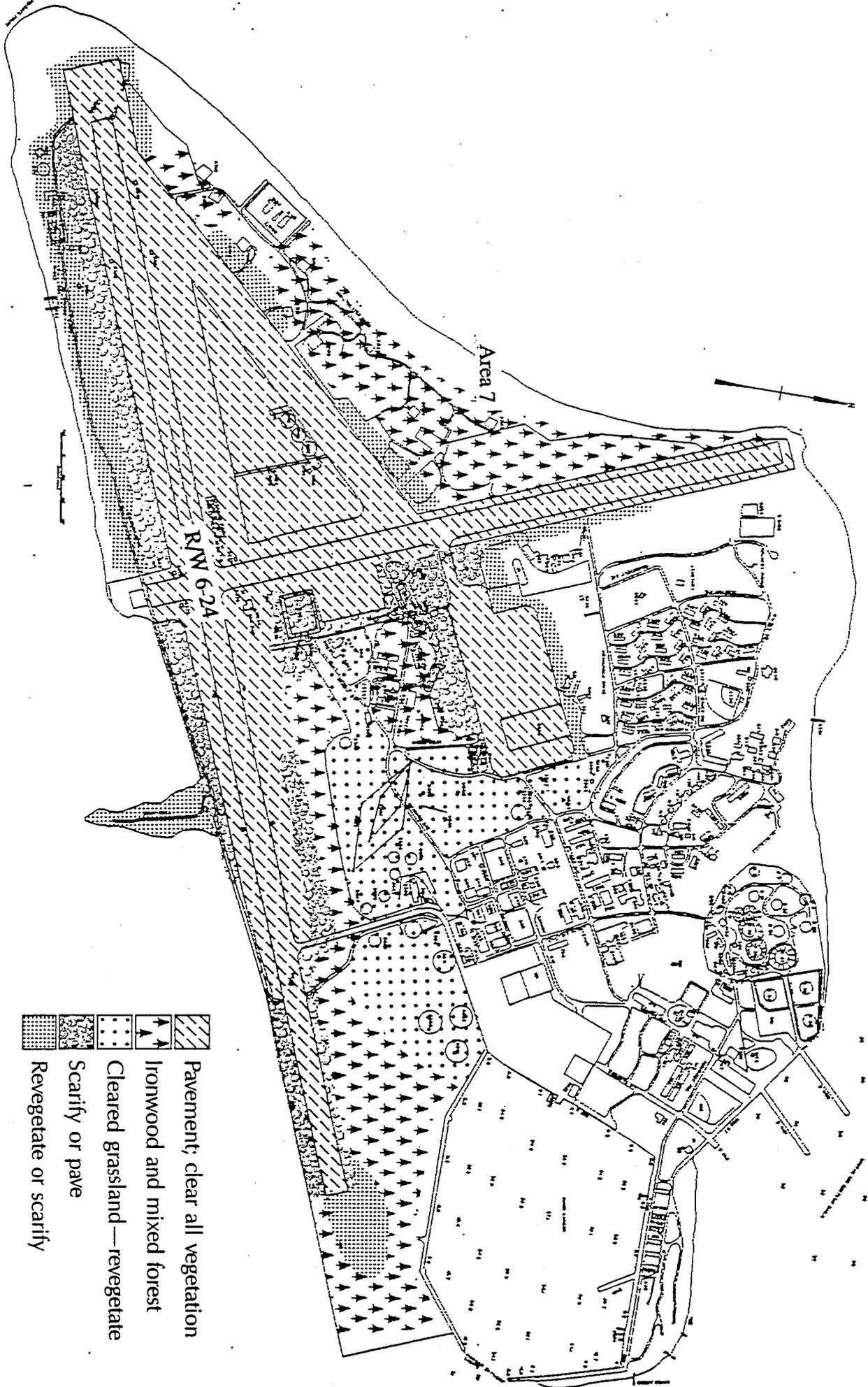


Figure III-5. Proposed vegetation management-interior, Sand Island

e. Area 7 and other ironwood forests

Except for shorelines (as discussed previously), Area 7 should remain densely forested. This forest inhibits nesting by albatross while providing nesting sites for other seabird species. Clearances should be minimized. Optimally, vegetation should be allowed to grow out to the edge of the pavement of the closed taxiway and closed runway (Figure III-5). Required clearances bordering the airfield should be scarified annually or paved. Antenna fields and other interior clearances should open only onto the shoreline to encourage flying birds to depart toward the beach and not across the airfield. Other ironwood forests are somewhat less important as wildlife habitat, but all serve to limit nesting by albatross.

f. Cultivation of native plants

It is recommended that the beach naupaka plants to be used in replanting programs be cultivated from seeds or cuttings from local plants. This will necessitate the establishment of a modest green house and nursery. Transplanted seedlings will probably need protection (e.g., mesh fencing) until large enough to withstand trampling by albatross. Replanting programs may also be hindered by herbivory on seedlings, unless rat control is conducted concurrently.

g. Eastern Island

The most pressing objective at Eastern Island is to save the remaining stands of beach naupaka and other native plants. Control of rats and ironwoods may be sufficient to enable existing plants to recover; otherwise, replanting will be necessary. Shoreline objectives are much the same as for Sand Island. It is recommended that the majority of ironwoods be removed as part of major habitat restoration efforts (see Section IV - Fish and Wildlife); most seabirds nesting in ironwood forests can relocate to stands of beach naupaka shrubs. Regular removal of ironwood saplings will be necessary to prevent recolonization.

8. Special management areas

Although all of Midway Atoll has been designated a National Wildlife Refuge, it is recommended that selected areas be placed off limits as sanctuaries for especially rare or sensitive species. Proposed sites on Sand Island include the dunes north of the small boat harbor and the stands of beach naupaka at Frigate Point and near the NOPF (Figure III-6); the shorelines of Eastern and Spit islands should also be designated as sanctuaries. For additional details, refer to Section IV - Fish and Wildlife.

E. Implementation

Expected costs and proposed schedules for recommended management projects are presented in Tables III-2 and III-3.

Frigate Point

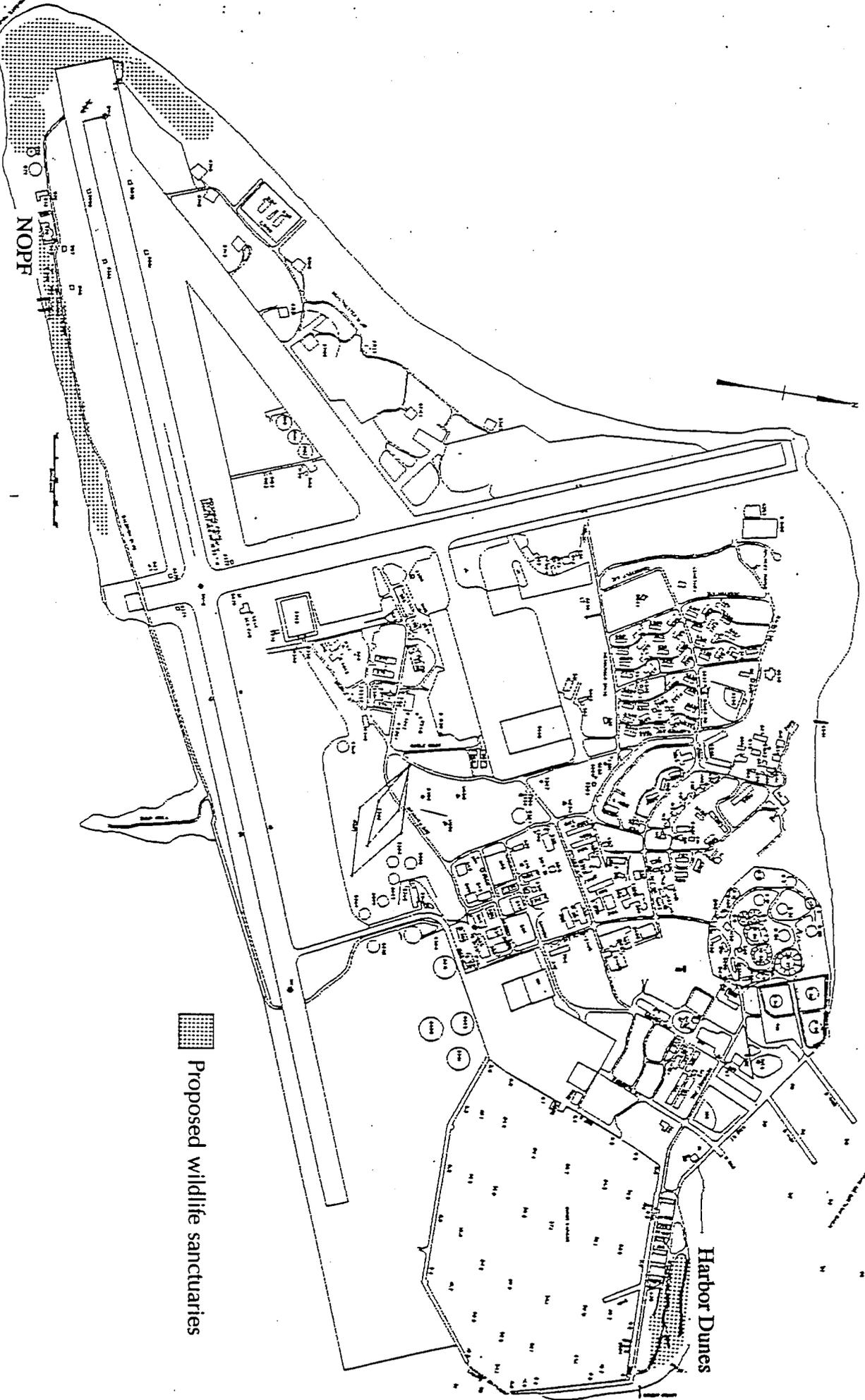


Figure III-6. Proposed wildlife sanctuaries

F. References

1. Apfelbaum, S.I., Ludwig, J.P., and C.E. Ludwig. 1983. Ecological problems associated with disruption of dune vegetation dynamics by *Casuarina equisetifolia* L. at Sand Island, Midway Atoll. *Atoll Research Bulletin* 260:1-13.
2. Fisher, H.I. 1966. Airplane-Albatross Collisions on Midway Atoll. *Condor* 68:229-242.
3. Murphy, J.G. and W.B. Tyler. 1988. Rat Population and Control Assessment on Midway Atoll. U.S. Department of Agriculture, Animal Damage Control. Honolulu, HI.
4. The Travers Group, Inc. 1988. Natural Resources Management Plan: Naval Air Station Barbers Point.
5. U.S. Department of the Interior, Environmental Protection Agency. 1988. Preliminary Assessment Report: Naval Air Facility, Midway Island.
6. U.S. Navy, Pacific Division, Naval Facilities Engineering Command. 1985. Master Plan NAF Midway Island. Appendix B in Master Plan NAS Barbers Point, Oahu, HI.

TABLE III-2

Ten Year Schedule of Land Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 1</u>		
• Investigate cleanup of underground storage tanks (UST) through various funding sources	1,000	
• Remove, top, or trim ironwoods as needed to protect structures	2,000	
• Scarify or pave required clearance areas near airfield and Area 7 as designated	8,000	
YEAR 1 TOTAL	11,000	
 <u>Year 2</u>		
• Investigate UST cleanup through various funding sources	1,000	
• Remove, top, or trim ironwoods as needed to protect structures	2,000	
• Initiate clearance of exotic plants (e.g., ironwood, golden-crown beard) from stands of native plants at Frigate Point	2,000	
• Scarify or pave required clearance areas near airfield and Area 7	8,000	
TOTAL YEAR 2	13,000	
 <u>Year 3</u>		
• Investigate UST cleanup through various funding sources	1,000	
• Remove, top, or trim ironwoods required to protect structures	2,000	
• Eliminate ironwoods from Area 7 native plant revegetation plot (40,000 sq ft)	10,000	
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	5,000	
• Scarify or pave required clearance areas around airfield and Area 7 as designated	8,000	
• Establish greenhouse nursery		15,000
• Initiate cultivation of native plants		3,000
YEAR 3 TOTAL	26,000	18,000

TABLE III-2 (cont'd)

Ten Year Schedule of Land Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 4</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in native plant revegetation plot and remove newly sprouted saplings	2,000	1,000
• Remove ironwoods and replant native vegetation in high erosion area test plot (1000 sq ft)	5,000	
• Remove exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Cultivate native plants		3,000
YEAR 4 TOTAL	16,000	4,000
<u>Year 5</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area	2,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Establish native plant revegetation test plot (1,000 sq ft)	3,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,000
YEAR 5 TOTAL	15,500	6,000

TABLE III-2 (cont'd)
Ten Year Schedule of Land Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 6</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Eliminate ironwoods from second section of Area 7 native plant revegetation plot (40,000 sq ft)	12,000	
• Evaluate revegetation in shoreline revegetation area and remove ironwood saplings	3,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Evaluate success of native plant revegetation test plot		1,000
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,000
YEAR 6 TOTAL	25,500	7,000
<u>Year 7</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area; remove new ironwood sprouts	3,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if test plot is successful	5,000	
• Cultivate native plants		3,000

TABLE III-2 (cont'd)
Ten Year Schedule of Land Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 7 (cont'd)</u>		
• Remove ironwood saplings following Eastern Island restoration		2,500
YEAR 7 TOTAL	18,500	6,500
<u>Year 8</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area; remove new ironwood sprouts	3,000	1,000
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if successful	5,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		2,500
YEAR 8 TOTAL	18,500	6,500
<u>Year 9</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Eliminate ironwoods from last section of Area 7 native plant shoreline revegetation area (40,000 sq ft)	14,000	
• Evaluate revegetation in shoreline revegetation area and remove ironwood saplings	4,000	1,500
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	

TABLE III-2 (cont'd)

Ten Year Schedule of Land Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 9 (cont'd)</u>		
• Clear exotic plants from stands of native vegetation along the southwest shoreline of Sand Island	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if successful	5,500	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		3,000
YEAR 9 TOTAL	34,000	7,500
<u>Year 10</u>		
• Remove, top, or trim ironwoods as required to protect structures	2,000	
• Evaluate revegetation in shoreline revegetation area	4,000	1,500
• Evaluate revegetation in high erosion test plot; remove new ironwood sprouts and continue planting if necessary	1,500	
• Clear exotic plants from stands of native vegetation at Frigate Point	1,000	
• Scarify or pave required clearance areas as designated	6,000	
• Continue native plant revegetation if successful	6,000	
• Cultivate native plants		3,000
• Remove ironwood saplings following Eastern Island restoration		3,000
YEAR 10 TOTAL	20,500	7,500

TABLE III-3
Project Costs - Land Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Watershed</u>		
• Investigate UST cleanup through various funding sources	3,000	
<u>Vegetation Management</u>		
Sand Island		
<i>Improved Lands</i>		
• Remove, top, or trim ironwoods as required to protect structures	20,000	
<i>Shorelines</i>		
• Eliminate ironwoods from Area 7 native plant revegetation plot (40,000 sq. ft.)	36,000	
• Evaluate revegetation of native plants in the above plot and remove newly sprouted ironwood saplings	21,000	8,000
• Remove ironwoods and replant native vegetation in high erosion area test plot (1000 sq. ft.)	5,000	
• Evaluate revegetation in high erosion area test plot, remove new ironwood sprouts; expand efforts to other areas if successful	9,000	
• Clear exotic plants (e.g., ironwood, golden crown-beard) from stands of native vegetation:		
- Frigate Point	8,000	
- Southwest shoreline (near NOPF)	8,000	
<i>Airfield clearances</i>		
• Scarify or pave required clearance areas as designated	36,000	
• Revegetate designated areas with low-growing native shrubs	4,000	
<i>Open fields and lawns</i>		
• Establish native plant revegetation test plot (1000 sq. ft.)	3,000	
• Evaluate success of native plant revegetation test plot		1,000

TABLE III-3 (cont'd)
Project Costs - Land Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Vegetation Management (cont'd)</u>		
• If successful, continue native plant revegetation of open areas	17,500	
<i>Area 7</i>		
• Scarify or pave required clearances	30,000	
<i>Cultivation</i>		
• Establish greenhouse/nursery		15,000
• Cultivate native plants		24,000
Eastern Island		
• Remove ironwood saplings after major habitat restoration		15,000
SECTION TOTAL	200,500	63,000

Fish & Wildlife Section

TABLE OF CONTENTS

IV. FISH AND WILDLIFE SECTION

A. Introduction	IV-1
1. Purpose	IV-1
2. Scope	IV-1
3. Objectives	IV-1
4. Responsibilities	IV-1
B. Policies and Programs	IV-4
1. Existing	IV-4
2. Current management issues and concerns	IV-5
C. Fish and Wildlife Goals and Objectives	IV-6
1. Long-term goals and objectives	IV-6
2. Short-term goals and objectives	IV-8
D. Fish and Wildlife Resource Inventory	IV-9
1. Site description	IV-9
2. Species and species group inventory and assessment	IV-12
3. Status of habitats, species, and species groups	IV-14
4. Fish and wildlife introductions	IV-27
5. Pest species	IV-29
E. Existing Management and Use Characteristics of Resources	IV-30
1. Consumptive uses	IV-30
2. Non-consumptive uses	IV-30
F. Fish and Wildlife Resources Versus Base/Mission Conflicts	IV-30
1. Effects of military programs/mission on fish and wildlife	IV-30
2. Effects of fish and wildlife on base/mission operations	IV-31
G. Existing Land Use Plans Affecting Fish and Wildlife Resources	IV-32
H. Opportunities and Constraints	OV-32

TABLE OF CONTENTS (cont'd)

I. Habitat Management Needs	IV-32
1. Terrestrial habitats	IV-32
2. Aquatic habitats	IV-33
3. Habitat values	IV-33
J. Species Management Needs	IV-33
1. Rare, threatened, and endangered species	IV-33
2. Other species of management interest	IV-35
3. Pest species	IV-35
K. Management Recommendations	IV-35
1. Habitat management	IV-35
2. Threatened and endangered species preservation	IV-36
3. Pest control	IV-37
4. General fish and wildlife management recommendations	IV-37
L. Proposed Management, Protection, and Conservation Programs	IV-38
1. Orientation	IV-38
2. Project consultation and conflict mitigation	IV-39
3. Wildlife sanctuaries	IV-39
4. Hazards to wildlife	IV-40
5. Vehicular traffic	IV-40
6. BASH	IV-41
7. Hawaiian monk seal	IV-41
8. Rat control	IV-42
9. Vegetation management	IV-42
10. Restoration of Eastern Island	IV-42
11. Public use of fish and wildlife resources	IV-43
12. Wildlife monitoring	IV-43
M. Implementation Costs and Schedule	IV-44
N. References	IV-44
<u>Appendices</u>	
IV-1 Checklist of the Birds of Midway Atoll	IV-61
IV-2 Predominant Reef Fish Families of Midway Atoll	IV-67
IV-3 Checklist of the Vascular Plants of Midway Atoll	IV-69
IV-4 Bird-aircraft Strike Hazard (BASH) Plan	IV-79
IV-5 Sample Applications for Special Use Permits	IV-87

TABLE OF CONTENTS (cont'd)

Figures

IV-1	Vegetation, Sand Island	IV-10
IV-2	Vegetation, Eastern Island	IV-11
IV-3	Critical habitat - endangered Hawaiian monk seal	IV-16
IV-4a	Distribution of nesting Black-footed and Laysan albatross	IV-19
IV-4b	Distribution of nesting Bonin Petrels, Wedge-tailed Shearwaters, and Christmas Shearwaters	IV-19
IV-5a	Distribution of nesting Masked Boobies, Red-footed Boobies, and Great Frigatebirds	IV-22
IV-5b	Distribution of nesting Red-tailed and White-tailed tropicbird	IV-22
IV-6a	Distribution of nesting Brown Noddies and White Terns	IV-25
IV-6b	Distribution of nesting Black Noddies, Gray-backed and Sooty terns	IV-25
IV-7	Monk seal haul-out and pupping sites	IV-28
IV-8	Relative value of lands as wildlife habitat	IV-34

Tables

IV-1	Responsibilities of Military Facilities: Fish and Wildlife Resources	IV-2
IV-2	Responsibilities of the Fish and Wildlife Service at Midway Atoll NWR	IV-3
IV-3	Estimated Seabird Nesting Populations at Midway Atoll	IV-13
IV-4	Proposed Costs and Schedule for Recommended Management Projects	IV-45
IV-5	Project Costs - Fish and Wildlife Management	IV-57

Plates

IV-1a	Rat predation on tropicbird egg
IV-1b	Rat herbivory on beach naupaka
IV-2a	Fenced storage area, Sand Island.
IV-2b	Entangled green sea turtle, Sand Island
IV-3a	Uncovered chamber, fuel farm, Sand Island
IV-3b	Subsurface chamber with mesh cover, Sand Island

IV. FISH AND WILDLIFE SECTION

A. Introduction

1. Purpose

Most of the undeveloped land and water areas on naval installations represent suitable or potential habitat for fish or wildlife. In order to promote enhancement of this valuable resource, it is necessary to maintain a continuing and progressive program of fish and wildlife habitat management which complies with current and accepted scientific practices and is integrated with the total natural resources program. In addition to meeting legal requirements, a fish and wildlife program can provide excellent public relations and recreational opportunities and can stimulate community support for the military presence.

Midway Atoll provides breeding and feeding habitat for more than one million migratory seabirds, as well as endangered Hawaiian monk seals, threatened green sea turtles, and a rich diversity of reef fishes and invertebrates. The atoll is considered to be of such significance to wildlife that it has been designated an Overlay National Wildlife Refuge. This abundance of resources means that a comprehensive and well integrated fish and wildlife program is essential for NAF Midway.

2. Scope of this section

The fish and wildlife section of the Natural Resources Management Plan for NAF Midway is organized for consistency with the directives and guidelines that set forth the authority, responsibilities, and procedures for the conservation and management of fish and wildlife under the jurisdiction of the Chief of Naval Operations. The fish and wildlife program includes fisheries management, management of game and non-game species, protection of threatened/endangered species, bird-aircraft strike hazards (BASH) reduction, and control of feral, exotic, and other problem species.

3. Objectives of this section

The three principle objectives of this section are to identify the facility's fish and wildlife resources, to present the key issues and objectives of wildlife management, and to recommend ways to implement management actions so as to maximize wildlife conservation while minimizing conflicts with the military mission. Conservation of indigenous species and their habitat will be stressed, with special attention given to rare, endangered, and threatened species. Management of pest species will be addressed in this section.

4. Responsibilities

The responsibilities of the facility with respect to the fish and wildlife program, including bird-aircraft strike hazard (BASH), as set forth in NAVFAC P-73, Volume II, are listed in Table IV-1. The responsibilities of the Fish and Wildlife Service (FWS), as set forth in the Midway Atoll Fish and Wildlife Refuge Management Plan, are presented in Table IV-2.

TABLE IV-1

Responsibilities of Military Facilities: Fish and Wildlife Resources

A. Installations with land or water areas which are suitable or potential habitat for fish and wildlife shall:

1. Have active and progressive programs for the preservation and management of federal and/or state listed threatened and endangered species and their habitats; for the conservation, enhancement, and management of fish, wildlife, and desirable or protected plant species naturally occurring on the installation; and, for the control and management of feral animals.
2. Ensure preparation of a cooperative agreement with the U.S. Fish and Wildlife Service, appropriate state fish and game departments, and other agencies (such as the National Marine Fisheries Service) as appropriate, for conservation and management of fish and wildlife resources.
3. Ensure all parties of the cooperative agreement coordinate at least once a year and discuss matters that relate to conserving and managing fish and wildlife resources on, or affecting, the property administered by the installation.
4. Implement a fish and wildlife management program.
5. Budget for and fund the fish and wildlife program.
6. Identify and protect threatened and endangered species listed pursuant to the Endangered Species Act.
7. Ensure consultations are conducted, as required under Section 7 of the Endangered Species Act, for any action which "may affect" a threatened or endangered species or its designated critical habitat. Coordinate threatened/endangered species consultations with the appropriate EFD (Engineering Field Division). Consultations shall be initiated and managed by the appropriate EFD, if the installation does not have personnel with expertise in wildlife biology.
8. Ensure adequate access for public recreational uses (when appropriate).
9. Ensure adequate access for federal and state natural resources conservation officials.
10. Ensure compliance with existing state and federal fish and game laws.
11. Ensure compliance with federal and state hunting, fishing, and trapping permit requirements.

B. In order to minimize bird-aircraft strike hazard (BASH) occurrences Commanders and Commanding Officers of Naval Air Facilities and Installations shall:

1. Develop, establish, and maintain a program to reduce potential for collisions between aircraft and birds or other animals in their air facility environment.
2. Prepare a written BASH plan and have the plan certified as technically adequate by the appropriate EFD.
3. Ensure procedures are established for the immediate exchange of information between ground agencies and aircrews concerning the existence and location of birds which could pose a hazard.
4. Request BASH program review and technical assistance from the appropriate EFD when a strike hazard potential is identified.

TABLE IV-2

Responsibilities of the Fish and Wildlife Service at Midway Atoll National Wildlife Refuge

1. Provide technical review and assessment of all station projects or programs with a potential impact on fish and wildlife resources.
2. Provide review comments and inputs relating to the contractor's scope of work and approved standard operating procedures relating to fish and wildlife resources.
3. Provide technical review, comments and recommendations regarding all proposed research projects with potential impact on fish and wildlife resources. According to the Endangered Species Act, conduct Section 7 consultation relating to listed species. Coordinate with scientists conducting wildlife-related research on Midway Island.
4. Enforce regulations in the fish and Wildlife Management Plan and other pertinent federal fish and wildlife regulations. Serve as Wildlife Law Enforcement Agent and designate deputies as appropriate.
5. Monitor the use and application of all pesticides, insecticides, and other chemical substances.
6. Monitor wildlife disease, evaluate causes, develop contingency plans, and respond to reported incidents involving diseased fish and wildlife.
7. Monitor seabird populations through continuing ecological studies of breeding success, population abundance, and distribution.
8. Conduct and coordinate seabird banding studies.
9. Coordinate and participate in control of vertebrate pest species and management of pest vegetation in wildlife habitats.
10. Coordinate all bird abatement programs, including study planning and implementation, permit review and issuance, actual abatement actions and assessment of results. This would include projects to limit the number of albatrosses nesting near the runway(s) and other such activities.
11. Provide guidance and participate in programs to enhance wildlife habitat.
12. Monitor habitat use, pupping, distribution, mortality, and other parameters relating to the monk seal.
13. Provide materials, displays, and guidance relating to interpretive or environmental education programs and participate in the implementation of these programs.
14. Provide guidance relating to hazardous waste spill contingency planning and participate in its implementation.
15. Coordinate with the OIC - NAF Midway, and the Commander, PACNAVFACENGCOM, on all of the above or any other projects and programs relating to fish and wildlife.

B. Policies and Programs

1. Existing

Federal and local laws, policies, and programs that affect natural resources management generally and fish and wildlife management specifically are presented in the Basic Section (Table II-1).

Navy policy for two important areas of fish and wildlife resources management is as follows:

Fish and wildlife resources. The Secretary of Defense, through DODDIR 4700.4, has established a program for fish and wildlife management to implement the provisions of the Sikes Act. The program applies to all Navy commands and personnel, and covers Navy installations on United States soil which contain land and water areas suitable for conservation and management of fish and wildlife resources.

Endangered species habitat. The Department of Defense, because of the protective or security nature of many of its installations, provides vital sanctuaries for threatened species of flora and fauna. OPNAVINST 5090.1, states that "The Navy Department will actively carry out a program to protect endangered and threatened species. The objective of the endangered species program is to minimize interference by military operations with endangered or threatened species and their habitat."

The Marine Bird Policy issued on 9 March 1981 by Region One of the FWS is presented here because it is especially relevant to wildlife management at Midway Atoll. The major tenets of this Policy are as follows:

- a. Implement to the fullest extent possible those Migratory Bird Treaty provisions dealing specifically with marine birds, especially those within the recent Japanese and Soviet Union treaties
- b. Maintain all marine birds occurring on National Wildlife Refuge lands and waters at not less than current population levels, in their natural diversity and on native habitat throughout their range
- c. Utilize all available programs and divisions of the FWS to influence the maintenance of the population and habitat conditions as described above on all non-FWS owned lands
- d. Recognize that most marine bird colonies, roosts, and loafing sites are important to their survival and work toward the establishment and active protection of these habitats and their adjacent waters as marine bird sanctuaries by private, local, state or federal interests
- e. Encourage formulation of comprehensive land management plans, effective regulation of offshore oil and mineral development, and stringent tanker safety laws to provide adequate protection for marine birds and their habitats in areas which may be developed
- f. Encourage appropriate research and surveys on marine birds and their ecosystems, especially work related to long-term monitoring of populations and habitats and identifying species nearing threatened status
- g. Remove all introduced predators from marine bird colonies on all national wildlife refuges and encourage their removal from all other colonies.

2. Current management issues and concerns

Determination of the following issues and concerns is based on current conditions at Midway Atoll; changes in wildlife populations or the level or type of military activities may result in a different set of management concerns.

Midway Atoll supports more than one million migratory seabirds, endangered Hawaiian monk seals, threatened green sea turtles, and a rich community of reef fishes and invertebrates. The overriding fish and wildlife concern is how to protect, maintain, and enhance this abundance of wildlife without interference with the facility's military mission. Specific issues relating to this concern are listed below:

- potential negative impacts to wildlife due to construction, renovation, or repair of buildings, roads, or other facilities
- new development within existing or potential wildlife habitat areas
- disturbance of wildlife by base personnel during daily operations and recreation activities
- presence of hazards to wildlife, including abandoned structures and debris, uncovered pits, fenced enclosures, antennas, overhead utility wires, lighting, deteriorating seawalls, nets entangled in piers, etc.
- conflict between wildlife and vehicular traffic
- potential hazards to wildlife related to storage or spillage of petroleum products, contaminants, and hazardous wastes
- bird-aircraft strike hazard (BASH).

Other wildlife issues of concern are the following:

- orientation of all personnel arriving at Midway for the first time, with respect to wildlife regulations and procedures
- enforcement of wildlife and fisheries regulations
- regulation of wildlife researchers, writers, photographers, and film-makers
- promotion of wildlife interpretation for base personnel
- predation by introduced rats on indigenous seabirds and native vegetation
- preservation and enhancement of coastal strand and beach habitat, including management of ironwood trees
- prevention of future introduction of alien or pest species
- restoration and enhancement of Eastern Island
- preservation of populations of lobster and other species harvested recreationally
- dwindling populations of Hawaiian monk seals and green sea turtles.

C. Fish and Wildlife Goals and Objectives

1. Long-term goals and objectives

National. In general, the goals of fish and wildlife management are to further the enhancement or development of fish and wildlife resources by protecting, restoring, developing, and managing the current and potential habitats for the reasonable production of the species involved. A summary of fish and wildlife goals and objectives, as viewed by the Navy and the Fish and Wildlife Service, respectively, is presented below.

Navy. To ensure compliance with NAVFAC P-73 and NAVFAC MO-100.3, natural resources must be managed in the public interest under the principles of multiple use - sustained yield, within the limitations of the military mission. When establishing goals and objectives the military mission has top priority, and fish and wildlife resources should be managed to prevent interference with the military mission, security risks, and safety hazards. Control and administration of natural resources, including fish and wildlife, on military lands and waters is usually the responsibility of the facility. Related goals identified in NAVFAC MO-100.3 include the following:

- a. all management plans should emphasize recreational values, although the welfare of the fish or wildlife resource should receive high priority in order to maintain the resource
- b. public enjoyment and utilization of fish and wildlife through non-consumptive nature-oriented recreation should be promoted
- c. tangible, intangible, social, historical, aesthetic, cultural, and economic values should be considered when determining greatest net public benefit.

Fish and Wildlife Service. Since Midway Atoll's designation as an overlay National Wildlife Refuge on 22 April 1988, the responsibility for management of fish and wildlife resources has been the province of the United States Fish and Wildlife Service (FWS). Thus, the basic long term goals and objectives of the FWS and the National Wildlife Refuge System are applicable to Midway Atoll.

The overriding management responsibility of the FWS is to conserve, protect, and enhance fish and wildlife, including endangered species, and their habitats, as essential natural resources. FWS is responsible also to manage and develop fish and wildlife resources in a manner that best serves the present and future needs of the people of the United States. Management goals for wildlife areas are based on the potential habitat use of the species inhabiting the area, with highest priority given to threatened and endangered species. Outdoor recreation uses (such as nature interpretation and education) of wildlife areas are encouraged, but the welfare of the wildlife and attendant habitats must be considered higher priority when interests conflict. Specific program goals which apply to Midway are the following:

- a. to prevent the endangering or extinction of plant and animal species which is caused by human influence on existing ecosystems, and to remove such species from threatened or endangered status
- b. to conserve and manage migratory birds in a way that provides optimum opportunity for their use and enjoyment by people
- c. to assure natural diversity and optimum population levels of wildlife for the benefit of people through those management activities that are FWS responsibility

- d. to inform and educate the public on environmental issues affecting fish and wildlife resources and provide compatible recreation on FWS lands.

The basic management responsibility of the National Wildlife Refuge System is to provide, preserve, restore, and manage a network of lands and waters, where the benefits associated with wildlife and wildlands are enhanced and made available. Specific goals of the NWRS are consistent with those listed above for the FWS:

- a. to preserve, restore, and enhance in their natural ecosystem all species that are endangered or threatened with becoming endangered
- b. to perpetuate the migratory bird resource
- c. to preserve a natural diversity and abundance of fauna and flora on refuge lands
- d. to provide an understanding and appreciation of fish and wildlife ecology and man's role in his environment, and to provide Refuge visitors with high-quality, enjoyable recreational experiences oriented towards wildlife, to the extent these activities are compatible with the original purposes of the Refuge.

Base specific. The principal long term fish and wildlife objective is to protect, maintain, and enhance the populations of indigenous birds, monk seals, sea turtles, and reef dwelling fishes and invertebrates, and their habitats, while minimizing conflicts with the military mission. This broadly scoped objective comprises a number of components:

- a. to minimize human-related disturbance of wildlife and their habitats
- b. to eliminate existing and future hazards to wildlife
- c. to control rats and, if necessary, other introduced species throughout the atoll and to prevent the future establishment of all alien species
- d. to manage vegetation so as to control the spread of introduced ironwood trees and promote restoration of the coastal strand vegetation complex, in order to arrest beach erosion while maintaining the maximum diversity of seabird nesting habitats
- e. to restore Eastern Island and other suitable lands to a state of natural vegetation communities and optimum wildlife habitat
- f. to reduce the risk of bird-aircraft strike hazard (BASH)
- g. to promote and provide opportunity for the use of fish and wildlife resources for the purposes of recreation, education, and scientific research, within the limits of refuge requirements
- h. to monitor the health and status of wildlife populations and habitats in order to evaluate existing management programs and identify additional management needs.

2. Short-term goals and objectives

- a. To minimize human-related disturbance of all native wildlife species and their habitats, by:
 - designing and implementing a program to orient all arriving personnel with regard to fish and wildlife regulations and responsibilities
 - establishing protocol for coordination and consultation between the Navy and FWS, in order to minimize conflicts between wildlife and military and civilian activities, including development, operations, and recreation
 - establishing sanctuaries for especially sensitive species and habitats.

- b. To minimize injuries to wildlife resulting from human activities and debris, by:
 - developing and implementing, with Navy consultation, a program to reduce conflicts between birds and vehicular traffic
 - eliminating existing hazards (beachcast nets, uncovered pits, toxic wastes, etc.).

- c. To enhance the population of endangered monk seals, by:
 - providing accessible, disturbance-free beach habitat
 - initiating the introduction of young breeding seals from other colonies.

- d. To implement a program designed to control introduced rats throughout the atoll

- e. To begin to manage vegetation, in order to reduce shoreline erosion and enhance wildlife habitat, by implementing measures to:
 - control the spread of ironwood trees
 - promote the recovery of beach naupaka and other native plants.

- f. To begin restoration of Eastern Island by:
 - initiating control programs for rats and ironwoods
 - investigating the availability of DERA or other sources of funds for removal of major hazards
 - investigating the use of volunteer labor for clean-up of minor hazards.

- g. To reduce the bird-aircraft strike hazard (BASH), by producing and implementing a BASH plan which includes the consistent collection of detailed data on bird-aircraft strikes.

- h. To provide opportunities for recreational, educational, and other public uses of fish and wildlife resources, by:

- establishing regulations to ensure the continued viability of a recreational fishery for finned fishes, lobsters, and other invertebrates
 - developing a program of wildlife interpretation
 - promoting and regulating the use of atoll wildlife by scientific researchers, journalists, photographers, and film-makers.
- i. To begin monitoring the health and status of populations of selected species to enable evaluation of ongoing management programs.

D. Fish and Wildlife Resource Inventory

- 1. Site description

Midway Atoll is a low sand and coral atoll comprising three islands and some small ephemeral spits enclosed within a reef approximately five miles in diameter. Originally nearly devoid of plant life, the larger islands (Sand, Eastern, and Spit) now are extensively vegetated, primarily with introduced species. The predominant plant throughout the atoll is the ironwood tree (*Casuarina equisetifolia*). Introduced in 1903, this aggressive species has colonized major portions of all the islands.

Since the late 1970s, most human activities have been confined to Sand Island, and much of this island is covered with runways, roads, and structures (see Plate II-1a). The developed areas feature numerous clearings, including large fields of mowed grass, and tall mature ironwoods sparsely distributed around habitations (see Plates II-1b and III-1a). Ironwoods have provided shade and shelter from windblown sand and salt, enabling many exotic plant species to grow in the island's interior. In abandoned areas, ironwoods grow more densely and unshaded clearings are over-grown by introduced herbs, such as golden crown-beard (*Verbesina encelioides*) and wild poinsettia (*Euphorbia heterophylla*). Undeveloped areas are characterized by dense, tangled forests of younger ironwood.

The western coastline of Sand Island is mostly sandy beach, while much of the eastern side is bordered by sheetpile bulkhead or riprap. Just inland from some shores are remnant stands of dune-binding species, primarily beach naupaka (*Scaevola sericea*) and heliotrope (*Tournefortia argentea*). Formerly, this vegetation community was predominant in the coastal strand, but now these plants are in severe danger of extirpation due to competition with ironwoods and herbivory by introduced rats. The only sizable stand of naupaka on Sand Island is located at Frigate Point (Figure IV-1).

Relative to Sand Island, Eastern Island is smaller and more open. A significant part of the interior is covered with abandoned runways, which are partially overgrown with ironwoods, and coral rubble flats vegetated with golden crown-beard and other low herbs and grasses (see Plate III-1b). Small stands of naupaka and heliotrope are distributed over most of the island (Figure IV-2), but the plants are thin and dessicated due to herbivory by rats and shading from ironwoods. A few large sections of the island are covered by ironwood forest, and ironwoods apparently are continuing to colonize new areas. Most of the northern and eastern shorelines are sandy beach and the southern (windward) coastline is covered with coral rubble. The southeast point is littered with metal debris (see Plate III-2b).

Figure IV-1. Vegetation, Sand Island

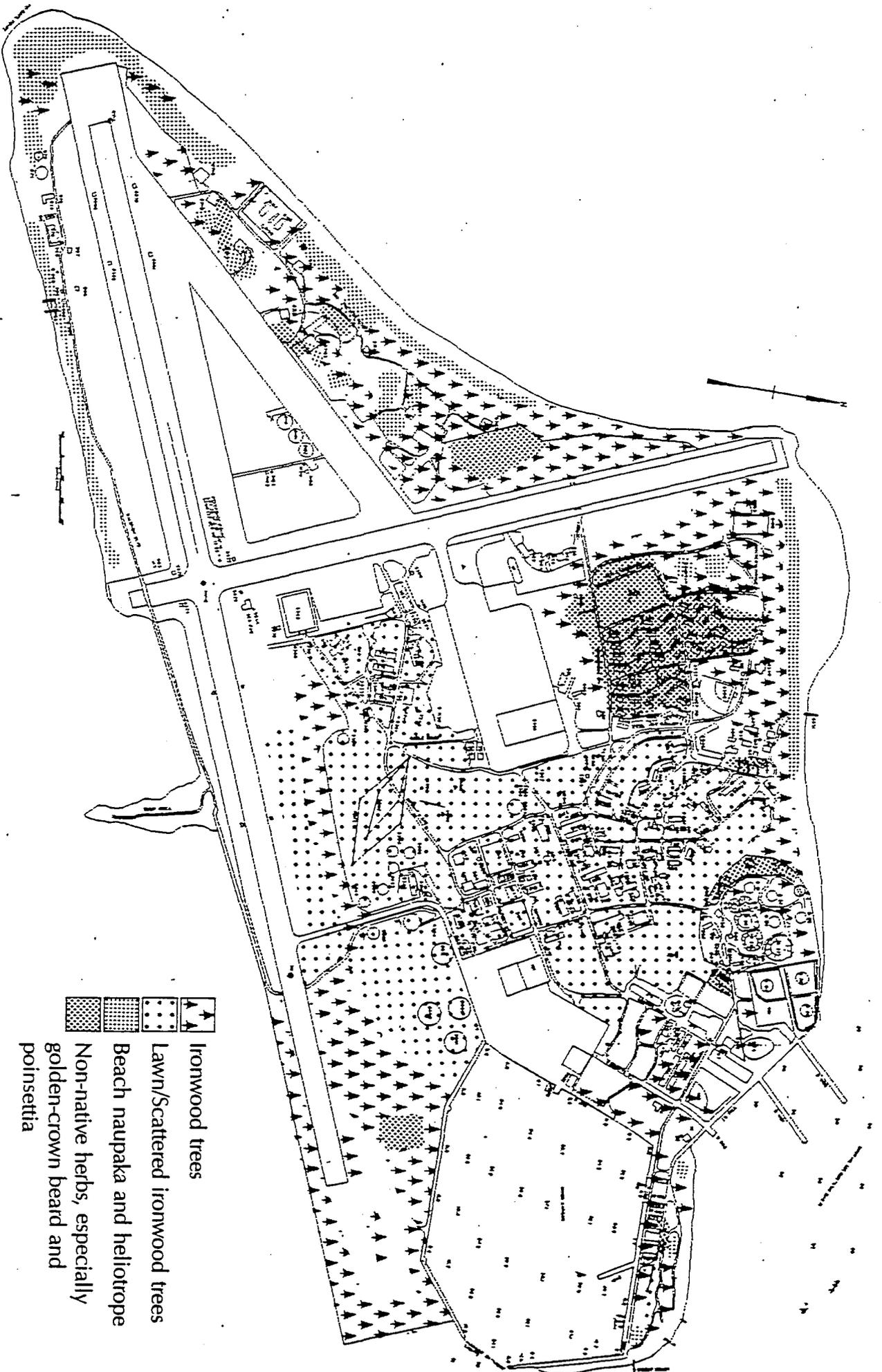
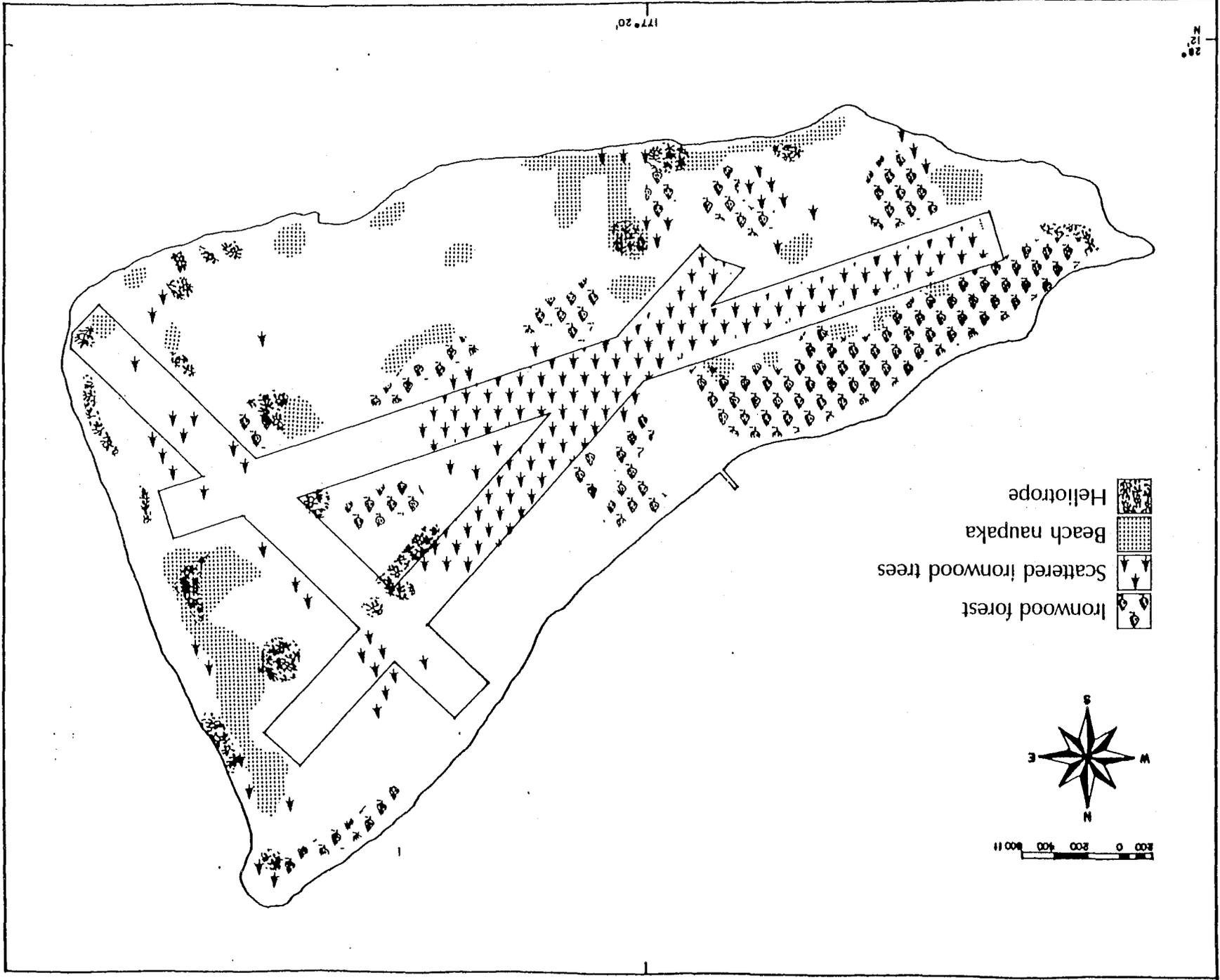


Figure IV-2. Vegetation, Eastern Island



Tiny Spit Island undergoes frequent reshaping by winter storms. The substrate is mostly coral rubble and currently the island features small patches of ironwood forest, naupaka, and heliotrope, and a small enclosed lagoon.

2. Species and species group inventory and assessment

Wildlife

Indigenous species. Fifteen species of migratory marine birds, comprising over one million individuals, breed at Midway Atoll and at least two additional species formerly nested there. The atoll supports the world's largest Laysan Albatross nesting colony and the largest colonies of Red-tailed Tropicbirds, Black Noddies, and White Terns in the Hawaiian Island chain. Nesting population estimates for all seabird species are presented in Table IV-3. Virtually all unpaved lands in developed, abandoned, and undeveloped areas represent current or potential nesting habitat for marine birds. Three species of migratory shorebirds, the Lesser Golden-Plover, Ruddy Turnstone, and Bristle-thighed Curlew, are seasonally numerous, and many other species of migratory birds have been seen at Midway. A complete list of bird species observed at Midway is presented in Appendix IV-1.

The only other fauna which features significant numbers of indigenous species is the coral reef community. Over 130 species of reef fishes and numerous invertebrates have been observed in lagoon waters. A list of the predominant reef fish families is presented in Appendix IV-2.

Exotic species. Two species of introduced landbirds, the Common Myna and Common Canary, are resident breeders on Midway. No game birds are present on the atoll. The only species of terrestrial mammals are two species of rodents, the roof rat (*Rattus rattus*) and the house mouse (*Mus musculus*) which are considered pests.

Threatened and endangered species. The atoll supports a small breeding population of the endangered Hawaiian monk seal (*Monachus schauinslandi*). In recent years, pupping has been observed only on Spit and Eastern islands, but adult and juvenile seals haul out on all shorelines of the atoll. Beaches free of human disturbance are considered essential to recovery of the population.

One highly endangered seabird species, the Short-tailed Albatross, visits Midway regularly during the winter. The worldwide population of this species is fewer than 500 individuals. Another endangered bird species, the Peregrine Falcon, is seen occasionally as a transient. The Bristle-thighed Curlew, which visits Midway during spring and fall migration, is currently a candidate for threatened or endangered status.

The green sea turtle (*Chelonia mydas*), listed as a threatened species, is frequently observed in the waters of the lagoon. Midway is considered an important feeding site for these animals. Currently there is no nesting, but the beaches of the atoll represent potential breeding habitat.

A pod of approximately 100 spinner dolphins (*Stenella longirostris*) is often seen within the lagoon and is probably resident. This species is protected under the Marine Mammal Protection Act.

Plants. Over 250 species of vascular plants have been collected from or observed at Midway (Herbst and Wagner, in press). Of these, 4 are endemic to the Hawaiian Islands and 20 are indigenous to the region; of the remainder, 99 are naturalized exotics (introduced deliberately or accidentally) and the rest survive only through cultivation. The complete list of plants is presented in Appendix IV-3. The number of extant plant species is probably much lower; a partial survey of Sand Island conducted in 1979 recorded 123 species (Apfelbaum et al. 1983).

TABLE IV-3

Estimated Seabird Nesting Populations at Midway Atoll

Black-footed Albatross	14,000
Laysan Albatross	350,000
Bonin Petrel	7,500
Wedge-tailed Shearwater	1,500
Christmas Shearwater	100
Red-tailed Tropicbird	9,000
White-tailed Tropicbird	10
Masked Booby	10
Red-footed Booby	1,000
Great Frigatebird	130
Sooty Tern	75,000
Gray-backed Tern	350
Brown Noddy	1,500
Black Noddy	8,000
White Tern	12,500
Total	470,100

(Adapted from Fefer et al.1984)

Appendix IV-3. The number of extant plant species is probably much lower; a partial survey of Sand Island conducted in 1979 recorded 123 species (Apfelbaum et al. 1983).

In most areas of Midway Atoll, the introduced ironwood tree (*Casuarina equisetifolia*) is predominant. In abandoned cleared areas golden crown-beard (*Verbesina encelioides*), Spanish needles (*Bidens* sp.), and wild poinsettia (*Euphorbia cyathopora*) are the most widely distributed herbs. Along the shores and dunes of the coastal strand, the predominant plant is the indigenous beach naupaka (*Scaevola sericea*), but beach heliotrope (*Tournefortia argentea*) and sea grape (*Coccoloba uvifera*) are also common. The major vegetation zones are mapped for Sand Island and Eastern Island, respectively, in Figures IV-1 and IV-2.

Three species are categorized as "candidate endangered plants": *Achyranthes atollensis* St. John (no common name), *Cenchrus agrimonioides* var. *laysanensis* F. Brown (kamanomano), *Phyllostegia variabilis* Bitter (no common name). Current locations of these plants, if any, are unknown. None of the species has been collected at Midway during the past 50 years.

- 3. Status of habitats, species, and species groups

Habitats

Prior to human settlement at the start of the 20th century, the islands of Midway Atoll were characterized by a naturally depauperate vegetation. Sand Island was flat and sparsely vegetated, featuring continuously shifting sand and small patches of dune-binding species, such as beach naupaka and morning glory (*Ipomoea* sp.). The geologically older Eastern Island was more lushly vegetated with low growing naupaka, alena vines (*Boerhavia repens*), grasses, and sedges. In 1903, ironwood trees were planted on the northern (windward) side of Sand Island. Initially, this windbreak enabled native plants to build dunes from the fine sands of Sand Island. Ironwoods subsequently colonized all of the islands and drastically restructured the atoll's terrestrial ecosystem. Ironwood forests occupied large portions of the emergent lands and provided shade and shelter from wind and wind-blown sand and salt spray, enabling numerous exotic and introduced plants to become established.

Today, ironwood remains the predominant plant throughout the atoll. Ironwoods occupy most areas of Sand Island that are not paved or landscaped, and they are rapidly invading abandoned areas (whether paved or not), including much of Eastern Island. In the interior of Sand Island mature trees coexist with a variety of naturalized and cultivated plants, but in outlying areas such as the northern and eastern sides of the island, dense tangles of younger growth advance steadily toward the shoreline.

The invasion of island margins by ironwoods has contributed to a significant reduction in native dune-binding plants, especially beach naupaka the predominant plant of the coastal strand. Naupaka is specially adapted for life in exposed habitats, and apparently it is unable to withstand shading by faster growing ironwoods. Herbivory by rats on seeds and succulent growing buds has also contributed considerably to the decline. The only extensive stand of naupaka on Sand Island is located at Frigate Point, and even there, ironwood seedlings are starting to gain a foothold. A few isolated, lush clones are found along the northern and southern (near the NOPF buildings) shorelines, but elsewhere the stands are sparse. Along the western shore, naupaka has been reduced to a thin band of understory, which may soon disappear entirely. Inland of the foredunes, thin, rat-damaged naupaka patches are overgrown with crown-beard. Naupaka remains more widely distributed on Eastern Island, but most stands are sparse and characterized by heavy rat damage and dessication. Competition with crown-beard and understory damage from albatrosses seeking shade contribute to the destruction.

of competition with ironwoods and herbivory by rats could eliminate naupaka and the entire dune complex from Midway Atoll. During the past decade, the patterns of decline that were documented by that study have continued unabated.

Ironwood trees and beach naupaka stands both are important habitat for nesting seabirds. The unusually large nesting colonies of White Terns and Black Noddies are a direct result of the abundance of mature ironwood trees, sparsely distributed in the interior of Sand Island. Moderately dense forests, such as are found in Area 7 (Sand Island) and Eastern Island, represent shaded nesting habitat for Brown Noddies, Red-tailed Tropicbirds, Wedge-tailed Shearwaters, and small numbers of albatross. Dense and tangled forests of younger trees are less often used by nesting seabirds. Beach naupaka, especially the more lush stands, appears to be essential nesting habitat for Red-tailed Tropicbirds, Red-footed Boobies, and Great Frigatebirds. It is important also for Brown Noddies, Wedge-tailed and Christmas shearwaters, and Black-footed Albatross. Dunes and other soft substrate are essential for Bonin Petrels, shearwaters, and other burrow nesters.

Sandy beaches, especially those with minimal human disturbance, represent important wildlife habitat. Beaches enhance the successful fledging of albatross and other seabird chicks and they represent pupping and resting habitat for endangered monk seals and potential nesting habitat for threatened green sea turtles.

On Sand Island, the area of accessible beach habitat available to wildlife is limited by recreational activities, erosion, and erosion control measures. One of the most deleterious effects of ironwoods replacing native dune species along shorelines is the increase in erosion. Ironwoods are not capable of stabilizing beaches as is evidenced by the erosion along the northwest and northeast shores of Sand Island, the southeast shore of Eastern Island, and other areas where ironwoods have invaded the coastal strand. Shoreline bulkheads and riprap may successfully reduce erosion, but they render beaches inaccessible to wildlife (see Plate III-2a). Conversely, the conservation and promotion of naupaka and other dune-building plants may effectively reduce erosion without reducing beach access.

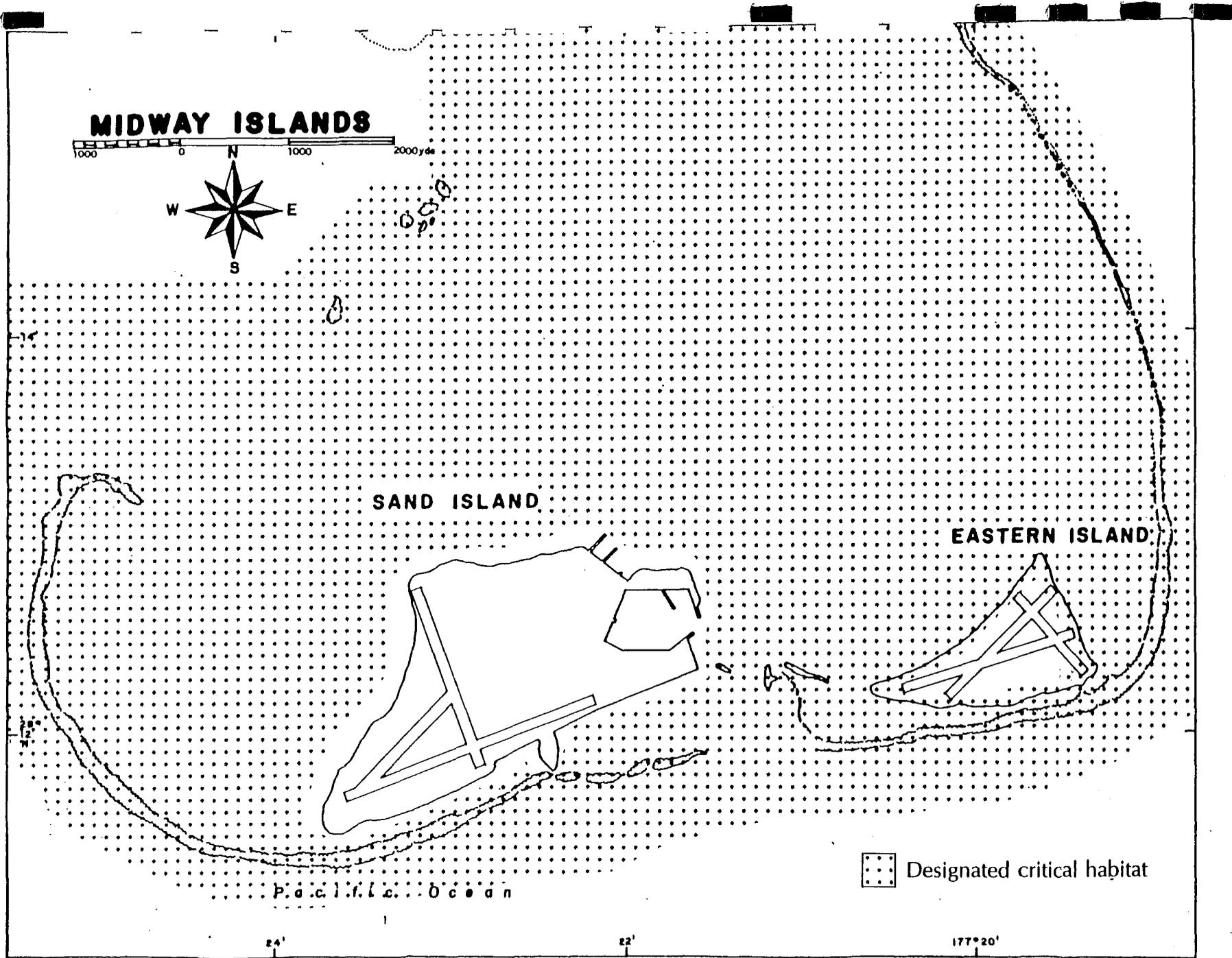
The shorelines of Eastern and Spit islands (plus lagoon waters and outer waters less than 20 fathoms deep) have been officially designated "critical" habitat for the Hawaiian monk seal under the Endangered Species Act (Figure IV-3). Sand beaches, located on most lagoon-fronting shores of these islands, are used extensively by resting and breeding monk seals. Access is limited by bulkhead and manmade debris in some areas.

Migratory Birds

More than 90 species of migratory birds have been seen at Midway, primarily seabirds, shorebirds, and waterfowl. Many of these are rare and unexpected visitors; some have been sighted only once or twice during the past century. Twenty-four species are considered regular visitors to the atoll and the status of each will be discussed in detail in this section.

Seabirds. Undoubtedly, seabirds nested on Midway Atoll for countless generations prior to the arrival of man, but the earliest historical accounts of the birds of Midway date back only to the late Nineteenth century. Little is known about population status prior to that time, but in all likelihood, the activities of feather hunters and shipwrecked sailors significantly reduced the populations from prehistoric levels.

In the following accounts, the former and current status of each species is reviewed. Unless otherwise noted, historical information is from the following sources: Bartsch (1922), Hadden (1941), Fisher and Baldwin (1946), and Bailey (1956). Maps of current nesting areas are also presented in this section.



IV-16

Figure IV-3. Critical habitat - endangered Hawaiian monk seal

Black-footed Albatross (*Diomedea nigripes*). In 1907, this albatross was described as a common nesting species on both islands, 20 times more abundant than the Laysan Albatross. Population size was probably small because feather hunting continued as late as 1902 (Bryan 1905). In the late 1930s, this was still the more abundant albatross, with an estimated population of 30,000 birds. In 1945, Fisher and Baldwin counted 35,000 and 18,000 birds on Sand and Eastern islands, respectively; this included chicks and some subadults and probably translates to about 10,000 breeding pairs. They reported that Black-footeds were less impacted by the war than Laysans, probably due to their use of island margins. The largest population estimate after 1960 was 6900 breeding pairs in 1961 (Robbins 1966). Ludwig et al. (1979) counted 2800 to 3200 nests on Sand Island in 1979 and felt that the population had decreased (or relocated) since their 1963 visit. The most recent estimate is 6500-7500 nesting pairs (Fefer et al. 1984).

In general, Black-footed Albatrosses nest in exposed areas adjacent to beach-lined shores; nests are scarce in island interiors. On Sand Island, Black-footeds are numerous only on the western side (Figure IV-4a), which features accessible beaches and minimal human disturbance. Small groups of nests in the woodlands of Area 7, the Fuel Farm, and other atypical habitats, may be remnants resulting from the birds' reluctance to abandon traditional nesting sites, despite changes in those sites. Use of Sand Island has declined in recent decades and Ludwig et al. (1979) have suggested that Black-footed Albatross populations are limited, perhaps even stressed, by loss of suitable habitat and competition with Laysan Albatrosses. Birds nesting near beaches rely on beach naupaka for shade; stands of naupaka and other native strand species are greatly reduced due to herbivory by introduced rats and competition with ironwoods. Black-footeds have virtually disappeared from the island's interior, while the number of Laysan Albatross nests has increased dramatically. On Eastern Island, Black-footeds are more widely distributed, but there too, nests are more numerous nearer shorelines.

The annual cycle for this species is fairly consistent from year to year. Breeding adults return to the colony in mid-October and lay eggs in November or early December. Chicks hatch from mid-January through mid-February. Adults are scarce after June and most chicks fledge and depart the atoll by the end of July. Late season chick mortality is significant in some years, especially on Sand Island.

Laysan Albatross (*Diomedea immutabilis*). This species was first recorded at Midway in 1891, but the exposed habitat and effects of feather hunters resulted in only small numbers of birds. In 1907, Laysans were outnumbered by Black-footed Albatrosses by twenty to one. Human colonization of the islands led to an increase in the area of protected habitat and by the 1930s, the Laysan population had increased to an estimated 20,000 birds. In 1945, 75,000 and 35,000 birds (of all ages) were estimated for Sand Island and Eastern Island, respectively, which translates to about 30,000 nesting pairs. Some residents felt that this was only half the number that nested at Midway just prior to the war. In any case, Laysans had supplanted Black-footeds as the predominant albatrosses by this time. Following the war, numbers increased rapidly; the 1956-57 population estimate was 60,000 pairs on Sand Island alone (Fisher 1966). Airplane-albatross collisions became a serious problem, prompting control efforts which reduced the number of breeding pairs on Sand Island to about 20,000 during the early 1960s. As control efforts relaxed, the population grew and by 1963-1964 it had reached 53,000 pairs.

In February 1979, Ludwig et al. (1979) measured nest density and used these data to estimate the nesting population. They estimated 58,000 nests on Sand Island and 140,000 to 210,000 nests on Eastern Island. Because nest density was much lower on Sand Island (134 versus 475 nests per acre), they believed that Sand Island could potentially support a threefold increase in nesting Laysans. The most recent estimate, by Fefer et al. (1984), is 150,000 to 200,000 pairs for the entire atoll.

Laysan Albatrosses (or "white goonies") nest on all three islands of the atoll (Figure IV-4a), but nest density is significantly higher in island interiors. Any soft substrate is suitable for nests, but soil and vegetation are preferred over sand; hard substrates such as pavement and packed coral rubble are not used.

Nesting at this colony is quite synchronous. The timing of the nesting cycle is consistent from year to year, lagging about two weeks behind that of the Black-footed Albatross. Adults return to the atoll in November and egg laying continues until mid-December. Chicks hatch during late January through mid-February. Few adults are present after June and most chicks fledge by mid August. Late season chick mortality has been very high in recent years, but the cause is not currently known.

Non-breeding birds, including pre-breeding age immatures seeking mates and future nest sites, comprise a significant portion of the birds on the colony. During spring, when breeding adults are foraging at sea, most of the birds observed on shore are non-breeders.

Short-tailed Albatross (*Diomedea albatrus*). The earliest record of this albatross at Midway was of one individual seen in 1938 and 1939. A single immature bird was observed in November 1940. Since February 1979, single birds have visited Sand Island each winter. In November 1985, a Short-tailed with a black plastic band (# 000) appeared; this bird has returned in subsequent years and in 1988 and 1989 it remained at Midway through most of April. In 1989, a banded (# 015) immature also was present through April.

Known locally as the "golden gooney," the rare and endangered Short-tailed Albatross is present at Midway only as a seasonal visitor. One or two individuals may be seen with other albatrosses on the crowns of outlying beaches from October through April. During the Nineteenth century, this species was abundant at Bonin Island and elsewhere in the Pacific. Today, the only remaining nesting colonies are found on islands near Japan and these total fewer than 500 birds.

Bonin Petrel (*Pterodroma hypoleuca*). The Bonin Petrel was first recorded at Midway in 1907; the species undoubtedly occurred there prior to that time but nothing is known about the population. In the mid-1930s, the population was "conservatively" estimated to be 500,000 birds. The introduction of rats and loss of habitat during World War II resulted in dramatically reduced numbers. In May 1946, only 25,000 pairs were estimated for Sand Island and none remained on Eastern Island. Predation by rats continued to erode the population and by 1979 the population had been reduced to an estimated 5000 pairs. The current population may be smaller still (Fefer et al. 1984, Woodby 1988).

Bonin Petrels are known locally as "nightbirds" because they are only active in the colony after dark. Eggs are laid in shallow burrows excavated in soft soil or sand. Successful nesting is limited to the inhabited areas of Sand Island where rats are controlled by baiting. The largest burrow colonies are located in the dunes southeast of the harbor and the lawns near the abandoned school (Figure IV-4B), but small groups of burrows can be found wherever there is soft substrate.

Bonin Petrels return to the atoll in August and begin to renovate nesting burrows. Adults are observed in the colony through the remainder of the year, but eggs are not laid until January. By March, egg laying declines and hatching begins. Chicks fledge in May and June and by July most birds have departed the atoll.

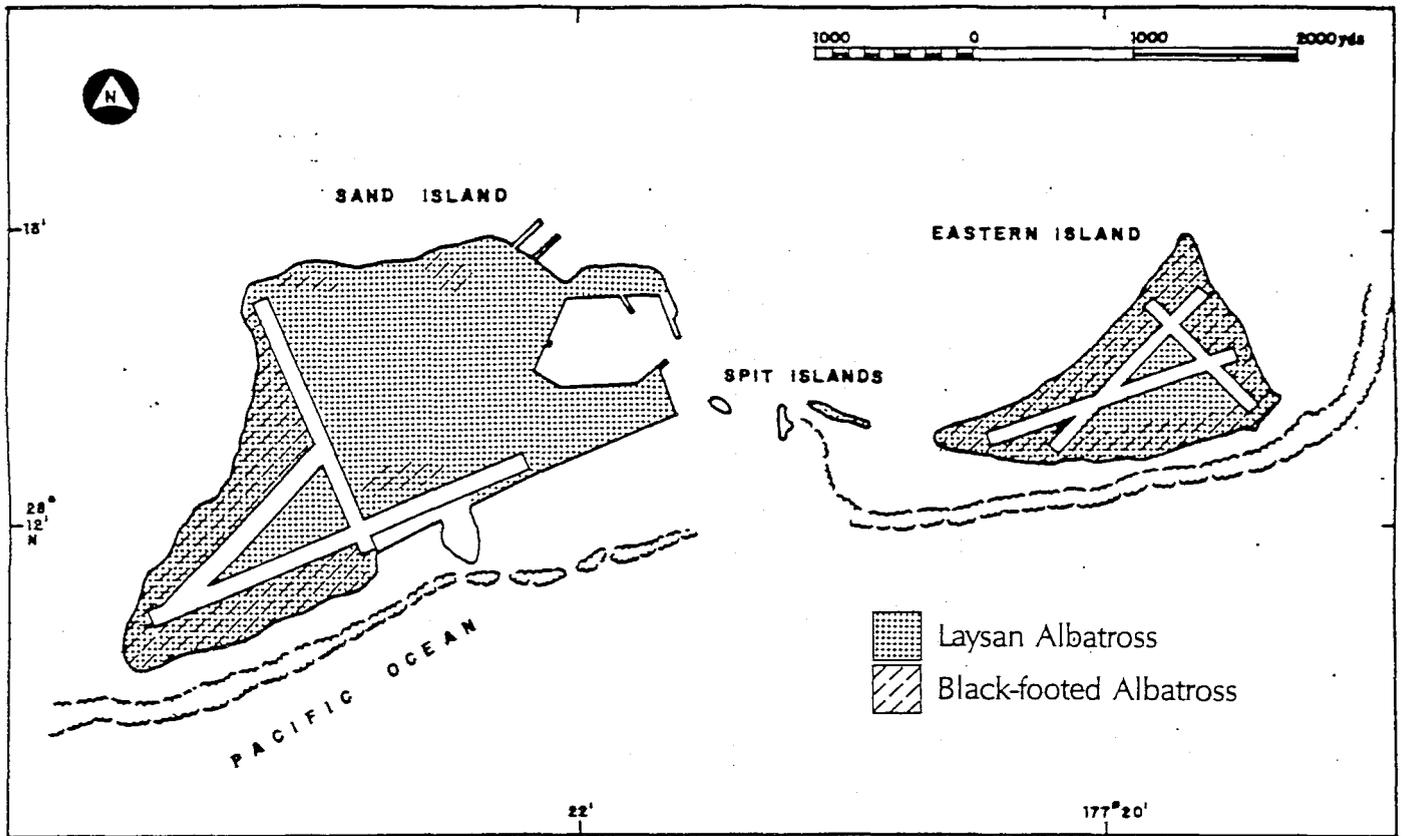


Figure IV-4a. Distribution of nesting Black-footed and Laysan albatross

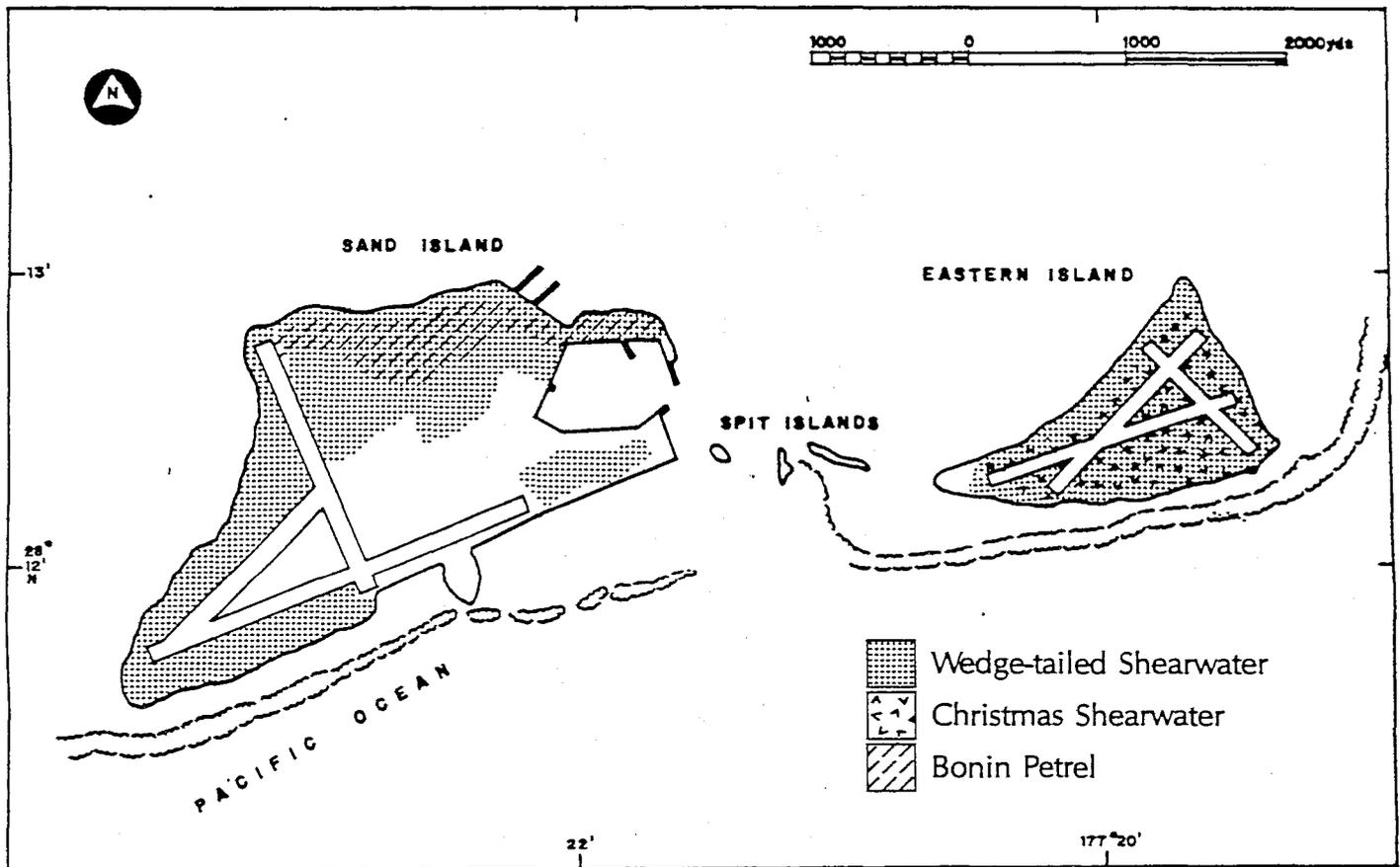


Figure IV-4b. Distribution of nesting Bonin Petrels, Wedge-tailed Shearwaters, and Christmas Shearwaters

Bulwer's Petrel (*Bulweria bulwerii*). Munro (1941) states that Bulwer's Petrels were abundant and nesting on Eastern Island in July 1891, but none of the ornithologists who visited Midway during the early twentieth century mentioned this species. Hadden (1941) considered them rare in the 1930s, but in the early 1940s they were described as very common on Eastern Island, with a few nesters on Sand Island as well. In 1945, just after the war, Bulwer's were found on Eastern Island, but not on Sand. By 1949, none remained and the species has not been seen at Midway since that time.

The extirpation of Bulwer's Petrels from Midway is thought to have resulted from predation by introduced rats. The birds nested in crevices under naupaka bushes making them highly vulnerable to rat predation. Nesting season probably lasted from April to September.

Wedge-tailed Shearwater (*Puffinus pacificus*). Prior to World War II, this shearwater was a very common nesting species at Midway, especially on Eastern Island. A very rough estimate by Fisher and Baldwin (1946) placed the population at 40,000 and 22,000 birds on Sand Island and Eastern Island, respectively. They believed this represented a decline from former numbers and this trend has continued, primarily due to predation by introduced rats. The current population is probably on the order of 1000 to 2000 birds (Fefer et al. 1984).

Known locally as "nightbirds" or "moaning birds," Wedge-tailed Shearwaters are active on land only at night. They nest in deep burrows dug in sand or soft soil and they nest in surface crevices under naupaka bushes and ironwood trees. On Sand Island, burrow density is highest in the dunes at Frigate Point, near the Harbor, and near the golf course (Figure IV-4B). Surface nests are more numerous on Eastern Island.

Adult shearwaters return to the colony and begin to burrow by April, but most eggs are laid in June and July. Early chicks hatch in August and most fledge and depart the island by November.

Christmas Shearwater (*Puffinus nativitatis*). Although not mentioned by most early visitors to Midway, Christmas Shearwaters were considered as numerous (i.e., "thousands") as Wedge-tailed Shearwaters on Eastern Island in the early 1940s. In 1945, only 400 birds were counted on Eastern Island and none on Sand Island, suggesting that rat predation had greatly reduced the population. The population is currently estimated to be less than 150 birds.

These shearwaters nest in surface crevices, primarily under naupaka bushes. Nesting is thought to be restricted to Eastern Island (Figure IV-4B), but courting birds have been heard at Frigate Point on Sand Island.

Christmas Shearwaters usually nest a month or so earlier than do Wedge-taileds. Adults return to the colony as early as March, but some years the major influx is not until May. Eggs are laid from April through June and chicks hatch in July and August. Young fledge and depart the atoll by October or November.

Masked Booby (*Sula dactylatra*). Masked Boobies have been observed at Midway since the 1890s, but nesting was not reported until 1940 when a few chicks were seen. One chick was observed on Sand Island in 1945, but none were seen in 1949. In 1979, one nest was reported at the southwest tip of Eastern Island. As many as three nest attempts were made in 1988 and 1989 at the northwest end of Eastern Island (Figure IV-5A); in each year, only one chick was fledged.

Masked Boobies nest on the ground in open terrain. At Midway they nest on coral rubble rather than on sand spits as is their habit elsewhere in the Hawaiian chain. Competition for nesting hab-

it with the enormous albatross population may prevent increases in the number of booby nests. In recent years, the successful nesters have hatched chicks in March or April and fledged chicks in August or September; the unsuccessful pairs have laid eggs in May or June.

Brown Booby (*Sula leucogaster*). During the early part of the Twentieth century, small numbers of Brown Boobies nested at Midway, probably on Eastern Island. Hadden (1941) stated that the Brown was the most common booby at Midway during the mid-1930s, but he doesn't mention nesting or population size. As many as six nests were seen on Eastern Island in 1940 and again in 1949, indicating that the species had survived the war. Continued disturbance and predation by introduced rats subsequently wiped out the nesting population and currently the species is considered an uncommon, non-breeding visitor to the atoll.

Brown Boobies nest in a wide variety of habitats, but at Midway they historically nested on the ground near naupaka bushes. Timing of the nesting cycle is also variable, but March through August appears to have been normal.

Red-footed Booby (*Sula sula*). Red-footed Boobies were reported nesting in "considerable numbers" on Eastern Island as early as 1913. Fisher and Baldwin counted 194 nests on Eastern Island in 1945 and suggested the population had been reduced by disturbance and destruction of habitat. In February 1979, Ludwig et al. (1979) counted 346 nests, but felt that rat predation and habitat loss were threatening the species. The current population is estimated to be about 450 to 500 nesting pairs.

Red-footeds nest atop naupaka, heliotrope, and other shrubs; ironwood trees are used only for roosting. Nesting is confined to Eastern Island and nest density is highest at the north end of the island (Figure IV-5A).

The nesting cycle is somewhat variable and adults may return to the colony and lay eggs anytime from December through May. By July, most chicks have hatched and by October all but the latest chicks have fledged.

Great Frigatebird (*Fregata minor*). Great Frigatebirds were first observed nesting on Eastern Island in 1902, but little is known about the population prior to World War II. Reports of nesting on Sand Island have not been confirmed. Hadden estimated that over 500 birds were present in 1936, but many of these were likely non-breeders. Frigatebirds nested on Eastern Island in 1944, but Fisher and Baldwin saw only 60 roosting birds in May 1945. Over 200 birds and many nests were reported in May 1949. Ludwig et al. (1979) estimated 30 to 80 nesting pairs on Eastern Island in 1978 and 1979. The current population comprises an estimated 500 to 600 birds, but only about 50 nesting pairs.

Frigatebirds build nests only in naupaka shrubs and nesting is confined to the central part of Eastern Island (Figure IV-5A). Roosting birds can be found in ironwood trees throughout Eastern Island and near the NOPF on Sand Island.

Adult frigatebirds lay eggs as early as February or as late as May. Chicks may hatch as early as April, but peak numbers of chicks are usually seen in June or July. Late chicks do not fledge until October or November.

Red-tailed Tropicbird (*Phaethon rubricauda*). The Red-tailed Tropicbird has been described as a common nesting species throughout Midway Atoll since the 1890s, but details about population

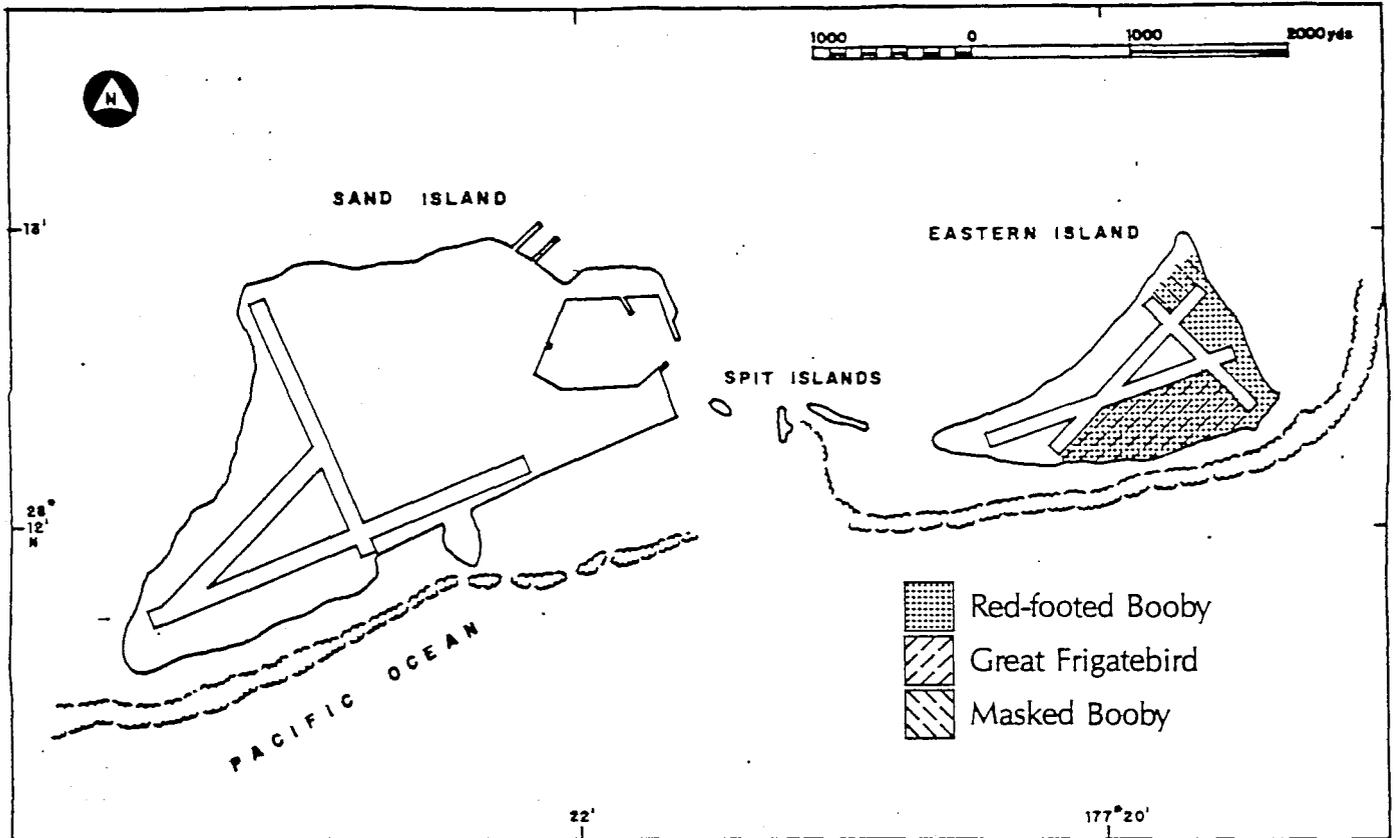


Figure IV-5a. Distribution of nesting Masked Boobies, Red-footed Boobies, and Great Frigatebirds

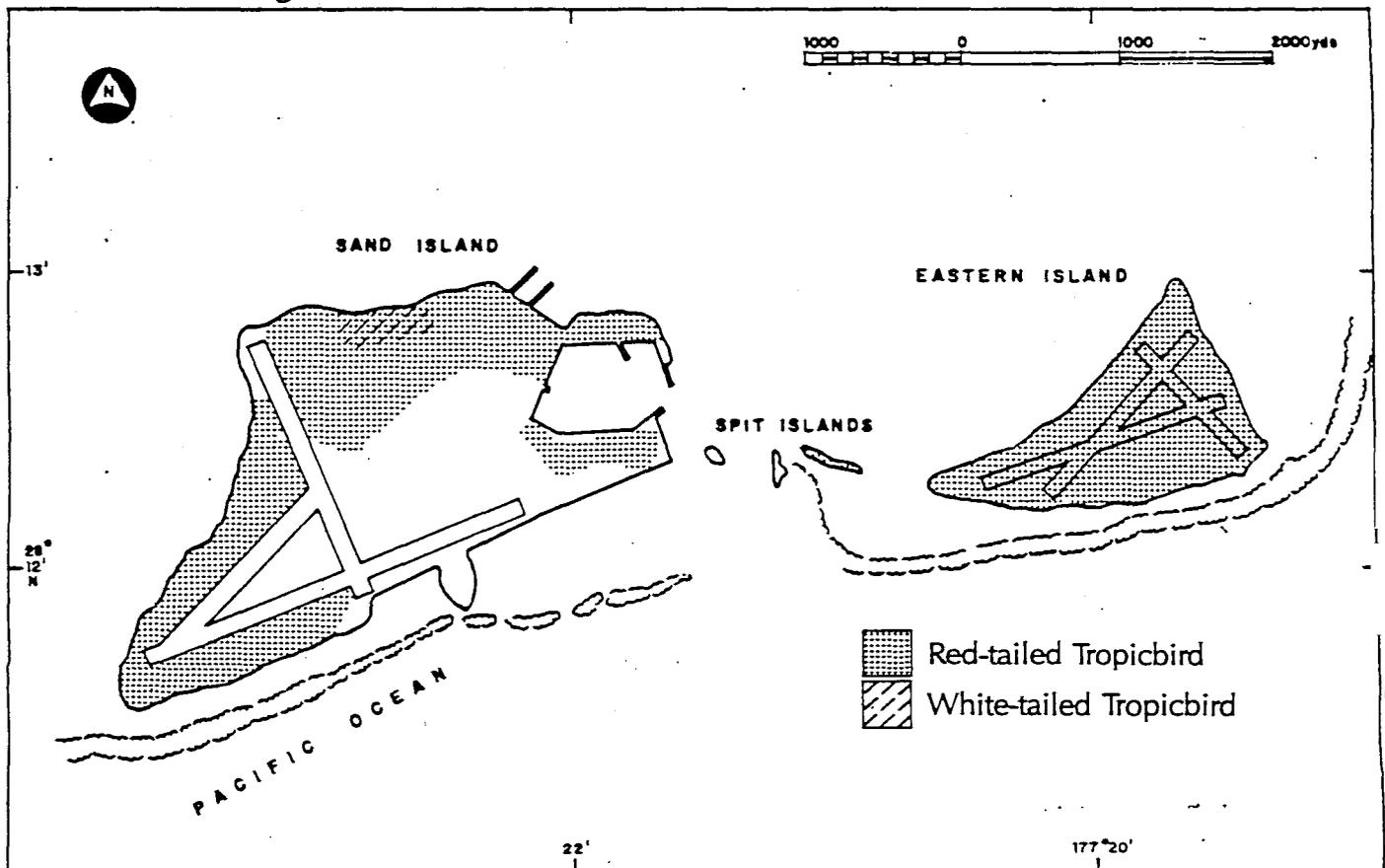


Figure IV-5b. Distribution of nesting Red-tailed and White-tailed tropicbirds

size are scant. In 1945, Fisher and Baldwin estimated 5000 and 4500 pairs, respectively, for Sand and Eastern islands. Declines resulting from rat predation and habitat destruction have left the current population at about 4000 to 5000 pairs on the entire atoll (Fefer et al. 1984).

Known locally as "bosunbirds," tropicbirds nest on the ground throughout the atoll, on any soft substrate, provided there is adequate overhead shade. Nest density is highest in stands of nau-paka, but ironwood forests and other vegetation are used as well (Figure IV-5B). Nesting success is much lower on Eastern and Spit islands, presumably because rat predation is more intense.

Adult tropicbirds return to the colony and begin to lay eggs by late February. The majority of eggs are laid from mid-March through mid-June, but some are laid as late as August. The peak of hatching is May through July. Fledging gets underway by July and continues through October.

White-tailed Tropicbird (*Phaethon lepturus*). This species was first recorded on Sand Island in 1940 and the first nest was found in 1949 (Bailey 1951). Small numbers (2 to 4 pairs) currently nest on Sand Island and presumably did so in the intervening years.

These tropicbirds nest in the crooks of ironwood trees, either at ground level or higher up, and occasionally in household planter boxes. In recent years nests have been restricted to wooded areas near human habitations on Sand Island (Figure IV-5B).

The seasonal cycle is not well known for Midway and nesting may go on throughout the year. In 1988, one chick fledged in May, while another hatched in June. In 1989, one egg was still being incubated at the end of August.

Brown Noddy (*Anous stolidus*). Small numbers of Brown Noddies have been seen at Midway since the 1890s, but no nests were reported until Blackman saw a few on Eastern Island in March 1940. No nests were observed in May 1945, but during November 1949, about 50 birds nested along the edge of a runway. Although little information has been published, the reduction of disturbance and increase in habitat have led to a significantly larger population, currently estimated to be 750 to 1250 nesting pairs.

Brown Noddies nest in a variety of surface and arboreal habitats on Sand and Eastern islands (Figure IV-6A). On Sand Island, density is highest under the naupaka stand at Frigate Point, but noddies also nest high up in the ironwood trees of Area 7 and along the edge of the abandoned taxiway. On Eastern Island, Brown Noddies nest in ironwood trees and under shrubs along the edge of abandoned runways.

The timing of the breeding cycle can be quite variable, but in recent years adults have begun to nest during April and most eggs were laid by the end of May. The majority of chicks hatched in July and fledged by late August. Some birds may be present throughout the year.

Black Noddy (*Anous minutus*). Early ornithologists saw few of these birds at Midway, probably due to the dearth of vegetation, but by 1936, the population had climbed to 2000 birds. Similar numbers (1350 and 750 on Sand and Eastern islands, respectively) were reported in 1945. By 1979, nesting was restricted to Sand island and the population comprised roughly 2000 nesting pairs. The most recent estimates place the current population at 2000 to 6000 nesting pairs.

Black Noddies formerly nested in naupaka shrubs on both islands, but now they nest only on Sand Island, high off the ground in mature (often dead) ironwood trees. Density is highest in residential areas, but some birds nest in Area 7 (Figure IV-6B).

The nesting cycle for the Black Noddy is extremely protracted and variable. Nests with eggs or chicks can be seen from October through August.

White Tern (*Gygis alba*). Formerly known as the Fairy Tern, this species was seen in small numbers on both islands by all early visitors. Due to the increase in vegetation, the White Tern population rose to 3000 birds by 1936 and to 20,000 (15,000 on Sand Island; 5,000 on Eastern Island) by 1945. The February 1979 estimate of 12,000 to 15,000 nesting birds is believed to accurately reflect current population size.

White Terns do not build nests, but lay eggs on tree branches, atop utility poles, and on ledges in a wide variety of structures. Site elevation ranges from near-ground level to the tops of ironwood trees. Breeding bird density is highest in mature ironwoods in inhabited areas of Sand Island, but nest sites can be found in various habitats on all islands (Figure IV-6A).

The nesting cycle at Midway appears to be rather protracted. Egg laying often begins in February and can continue into June or July. Chicks are present from March onward, but most have fledged by the end of August. Peak numbers of birds (possibly including many non-breeders) are present from late May through June.

Gray-backed Tern (*Sterna lunata*). This species was not reported by early visitors to Midway, but a few Gray-backed Terns were seen nesting on Eastern Island in March 1913. Hadden estimated the population to be about 500 birds in 1936, apparently all on Sand Island. Fisher and Baldwin reported a colony of 750 birds on Eastern Island in May 1946, and they felt that numbers were declining due to loss of habitat. The current population estimate is 200 to 400 nesting pairs.

Gray-backed Terns nest in small groups on Eastern and Spit islands (Figure IV-6B). Nests are usually found along island margins, often just above the beach crown. Eggs are laid on the ground, amid coral rubble or on abandoned runways. The cryptically colored eggs may be laid in the open or in the shade of low vegetation or debris.

Adult terns return to the atoll by February and the earliest eggs are laid in March. Late nesting or renesting birds may lay eggs as late as June. Chicks of varying ages may be seen from April onward and the young fledge from June through August.

Sooty Tern (*Sterna fuscata*). Although Palmer did not mention this species during his visit in July 1891, all others who visited during the summer breeding season reported enormous numbers of Sooty Terns. The earliest estimate was of 600,000 birds in 1936. Large nesting colonies were observed on both Sand and Eastern islands through the early 1940s. The estimate for May 1945 was 174,000 birds, mostly on Sand Island; although this count was made prior to the seasonal peak, it suggests that numbers had declined, probably due to disturbance and loss of habitat, especially on Eastern Island. Although there is little documentation, the combination of paving and other construction activities on Sand Island and the abandonment of Eastern Island during the 1950s and 1960s, must have brought about the relocation of the Sooty Tern colony. Currently, at least 35,000 to 50,000 pairs nest on Eastern Island.

Sooty Terns nest in dense colonies on level terrain throughout the interior of Eastern Island (Figure IV-6B). Nests can be found anywhere with even marginal shade, including abandoned runways, coral rubble, and stands of naupaka.

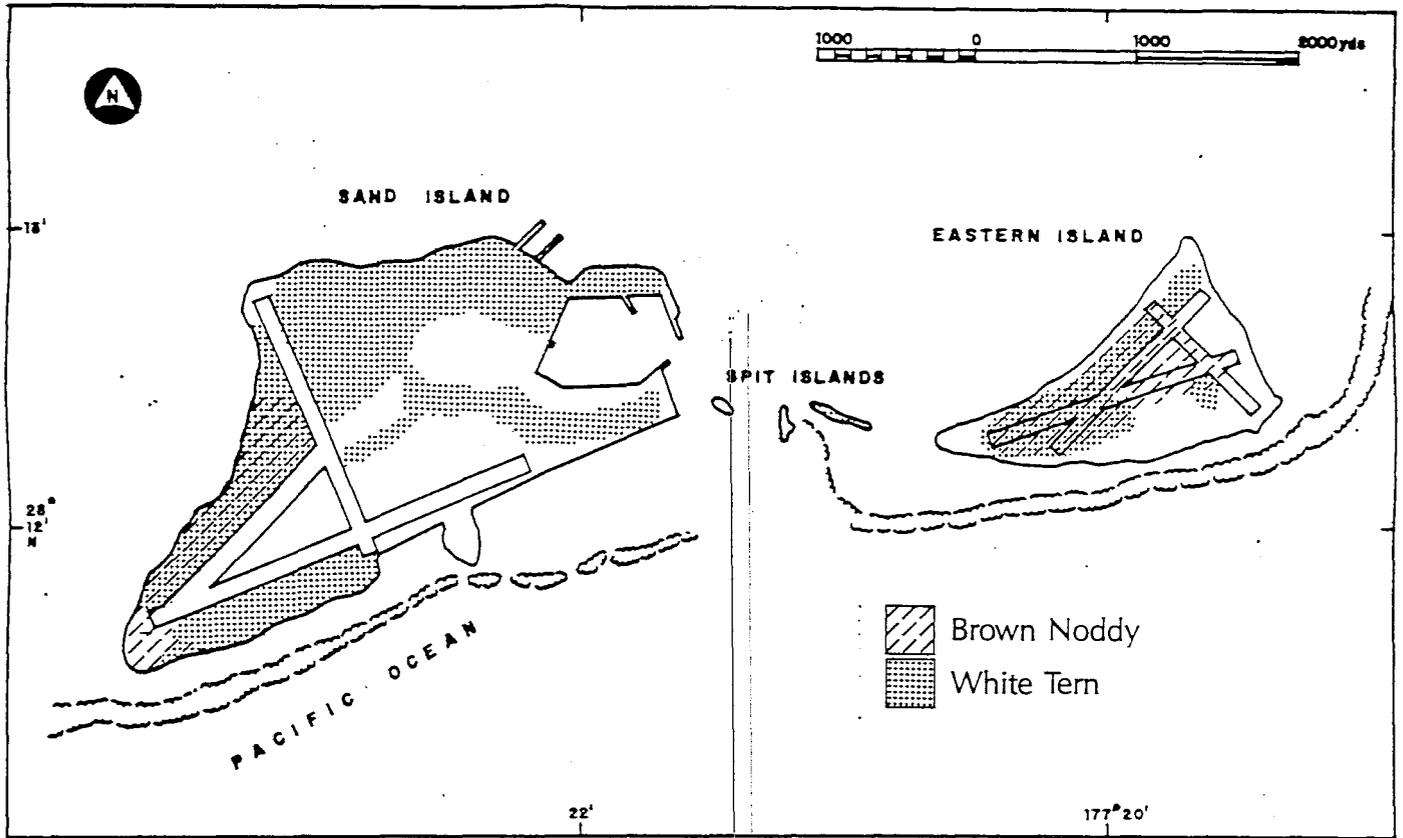


Figure IV-6a. Distribution of nesting Brown Noddies and White Terns

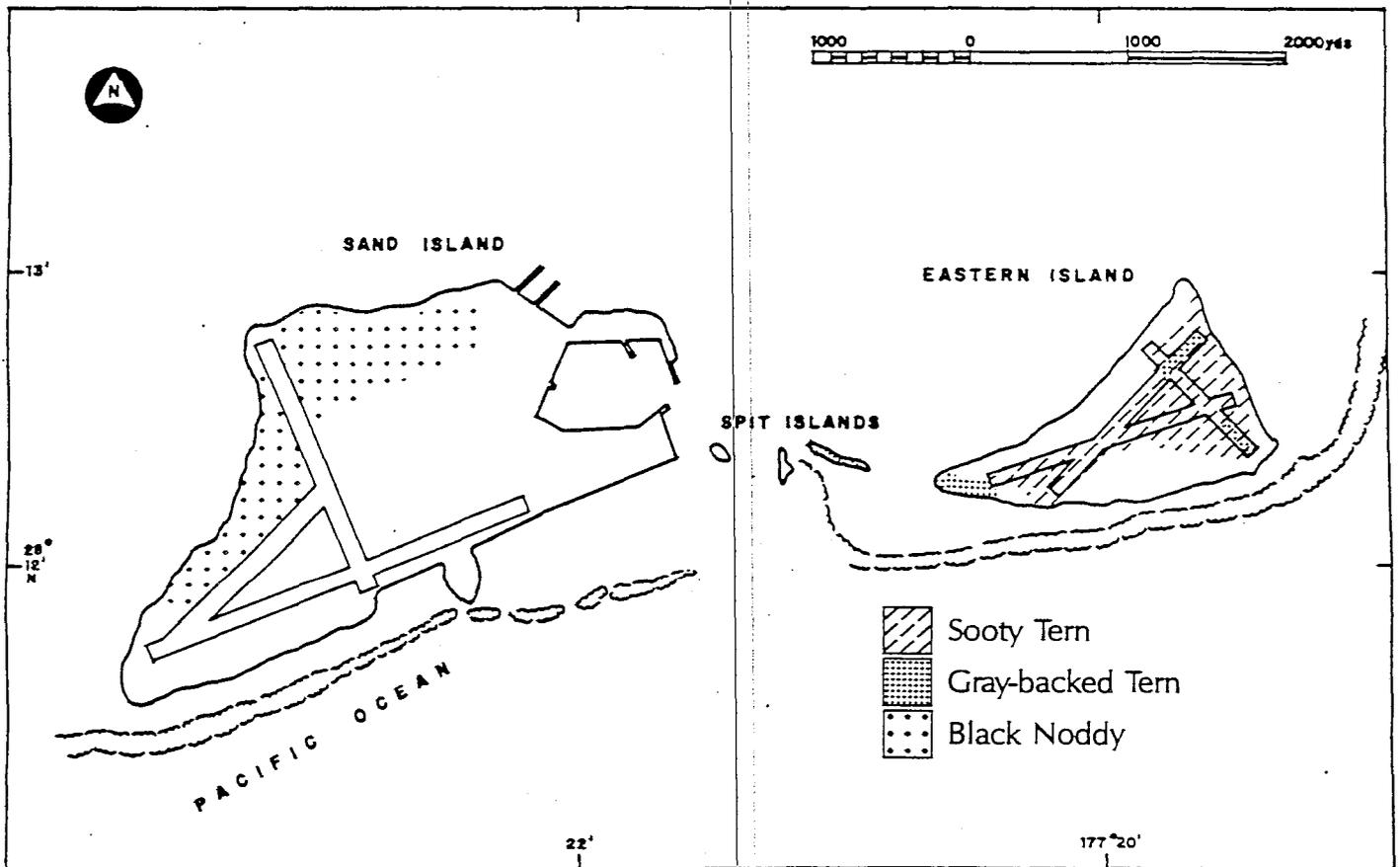


Figure IV-6b. Distribution of nesting Black Noddies, Gray-backed and Sooty terns

Adults begin to return to the atoll in February or March, but peak numbers are not attained until May or June. The earliest eggs are laid in late April and the peak falls in May, but laying may continue through June. Most chicks hatch in June and fledge during August. The majority of birds depart the atoll by the end of September.

Shorebirds. No species of shorebird or wader nests at Midway, but several are common visitors to the atoll. The number of birds is highest during spring and fall migration to and from nesting grounds in the far north. Moderate numbers remain through the winter, but only a few nonbreeders are present during the summer nesting season. The current status of these species is very similar to that reported earlier this century.

Lesser Golden-Plover (*Pluvialis dominica*). Thousands of these plovers visit Midway each year. Small numbers of birds can be seen in any month (although they are scarce during summer), but the population peaks in March-April and again in August-September. Plovers forage most often in lawns, fields, woodlands, and rainwater ponds.

Bristle-thighed Curlew (*Numenius tahitiensis*). Although the world population is small (the species is a candidate for threatened or endangered status), these curlews are seen at Midway throughout the year. Peak counts of 100 to 200 birds are made in April and September, but significant numbers of curlews remain on the atoll during some winters. These birds forage primarily in fields and woodlands. Prey includes mice and the unattended eggs of seabirds.

Wandering Tattler (*Heteroscelus incanus*). Tattlers are relatively uncommon visitors during migration and winter. Small groups of birds are often seen foraging along shorelines or near standing water.

Ruddy Turnstone (*Arenaria interpres*). Turnstones are numerous at Midway during winter and migration. Just prior to departure in spring (late April or early May), several thousand birds may be present. Breeding birds start to return by early August. These birds forage in a wide range of habitats.

Cattle Egret (*Bulbulcus ibis*). Although absent from the historical record, this species has been seen regularly during the past decade. Cattle Egrets probably visit Midway from the main Hawaiian islands, where they were introduced in 1959. Single birds and small flocks forage in fields and woodland margins.

Raptors. Several species of birds of prey, including the endangered Peregrine Falcon, have been recorded at Midway, but only one species is a regular visitor.

Short-eared Owl (*Asio flammeus*). First recorded in 1907, this species of owl has been a regular, but rare, visitor to the atoll. Most sightings are of single birds (but groups of four or more have been reported) roosting in ironwood trees. Most birds are probably visitors from the main Hawaiian islands, although some may be of Asian origin. No nesting has been observed, but the abundance of rodents could support a breeding pair.

Seals and Sea Turtles

Hawaiian monk seal (*Monachus schauinslandi*). Found only in the Hawaiian Island chain, this species of monk seal was hunted to near extinction during the 19th century. By the late 1950s,

the population had recovered sufficiently to occupy its former range. Aerial counts during 1957, placed the population at approximately 1000 animals, including 61 at Midway (Kenyon and Rice 1959). Four pups were born at Midway during the spring of 1957. Subsequently, the monk seal population has declined significantly throughout the chain; counts made in 1980 were 50% lower than counts in 1958. Disturbance and disease are the probable causes of the decline. At Midway, the population during 1988 and 1989 was on the order of 15 to 25 seals; only one pup was born and weaned in each of the two years.

Monk seals of all ages are seen at Midway throughout the year. In 1988 and 1989, females with pups were observed during March through May, but pups can be born anytime from late December through June.

Critical habitat for monk seals includes permanent sand islets or beaches above high tide for pupping, sandspits and beaches for haul-out grounds, and nearby shallow water for foraging. At Midway, seals haul out on beaches of all islands, but pupping is confined to the less disturbed shores of Eastern and Spit islands (Figure IV-7).

Pacific green sea turtle (*Chelonia mydas agasszi*). The history of this threatened species is not well known, but the current population of green sea turtles comprises only 500 to 1000 mature animals in the entire Hawaiian Island chain. About 200 females nest each year at French Frigate Shoals and this is believed to be over 90 % of the annual breeding effort for the entire region (Balazs 1980). Sea turtles mature very slowly, some taking 25 to 50 years to attain sexual maturity; thus, it is very difficult to detect population fluctuations over short time scales.

The green sea turtle (and rarely, the endangered hawksbill turtle, *Eretmochelys imbricata*) has historically been a regular visitor to Midway. Large adults are rather scarce, but small animals often bask on undisturbed beaches. Midway's lagoon is considered an important feeding area for turtles. Although there are few, if any, records of nesting, further reduction of disturbance, especially during the summer breeding season, could lead to future nesting on the sand beaches of Eastern and Spit islands.

4. Fish and wildlife introductions

Many species of exotic plants and animals have been introduced to Midway either purposefully or accidentally. Those that established naturalized wild populations have contributed to drastic changes in the atoll's ecosystem during the past century. Five species of birds, two or three mammals, several reptiles, and numerous insects have been introduced since humans began to inhabit the atoll on a permanent basis.

Prior to 1900, two species of birds endemic to Laysan Island, the Laysan Rail (*Porzana palmeri*) and the Laysan Finch (*Telespiza cantans*), were brought to Midway in an effort to prevent their extinction. In July 1891, pairs of each species were introduced to Eastern Island. Apparently, the finches did not survive, but the rails flourished and by 1907 they had become the most abundant birds on that island. Finches were successfully reintroduced to Sand Island about 1905 and in 1910 rails were brought over from Eastern Island. The species inhabited Midway until rats were introduced during World War II, but by 1945 both had been eliminated from the atoll (Fisher and Baldwin 1946).

In 1910, twelve caged Common Canaries (*Serinus canaria*) were released and subsequently the species became established in the wild. Currently, about 500 canaries are resident on Sand Island. Although there is no record of the introduction (the species is not mentioned in Bailey's 1956 review of Midway birds), the Common Myna (*Acridotheres tristis*), a native of India, has also

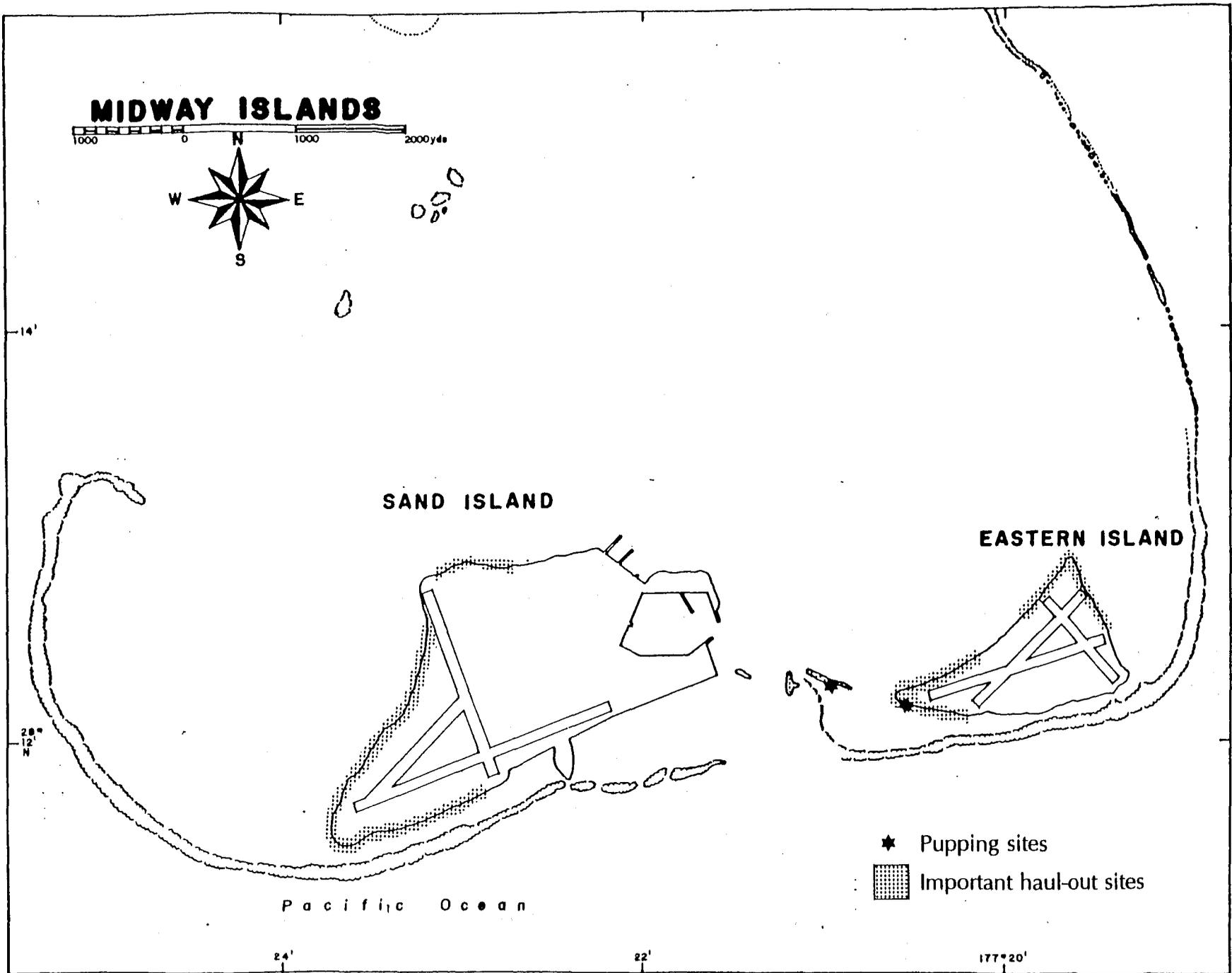


Figure IV-7. Monk seal haul-out and pupping sites

become naturalized at Midway; the current population of 500 to 1000 birds appears to be increasing. The Rock Dove (or feral pigeon; *Columba livia*) was introduced by cable company personnel; this species was thought to be resident at Midway through the 1970s, but none has been recorded in recent years.

The only non-domesticated, terrestrial mammals on the atoll are two species of introduced rodents, the roof rat (*Rattus rattus*) and the house mouse (*Mus musculus*). Unconfirmed records from previous decades include the Norway rat (*Rattus norvegicus*) and tree squirrel (*Sciurus* sp.) Roof rats were introduced inadvertently from ships during World War II (about 1943) and presumably mice arrived about the same time. Rodent studies conducted in 1988 by Animal Damage Control found that rats were numerous on all islands in abandoned areas without pest control and that mice were common throughout the interior of Sand Island. For additional detail see subsection D.5. - Pest Species.

Other introduced vertebrates include several species of geckos and a skink (current status of these is unclear). Several species of introduced insects warrant management concern, including cockroaches, termites, mosquitos, and green-bottle flies.

5. Pest species

Without a doubt, the pestiferous species of greatest concern is the roof rat (*Rattus rattus*). Rats are a potential threat to human health, and they prey on the chicks and eggs of seabirds (Plate IV-1a) and the seeds and vegetative growth of native plants (Plate IV-1b). Introduced about 1943 to Midway, an atoll with no predators and abundant food, rats quickly infested all the islands. Within five years, the introduced Laysan Rail became extinct and the Laysan Finch and two species of nesting seabirds (Bulwer's Petrel and Brown Booby) were extirpated. Many other species of seabirds declined in number, but the burrow nesting petrels and shearwaters suffered most; for example, Bonin Petrels declined from an estimated 500,000 birds in the 1930s to fewer than 10,000 in the 1980s. Recent studies have shown that surface nesting birds, such as Red-tailed Tropicbirds, also suffer from rat predation. Another problem is herbivory by rats on beach naupaka and other dune binding plants which provide essential seabird habitat and reduce the incidence of beach erosion.

Following the initial infestation, the size of the rat population has varied proportionately with the level of control effort (Woodby 1988). Vigorous control efforts in the 1960s apparently reduced the number of rats and the impacts on seabirds, but the population swelled again as control efforts decreased during the 1970s. In the early 1980s, civilian contractors successfully used anticoagulant rodenticides to reduce rat numbers, but significantly fewer bait stations have been in operation since 1987. Trapping studies conducted by Animal Damage Control in 1988 found few rats in inhabited areas, where baiting still occurs, but moderate to high densities in the outlying areas of Sand Island and throughout Eastern and Spit islands.

The house mouse (*Mus musculus*) is common in forested and inhabited areas of Sand Island, but scarce or absent along shorelines and on the other islands of the atoll. Mice are often found in inhabited structures and they may represent a hazard to human health. In outlying areas they eat mostly seeds of introduced plants and do not appear to affect seabirds. Mice are occasionally taken as prey by the bristle-thighed curlew; these birds could suffer secondary toxicity if the mice have been feeding on poisoned bait.

Insects such as termites and cockroaches represent potential health threats to humans, but they do not appear to affect wildlife. Flies and mosquitos are considered potential vectors for avian pox, a potentially lethal disease of birds that periodically affects albatrosses, tropicbirds, and other

species. Mosquitos are especially numerous in windless, damp, densely-vegetated areas such as patches of golden crown-beard.

E. Existing Management and Use Characteristics of Fish and Wildlife Resources

1. *Consumptive uses*

Wildlife. Recreational hunting is not practiced on the atoll because no game species are present and firearms are restricted for security and safety reasons. Authorized personnel may use firearms to kill feral mammals which are potential predators on migratory birds. Introduced rats and mice are controlled in inhabited areas by baiting with an anticoagulant rodenticide.

Fishing. Fishing by hook-and-line and throw net is practiced from shorelines, piers, and boats, both within the lagoon and outside the reef. Only pelagic fishes, such as tuna and wahoo, caught outside the reef are considered edible; reef-dwelling or reef-feeding species are considered inedible due to the possibility of ciguatera poisoning. Shoreline fishing is limited to recreational and bait-catching purposes. Lobsters (excluding females with eggs) may be taken by trap or by hand, but not by spear. No other invertebrates are captured regularly for food, but several species are collected for their shells. Current rates of capture pose no apparent threat to fish and lobster populations, but shell collectors have significantly reduced the number of corals and other shelled invertebrates that can be seen by shore-based snorkelers.

Plants. Coconuts and fruits from other introduced species are collected for food. Possibly other species are gathered for culinary or medicinal purposes, but at present this poses no threat to any native plant species.

2. *Non-consumptive uses*

For military and civilian personnel, non-consumptive uses at NAF Midway are limited to casual birdwatching and wildlife photography. No formal program exists for wildlife interpretation. Fishes and other reef inhabitants are observed and photographed by scuba divers and snorkelers. Scientists and film-makers from recognized institutions are granted special use permits by the Fish and Wildlife Service to work with island wildlife.

F. Fish and Wildlife Resources versus Base/mission Conflicts

1. *Effects of existing military programs/mission on fish and wildlife*

The military presence is beneficial to the wildlife at Midway in the following ways:

- reduction of human access for security reasons minimizes disturbance from boaters, sightseers, and other casual visitors
- maintenance of clear and landscaped areas provides habitat for nesting Laysan Albatrosses
- thinning of ironwood trees promotes the survival of mature trees, thus increasing the nesting habitat for arboreal White Terns and Black Noddies



Plate IV-1a. Rat predation on tropicbird egg



Plate IV-1b. Rat herbivory on beach naupaka

- inhabited and abandoned structures provide nesting habitat for White Terns
- baiting of rats by pest control personnel reduces rat predation on burrow nesting Bonin Petrels and Wedge-tailed Shearwaters on Sand Island
- collection of bird carcasses on Sand Island reduces insect populations and, potentially, insect-vector avian diseases
- base presence facilitates access to the atoll for wildlife researchers.

Some military and base operations result in negative impacts to wildlife:

- development of unimproved areas or construction of new facilities or roads may reduce the habitat available to wildlife
- construction and repair projects during bird nesting seasons can result in nesting failure or death of adults or young
- maintenance and normal operations can cause disturbance or mortality of seabirds and other wildlife
- birds colliding with utility wires, antennas, and towers may be killed or injured
- birds attracted by lights often collide with buildings resulting in death or injury
- birds colliding with motor vehicles may be killed or injured
- fenced enclosures and uncovered pits entrap seabirds (Plates IV-2a and IV-2b)
- bird mortality can result from ingestion of lead paint, plastic, and other toxic substances
- erosion control methods such as bulkhead and riprap reduce accessibility to shorelines for seals, turtles, and seabirds (see Plate III-2a)
- seals and turtles become entangled in monofilament fishing line and other debris beneath piers (Plate IV-3a)
- recreational use of beaches results in disturbance of endangered monk seals
- golfers trample petrel and shearwater burrows adjacent to fairways.

2: Effects of fish and wildlife resources on base/mission operations

The most serious negative affect of wildlife on base operations is bird-aircraft strike hazard (BASH). Damage to aircraft sometimes results from collisions with Laysan Albatrosses. For details, refer to Appendix IV-4.

The overwhelming size of the seabird population, especially the Laysan Albatross population, reduces the efficiency of many base operations. Maintenance, groundskeeping, transport of personnel and equipment, and many other tasks require more time and patience to complete in order to

minimize impacts to wildlife. Construction activities often must be scheduled so as not to conflict with bird nesting seasons.

G. Existing Land Use Plans Affecting Fish and Wildlife Resources

Virtually all land use plans at NAF Midway affect wildlife or wildlife habitat. For a complete discussion of land use projects, refer to Section III - Land Management.

H. Opportunities and Constraints

The management of unimproved lands and the restoration to a natural state of abandoned lands represent excellent opportunities for increasing the area and variety of habitat available to wildlife. The most significant site is Eastern Island, although several suitable areas exist on Sand Island. Enhancement of wildlife habitat is constrained in some areas of Sand Island by facility requirements, airfield and antenna clearances, and recreational uses.

I. Habitat Management Needs

1. Terrestrial habitats

In general, wildlife habitat needs to be managed in a manner that maintains the existing diversity (or restores former diversity level) of species, while maintaining or enhancing the abundance of each species. Furthermore, although change is inherent in all natural communities, management programs that promote habitat stability (and thus ecosystem stability) are encouraged.

With respect to habitat management, the most urgent need is to restore the coastal strand vegetation community. Beach naupaka and other dune-binding plants represent essential habitat for several seabird species and are integral in maintaining shoreline stability. Initial steps toward recovery include the control of rats and the removal of ironwoods and golden crown-beard from dunes and shorelines, especially near remnant naupaka stands. Along coasts where naupaka has already been eliminated or where existing stands do not regenerate, replanting efforts may be effective.

One of the key elements needed for the recovery of endangered monk seals is to ensure the availability of disturbance-free beach habitat. Beach area and accessibility are reduced by erosion and existing erosion control measures (bulkhead, riprap), and recreational use often causes disturbance. Alternative erosion control techniques and enforcement of wildlife regulations might increase seal habitat on Sand Island. Manmade debris and erosion resulting from the spread of ironwoods to coastal zones are the primary threats to beaches on Eastern Island.

The predominance of ironwood trees has produced mixed effects on wildlife. Mature trees provide nest sites for arboreal nesting noddies and White Terns, and shade for numerous surface nesters. Conversely, aggressive colonization by saplings has reduced plant diversity and nesting habitat for shrub nesting birds, such as boobies and frigatebirds. In order to meet the needs of all wildlife species, a comprehensive program to control and manage ironwoods is urgently needed.

The introduced herb, golden crown-beard (*Verbesina encelioides*) is the predominant plant in

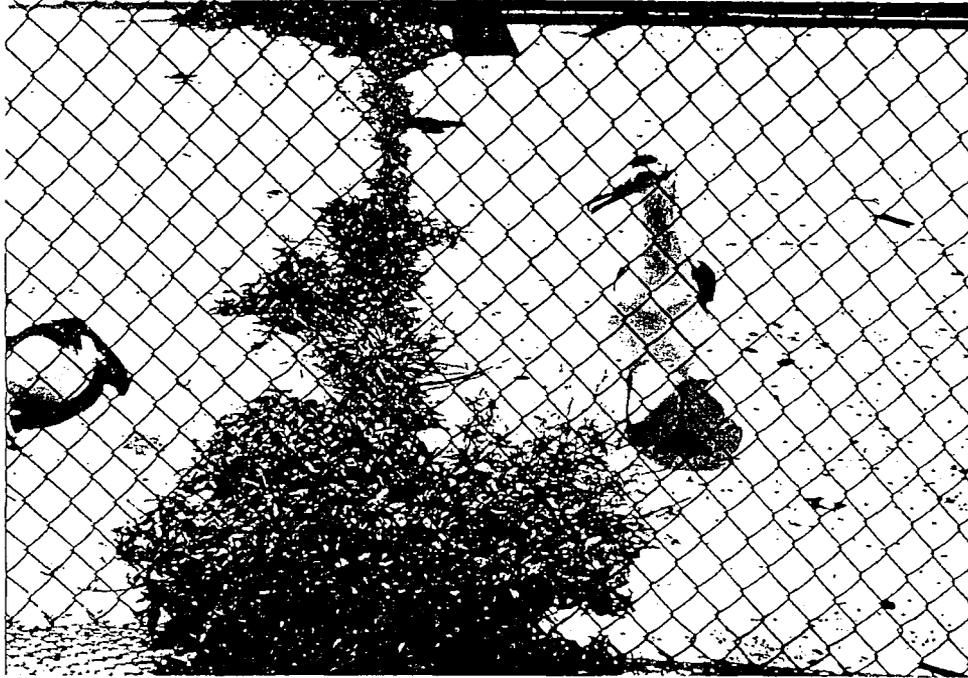


Plate IV-2a. Fenced storage area, Sand Island

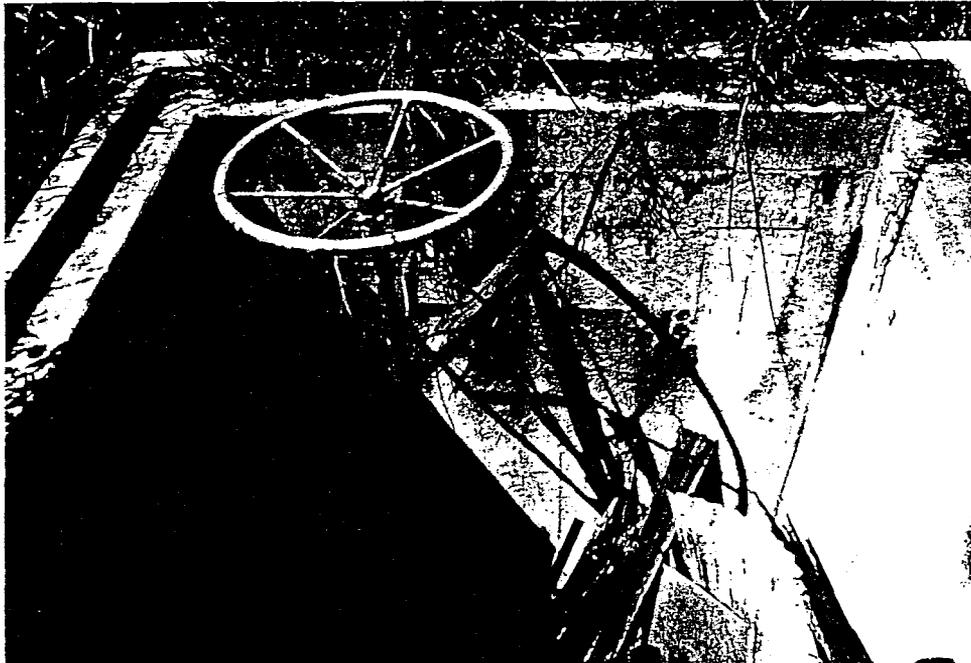


Plate IV-2b. Uncovered chamber, fuel farm, Sand Island



Plate IV-3a. Entangled green sea turtle

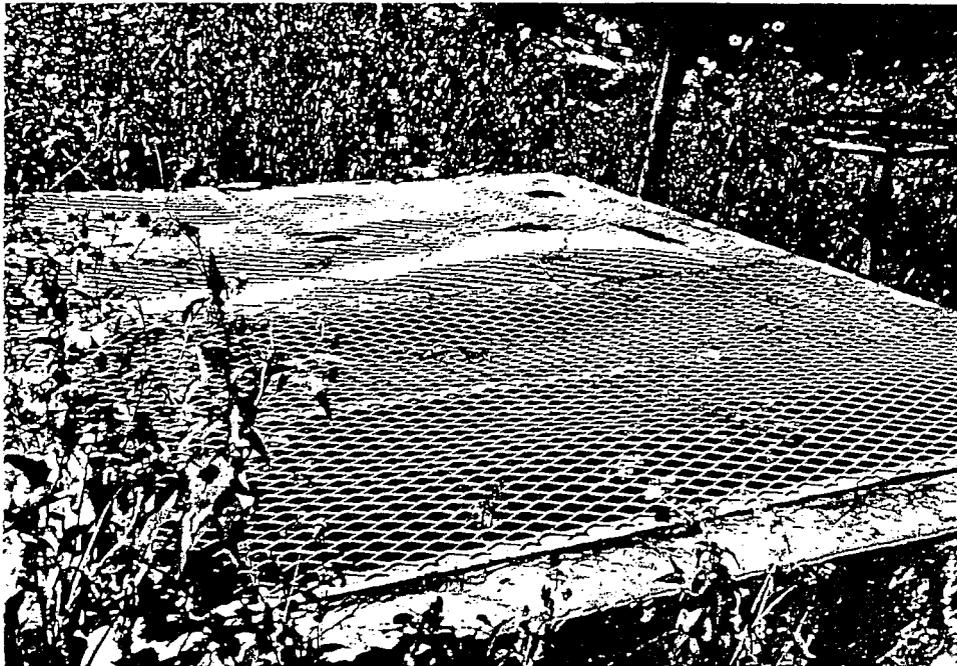


Plate IV-3b. Subsurface chamber with mesh cover, Sand Island

abandoned clearings throughout the atoll. The species has been implicated as habitat for insect (mosquitos, flies) vectors of avian pox and as a competitor with native strand species. A control/eradication program for this noxious plant is needed.

One of the key responsibilities of a national wildlife refuge is to provide significant areas of undisturbed wildlife habitat. At Midway, the area best suited to this purpose is Eastern Island. Abandoned for nearly a decade, Eastern has begun to return to a wild condition and it supports numerous seabirds too sensitive to nest on Sand Island. For complete restoration, human effort is needed; specifically, debris must be cleaned up and rats and ironwoods must be controlled. Sanctuaries for sensitive species or habitats are also needed on Sand Island.

2. Aquatic habitats

No natural fresh water habitat exists at Midway.

3. Habitat values

All lands at Midway, developed, abandoned, and unimproved, have existing or potential value as wildlife habitat. Except for endangered species, it is difficult to say that the habitat of one species is more valuable than that of another; however, it is possible to compare the relative abundance or scarcity of various habitats, the diversity of species supported by different habitats, and the suitability of habitats for different purposes. These topics are addressed in more detail in other sections, but a general overview of the relative value to wildlife of each area at Midway Atoll is presented in Figure IV-8.

J. Species Management Needs

1. Rare, threatened, and endangered species

The dangerously depleted status of the Hawaiian monk seal is well documented. Midway is considered a valuable potential breeding site, and the atoll's importance to the monk seal's recovery was one of the major reasons for its designation as an overlay national wildlife refuge. The designation of critical habitat has given this area further protection. Midway's small current population has produced only one pup during each of the last two years. It is expected that the atoll could support a larger breeding population if given the opportunity. Necessary enhancement measures include: 1) reducing disturbance by humans through education, strict enforcement of regulations, and reduction of access to Eastern and Spit islands; 2) increasing accessible beach habitat by use non-preventive erosion control measures; 3) cleanup of entrapment hazards at Eastern Island; and 4) introduction of young monk seals from other colonies in the Hawaiian chain. Item 4 is identified in recommendations of the Monk Seal Recovery Team with the stipulation that Eastern Island debris be removed prior to introduction of new seals.

Midway is an important feeding area for threatened green sea turtles and, potentially, for hawksbills and other sea turtles reported there historically. Turtles are susceptible to mortality from entanglement, especially along improved shorelines (Plate IV-2a). Periodic clean-up of beachcast nets and use of divers to clear fishing lines from beneath piers and submerged debris are needed to reduce mortality, especially of large, breeding age turtles. Turtles do not currently nest at Midway, but nesting should be encouraged, primarily by implementing the same measures outlined for monk seals.

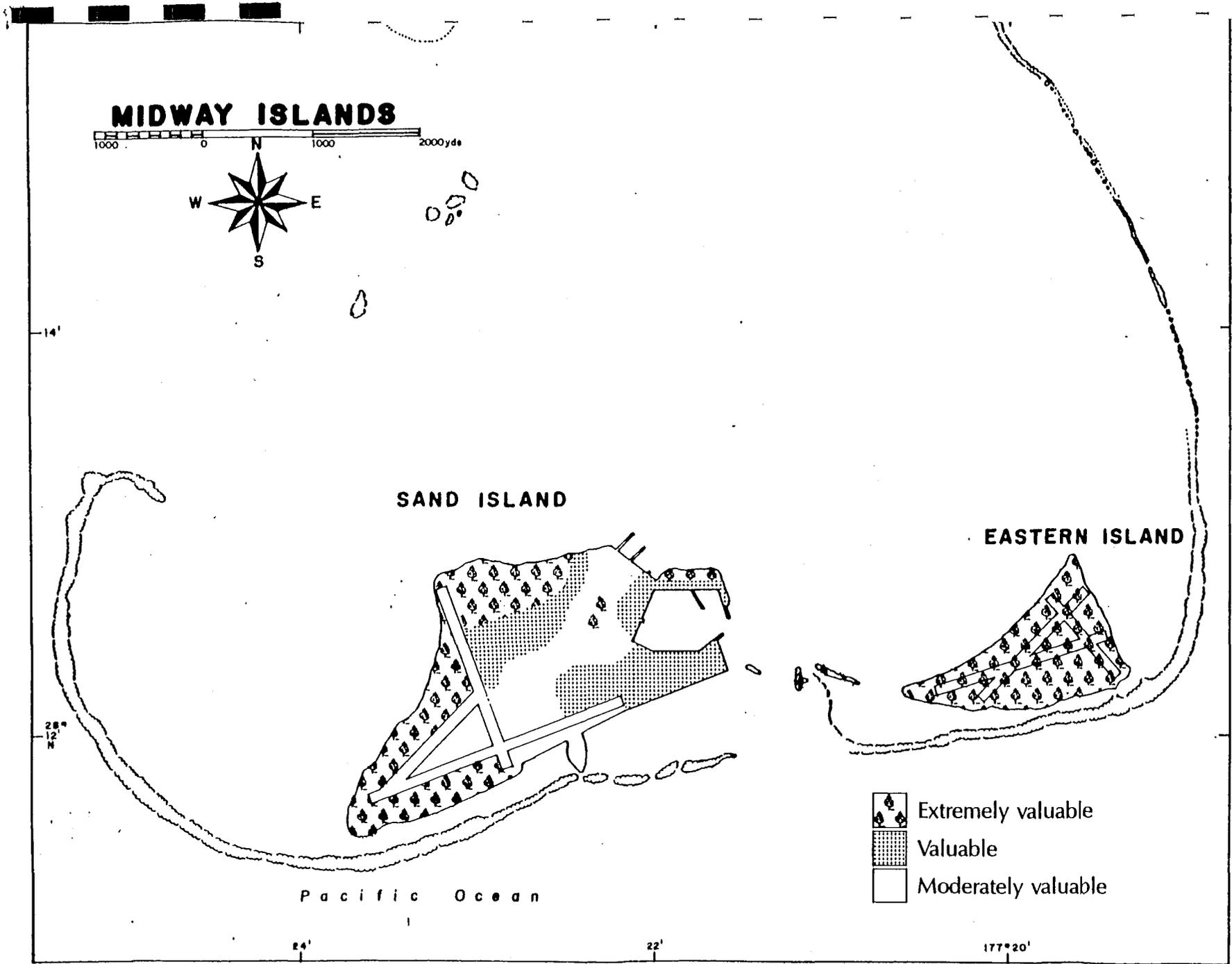


Figure IV-8. Relative value of lands as wildlife habitat

The Short-tailed Albatross is one of the rarest seabird species in the world, but one or more individuals visit Midway each winter. Visitation should be encouraged by eliminating disturbance by humans. If any indication of breeding is observed (e.g, courting, nest building) the area in use should be placed off limits.

2. Other species of management interest

Midway supports 15 species of nesting seabirds and the overriding need is to preserve this community diversity while maintaining or enhancing the success of each population. At the least, this requires consistent protection from disturbance. In addition, to facilitate management decisions, it is essential to monitor the health and status of each population. Development of standardized census techniques and study plots is needed to ensure comparability of data collected in different years.

Several seabird species experienced drastic population reductions following the introduction of rats. Burrow nesting species suffered most from rat predation; the numbers of Bonin Petrels, Wedge-tailed Shearwaters, and Christmas Shearwaters have declined substantially from pre-World War II levels, and the Bulwer's Petrel is no longer present. Two surface nesting species, the Brown Booby and Masked Booby, suffered similar declines. Control of rats is the necessary first step to promote recovery of these species. In the future, it may be necessary to restrict access to burrow colonies, areas of potential nesting habitat, and sites of recolonization attempts.

The Gray-backed Tern, one of the least abundant species at Midway, nests along the shores of Eastern and Spit islands, though exact sites of colonies vary from year to year. The well-camouflaged eggs are laid amid coral rubble on the crowns of windward beaches where they may be trampled inadvertently by human visitors. Access to Eastern and Spit islands needs to be limited and personnel visiting those islands need to be advised to stay clear of Gray-backed Tern colonies.

3. Pest species

Control of introduced roof rats (*Rattus rattus*) on all islands of the atoll is of paramount importance. Rat predation on eggs and chicks results in significantly decreased populations of most burrow nesting and surface nesting seabird species. Extinction or extirpation of several bird species has resulted from rat predation and others may suffer the same fate. Herbivory by rats has contributed, also, to reduction of native dune building plants, such as beach naupaka. Strand vegetation is needed to sustain nesting populations of boobies, frigatebirds and other seabirds, and to reduce the incidence of beach erosion.

The Common Myna, an introduced species, aggressively harasses and competes for nest space with White Terns. The small population of mynas has, historically, had only a minor affect on seabirds, but the number of mynas appears to have increased in recent years. It is necessary to begin to monitor the myna population to determine whether the species should be controlled.

K. Management Recommendations

1. Habitat management

- a. In order to maintain and enhance the quality and quantity of wildlife habitat, while minimizing BASH and conflicts with other land use programs, it is recommended that:

- in general, Sand Island should be managed in a manner that maintains existing wildlife populations while fulfilling the operational and recreational needs of the facility. Existing wildlife habitat should be enhanced by the elimination of hazards, reduction of human disturbance, and control of introduced species. Sanctuaries should be established to protect rare or sensitive habitats
 - in general, Eastern and Spit islands should be managed so as to enhance existing and potential wildlife populations. These islands should be restored to a condition of optimal wildlife habitat by elimination of manmade hazards and debris, reduction of human disturbance, and control of introduced species.
- b. In order to maintain or enhance the existing diversity of wildlife habitat, reduce risks to structures, control erosion, and reduce the bird-aircraft strike hazard it is recommended that a program of vegetation management be developed and implemented. The major features of this program should be the following:
- to control the spread of ironwood trees, especially along shorelines, near structures, and in stands of native vegetation
 - to promote the recovery and reestablishment of native plants, primarily beach naupaka and other dune-building species, especially along shorelines and in cleared areas not constrained by air-field clearances. Existing stands of native strand vegetation should be cleared of introduced plants, especially ironwood and golden crown-beard.
- c. In order to maximize the area of accessible sandy beach, as habitat for endangered monk seals and other wildlife, and for recreational use, it is recommended that:
- whenever feasible, shoreline erosion should be controlled or reduced by use of techniques that do not prevent access; for example, control through vegetation management is preferable to use of seawall or riprap
 - hazards and debris, such as the discarded antennas on the southeastern side of Eastern Island (see Plate III-2b), should be cleared from sandy shorelines.

2. Threatened and endangered species preservation

- a. In order to enhance populations and encourage breeding by endangered monk seals and threatened sea turtles the following actions are recommended:
- minimize disturbance of animals along shores of Sand Island through education programs and enforcement of regulations; if this action is not effective, beaches used regularly by seals, such as Frigate Point and the Area 7 beach, should be placed off limits
 - eliminate disturbance of animals on Eastern and Spit islands, by minimizing non-essential visitation
 - enhance beach habitat by reducing erosion, minimizing use of access-preventing erosion control techniques, and clearing shoreline debris
 - reduce mortality due to entanglement by periodic clean up of nets and fishing line from beaches and pier pilings

- introduce young seals from other colonies.
- b. In order to promote conservation of the highly endangered Short-tailed Albatross, the following actions are recommended:
- birds of this species should be protected from human disturbance, through education, enforcement of regulations, and, if necessary, restricting access to use areas
 - in the event that nesting occurs or appears likely (e.g., a pair is seen courting), the immediate area should be placed off limits.

3. Pest control

- a. In order to eliminate predation on seabirds and herbivory on native plants, by introduced rats, it is recommended that a comprehensive program of rat control be initiated. The control program should follow the guidance of reports by Murphy and Tyler (1988) and Reidinger (1982). Control efforts should focus on native vegetation communities and burrow colonies of Sand Island, and the whole of Eastern and Spit islands.
- b. In order to evaluate the severity of the threat to native seabirds from introduced Common Mynas, population size of the common mynah should be monitored.
- c. In order to control mosquitos, which represent a threat to human health and a vector for avian disease, it is recommended that alien plants, such as golden crown-beard, be controlled.

4. General wildlife management recommendations

- a. In order to minimize human-related disturbance of all wildlife species and their habitats, it is recommended that:
- all incoming personnel (except returning residents), military or civilian, arriving by aircraft or vessel, should receive an orientation briefing, in which wildlife regulations and the importance of preventing the introduction of any alien or domestic species are explained
 - all wildlife and fisheries regulations should be enforced
 - a protocol should be established for coordination and consultation between the FWS, the Navy, and any civilian contractor, in order to mitigate conflicts between wildlife and military and civilian activities, including construction, renovation, operations, and recreation
 - on Sand Island, sanctuaries for especially rare or sensitive species should be established and clearly posted.
- b. In order to minimize mortality and injury to wildlife resulting from human activities, structures, and debris, it is recommended that:
- abandoned structures and debris, including uncovered pits, utility lines, and fenced enclosures, that represent potential hazards to wildlife, should be eliminated

- entanglement hazards, such as fishing nets and monofilament line, should be cleared, periodically, from shorelines and pier pilings
 - toxic substances, including waste oil and lead paint from demolished buildings, should be collected, stored, and removed from the atoll
 - construction of new hazards, such as fences, lights, and above-ground wires, should be minimized
 - a program to reduce conflicts between wildlife and vehicular traffic should be developed and implemented.
- c. In order to reduce the bird-aircraft strike hazard (BASH), a comprehensive BASH plan should be prepared and implemented. This plan should include the collection of detailed information on bird-aircraft collisions.
- d. In order to provide opportunities for public use of fish and wildlife resources, the following actions are recommended:
- a program of environmental education and wildlife interpretation should be initiated, which includes an interpretive display of photographs and information on the atoll's wildlife, an informational brochure, nature walks, and slide presentations
 - a set of regulations should be adopted, which ensure the continued viability of the recreational harvest of fishes, lobsters, coral, and other invertebrates. These regulations could be modeled after existing regulations for the state of Hawaii
 - the use of fish and wildlife resources by scientific researchers, journalists, photographers, and film-makers should be encouraged; these activities should be regulated by the FWS.
- e. In order to evaluate ongoing management programs and assess additional management needs, it is recommended that the health and status of selected wildlife species be monitored.

L. Proposed Management, Protection, and Conservation Programs

1. Orientation

All incoming personnel should be advised of wildlife regulations and responsibilities by one of the following methods.

- a. A one-page orientation sheet, to be prepared by FWS, approved by the OIC, and duplicated and distributed by the Navy. Receipt of this sheet and responsibility to read, understand, and be responsible for its contents shall be mandatory for anyone visiting the installation. MAC passengers and other overnight visitors should receive sheets as part of billeting check-in. Crews from other aircraft should receive sheets immediately upon arrival, by whatever means is determined by the Navy to be most efficient. Crews from ships should receive sheets prior to setting foot on the island. This sheet will fulfill the orientation requirement for short term (< one week) visitors and also for long term visitors when no other method is available.

- b. An in-person orientation session, not to exceed one hour, to be conducted by the on-island FWS representative. This will be required for all newly arriving, long-term (> one week) residents, whenever a FWS representative is present. Large groups, such as Seabee detachments, will receive a group orientation during the first week on-island. Individuals will be briefed by appointment during regular working hours; civilian employees should be allowed time off for this session.
- c. A videotaped version of the orientation session described above, to be produced by FWS. This video is to be used for long-term residents when no FWS representative is present.

2. Project consultation and conflict mitigation

To facilitate consultation on land use projects, between the FWS, the Navy, and civilian contractors, the following protocol is proposed:

- a. 1st notification - as far in advance as is feasible, FWS will be informed in writing of the proposed project; the letter of notification will include a description, purpose, and schedule of the project; copies of the letter will be sent to the Refuge Complex Manager (Pacific Islands Office, Honolulu) and the on-island representative, if present; copies of proposal letters to the Navy from civilian contractors may be sent to FWS to satisfy this requirement. After reviewing the proposed project, FWS will send a written response to the Navy and the contractor; the response will include recommendations for mitigation measures. FWS will perform an on-site inspection, if necessary. In cases where there are potential impacts to monk seals or green sea turtles, it is the responsibility of the Navy/contractor to contact also the National Marine Fisheries Service (Protected Species Branch, Pacific Area Office, Honolulu).
- b. 2nd notification - allowing at least 30 days prior notice, the contractor will inform FWS in writing of the actual start up date of the project; if present, the on-island FWS representative will conduct an on-site survey to determine expected impacts to wildlife ("take"); if no FWS representative is present, the Navy/contractor is responsible for evaluation of "take."
- c. Project modification - if present, the on-island FWS representative will monitor the project and recommend modifications if necessary.
- d. 3rd notification - after completion of the project, the Navy/contractor will inform FWS in writing that work has been concluded; this notice should include a summary of impacts to wildlife and recommendations for mitigation of future projects.

3. Wildlife sanctuaries

Selected areas on Sand Island which represent nesting habitat for rare or sensitive species of sea-birds, should be designated wildlife sanctuaries. These areas should be placed off-limits to all personnel (unless authorized by FWS) and the boundaries posted with warning signs. Although other areas may be nominated for sanctuary status in the future, only two require immediate designation (see Figure III-6):

- a. The sand dunes above the Harbor office, which support the densest colony of burrow nesting birds (Bonin Petrels and Wedge-tailed Shearwaters) in the atoll.
- b. The stands of beach naupaka at Frigate Point and the southwest shore (near NOPF). These remaining stands of dune-building plants provide essential habitat for Wedge-tailed Shear-

waters, Brown Noddies, Red-tailed Tropicbirds, and possibly Black-footed Albatross. In addition, they play an important role in reducing erosion and BASH.

4. Hazards to wildlife

- a. Nets, ropes, and other beachcast hazards should be removed quarterly from Sand Island beaches and annually from shorelines of Eastern and Spit islands. Collected debris could be transported to the dump or burned at the collection site. Island residents might be given the opportunity volunteer to help with clean up, in exchange for the chance to visit the restricted islands.
- b. Fishing line and other entanglement hazards should be removed from pier pilings and other underwater debris, at least twice annually, by divers; members of the Koral Kings Dive Club might be available on a volunteer basis.
- c. Open pits and subsurface control chambers still in use should be securely covered to prevent access by even small birds. Covers, which can be mesh or solid, must fit snugly and be heavy enough to withstand wind (Plate IV-3b). Abandoned pits, which are numerous at the fuel farm, should be filled in or covered, as described above.
- d. Fenced and other open enclosures should be secured or monitored to prevent entrapment of birds. Small enclosures should be covered, possibly with fencing or screen, and free of ground level holes. Larger enclosures, such as tennis courts, must have ground level access ways that remain open. Enclosures which cannot be left open for safety or security reasons must be checked daily to release entrapped birds.
- e. Security lighting needs for structures that are not used at night should be re-evaluated on a case by case basis; non-essential lights near structures should be removed; in places where lighting is essential, existing lights should be replaced using uni-directional bulbs.
- f. Ramps should be installed in each of the water treatment ponds to prevent entrapment of birds.
- g. Following demolition of abandoned structures, all debris (including wiring, fencing, paint chips, etc.) should be disposed of properly.
- h. Toxic substances, including waste oil, pesticides, and paint, should be stored carefully.

5. Vehicular traffic

- a. In order to increase traffic flow efficiency during months when albatross chicks are mobile (May through July), temporary low (12 - 16" high) fences or barriers should be erected along major roadways, especially those used by large construction vehicles.
- b. In order to reduce accidental collisions with albatrosses, efforts should be made to reduce significantly the amount of vehicular traffic during nesting season, as follows:
 - eliminate automobile and truck driving after dark, except as needed for work or emergency; ensure compliance by requiring that anyone driving a vehicle after dark must obtain a permit from the security office
 - close all secondary roads (those not necessary for normal circulation) to through traffic of motorized vehicles, except security and pest control

- encourage and promote the use of golf carts, mopeds, and bicycles for all personal transportation.
- c. In order to eliminate unnecessary vehicle-related mortality of slow moving albatross chicks, the following guidelines are proposed. For drivers observed running over an albatross chick, accidentally:

1st offense - official warning from Chief of Police

2nd offense - suspension of driving privileges for the remainder of that nesting season

3rd offense - fine and/or deportation from the island.

Any driver observed running over any bird deliberately should be fined and deported.

- d. In order to ensure enforcement of protective regulations, the Navy should notify BSI of its commitment to this program. Midway Police officers should be given instructions and support in the enforcement of bird-vehicle violations.

6. *BASH* (see Appendix IV-4)

7. *Hawaiian monk seals*

- a. Disturbance of seals hauled out on Sand Island beaches should be minimized by:
 - educating visitors (see orientation and interpretation proposals)
 - stringent enforcement of regulations
 - posting of reminder/warning signs, designed by FWS and produced by the Navy, at main access paths to heavily used beaches; for example, signs should be posted at the pavilion and the sailboat rental beach access
 - if the above measures are not effective, the Frigate Point, NOPE, and Area 7 beaches should be considered for off-limits status.
- b. Disturbance of seals hauled out and, especially, breeding on the critical habitat of Eastern and Spit islands should be eliminated by:
 - requiring that all visitors to these islands request and obtain a special use permit from the FWS. These permits could be issued by the on-island representative, if present, but otherwise must be obtained from the Pacific Islands office in Honolulu. Possibly, a telephone or fax protocol could be established to facilitate the permit process.
- c. Beaches should be cleared of entanglement hazards at least twice annually (see Wildlife Hazards, this section)
- d. Seals from other colonies should be released at Eastern Island. This program should be designed, implemented, and monitored by the FWS and the National Marine Fisheries Service.

8. Rat control

In order to protect nesting seabirds and native plants, a comprehensive program of rat control should be initiated. The goals of the program include eradication of rats on Eastern and Spit islands and the significant reduction of the rat population on Sand Island, where total eradication may not be possible.

The program should include bird carcass removal on Sand Island to eliminate a primary food source for rats and flies. Eradication measures should be based on the recommendations presented in reports by Murphy and Tyler (1988) and Reidinger (1982). Measures to prevent the future introduction of pest species (from cargo vessels, aircraft, etc.) should be included.

Implementation of rat eradication measures should proceed through the following stages:

- a. Initiate rat control measures in areas of native plants and burrow-nesting seabirds on Sand Island
- b. Pursue through various sources funding for the rat control program in order to enhance wildlife habitat, reduce BASH, and prevent erosion
- c. Implement the program of rat control throughout Sand Island and rat eradication on Eastern and Spit islands.

9. Vegetation management

In order to maintain and enhance the existing diversity of wildlife habitat and reduce the bird-aircraft strike hazard, an integrated program, designed to control ironwood trees and promote the recovery of native plants, is necessary. The details of this program are presented in Section III - Land Management. The role of vegetation management in reducing BASH is discussed in Appendix IV-4

10. Restoration of Eastern Island

Restoration of Eastern Island to a condition of optimal wildlife habitat is expected to be a long-term project, but the first steps should be undertaken at this time. This restoration program must comprise several elements:

- a. The elimination or control of introduced species, especially rats and ironwoods. Specific control measures for these species are presented in Section IV-L-8 and Section III-D-7, respectively. Ideally, control efforts should follow the large scale demolition work (see b), but the need is too urgent. It is essential that control measures be implemented immediately. Delay will result in further deterioration of the habitat.
- b. The demolition and elimination (removal or burial) of abandoned structures, runways, and debris. This is a major project, that will require considerable technical expertise, in order to complete the task without inflicting additional environmental damage. The availability of funds from DERA and other public and private sources, for either the assessment or implementation phase, should be investigated. Use of Eastern Island as a training site for Seabees or Navy demolition teams should be considered.

- c. The clean up of small debris and other minor hazards. This project is not practical until after the major demolition has been completed. At that time, the use of volunteers (from the Audubon Society, for example) for this clean up should be investigated.

11. *Public use of fish and wildlife resources*

- a. Nature and wildlife interpretation. To provide recreation and enhance wildlife appreciation, an interpretive program is proposed. The program will include an informational and photographic display, a brochure, nature walks, and lectures or slide presentations. Details of this program are presented in Section V - Outdoor Recreation.
- b. Recreational fishing and shell collecting. In order to ensure the continued viability of the recreational harvest of fishes, lobsters, corals, and other invertebrates, a set of regulations is necessary. The regulations and other details of this program are presented in Section V - Outdoor Recreation.
- c. Scientific research, documentary film-making, wildlife photography, and nature journalism. The use of fish and wildlife resources for these purposes is encouraged, but these activities are strictly regulated by the FWS. Interested and responsible persons or groups must obtain a Special Use Permit through the Pacific Islands office of the FWS, located in Honolulu. Sample permit application forms are presented in Appendices IV-5 and IV-6.

COMNAVBASE and OIC-Midway Island should refer all applicants seeking access to NAF-Midway for research, journalism, or other wildlife related purposes, to the FWS for permitting. For each applicant, the FWS will provide the OIC and COMNAVBASE with a draft Special Use Permit for their consideration in allowing access. If the OIC concurs with permit issuance, the FWS will issue the final Special Use Permit to the user.

12. *Wildlife monitoring*

In order to accurately evaluate ongoing management programs and assess the need for additional programs, it is necessary to monitor the health and status of wildlife populations and habitats.

- a. In order to monitor changes in vegetation communities and shoreline configuration, it is necessary to conduct aerial photographic surveys of the atoll, at least once every other year. Photographs taken from directly overhead (i.e. not oblique) will be most useful.
- b. Migratory birds. The FWS will institute a monitoring program to document the status of native migratory bird populations. The program will focus on the development of a baseline of information on population size, critical reproductive parameters, general health parameters, and contaminant levels. Information will be collected on an annual basis to enable assessment of short- and long-term trends.
- c. Hawaiian monk seals. The FWS will implement measures for monitoring the population and survivorship of Hawaiian monk seals. The National Marine Fisheries Service will be encouraged to investigate the factors contributing to the depressed population currently found at Midway.
- d. Green sea turtle. The FWS will implement measures to monitor the population of this threatened species.

M. Implementation

Expected costs and proposed schedules for recommended management programs are presented in Tables IV-4 and IV-5.

N. References

1. Apfelbaum, S.I., Ludwig, J.P., and C.E. Ludwig. 1983. Ecological problems associated with disruption of dune vegetation dynamics by *Casuarina equisetifolia* L. at Sand Island, Midway Atoll. *Atoll Research Bulletin* 260:1-13.
2. Bailey, A.M. 1956. Birds of Midway and Laysan Islands. *Denver Museum of Natural History, Mus. Pict.* 12.
3. Balazs, G.H. 1980. A review of basic biological data on the green turtle in the Northwestern Hawaiian Islands. In Grigg, R.W. and R.T. Pfund (eds.), Proceedings of the symposium on status of resource investigations in the Northwestern Hawaiian Islands. *Sea Grant Miscellaneous Report 80-04*.
4. Bartsch, P. 1922. A visit to Midway Island. *Auk* 39:481-488.
5. Fefer, S.I., C.S. Harrison, M.B. Naughton, and R.J. Shallenberger. 1984. Synopsis of results of recent seabird research conducted in the Northwest Hawaiian Islands. U.S. Fish and Wildlife Service, Honolulu, HI.
6. Fisher, H.I. 1966. Airplane-albatross collisions on Midway Atoll. *Condor* 68:229-242.
7. Fisher, H.I. and P.H. Baldwin. 1946. War and the birds of Midway Atoll. *Condor* 48:3-15.
8. Hadden, F.C. 1941. Midway Islands. *The Hawaiian Planter's Record*, Vol. XLV No. 3.
9. Herbst and Wagner. In press. Alien plants on the Northwestern Hawaiian Islands.
10. Ludwig, J.P., Ludwig, C.E., and S.I. Apfelbaum. 1979. Observations on status and interactions of the avifauna and plants of Midway Atoll, Leeward Hawaiian Islands between February 1-24, 1979. Ecological Research Services. Iron River, MI.
11. Murphy, J.G. and W.B. Tyler. 1988. Rat Population and Control Assessment on Midway Atoll. U.S. Department of Agriculture, Animal Damage Control. Honolulu, HI.
12. Reidinger, R.F., Jr. 1982. Trip report - Hawaii and Pacific Islands National Wildlife Refuge. Unpublished report to the U.S. Fish and Wildlife Service, Honolulu, HI.
13. Robbins, C.S. 1966. Birds and Aircraft on Midway Islands: 1959-1963 Investigations. U.S. Fish and Wildlife Service, Special Scientific Report, Wildlife 85. Washington, D.C.
14. U.S. Department of Interior, Fish and Wildlife Service. 1984. Midway Atoll Fish and Wildlife Refuge Management Plan.
15. U.S. Department of Interior, Fish and Wildlife Service, Region One. 1986. Hawaiian Islands National Wildlife Refuge: Master Plan/Environmental Impact Statement.
16. Woodby, D. 1988. Rats and petrels at Midway Islands: Status, methods of study, and suggestions for future work. *Elepaio* 48:53-56.

TABLE IV-4

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 1</u>		
• Develop orientation sheet for all personnel visiting Midway Atoll		500
• Initiate and conduct in-person orientation		1,500
• Initiate evaluation of effects of disturbance on monk seals		2,000
• Implement permitting process for Eastern and Spit islands		1,000
• Initiate removal of nets, ropes, and other beachcast hazards from atoll beaches	3,000	2,000
• Initiate removal of entanglement hazards from underwater structures such as pilings	Volunteer labor--Dive Club	
• Establish, post, and maintain wildlife sanctuaries as designated		1,000
• Institute recommended enforcement system for vehicle-related albatross mortality incidents	500	
• Implement proposed protocol for project consultation and conflict mitigation	2,000	2,000
• Control rats in housing areas, work places, and dump (including dead bird pickup)	12,000	
• Investigate options for debris removal and habitat restoration on Eastern Island	1,000	1,000
• Initiate special-use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Initiate migratory bird resources monitoring: populations, reproductive parameters, and contaminants		7,000
• Initiate monk seal population monitoring		1,000
• Initiate BASH data collection	1,000	
YEAR 1 TOTAL	19,500	21,000

TABLE IV-4 (cont'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 2</u>		
• Produce and distribute orientation sheet; review and update yearly	1,000	
• Conduct in-person orientation		1,500
• Produce, duplicate, and distribute orientation video		1,000
• Evaluate effects of disturbance on monk seals		2,000
• Develop, produce, and post monk seal information signs at beach access points		11,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,000	2,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Develop and install covers or other avian exclusion devices on open pits and sub-surface control chambers	5,000	1,000
• Evaluate base lighting needs in relation to potential wildlife hazards		1,000
• Develop barrier system to prevent albatross chicks from walking onto major roadways	1,000	1,000
• Close roads not required for normal vehicle circulation to four-wheeled traffic	1,000	
• Implement vehicular traffic reduction recommendations	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	12,000	
• Initiate rat control efforts in known burrow-nesting seabird colony areas and beach naupaka stands on Sand Island		20,000
• Investigate funding sources to increase rat control efforts throughout the atoll		1,500
• Pursue alternatives for debris removal and habitat restoration on Eastern Island	1,000	1,000
• Continue project consultation protocol	500	500

TABLE IV-4 (cont'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 2 (cont'd)</u>		
• Conduct special use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Initiate vegetation monitoring via aerial photography	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		17,000
• Monitor monk seal populations		1,000
• Initiate green sea turtle population monitoring		1,000
• Collect BASH data	500	
TOTAL YEAR 2	31,000	66,500
<u>Year 3</u>		
• Produce and distribute orientation sheet ; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	2,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Develop and install avian exclusion or escape devices on all enclosures, such as tennis courts, fenced compounds, or similar smaller hazards	10,000	1,000
• Modify base lighting to minimize wildlife impacts	15,000	
• Install ramps in water treatment ponds to provide escapeways for birds	3,000	
• Install barrier system to prevent albatross chicks from wandering onto major roadways	10,000	

TABLE IV-4 (cont'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 3 (cont'd)</u>		
• Implement vehicular traffic reduction recommendations and maintain closure of non-essential roads	1,000	
• Control rats in housing areas, work areas, and dump (including dead bird pickup)	12,000	
• Continue rat control efforts in known burrow-nesting seabird areas and naupaka stands on Sand Island		20,000
• Investigate funding sources to increase rat control efforts throughout the atoll		1,000
• Pursue alternatives for debris removal and habitat restoration on Eastern Island	1,000	1,000
• Continue project consultation protocol	500	500
• Conduct special use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		17,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Implement recommended BASH aircraft operational procedures	1,000	
• Initiate study of albatross flight patterns	20,000	
• Collect BASH data	500	
YEAR 3 TOTAL	78,500	54,500

Year 4

• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island Eastern Island		2,000

TABLE IV-4 (cont'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 4 (cont'd)</u>		
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	2,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and maintain closure of non-essential roads	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	12,000	
• Continue rat control efforts in known burrow-nesting seabird areas and naupaka stands on Sand Island		20,000
• Implement increased rat control measures on Sand Island		40,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		17,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Continue study of albatross flight patterns	20,000	
• Collect BASH data	500	
YEAR 4 TOTAL	46,500	91,500

TABLE IV-4 (cont'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 5</u>		
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	3,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain avian exclusion or escape devices on all enclosures	1,000	
• Maintain wildlife sanctuary signs		1,000
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and maintain closure of non-essential roads	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Implement rat control measures on Eastern and Spit islands; continue efforts on Sand Island		70,000
• Continue project consultaion protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography and journalism		2,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	

TABLE IV-4 (cont 'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
• Collect BASH data	500	
TOTAL YEAR 5	23,500	92,000
<u>Year 6</u>		
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	3,500	3,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		40,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations and and reproductive parameters		7,000
• Monitor monk seal populations		1,000

TABLE IV-4 (cont 'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 6 (cont'd)</u>		
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
YEAR 6 TOTAL	28,500	62,000
<u>Year 7</u>		
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Refurbish or replace post monk seal information signs at beach access points		10,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	4,000	3,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain avian exclusion or escape devices on all enclosures	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500

TABLE IV-4 (cont 'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 7 (cont'd)</u>		
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
YEAR 7 TOTAL	24,000	51,500
<u>Year 8</u>		
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	4,000	3,500
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	

TABLE IV-4 (cont 'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 8 (cont'd)</u>		
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations, reproductive parameters, and contaminants		13,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
YEAR 8 TOTAL	29,000	48,500
<u>Year 9</u>		
• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	4,500	4,000
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain avian exclusion or escape devices on all enclosures	1,000	
• Maintain wildlife sanctuary signs		1,000

TABLE IV-4 (cont 'd)
Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 9 (cont'd)</u>		
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
YEAR 9 TOTAL	24,500	43,000

Year 10

• Produce and distribute orientation sheet; review and update	1,000	
• Conduct in-person orientation		1,500
• Evaluate effects of disturbance on monk seals		2,000
• Introduce "Headstart Program" seals to Eastern Island		2,000
• Conduct permitting process for Eastern and Spit islands		1,000
• Remove nets, ropes, and other beachcast hazards from atoll beaches	4,500	4,000

TABLE IV-4 (cont 'd)

Ten Year Schedule of Fish and Wildlife Management Projects

	Funding Agency	
	Navy	FWS
<u>Year 10 (cont'd)</u>		
• Remove entanglement hazards from underwater structures such as pilings		Volunteer labor--Dive Club
• Maintain covers or other avian exclusion devices on open pits and sub-surface control chambers	1,000	
• Maintain roadway barrier system	1,000	
• Continue vehicular traffic reduction and road closures	1,000	
• Control rats in housing areas, work places, and dump (including dead bird pickup)	14,000	
• Continue increased rat control measures on Sand, Eastern, and Spit islands		20,000
• Continue project consultation protocol	500	500
• Conduct special-use permitting and coordination procedures for research, filmmaking, wildlife photography, and journalism		2,000
• Conduct aerial photographic survey of vegetation	5,000 (flight time)	1,000
• Monitor migratory bird resources: populations and reproductive parameters		7,000
• Monitor monk seal populations		1,000
• Monitor green sea turtle populations		1,000
• Continue recommended BASH operational procedures	1,000	
• Collect BASH data	500	
YEAR 10 TOTAL	29,500	43,000

TABLE IV-5

Project Costs - Fish and Wildlife Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Orientation</u>		
• Develop orientation sheet		500
• Produce and distribute orientation sheet; review and update yearly	9,000	
• Initiate in-person orientation		15,000
• Produce, duplicate, and distribute orientation video		1,000
<u>Monk Seals</u>		
• Evaluate effects of disturbance on monk seals		20,000
• Introduce "Headstart Program" seals to Eastern Island		16,000
• Develop, produce, and post information signs at beach access points		21,000
• Implement permitting process for Eastern and Spit islands		10,000
<u>Wildlife Hazards</u>		
• Remove nets, ropes, and other beachcast hazards from atoll beaches	37,000	30,000
• Remove entanglement hazards from underwater structures such as pilings	Volunteer labor, e.g., Dive Club	
• Install and maintain covering or other avian exclusion devices on open pits and sub-surface control chambers	9,000	1,000
• Install and maintain avian exclusion or escape devices on fenced enclosures, such as tennis courts, storage yards, fuel storage tanks, etc.	13,000	1,000

TABLE IV-5 (cont'd)

Project Costs - Fish and Wildlife Management

PROJECT	FUNDING	
	Navy	FWS
<u>Wildlife Hazards</u> (cont'd)		
• Evaluate base lighting needs in relation to potential wildlife hazards		1,000
• Modify base lighting to minimize wildlife impacts	15,000	
• Install ramps in water treatment ponds to provide escapeways for birds	3,000	
<u>Wildlife Sanctuaries</u>		
• Establish, post, and maintain sanctuaries in harbor dunes and Frigate Point areas		3,000
<u>Vehicular Traffic</u>		
• Develop, install, and maintain barrier system to prevent albatross chicks from wandering onto major roadways	18,000	
• Implement vehicular traffic reduction recommendations	5,000	
• Close to 4-wheeled traffic, roads not required for normal vehicle circulation	5,000	
• Institute recommended enforcement system for vehicle-related albatross mortality incidents	500	
<u>Project Consultation and Conflict Mitigation</u>		
• Institute proposed protocol	6,500	6,500
<u>Rat Control</u>		
• Continue rat control (including dead bird pickup) in inhabited areas and at the dump	132,000	

TABLE IV-5 (cont'd)

Project Costs - Fish and Wildlife Management

PROJECT	FUNDING	
	Navy	FWS
<u>Rat Control</u> (cont'd)		
• Increase control efforts to include known burrow nesting seabird areas and remnant beach naupaka stands on Sand Island		60,000
• Pursue funding sources to increase rat control efforts throughout Sand Island		2,000
• Pursue funding sources to eradicate rats from Eastern/Spit islands		2,000
• Implement increased rat control measures on Sand and Eastern/Spit islands		230,000
<u>Eastern Island Restoration</u>		
• Pursue alternatives for debris removal and habitat restoration	3,000	3,000
<u>Public Use</u>		
• Initiate special use permitting and coordinating procedures for research, filmmaking, wildlife photography, and journalism		20,000
<u>Monitoring</u>		
• Aerial photographic survey of vegetation	25,000 (flight time)	5,000
• Monitor migratory bird resources:		
- Populations		40,000
- Reproductive parameters		30,000
- Contaminants		36,000
• Monitor monk seal populations		10,000
• Monitor green sea turtle populations		10,000
BASH		
<i>Aircraft Operational Procedures</i>		
• Implement procedures	8,000	

TABLE IV-5 (cont'd)

Project Costs - Fish and Wildlife Management

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
BASH (cont'd)		
<i>Wildlife Management</i>		
• Conduct study of albatross flight patterns with respect to vegetation	40,000	
<i>Monitoring</i>		
• Implement data collection methods	5,500	
SECTION SUBTOTAL	334,500	574,000

APPENDIX IV-1

Checklist of the Birds of Midway Atoll

Symbols used for species status:

N = Native (indigenous), currently nests at Midway

I = Introduced, currently nests at Midway

M = Migrant; regular visitor to Midway, usually during migration

R = Rare visitor or vagrant

F = Formerly nested at Midway

I/F = Introduced, formerly nested at Midway

E = Endangered

X = Extinct

Family and Common Name	Hawaiian Name	Scientific Name	Status
ALBATROSSES		DIOMEDEIDAE	
Short-tailed Albatross		<i>Diomedea albatrus</i>	M, E
Black-footed Albatross		<i>Diomedea nigripes</i>	N
Laysan Albatross	Moli	<i>Diomedea immutabilis</i>	N
SHEARWATERS, PETRELS		PROCELLARIIDAE	
Northern Fulmar		<i>Fulmarus glacialis</i>	R
Wedge-tailed Shearwater	'Ua'u-kani	<i>Puffinus pacificus chlororhynchus</i>	N
Sooty Shearwater		<i>Puffinus griseus</i>	R
Christmas Shearwater		<i>Puffinus nativitatis</i>	N
Little Shearwater		<i>Puffinus assimilis</i>	R
Newell's Shearwater	'a'o	<i>Puffinus newelli</i>	R
Bonin Petrel		<i>Pterodroma hypoleuca hypoleuca</i>	N
Bulwer's Petrel	'Ou	<i>Bulweria bulwerii</i>	F

Family and Common Name	Hawaiian Name	Scientific Name	Status
STORM-PETRELS			
HYDROBATIDAE			
Tristram's (Sooty) Storm-petrel		<i>Oceanodroma tristrami</i>	R
Leach's Storm-petrel		<i>Oceanodroma leucorhoa</i>	R
TROPICBIRDS			
PHAETHONTIDAE			
White-tailed Tropicbird	Koa'e kea	<i>Phaethon lepturus dorotheae</i>	N
Red-tailed Tropicbird	Koa'e 'ula	<i>Phaethon rubricaudus rothschildi</i>	N
BOOBIES			
SULIDAE			
Masked Booby	'A	<i>Sula dactylatra personata</i>	N
Brown Booby	'A	<i>Sula leucogaster plotus</i>	M, F
Red-footed Booby	'A	<i>Sula sula rubripes</i>	N
FRIGATEBIRDS			
FREGATIDAE			
Great Frigatebird	Iwa	<i>Fregata minor palmerstoni</i>	N
HERONS, EGRETS			
ARDEIDAE			
Cattle Egret		<i>Bubulcus ibis</i>	M
SWANS, GEESE, DUCKS			
ANATIDAE			
Tundra Swan		<i>Cygnus columbianus</i>	R
Canada Goose		<i>Branta canadensis minimus</i>	R
Emperor Goose		<i>Phalacrocorax canaliculatus</i>	R
White-fronted Goose		<i>Anser albifrons</i>	R
Mallard		<i>Anas platyrhynchos</i>	R
Gadwall		<i>Anas strepera</i>	R
Northern Pintail	Koloa-mapu	<i>Anas acuta</i>	R
Garganey		<i>Anas querquedula</i>	R

Family and Common Name	Hawaiian Name	Scientific Name	Status
Green-winged Teal		<i>Anas crecca</i>	R
Eurasian Wigeon		<i>Anas penelope</i>	R
American Wigeon		<i>Anas americana</i>	R
Northern Shoveler	Koloa-moha	<i>Anas clypeata</i>	R
Common Pochard		<i>Aythya ferina</i>	R
Redhead		<i>Aythya americana</i>	R
Tufted Duck		<i>Aythya fuligula</i>	R
Bufflehead		<i>Bucephala albeola</i>	R
Harlequin Duck		<i>Histrionicus histrionicus</i>	R
Oldsquaw		<i>Clangula hyemalis</i>	R
Black Scoter		<i>Melanitta nigra</i>	R
Common/Red-breasted Merganser		<i>Mergus</i> sp.	R
HAWKS, EAGLES		ACCIPITRIDAE	
Steller's Sea Eagle		<i>Haliaeetus pelagicus</i>	R
Northern Harrier		<i>Circus cyaneus</i>	R
FALCONS		FALCONIDAE	
Peregrine Falcon		<i>Falco peregrinus</i>	R, E
RAILS, GALLINULES, COOTS			
Laysan Rail		<i>Porzana palmeri</i>	I/F, X
Common Moorhen	'alae 'ula	<i>Gallinula chloropus</i>	R
PLOVERS		CHARADRIIDAE	
Semipalmated Plover		<i>Charadrius semipalmatus</i>	R
Black-bellied Plover		<i>Pluvialis squatarola</i>	R
Lesser Golden-Plover	Kolea	<i>Pluvialis dominica</i>	M

Family and Common Name	Hawaiian Name	Scientific Name	Status
SANDPIPERS, WADERS		SCOLOPACIDAE	
Bristle-thighed Curlew	Kioea	<i>Numenius tahitiensis</i>	M
Whimbrel		<i>Numenius phaeopus</i>	R
Greater Yellowlegs		<i>Tringa melanoleuca</i>	R
Lesser Yellowlegs		<i>Tringa flavipes</i>	R
Wood Sandpiper		<i>Tringa glareola</i>	R
Wandering Tattler	'Ulili	<i>Heteroscelus incanus</i>	M
Gray-tailed (Polynesian) Tattler		<i>Heteroscelus brevipes</i>	R
Ruddy Turnstone	'Akekeke	<i>Arenaria interpres</i>	M
Red Knot		<i>Calidris canutus</i>	R
Sharp-tailed Sandpiper		<i>Calidris acuminata</i>	R
Pectoral Sandpiper		<i>Calidris melanotos</i>	R
Western Sandpiper		<i>Calidris mauri</i>	R
Long-toed Stint		<i>Calidris subminuta</i>	R
Dunlin		<i>Calidris alpina</i>	R
Sanderling	Huma-kai	<i>Calidris alba</i>	R
Short-billed Dowitcher		<i>Limnodromus griseus</i>	R
Bar-tailed Godwit		<i>Limosa lapponica</i>	R
Ruff		<i>Philomachus pugnax</i>	R
Buff-breasted Sandpiper		<i>Tryngites subruficollis</i>	R
GULLS, TERNS, NODDIES		LARIDAE	
Glaucous Gull		<i>Larus hyperboreus</i>	R
Glaucous-winged Gull		<i>Larus glaucescens</i>	R
Herring Gull		<i>Larus argentatus</i>	R
Franklin's Gull		<i>Larus pipixcan</i>	R
Common Black-headed Gull		<i>Larus ridibundus</i>	R
Bonaparte's Gull		<i>Larus philadelphia</i>	R

Family and Common Name	Hawaiian Name	Scientific Name	Status
Black-legged Kittiwake		<i>Rissa tridactyla</i>	R
Least Tern		<i>Sterna antillarum</i>	R
Sooty Tern	Ewa'ewa	<i>Sterna fuscata oahuensis</i>	N
Gray-backed Tern	Pakalakala	<i>Sterna lunata</i>	N
Black Tern		<i>Chlidonias niger</i>	R
Brown (Common) Noddy	Noio-koha	<i>Anous stolidus pileatus</i>	N
Black (Hawaiian) Noddy	Noio	<i>Anous tenuirostris melanogenys</i>	N
White (Fairy) Tern	Manu-o-Ku	<i>Gygis alba rothschildi</i>	N
AUKS, PUFFINS, MURRES		ALCIDAE	
Parakeet Auklet		<i>Cyclorhynchus psittacula</i>	R
Horned Puffin		<i>Fratercula corniculata</i>	R
DOVES, PIGEONS		COLUMBIDAE	
Rock Dove (Domestic Pigeon)		<i>Columbia livia</i>	I/F
OWLS		STRIGIDAE	
Short-eared Owl	Pueo	<i>Asio flammeus</i>	M
LARKS		ALAUDIDAE	
Eurasian Skylark		<i>Alauda arvensis</i>	R
SWALLOWS		HIRUNDINIDAE	
Barn Swallow		<i>Hirundo rustica</i>	R
STARLINGS, MYNAS		STURNIDAE	
Common Myna		<i>Acridotheres tristis</i>	I
HAWAIIAN HONEYCREEPERS		DREPANIDIDAE	
Laysan Finch		<i>Telespyza cantans cantans</i>	I/F

Family and Common Name	Hawaiian Name	Scientific Name	Status
FINCHES		FRINGILLIDAE	
Common Canary		<i>Serinus canarius</i>	I
Common Redpoll		<i>Carduelis flammea</i>	R
WEAVERS		PASSERIDAE	
House Sparrow		<i>Passer domesticus</i>	R

APPENDIX IV-2

Predominant Reef Fish Families of Midway Atoll

Family Name	Common Name
Acanthuridae	Surgeonfishes
Albulidae	Bonefishes
Apogonidae	Cardinalfishes
Atherinidae	Silversides, iao
Aulostomidae	Trumpetfishes
Balistidae	Triggerfishes
Belonidae	Needlefishes
Canthigasteridae	Puffers
Carangidae	Uluas, jack crevalles
Carcharinidae	Sharks
Chaetodontidae	Butterfly, angel fishes
Chanidae	Milkfishes, awa
Cirrhitidae	Hawkfishes
Clupeidae	Herring
Coryphaenidae	Dolphin, mahimahi
Diodontidae	Porcupinefishes
Elopidae	Tarpon, awaawa
Engraulidae	Anchovy, nehu
Exocoetidae	Flying fishes
Fistulariidae	Cornetfishes
Gempylidae	Snake mackerels
Gobiidae	Gobies
Hemiramphidae	Half-beaks
Holocentridae	Squirrelfishes
Istiophoridae	Marlin
Kuhliidae	Aholehole
Kyphosidae	Rudderfishes
Labridae	Wrasses
Lutjanidae	Snappers
Molidae	Ocean sunfishes
Monacanthidae	Filefishes
Mugilidae	Mulletts
Mullidae	Goatfishes
Muraenidae	Moray eels
Myctophidae	Lanternfishes
Myliobatidae	Eagle rays
Nomeidae	Shepardfishes
Ostraciontidae	Boxfishes
Polynemidae	Threadfins, moi
Pomacentridae	Damselfishes
Priacanthidae	Big-eyes, aweoweo
Scaridae	Parrotfishes
Scombridae	Mackerels, tmas
Scorpaenidae	Scorpionfishes
Scorpididae	Convictfishes
Sphyraenidae	Scorpionfishes
Sphyrnidae	Hammer-head sharks
Synodontidae	Lizardfishes
Tetraodontidae	Balloonfishes, puffers

APPENDIX IV-3

Checklist of the Vascular Plants of Midway Atoll

Symbols used for species status:

E = Endemic to the Northwestern Hawaiian Islands; i.e., occurring naturally nowhere else in the world, including the main Hawaiian Islands

I = Indigenous; i.e., native to the Northwest Hawaiian islands but occurring naturally (without the aid of humans) elsewhere. However, the plant may be endemic to the Hawaiian archipelago

X = Non-cultivated alien species; i.e., plants of accidental or deliberate introduction that have become naturalized on the islands

C = Cultivated species which have not become naturalized

? = Status unknown

N = Candidate endangered plant species

* = An asterisk indicates that the species was observed or vouchered by James and Catherine Ludwig and Steven Apfelbaum (Ludwig et al. 1979)

(Adapted from D.R. Herbst and W.L. Wagner, in press)

Scientific Name	Common Name	Status
PTERIDOPHYTA		
DAVALLIACEAE (Sword fern family)		
<i>Nephrolepis multiflora</i>		C*
DICSONIACEAE (Dicksonia family)		
<i>Cibotium</i> sp.	Hawaiian tree fern	C
POLYPODIACEAE (Polypody family)		
<i>Phymatodes scolopendria</i>	laua'e	C
PSILOACEAE (Psilotum family)		
<i>Psilotum nudum</i>	moa	?
GYMNOSPERMAE		
ARAUCARIACEAE (Araucaria family)		
<i>Araucaria heterophylla</i>	Norfolk Island pine	C*
<i>Conyza bonariensis</i>	iloha	X*
<i>Gnaphalium purpureum</i>	cudweed	X
<i>Gnaphalium sandwicensium</i> var. <i>sandwicensium</i>	'ena'ena	I*
<i>Helianthus annuus</i> var. <i>macrocarpus</i>	sunflower	C
<i>Pluchea xosbersgii</i>		X
<i>Pluchea indica</i>	Indian pluchea	X
<i>Pluchea odorata</i>	fleabane	X*

Scientific Name	Common Name	Status
<i>Pluchea symphytifolia</i>	sour bush	X
<i>Sonchus oleraceus</i>	sow thistle	X*
<i>Tridax procumbens</i>	coat buttons	X
<i>Verbesina encelioides</i>	golden crown-beard	X*
<i>Wedelia trilobata</i>	wedelia	C
<i>Xanthium strumarium</i> var. <i>canadense</i>	cocklebur	X
BIGNONIACEAE (Bignonia family)		
<i>Spathodea campanulata</i>	African tulip tree	C
<i>Tabebuia</i> sp.		C
BORAGINACEAE (Heliotrope family)		
<i>Cordia sebestena</i>	kou-haole	C
<i>Heliotropium procumbens</i> var. <i>depressum</i>		X
<i>Tournefortia argentea</i>	tree heliotrope	X*
BRASSICACEAE (Mustard family)		
<i>Brassica nigra</i>	black mustard	X*
<i>Capsella rubella</i>	shepard's purse	X*
<i>Coronopus didymus</i>	swine cress	X*
<i>Lepidium bidentatum</i> var. <i>o-waihiense</i>	'anounou	I
<i>Lepidium densiflorum</i>		X*
<i>Lepidium virginicum</i>	pepper grass	X
<i>Lobularia maritima</i>	sweet alyssum	X*
<i>Raphanus sativus</i>	radish	C
CACTACEAE (Cactus family)		
<i>Epiphyllum oxpetalum</i>	gooseneck cactus	X
<i>Hylocereus undatus</i>	night blooming cereus	C
CAPPARACEAE (Caper family)		
<i>Capparis sandwichiana</i>	puapilo	I
CARICACEAE (Papaya family)		
<i>Carica papaya</i>	papaya	C*
CARYOPHYLLACEAE (Pink family)		
<i>Cerastium vulgatum</i>	larger mouse ear chickweed	X*
<i>Cerastium fontanum</i> var. <i>triviale</i>	common mouse ear	X
<i>Spergularia marina</i>	mimi'ilio	X*
CUPRESSACEAE (Cypress family)		
<i>Cupressus</i> sp.		C*
CYCADACEAE (Cycas family)		
<i>Cycas circinalis</i>	sago palm	C*
<i>Cycas revoluta</i>	sago palm	C

Scientific Name	Common Name	Status
MONOCOTYLEDONAE		
AGAVACEAE (Agave family)		
<i>Agave sisalana</i>	sisal	C*
<i>Cordyline terminalis</i>	ti	C
<i>Cordyline</i> sp.		C*
<i>Dracaena</i> sp.		C*
<i>Sansevieria</i> sp.	bowstring hemp	C*
ALOEACEAE (Aloe family)		
<i>Aloe</i> sp.		C*
ARACEAE (Taro family)		
<i>Alocasia cucullata</i>	Chinese taro	C*
- <i>Anthurium andraeanum</i>	anthurium	C*
<i>Caladium bicolor</i>	caladium	C
<i>Colocasia esculenta</i>	taro	C*
<i>Dieffenbachia</i> sp.	dumb cane	C*
<i>Monstera deliciosa</i>	monstera	C*
<i>Philodendron</i> sp.	philodendron	C
<i>Rhaphidophora aurea</i>	taro vine	C*
<i>Syngonium podophyllum</i>	syngonium	C*
<i>Xanthosoma</i> sp.	'ape, elephant ear	C*
ARECACEAE (Palm family)		
<i>Cocos nucifera</i>	coconut	C*
<i>Phoenix</i> sp.		C
<i>Prüchardia</i> sp.	fan palm	C*
<i>Roystonea</i> sp.		C*
CANNACEAE (Canna family)		
<i>Canna indica</i>	canna	C*
COMMELINACEAE (Spiderwort family)		
<i>Commelina diffusa</i>	honohono	X*
<i>Dichorisandra thrysiflora</i>	blue ginger	C
<i>Rhoeo spathacea</i>	oyster plant	C*
<i>Zebrina pendula</i>	wandering jew	C*
CYPERACEAE (Sedge family)		
<i>Cyperus alternifolius</i>	umbrella plant	X*
<i>Cyperus hypochlorous</i>		I
<i>Cyperus javanicus</i>	'ahu'awa	I
<i>Cyperus papyrus</i>	papyrus	C*
<i>Cyperus rotundus</i>	nutgrass	X*
<i>Fimbristylis pycnocephala</i>	button sedge	I*
LILIACEAE (Lily family)		
<i>Allium cepa</i>	onion	C*
<i>Asparagus setaceus</i>	asparagus fern	C*
<i>Crinum asiaticum</i>	spider lily	C
<i>Hemerocallis</i> sp.	day lily	C
<i>Hippeastrum</i> sp.		C
<i>Pancratium littorale</i>	spider lily	C

Scientific Name	Common Name	Status
MUSACEAE (Banana family)		
<i>Heliconia psittacorum</i>		C
<i>Musa</i> sp.	banana	C
<i>Strelitzia reginae</i>	bird of paradise	C
ORCHIDACEAE (Orchid family)		
<i>Vanda</i> sp.		C*
Various orchids		C*
PANDANACEAE (Screwpine family)		
<i>Pandanus</i> sp.	hala, screwpine	C*
POACEAE (Grass family)		
<i>Ammophila arenaria</i>	European beachgrass	X
<i>Brachiaria mutica</i>	paragrass	X
<i>Bromus catharticus</i>	prairie grass	X
<i>Cenchrus agrimonioides</i>		
var. <i>laysanensis</i>	kamanomano	E, N
<i>Cenchrus echinatus</i>	sandbur	X*
<i>Chloris inflata</i>	swollen fingergrass	X*
<i>Cynodon dactylon</i>	Bermuda grass	X*
<i>Digitaria adscendens</i>	Henry's crabgrass	X
<i>Digitaria sanguinalis</i>		
var. <i>ciliaris</i>		X*
<i>Eleusine indica</i>	goosegrass	X*
<i>Eragrostis enella</i>	Japanese lovegrass	X*
<i>Eragrostis variabilis</i>	'emo-loa	I*
<i>Eragrostis whitneyi</i> var. <i>caumii</i>		E
<i>Eustachys petraea</i>		X
<i>Hordeum leporinum</i>		X
<i>Lepturus repens</i> var. <i>repens</i>		I
<i>Lepturus repens</i> var. <i>subulatus</i>		I*
<i>Paspalum urvillei</i>	Vaseygrass	X
<i>Poa annua</i>	annual bluegrass	X*
<i>Polypogon interruptus</i>	ditch polypogon	X
<i>Polypogon monspeliensis</i>	rabbitfoot grass	X
<i>Setaria verticillata</i>	bristly foxtail	X*
<i>Sporobolus africanus</i>	African dropseed	X*
<i>Sporobolus indicus</i>	West Indian dropseed	X
<i>Sporobolus pyramidatus</i>		X
<i>Sporobolus virginicus</i>	beach dropseed	I
<i>Stenotaphrum secundatum</i>	buffalo grass	X*
<i>Tricachne insularis</i>	sourgrass	X
<i>Tricholaena roseus</i>	Natal red top	X*
<i>Vulpia megalura</i>	foxtail fescue	X
<i>Zea mays</i>	corn	C*
ZINGIBERACEAE (Ginger family)		
<i>Catimbiium speciosum</i>	shell ginger	C*
<i>Hedychium gardnerianum</i>	kahili ginger	C*

Scientific Name	Common Name	Status
DICOTYLEDONAE		
ACANTHACEAE (Acanthus family)		
<i>Asystasia gangetica</i>	asystasia	X*
<i>Odontonema strictum</i>	odontonema	C*
<i>Ruellia brittoniana</i>		X
AMARANTHACEAE (Amaranth family)		
<i>Achyranthes atollensis</i>		E, N
<i>Alternanthera tenella</i>	joyweed	C
<i>Amaranthus dubius</i>	pakai	X
<i>Amaranthus hybridus</i>	green amaranth	X
<i>Amaranthus spinosus</i>	spiny pigweed	X
<i>Amaranthus viridius</i>	slender amaranth	X
ANACARDIACEAE (Mango family)		
<i>Mangifera indica</i>	mango	C*
<i>Schinus terebinthifolius</i>	Christmas berry	X
APIACEAE (Carrot family)		
<i>Ciclospermum leptophyllum</i>	fine-leaved celery	X
APOCYNACEAE (Periwinkle family)		
<i>Allamanda cathartica</i>	allamanda	C
<i>Carissa macrocarpa</i>	Natal plum	C*
<i>Catharanthus roseus</i>	periwinkle	C*
<i>Ervatamia</i> sp.	crape jasmine	C
<i>Nerium oleander</i>	oleander	C*
<i>Plumeria obtusa</i>	Singapore plumeria	C
<i>Plumeria</i> sp.	plumeria	C*
<i>Thevetia peruviana</i>	be still tree	C*
ARALIACEAE (Ginseng family)		
<i>Polyscias guilfoylei</i>	panax	C
<i>Schefflera actinophylla</i>	octopus tree	C*
ASTERACEAE (Daisy family)		
<i>Arctium lappa</i>	gobo	C
<i>Bidens alba</i>	Spanish needles	X*
<i>Bidens pilosa</i>	Spanish needles	X*
<i>Stellaria media</i>	common chickweed	X*
CASUARINACEAE (Casuarina family)		
<i>Casuarina equisetifolia</i>	ironwood	X*
CHENOPODIACEAE (Goosefoot family)		
<i>Chenopodium murale</i>	nettle-leaved goosefoot	X*
CLUSIACEAE (Mangosteen family)		
<i>Calophyllum inophyllum</i>	kamani	C
<i>Clusia rosea</i>	copeye	C
COMBRETACEAE (Indian almond family)		
<i>Conocarpus erectus</i>	buttonwood	C
<i>Terminalis catappa</i>	false kamani	C

Scientific Name	Common Name	Status
CONVOLVULACEAE (Morning-glory family)		
<i>Ipomoea batatas</i>	sweet potato	C*
<i>Ipomoea indica</i> f. <i>indica</i>	koali'awahia, morning glory	I*
<i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i>	beach morning glory	I*
<i>Ipomoea triloba</i>	little bell	X
<i>Ipomoea</i> sp.	morning glory	C*
<i>Merremia tuberosa</i>	wood rose	C
CRASSULACEAE (Stonecrop family)		
<i>Crassula</i> sp.		C
<i>Kalanchoe daigremontiana</i> x <i>tubiflora</i>		C
<i>Kalanchoe pinnata</i>	air plant	X
<i>Kalanchoe tubiflora</i>	chandelier plant	C
CUCURBITACEAE (Gourd family)		
- <i>Cucurbita pepo</i>	squash, zucchini	C*
EUPHORBIACEAE (Spurge family)		
<i>Acalypha wilkesiana</i>	beefsteak plant	C
<i>Breynia disticha</i> var. <i>rosi-picta</i>	snow bush	C
<i>Chamaesyce hirta</i>	hairy spurge	X
<i>Chamaesyce hypericifolia</i>		X
<i>Chamaesyce maculata</i>		X
<i>Chamaesyce prostata</i>	small ground fig	X
<i>Codiaeum variegatum</i> var. <i>pictum</i>	croton	C
<i>Euphorbia cyathopora</i>	wild poinsettia	X*
<i>Euphorbia heterophylla</i>		X
<i>Euphorbia peplus</i>	petty spurge	X
<i>Euphorbia pulcherrima</i>	poinsettia	C
<i>Pedilanthus tithimaloides</i>	slipper flower	C
<i>Ricinus communis</i>	castor bean	X
FABACEAE (Pea family)		
<i>Acacia farnesiana</i>	klu	X
<i>Albizia lebbek</i>	siris tree	C*
<i>Cassia</i> sp.		C
<i>Crotalaria incana</i>	fuzzy rattle-pod	C
<i>Delonix regia</i>	Royal poinciana	C*
<i>Desmanthus virgatus</i>	virgate mimosa	X*
<i>Desmodium sandwicense</i>	Spanish clover	X
<i>Erythrina variegata</i> var. <i>orientalis</i>	tiger's claw	C*
<i>Glycine soja</i>	soy bean	C
<i>Leucaena leucocephala</i>	koa haole	X*
<i>Medicago lupulina</i>	black medic	X*
<i>Medicago orbicularis</i>		X
<i>Medicago stiva</i>	alfalfa	X
<i>Melilotus officinalis</i>	yellow sweet clover	X
<i>Phaseolus vulgaris</i>	green bean	C
<i>Prosopis pallida</i>	kiawe	C
<i>Samanea saman</i>	monkeypod	C*
<i>Senna surattensis</i>	kolomona	C
GENTIANACEAE (Gentian family)		
<i>Centarium erythraea</i>	bitter herb	X

Scientific Name	Common Name	Status
GERANIACEAE (Geranium family) <i>Pelargonium hortorum</i>	fish geranium	C*
GOODENIACEAE (Goodenia family) <i>Scaevola sericea</i>	naupaka kahakai	I*
LAMIACEAE (Mint family) <i>Phyllostegia variabilis</i> <i>Plectranthus scutellarioides</i> <i>Stachys arvensis</i>	coleus staggerweed	E,N C X
MALPHIGIACEAE (Malphigia family) <i>Tristellateia australasiae</i>	bagnit	C
MALVACEAE (Mallow family) - <i>Abutilon grandifolium</i> <i>Hibiscus esculentus</i> <i>Hibiscus rosa-sinensis</i> <i>Hibiscus tiliaceus</i> <i>Hibiscus</i> sp. <i>Malva parviflora</i> <i>Malvastrum coromandelianum</i> <i>Malvastrum arboreus</i> <i>Sida fallax</i> <i>Thepesia populnea</i>	hairy abutilon okra red hibiscus hau cheese weed false mallow Turks cap 'ilima milo	X* C* C C C X* X* C* I C
MORACEAE (Mulberry family) <i>Ficus benghalensis</i> <i>Ficus elastica</i> <i>Ficus microcarpa</i> <i>Ficus</i> sp. <i>Morus alba</i>	Indian banyan Indian rubber tree Chinese banyan white mulberry	C* C* C* C C
MYRTACEAE (Myrtle family) <i>Eugenia uniflora</i> <i>Psidium guajava</i>	Surinam cherry guava	C C
NYCTAGINACEAE (Four o'clock family) <i>Boerhavia repens</i> <i>Bougainvillea spectabilis</i> <i>Mirabilis jalapa</i>	alena bougainvillea four o'clock	I* C* X
OLEACEAE (Olive family) <i>Jasminum sambac</i> <i>Noronia emerginata</i>	pikake Madagascar olive	C C
ONAGRACEAE (Evening primrose family) <i>Oenothera laciniata</i>		X
OXALIDACEAE (Wood sorrel family) <i>Oxalis corniculata</i> <i>Oxalis corymbosa</i>	yellow wood sorrel pink wood sorrel	X* X*
PASSIFLORACEAE (Passion flower family) <i>Passiflora edulis</i>	liliko'i	C

Scientific Name	Common Name	Status
PLANTAGINACEAE (Plantain family)		
<i>Plantago lanceolata</i>	English plantain	X*
<i>Plantago major</i>	common plantain	X*
PLUMBAGINACEAE (Leadwort family)		
<i>Plumbago auriculata</i>	plumbago	C
POLYGONACEAE (Buckwheat family)		
<i>Coccoloba uvifera</i>	sea grape	C*
PORTULACACEAE (Purslane family)		
<i>Portulaca lutea</i>	'ihi	I
<i>Portulaca oleracea</i>	common purslane	X*
<i>Portulacaria afra</i>	jade tree	C
PRIMULACEAE (Primrose family)		
<i>Anagallis arvensis</i>	scarlet pimpernel	X*
ROSACEAE (Rose family)		
<i>Rosa sp.</i>	rose	C*
RUBIACEAE (Coffee family)		
<i>Gardenia sp.</i>		C*
RUTACEAE (Citrus family)		
<i>Citrus sp.</i>		C*
<i>Murraya paniculata</i>	mock orange	C*
SOLANACEAE (Nightshade family)		
<i>Capsicum annum</i>	nioi, red pepper	C*
<i>Lycopersicon esculentum</i>	tomato	C*
<i>Solanum americanum</i>	popola	X
<i>Solanum nelsoni</i>		I
<i>Solanum nigrum</i>	nightshade	X*
STERCULIACEAE (Cocoa family)		
<i>Waltheria indica</i>	'uhaloa	I
TROPAEOLACEAE (Nasturtium family)		
<i>Tropaeolum majus</i>	nasturtium	X
URTICACEAE (Nettle family)		
<i>Pilea microphylla</i>	artillery plant	X*
VERBENACEAE (Verbena family)		
<i>Lantana camara</i>	lantana	X*
<i>Phyla nodiflora</i>		X
<i>Stachytarpheta dichotoma</i>	oi	X
<i>Stachytarpheta jamaicensis</i>	owi	X
<i>Verbena litoralis</i>	ha'uowi	X
<i>Vitex trifolia</i> var. <i>subtrisecta</i>	polinalina	C*
f. <i>subtrisecta</i>		
<i>Vitex trifolia</i> var. <i>subtrisecta</i>	polinalina	C
f. <i>variegata</i>		

Scientific Name	Common Name	Status
VIOLACEAE (Violet family) <i>Viola odorata</i>	violet	C
VITACEAE (Grape family) <i>Vitis</i> sp.	grape	C
ZYGOPHYLLACEAE (Tribulus family) <i>Tribulus cistoides</i>	nohu, puncture vine	I*

APPENDIX IV-4

Bird Aircraft Strike Hazard (BASH) Plan

1. Purpose

A bird-aircraft strike hazard exists at NAF Midway due to the presence of large numbers of nesting and migratory seabirds. The severity of the hazard varies with daily and seasonal patterns of bird activity, but hazardous conditions are expected during daylight hours throughout most of the year. The purpose of this plan is to establish procedures to minimize this hazard; however, no single solution to this BASH problem exists, and a variety of actions and organizations must be involved in any program designed to control or reduce this hazard. The objectives of this plan are to:

- a. Identify needs and assign responsibilities
- b. Establish procedures to identify high hazard conditions, times, and locations
- c. Establish a standardized system of evaluating the severity of hazard conditions
- d. Identify aircraft and airfield operating procedures to avoid high hazard situations
- e. Evaluate potential methods of reducing airfield attractiveness to birds
- f. Evaluate potential methods of dispersing or eliminating birds from the airfield.

This plan follows the guidance of the BASH Plan Outline presented in Appendix F of NAVFAC P-73, Volume II.

2. Airfield Local Area

Naval Air Facility Midway Island is located on Midway Atoll, a coral atoll at the northwest end of the Hawaiian chain, at 28 degrees N latitude and 177 degrees W longitude. It is 1150 linear miles from Honolulu, Hawaii. The atoll has recently been designated an Overlay National Wildlife Refuge.

Midway Atoll comprises two large islands and a smaller islet enclosed within a circular reef approximately five miles in diameter. Sand Island, the site of the present airfield, is 1.8 miles long by 1.2 miles wide, comprising 1205 acres of emergent land, and with a maximum elevation of 43 feet ASL. Eastern Island, located one mile east of Sand and the site of an abandoned airfield, covers about 800 acres and has a maximum elevation of 35 feet ASL.

Facility operations are restricted to Sand Island, much of which is covered with runways, roads, and structures. Operational and support facilities are located primarily in the island's interior. The island is basically flat with no significant topographical features. Shorelines consist of sandy beach or sheerpile bulkhead.

Developed areas are characterized by landscaped grass lawns and fields, but the predominant vegetation community is the ironwood forest. Ironwood trees occupy most areas that are not paved or landscaped, and they are rapidly colonizing abandoned areas whether paved or not. In the island interior, mature ironwoods coexist with a wide variety of naturalized and cultivated plants. In outlying areas dense tangles of younger trees move steadily towards the shoreline. Along some shorelines, stands of beach naupaka and other native shrubs are found. Shading by ironwoods

and herbivory by rats have greatly reduced these dune building species. A map of the major vegetation zones is presented in Figure IV-1 (Fish and Wildlife Section).

Fifteen species of migratory seabirds, totalling over one million individuals, nest at Midway Atoll. Birds are present during all seasons and virtually all emergent lands represent existing or potential seabird habitat. The most abundant species, the Laysan Albatross, is the species most often involved in BASH incidents. These birds nest in all unpaved areas of Sand Island, but density is highest in grass lawns and fields and other cleared areas (see Plate III-1a). Albatrosses are numerous from November through July.

3. Training Areas/Gunnery Ranges/Low-level Routes

None of these exists at NAF Midway.

4. Responsibilities

The following responsibilities should be assigned to a specific staff organization. We recommend formation of a bird-hazard working group, chaired by the Chief of Safety and composed of representatives of pertinent staff organizations. In general, it collects, compiles, and review data on bird strikes, identifies and recommends actions to reduce hazards, recommends changes in operational procedures, prepares informational programs for aircrews, and provides training for assigned personnel. Responsibilities of the working group should include:

- a. Obtaining and maintaining U.S. Fish and Wildlife Service depredation permits for any species that must be killed
- b. Identifying/storing bird remains and submitting for identification as necessary
- c. Utilizing the Bird Hazard Warning System to report significant bird activity noted at the installation. Report sighting to the Aviation Safety Officer (ASO) and advise aircrews of hazardous conditions
- d. Identifying high risk areas, establishing procedures to avoid them, and disseminating information
- e. Modifying airfield habitat consistent with runway lateral and approach management criteria
- f. Providing any additional information on migratory, local and seasonal bird activities through contact with the U.S. Fish and Wildlife Service
- g. Reviewing approach routes and schedules
- h. Declaring, disseminating and terminating bird watch conditions
- i. Monitoring bird activity and strike statistics and advising the chairman of the working group when a meeting is deemed necessary
- j. Including bird hazard conditions in weather briefings
- k. Issuing specific guidance for aviators to follow under bird watch conditions

- l. Reporting all bird-strikes in accordance with OPNAVINST 3750.6N
- m. Ensuring aircrews participate in the BASH reduction program by promptly reporting all bird strikes and hazardous conditions
- n. Obtaining and posting current bird activity data and ensuring it is readily available for briefing aircrews. Advising each unit of the daily bird condition. Each unit will post the bird condition on a status board and inform all aircrews of any change in status
- o. Briefing aircrews on seasonal bird hazards.

5. Bird Watch Conditions

By the standards of other installations the BASH conditions at NAF Midway are always extreme. Within this perspective, Air Traffic Control personnel use the categories high, moderate, and low to describe the level of activity of birds flying over the runway.

6. Bird Remains Identification

After each air traffic event, the runway and adjacent aprons should be searched for fresh bird carcasses or parts, which can be used to identify the species involved in the strike. If the species can be identified easily, such as with Laysan Albatross ("white gooney birds"), by runway personnel, then it is not necessary to save the remains; however, the information must be reported to the appropriate office. If the species is not recognizable, non-fleshy remains (e.g., feathers) should be collected and forwarded to personnel with expertise in bird identification, such as the FWS representative. If local identification is not possible, the remains should be forwarded to PACNAV-ENGCOD Code 243. Include the General Use Naval Aviation Bird Strike Hazard Report which provides:

- a. Installation from which remains are shipped
- b. Hazard report number
- c. Date of strike
- d. Type of aircraft and squadron
- e. Damage amount
- f. Geographic location and altitude at time of strike.

7. Bird Strike Reduction

- a. Bird strike hazard

During the first 130 days of 1989, 14 % of all aircraft events (landings and takeoffs) sustained bird strikes; 25 % of these (or 3.5 % of the total) suffered at least some damage. This strike rate is higher than that reported for the years 1956 through 1964; however, the albatross population is at least three times larger now than it was 25 years ago.

The Laysan Albatross is the species most often involved in BASH incidents at Midway. Approximately one million of these birds visit Midway Atoll each year, including about 200,000 pairs of nesting adults; slightly less than half of these are found on Sand Island. Albatrosses nest on the ground throughout the island interior in level areas that are not pavement or other hard substrate; nest density is highest on grass fields and lawns.

Adult albatrosses return to the colony in November and egg laying is completed by mid-December. Chicks hatch in late January and early February. For the first month, one parent attends the nest while the other forages. By March, adults spend most of their time at sea, each parent returning only every other day to feed the chick. During May, chicks begin to walk well enough to move around the colony and by mid-June they start to use their wings. The majority become flighted and leave the island during July.

Up to 50% of the adult-plumaged birds on the colony are "walkers", non-breeding subadults (3 to 6 years old) seeking mates and sites for future nest attempts. Subadults are most numerous during March and April. Few albatrosses of any age are present August through October.

Counts of albatrosses flying near runway 6-24, conducted by FWS personnel from 1958 through 1960, revealed the following general patterns:

- increased wind speed results in higher numbers of flying birds
- wind direction of North to Northeast results in highest numbers of flying birds
- wind at a 45 degree angle to the runway results in highest numbers of flying birds
- the number of flying birds is the same on clear and overcast days
- the number of flying birds is highest morning (0630-0930) and evening (1530-1830), lower during the day, and almost zero at night
- the number of flying birds is highest over the dunes, moderate over paved aprons, and lowest over runways.

In order to evaluate habitat management options, it is essential to understand how topography affects albatross flight patterns. Originally it was thought that the birds soared on thermals created by heat rising above the runway, but since flying birds are least numerous at midday and more numerous beyond the edges of runways, it is now clear that thermals are not involved. Instead, albatrosses glide along updrafts created by winds striking high dunes, trees, and other obstructions. These updrafts carry birds up to 50 feet above runway level. Even during loops and turns, birds riding updrafts seldom deviate more than 50 feet from the windward edge of the obstruction, so they rarely get out over the runway.

In the absence of updrafts, such as over water or level ground, albatrosses fly low, closer to surface level. Although the birds prefer to fly along continuous paths of updrafts, cleared land such as fields and runways allows smooth flying, too. The wider the clearing (e.g., runway and apron combined) the more likely it is that birds will cross at low levels. Irregular terrain, such as that found on the northern half of Sand Island produces turbulence and poor flying conditions.

Most albatrosses seen flying above the airfield are birds crossing over the runway in transit from nest sites to offshore feeding waters. Existing landscape patterns strongly influence the paths birds use to depart the island and whether they fly across the airfield. While their windward edges create

updrafts, dense forests also act as barriers to movement from one part of the island to another. Conversely, gaps in the trees, such as roads and paths, funnel flying birds between areas. In general, birds depart the colony to the south and west, because that is the most direct route to deep water and departures north are hampered by the uneven terrain of trees and buildings; however, departure routes vary considerably for different nest sites.

Clearly, albatross flight patterns are determined by the direction and placing of low level wind currents. The goal of habitat management should be to manipulate these currents in an effort to produce bird flight patterns that are least dangerous to aircraft.

b. Previous control efforts

The problem of bird-aircraft strikes at Midway Island received considerable attention during the late 1950s and early 1960s. During the period 1955 to 1963, albatross population status and nesting biology and the effects of population control techniques were investigated by the FWS, at the Navy's request. The results of these investigations were presented by Robbins (1966) and reviewed by Fisher (1966). This section will derive extensively from these two reports; however, anyone actively involved in a BASH control program should refer to these documents directly.

Bird control programs of the late 1950s and 1960s were predicated on the contention of Kenyon et al. (1958) that birds nesting within 750 feet of the center of a runway were most likely to be involved in collisions with aircraft. In order to prevent nesting in the identified areas, a number of procedures were tested. Disturbance techniques, including gunfire and other loud noises, radar beams, odors, and smoke, were quickly determined to be ineffectual, as was relocation of birds or nests. It was decided that destruction of nests and leveling and paving of nesting colonies was the best option. During the period 1955 to 1965, nearly one hundred thousand adults, chicks, and eggs were destroyed and most land adjacent to the airfield was leveled and paved. The results of this intensive control program were mixed, as follows:

- 1) In the short term, the confusion caused by colony destruction led to higher numbers of birds flying over runways; this was the case in each year having a massive kill
- 2) Hard surfacing of nesting habitat near runways, especially the between-runway triangle, successfully reduced the number of birds flying across runways. Counts of birds over runway 6-24 declined from 1958 to 1960, but this is primarily attributable to paving of the between-runway triangle, birds from which could only depart by crossing the runway
- 3) Other habitat manipulation, especially clearing and leveling of dunes may have had adverse effects. When the sources of updrafts are removed, winds move across runways at low levels. Wider clearances allow the smoother passage of low level currents and thus better flying conditions over the runway
- 4) Most importantly, the frequency of bird-aircraft strikes was not consistently or significantly reduced by 10 years of exhaustive control efforts. Although over 60,000 birds were eliminated from the areas along runways, strike frequency didn't change much, indicating that proximate nesters are not the only birds flying over runways and that flight patterns of the population as a whole need to be managed.

c. Recommendations

1) Aircraft Operational Procedures

- during the months November through July, regular flights should be scheduled to arrive and depart during darkness or, at least, to avoid the hours of peak bird activity (i.e., 0600 to 1000 and 1500 to 1900)
- pilots should be advised to employ a steep angle of ascent/descent, so as to minimize the time spent below 100 feet, where the density of flying birds is highest
- pilots should be advised of known high risk places (such as major crossing spots) along the runway
- special operations should be scheduled during the months with fewest birds (i.e., August through October).

2) Habitat manipulation

Habitat manipulation is considered the most promising method of reducing BASH over the long term. Some measures may produce immediate results, but others cannot be accurately evaluated until they have been in effect for a number of years. This program will require a sustained commitment in order to achieve maximum success.

In order to reduce the risk of BASH, habitat should be manipulated in two ways: a) albatross nesting habitat should be reduced near the airfield, but increased in areas removed from the airfield; b) the pattern of forested and cleared land should be designed to control and direct the flow of birds departing the colony.

a) Nesting habitat management

Land that is near or part of the airfield (including runway aprons, the between-runway triangle, antenna fields, etc.), that is constrained from even moderate vegetation, should be paved or scarified annually to prevent nesting by albatrosses. Adjacent cleared lands (including lawns and grass fields) should be densely planted with beach naupaka or other native shrubs to discourage nesting by albatrosses. Recommendations for specific areas are presented in Section II - Land Management.

In the long term, it will be desirable to provide alternative nesting habitat in areas removed from the airfield, so as to gradually effect the permanent relocation of the nesting colony. Abandoned land (especially Eastern Island) could be made attractive to nesting albatrosses by clearing of structures, runways, debris, and trees.

b) Control of bird flight patterns

Albatross flight patterns are complex and not adequately studied at Midway. Annual and seasonal variations in flight patterns resulting from changes in wind direction, prey location, and other factors are not documented. In order to maximize the success of vegetation management measures, it is advised that the Navy fund a two year study of albatross flight patterns in the vicinity of the airfield on Sand Island. Until such time as more detailed information is available, the following measures are recommended as the ones most likely to be effective in reducing BASH.

away from the middle of the runway. Clearances bordering runways should be as narrow as possible to deter birds from flying across the runway at low altitude.

Gaps through forests (including roadways) which lead from nesting areas (e.g., antenna fields) to the airfield should be minimized. Existing excess passageways could be blocked by planting ironwoods. Care should be taken to avoid opening new pathways when land is cleared. Passageways from nesting areas to the nearest northern and eastern shorelines should be kept clear to facilitate departure of nesting birds away from the airfield.

3. Wildlife control considerations

The control efforts of previous decades have shown that massive killing of adult birds or eggs is not an effective means of reducing the BASH hazard. As such, these methods are not recommended. If the Navy determines that limited control efforts are essential, it is recommended that Animal Damage Control (DOA) be consulted with regard to implementation.

4. Monitoring bird-aircraft collisions

Whichever BASH reduction measures are implemented, the success of the program should be monitored carefully. Monitoring, including the collection and analysis of strike data, should be the responsibility of the committee described in section 4 of this plan. At the least, the following data should be obtained for each aircraft event, regardless of whether a strike is reported: date, time, bird activity, wind speed and direction, aircraft type and affiliation, direction of take-off/landing, number of bird strikes or near misses, types of birds involved, location and altitude of strikes, and damage to aircraft. A sample data collection form is presented in Figure IV-4-1.

MIDWAY ISLAND BIRD-AIRCRAFT STRIKE REPORT

This form should be completed for each take off or landing of all aircraft landing at Midway Island.

DATE _____ TIME _____ WIND SPEED _____ WIND DIRECTION _____ °

TYPE OF AIRCRAFT: _____ C-141 _____ P-3 _____ C-130 _____ other: _____

AIRCRAFT ACTIVITY: _____ Landing R/W 24 (east → west) _____ Landing R/W 06 (west → east)
 _____ Taking-off R/W 24 (east → west) _____ Taking-off R/W 06 (west → east)

BIRD ACTIVITY: _____ High _____ Medium _____ Low _____ None

WAS A BIRD STRUCK? _____ No _____ Yes. WERE THERE NEAR MISSES? _____ No _____ Yes, if yes how many? _____

PLACE NUMBER IN APPROPRIATE BOX OF EACH TYPE OF BIRD HIT:

_____ Laysan Albatross (large, white & dark brown) _____ Fairy tern (small, all white)
 _____ Black-footed Albatross (large, all dark) _____ Noddy (small, brown with white head)
 _____ Red-tailed Tropicbird (medium size, white, red bill and tail) _____ Shorebird (very small, usually brown)
 _____ Frigatebird (Large, mostly black, may have white on head and belly, looks like pterodactyl)
 _____ Unknown or other, describe: _____

Was aircraft damaged? _____ No _____ Unknown _____ Yes, if yes please describe below:

Indicate on the map below where the bird(s) were struck and the bird's flight path if known.

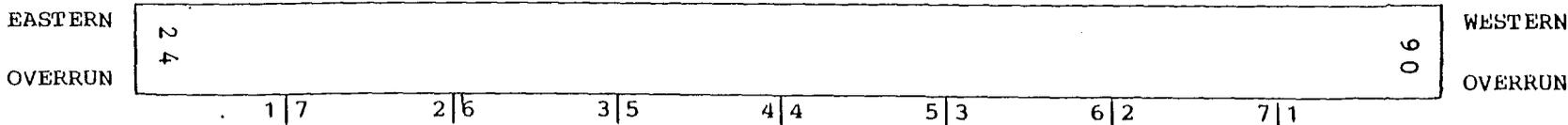


Figure IV-4-1. BASH Data Collection Form

APPENDIX IV-5

Sample Applications for Special Use Permits

REFUGE MANUAL

RESEARCH/MANAGEMENT STUDY PROPOSAL

Mudhen National Wildlife Refuge
Somewhere, Oklahoma

1. Title: (State concisely, preferably ten words or less)
2. Project Number: (The five digit station number of the refuge followed by a unique sequential number assigned by the field station. e.g. 22495-14)
3. Objectives: (Number each objective and present it clearly and concisely. State clearly the hypotheses to be tested or the descriptive data to be obtained.)
4. Justification: (Describe the problem which presently exists. Discuss briefly how the proposed study will contribute to the elimination or solution of the problem and lead to improved management of the area.)
5. Procedure:
 - A. Methods and Materials: (Describe techniques and locations of activities. For example, describe any markers, structures, or other materials to be placed on the area and affirm that such materials will be removed by the investigator. Describe in detail any capture, marking, or tagging techniques. Be sure to cover who is to do what, when, where, and how. Outline the necessary application for permits. If wildlife, whether adult, young, or eggs, are to be collected or sacrificed, the official status of the species involved, i.e., endangered, threatened, or etc. should be noted, indicating what impact on the species is expected to result from the proposed research. Describe the methods which will be used for data analysis and interpretation including suggested statistical tests and significance levels selected.)
 - B. Results: Describe the format in which results will be presented, i.e., tables, charts, graphs, photographic material, etc.
 - C. Interpretion: Describe how the results of hypotheses investigated will relate to management of the refuge.
6. Cooperators: (List other participating institutions, agencies, organizations, or individuals, and the nature of their cooperative effort.)
7. Responsibility: (Provide a list of accountable parties including the role of NWRS personnel in the execution of the effort.)

U.S. FISH AND WILDLIFE SERVICE
REFUGE MANUAL

PLANNING

4 RM 6 Exhibit 1

Format for Research/Management Study Proposal

Page 2

8. Cost: (Costs, if any, to the Fish and Wildlife Service, should be broken down by fiscal year - October 1 through September 30 - and include man-years, equipment, supplies, etc., to accomplish the investigation.)
9. Schedule: (Estimate starting and completion dates. If a portion of a given project is to be accomplished separately, the planned starting and completion dates of each phase should be shown.)
10. Reports: (Establish schedule for progress and completion reports. Copies of the reports will be required by the offices described in 4 RM 6.)
11. Publications: (For all efforts except those that may be described as for the major purpose of introducing participants to the principles of wildlife management and the National Wildlife Refuge System, it is intended that results shall be of sufficient quality to warrant publication, presentation at a symposium, or presentation as a seminar to other Service personnel. Intended ultimate disposition of the data in one of these forms in addition to the required final report must be outlined here).

Submitted By: _____ Date: _____

Endorsement: _____ Date: _____

Refuge Manager Approval: _____ Date: _____

Regional Office Concurrence/Approval: _____

Date: _____

Regional Office Disposition:

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
COMMERCIAL AUDIO-VISUAL PRODUCTION
APPLICATION

Date _____

To the Refuge Manager _____, Fish and Wildlife Service
(Name and facility)
Department of the Interior, _____

(1) -Permission is requested to make, in the area mentioned above, a _____

(Description of audio-visual including title of production if applicable)

(2) The scope of the audio-visual activity and the manner and extent that the production will involve the use of the FWS facilities are as follows:

(An additional sheet should be used if necessary)

Weather conditions permitting, work will commence on approximately _____ and will be completed on _____. Extension of the permit may only be made by the refuge manager in writing.

(3) The undersigned accepts and will comply with the following conditions:

(i) Utmost care will be exercised to see that no natural, historic or cultural features are injured, and after completion of the work the area will, as required by the refuge manager, either be cleaned up and restored to its prior condition or left, after clean-up, in a condition satisfactory to the refuge manager.

(ii) Credit will X will not _____ be given to the Department of the Interior and the Fish and Wildlife Service through the use of an appropriate title or announcement.

(iii) Photographing or filming of resident wildlife will be permitted only when such wildlife will not be molested, harmed, or disturbed thereby. Trained or untrained, wildlife captured elsewhere will not be allowed in any production.

(iv) Any special instructions received from the refuge manager will be complied with.

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
COMMERCIAL AUDIO-VISUAL PRODUCTION
APPLICATION

- (v) Any additional information relating to the privilege applied for by this application will be furnished upon request of the refuge manager.
 - (vi) No employee of the Service may work for the permittee in any capacity whatsoever while in uniform or directly involved in supervision of the permittee.
 - (vii) No personal gratuity of any nature whatsoever will be offered to any employee of the Government in connection with the exercise of the privilege granted.
- (4) A member of the Service staff will supervise the production within the Service boundaries. He/she will have the authority to make all supervisory decisions to assure compliance with the permit, applicable regulations, and Service audio-visual production policy. Any overtime expense incurred due to the necessity for such supervision will be borne by the permittee.
- (5) The permittee will be required to post a bond or cash deposit to ensure that the area is left in as good condition after completion of production as it was before. The bond or deposit will be determined by the Service refuge manager and will be an amount equal to the estimated cost to the Government of clean-up restoration operations that would occur in the event that the permittee causes damage to resource or facilities or fails to clean up the area satisfactorily. Return of the bond or deposit is subject to compliance with the terms of this permit.
- (6) The permittee, in exercising the privileges granted by this permit, shall comply with the regulations of the Department of the Interior, the Service, and all Federal, State, county and municipal laws, ordinances, or regulations which are applicable to the area of operations covered by this permit.
- (7) This permit is a revocable permit and may be revoked at the discretion of the Director of the Fish and Wildlife Service or his designee upon 24 hours notice, or without notice, if damage to resources or facilities is threatened, notwithstanding any other term or condition of the permit to the contrary.
- (8) The permittee hereby agrees to save and hold harmless the United States of America, its agents and employees, from any and all claims, damages, suits at law or equity or whatever kind or nature for damages to or loss

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
COMMERCIAL AUDIO-VISUAL PRODUCTION
APPLICATION

of property, or injury or death to persons resulting directly or indirectly from or attributable to the permittee or its employees in connection with the filming activities authorized by this permit. In addition, the permittee agrees to carry a general liability insurance policy in the amount of \$ _____ in which the United States is named as a coinsured.

(Applicant)

For: _____
(Company)

(Address)

Bond/Deposit Requirement: \$ _____

Approved: _____
(Signature)

(Title)

(Date)

Bond/Deposit
Returned

(Signature of person accepting return of bond/deposit and date)

Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact or makes any false, fictitious or fraudulent statements or representations, or makes or uses an false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than \$10,000 or imprisoned not more than five years, or both.



Outdoor Recreation Section

TABLE OF CONTENTS

V. OUTDOOR RECREATION

A. Introduction	V-1
B. Policies and Programs	V-1
1. Existing	V-1
2. Recommended	V-1
C. Objectives	V-1
D. Resource Analysis	V-2
1. Natural resources	V-2
2. Other resources	V-3
E. Existing and Potential Recreation Activities	V-3
1. Dispersed recreation activities	V-3
2. Concentrated recreation activities	V-4
F. Project Recommendations	V-4
G. Implementation	V-8
H. References	V-8
<u>Tables</u>	
V-1 Proposed Recreational Fishing Regulations	V-6
V-2 Ten Year Schedule of Outdoor Recreation Management Projects	V-9
V-3 Project Costs - Outdoor Recreation	V-13



V. OUTDOOR RECREATION SECTION

A. Introduction

The purpose of this section is to develop an integrated program of outdoor recreation, which facilitates use and appreciation of the natural resources of Midway Atoll, within the constraints of the military mission and national wildlife refuge regulations. Recreation planning must be undertaken within the broader context of natural resources management; that is, even in multiple-use areas appropriate for recreation, preservation of the existing natural resources remains a priority.

For the purposes of this section, outdoor recreation refers to activities which take advantage of the area's existing natural resources in order to provide recreational opportunities for base personnel and residents. At NAF Midway these include fishing, snorkeling, diving, nature photography, and beach activities. This section does not address the provision or management of recreational facilities generally associated with urban developments, such as playgrounds, cookout facilities, golf courses, and athletic fields.

The objectives of this section are to identify ongoing recreational activities and to recommend ways to enhance recreational opportunities, primarily the use and appreciation of natural resources, while preserving the existing resources.

It is the responsibility of the facility commanding officer to ensure that an outdoor recreation program is developed in coordination with appropriate federal agencies. The public works officer develops and maintains the installation's outdoor recreation program by implementing the outdoor recreation management section and appropriate cooperative agreements. In addition, the public works officer coordinates with the appropriate morale, welfare, and recreation (MWR) offices on outdoor recreation-related projects and operations. MWR supports and participates in management of the outdoor recreation program. MWR may collect fees (in accordance with procedures in the Sikes Act), coordinate reservations, and regulate fishing. The public works officer may develop and maintain the recreational facilities.

B. Policies and Programs

1. Existing

Federal and facility laws, regulations, and programs that affect recreational use of natural resources are included Table II-1 (Section II - Basic Section).

2. Recommended

It is recommended that a program of wildlife interpretation be designed and implemented and that a set of regulations governing recreational fishing be established. Details of these and other recommended programs are presented in Part F of this section.

C. Objectives

- To optimize recreational opportunities within the constraints of the military mission, fish and wildlife regulations, and the capacities of the natural resources.

- To identify the natural resources and resource areas and indicate which recreational activities are appropriate for each.
- To encourage multiple use programs for natural resources, while mediating conflicts between competing recreational and/or preservation needs.
- To encourage Passive-Appreciative (as defined by the Bureau of Outdoor Recreation, DOI) forms of recreation, such as nature walks, birdwatching, and wildlife photography, which are the type most compatible with wildlife preservation regulations.
- To establish regulations for the capture of fish, lobster, and shellfish and for collection of shells and coral, which ensure the preservation of the resource at levels sufficient for future residents.

D. Resource Analysis

The following analysis of natural resources, resource areas, and the opportunities for outdoor recreation refers only to Sand Island, unless stated otherwise. At this time, Eastern and Spit islands are not appropriate for recreational use or development due to constraints relating to wildlife protection and conservation.

1. *Natural resources*

Botanical. No endangered plants have been located at Midway; however, remnant stands of beach naupaka and other indigenous plant species are found along some shorelines. These plants are in danger of extirpation due to competition with introduced vegetation. Potential impacts to indigenous vegetation should be considered before an area is developed for recreational use.

Wildlife. Fifteen species of migratory seabirds, totalling more than one million birds, nest at Midway. The opportunities for wildlife observation and photography are many, so long as these activities do not result in disturbance or harassment of birds. These passive recreational activities are plentiful in inhabited areas, so that access to restricted areas is not normally necessary. Selected lands will remain off limits to all personnel, except those authorized by the FWS, in order to provide disturbance-free sanctuaries for sensitive species.

Virtually all unpaved lands represent current or potential nesting habitat for seabirds. Any program of recreational use or development must consider the potential affects on wildlife; the U.S. Fish and Wildlife Service should be consulted when planning such programs.

The Hawaiian monk seal, an endangered species, is frequently observed along beaches. These animals are easily disturbed by humans and so are not appropriate for close observation or photography. Regulations dictate that humans remain sufficiently far away that the seals do not respond to their presence. Personnel interested in observing seals should remain at a safe distance and use binoculars.

Coral reef and marine life. Inside the lagoon, there is a great diversity of marine organisms. The reef community includes dolphins, sea turtles, fishes, lobsters, corals, shellfish, and other invertebrates. Gamefish are abundant in the waters outside the reef. Marine life provide a number of recreation opportunities: viewing and photographing of marine life by swimming, snorkeling, and scuba diving; fishing for sport or for food; and collecting shells and corals. These opportun-

ities are constrained by the protected status of turtles and dolphins, fishing regulations, and the presence of ciguatera toxins in certain fishes caught inside the reef.

Shorelines and lagoon waters. Approximately 40% of the shoreline of Sand Island consists of sandy beaches. All beaches are appropriate for recreational activities such as walking, running, sunbathing, shell collecting, and swimming in adjacent waters, so long as seals and other wildlife are not disturbed. Designated beaches may be appropriate also for picnicking, cookouts, and camping. Shorelines and associated facilities such as harbors and piers provide opportunities for fishing by throw net or hook-and-line.

The relatively warm, calm, shallow waters within the lagoon provide opportunities for a variety of water sports, such as swimming, snorkeling, scuba diving, boating, sailing, windsurfing, kayaking, and water skiing. Waters outside the reef are appropriate only for deep sea fishing.

Sand Island interior. The relatively flat interior of Sand Island features numerous paved roads, suitable for walking, jogging, running, and bicycling. Archery, target shooting, hunting, and off-road vehicles (including bicycles) are not appropriate due to possible threats to wildlife.

2. Other resources

Historical civilian and military sites are identified in Section II; there is no organized recreational use of these sites at present. No other cultural, scenic, or other resources have been identified for Midway Atoll.

E. Existing and Potential Recreation Activities

1. Dispersed recreation activities

Nature study. As defined here, nature study pertains to all Passive-Appreciative recreation activities relating to natural resources, including birdwatching, wildlife observation and photography, and sightseeing.

All aspects of nature study listed above are practiced by visiting and resident personnel. Observation and photography of wildlife, especially seabirds and seals, are among the most popular recreational pastimes. Currently, no organized programs for nature study or interpretation exist. The design and use of interpretive displays, pamphlets, slide shows, and tours could potentially increase the participation, enjoyment, and value of nature-related activities. Properly guided nature study tours might be appropriate for Eastern Island during some months.

Fishing. Throw net and hook-and-line fishing are commonly practiced along shorelines and from breakwaters and piers. Hook-and-line fishing from boats is usually limited to waters outside the reef. Only pelagic fishes such as tuna and wahoo, which are caught outside the reef, are considered to be edible; all fishes that dwell or feed near the reef are potentially contaminated by ciguatera toxin. For safety, regulations dictate that fishing within the lagoon is for recreation (catch and release) or bait procurement only. Spearfishing is not permitted, nor should it be allowed in the future. Lobster, crabs, and other invertebrates are captured by hand and trap; capture by spear is not permitted. These activities are subject to regulations covering limits and seasons.

Shell collecting. Shells and coral, live or dead, are collected along beaches and in lagoon waters. Collecting is not regulated.

Swimming, snorkeling, and scuba diving. These activities are practiced extensively in waters inside the reef. Swimming is permitted off most beaches, but the waters adjacent to the pavilion beach are most popular. Snorkeling and diving are possible from shore and small boats are available to take experienced divers and snorkelers to outlying coral heads or the inside edge of the reef. Snorkeling gear may be obtained through MWR. Scuba divers are required to have proof of certification, sign a release of liability, and provide their own equipment.

Sailing and windsurfing. Small boat sailing and windsurfing are practiced on the waters adjacent to the pavilion beach. Sailboats (Lasers) and sailboards can be checked out from MWR.

Power boating and water skiing. Power boats may be rented from the MWR boathouse; three boats are outfitted for deep sea fishing, one for water skiing, and smaller Boston whalers are available for snorkeling or diving trips. A Midway boat driver's license, obtained from the harbor-master, is required to operate these boats. Only the fishing boats are permitted outside the reef.

Running, walking, and bicycling. Running (including jogging) and walking are permitted on beaches, roads, and abandoned runways; bicycle riding is restricted to the latter two areas. These activities, especially off-road bicycling, are not allowed in other areas due to threats to wildlife.

Hiking. This activity is not appropriate for Midway due to the lack of topographic variation and restricted access due to wildlife regulations.

Hunting and shooting. These activities are not permitted at Midway Atoll due to security and wildlife protection requirements.

2. Concentrated recreation activities

Picnics and cookouts. One site is available for group picnics or cookouts - the beach pavilion, located on the north shore of Sand Island. A cookout permit must be obtained from the fire chief. These activities are permitted also on the grounds adjacent to the softball field. If the demand for sites increases in the future, the abandoned cookout area at the NOP facility could be renovated. Development of new sites is constrained by conflicts with wildlife.

Camping. No developed or primitive camp sites exist and none are recommended due to potential conflicts with wildlife. Informal tent camping on beaches is permitted for small groups, with the approval of the OIC-NAF Midway.

Off-road vehicles. Vehicles of all types, including motorcycles and bicycles, are restricted to roads and paved areas. No recreational off-road driving is permitted due to potential hazards to wildlife.

F. Project Recommendations

1. Recreational opportunities relating to wildlife observation, photography, and appreciation could be significantly enhanced by a program of wildlife interpretation. It is recommended that such a program be planned in coordination with the U.S. Fish and Wildlife Service. It is recommended that the program include the following elements:
 - An interpretive display, featuring photographs and information about island wildlife. The dis-

play should be designed (by the FWS) to facilitate periodic changes or updates and it should be centrally located in an area with regular pedestrian traffic, either inside a building or outdoors. An outdoor display will require a kiosk or other structure (to be built by the Navy) for protection from sun and rain. The best location for an outdoor display might be in front of the Midway mall. A display situated inside a building, the hanger or the dining hall, for example, would deteriorate less rapidly, but would be seen by fewer visitors.

- An interpretive brochure, produced by the FWS, briefly describing and illustrating the main wildlife features of interest and outlining the visitor's responsibilities with respect to wildlife regulations. These brochures should be available at several locations around the facility; permanent wall-mounted or tabletop dispensers, built by the Navy, will facilitate distribution.
 - Scheduling of interpretive slide shows or other presentations to enhance appreciation and knowledge of island wildlife. If present on-island, Fish and Wildlife personnel will be the most readily available source of expertise, but experienced naturalists and biologists from the University of Hawaii, the Audubon Society, or other Hawaii-based organizations, might be invited on occasion. Such visitors may be happy to volunteer their time and expertise in exchange for a chance to see the atoll's wildlife.
 - Scheduling of interpretive tours or nature walks to enhance appreciation and knowledge of island wildlife. If available, Fish and Wildlife Service personnel should serve as tour guides. Small groups under the supervision of a FWS guide might be able to visit Eastern Island in order to observe its rather different wildlife community.
2. Despite the abundance of underwater resources, scuba diving is currently a limited recreational option. Because rental equipment is not available, short term visitors usually cannot scuba dive and residents (such as Seabee detachments) desiring scuba instruction and certification are unable to obtain this training. Therefore, it is recommended that scuba equipment, including air tanks, regulators, and buoyancy compensators be made available through MWR.
3. Current rates of consumption of lobsters, other shellfish, and coral do not appear to represent a threat to populations of the atoll as a whole. However, some of these resources are being depleted in localized areas; for example, the waters adjacent to the most heavily used swimming beaches are nearly devoid of live coral and shellfish. In order to insure that these resources are preserved for consumptive and non-consumptive activities in the future, it is recommended that:
- A clear and specific set of regulations (based on those of the State of Hawaii) for the recreational harvest of finned fishes, lobsters, shellfish, and corals be established and adopted, which addresses season duration, daily and possession limits, transport off island, use of traps, banning of spears, and other issues. A proposed set of regulations is presented in Table V-1.
 - Island personnel be advised of these regulations and that copies of the regulations be posted in appropriate locations (e.g., the boathouse, the cargo pier, the beach pavilion).
 - These regulations be reviewed at least every three years or whenever consumption levels change significantly. If necessary, modifications should be made by the OIC in coordination with the Fish and Wildlife Service.
 - Collection of living coral be prohibited within 200 yards of beaches any shoreline. Collection of non-living or beachcast shells should be permitted along these shores.

TABLE V-1

Proposed Recreational Fishing Regulations

I. Finned Fishes

- A. Season: Fishing for finned fishes is allowed throughout the year.
- B. Limit: No limit is set on the number of pelagic or reef fish that can be legally captured; however, any fish that will not be used for home consumption or for bait, must be returned to the water immediately.
- C. Closures: Fishing is not permitted within 200 yards of the shorelines of Eastern and Spit islands, unless authorized by the OIC-NAF Midway and the FWS. Human consumption of fish caught within the reef is prohibited, due to the high risk of ciguatera. Use of these fish for bait is permitted.
- D. Equipment: The use of rods, reels, and handlines for hook-and-line fishing is encouraged. The use of hand held nets, including dip nets and throw nets, is allowed. Gill nets and seine nets are prohibited. The use of long-lines and unattended nets is prohibited. Fishing with firearms, spear guns, bang-sticks, or hand spears is prohibited.
- E. Sale of Fish: Fishing or the take of fish for sale or profit is prohibited.
- F. Transport of Fish: Frozen fish, not to exceed 100 lbs. per person, may be transported off the island for personal consumption. Transportation of fish for commercial purposes is prohibited.

II. Lobsters

- A. Season: Lobsters of all species, except females with eggs, may be captured throughout the year.
- B. Limits: Spiny lobsters must have a carapace length of at least 8.5 cm (approximately 3.25 inches) to be of legal size. Slipper lobsters must weigh at least one pound to be legal. Smaller lobsters must be released at the spot of capture. A single day's catch shall not exceed six (6) lobsters per person. Egg-bearing female lobsters may not be taken at any time. It is illegal to be in possession of a female lobster from which the eggs or swimmerets have been removed.
- C. Capture: Lobsters may be captured by hand or by trap, so long as the method does not injure undersized or egg-bearing individuals that must be released. Use of spears, spear-guns, firearms, explosives, or poisons is prohibited.
- D. Sale of lobsters: The capture of lobsters for sale or profit is prohibited.
- E. Transport of lobsters: Frozen lobsters, not to exceed 25 per person, may be transported off the island for personal consumption. Transport for commercial use is prohibited.

TABLE V-1 (cont'd)

Proposed Recreational Fishing Regulations

III. Shellfish (excluding lobster) and corals

- A. Season: Shellfish (e.g., crabs, scallops, etc.) and corals, living or non-living, may be taken for the purposes of home consumption or recreational collecting throughout the year.
- B. Limits: Three per day.
- C. Closures: No living coral may be taken within 200 yards of the shoreline of any island. Beachcast and other non-living shells are not included in this closure.
- D. Sale of shellfish or corals: The taking of live shellfish or corals for commercial purposes is prohibited.

G. Implementation

Expected costs and proposed implementation schedules for recommended management projects are presented in Table V-2 and V-3.

H. References

1. The Travers Group, Inc. 1988. Natural Resources Management Plan: Naval Air Station Barbers Point.
2. U.S. Department of Interior, Environmental Protection Agency. 1988. Preliminary Assessment Report: Naval Air Facility, Midway Island.
3. U.S. Department of Interior, Fish and Wildlife Service. 1984. Midway Atoll Fish and Wildlife Refuge Management Plan.
4. U.S. Department of Interior, Fish and Wildlife Service, Region One. 1986. Hawaiian Islands National Wildlife Refuge: Master Plan/Environmental Impact Statement.
5. U.S. Navy, Pacific Division, Naval Facilities Engineering Command. 1985. Master Plan NAF Midway Island. Appendix B in Master Plan NAS Barbers Point, Oahu, HI.

TABLE V-2

Ten Year Schedule of Outdoor Recreation Projects

	Funding Agency	
	Navy	FWS
<u>Year 1</u>		
• Develop, produce, and install an interim interpretive display		12,000
• Facilitate the availability of equipment for scuba and skin diving	5,000	
• Establish and enforce regulations for taking of fish, shellfish, and corals	1,000	1,000
YEAR 1 TOTAL	6,000	13,000
<u>Year 2</u>		
• Evaluate location for permanent interpretive display		500
• Develop refuge interpretive brochure		15,000
• Review and develop printing requirements for refuge interpretive brochure		2,000
• Initiate bi-monthly nature interpretation tours		500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 2 TOTAL	1,000	18,000
<u>Year 3</u>		
• Develop plans for permanent interpretive display structure		2,000
• Print and distribute refuge interpretive brochure	8,000	
• Initiate quarterly presentations relating to island wildlife		500
• Conduct bi-monthly nature tours		500
• Facilitate the availability of equipment for scuba and skin diving	5,000	
• Enforce regulations for taking of fish, shellfish, and corals	1,000	

TABLE V-2 (cont'd)

Ten Year Schedule of Outdoor Recreation Projects

	Funding Agency	
	Navy	FWS
<u>Year 3 (cont'd)</u>		
• Review and revise above regulations		1,000
YEAR 3 TOTAL	14,000	4,000
<u>Year 4</u>		
• Acquire materials and construct permanent interpretive display structure	15,000	
• Develop, produce, and install display materials		20,000
• Provide quarterly presentations relating to island wildlife		1,000
• Conduct bi-monthly nature tours		1,000
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 4 TOTAL	16,000	22,000
<u>Year 5</u>		
• Provide quarterly presentations relating to island wildlife		1,000
• Conduct bi-monthly nature tours		1,000
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Review and revise above regulations		1,000
YEAR 5 TOTAL	1,000	3,000

TABLE V-2 (cont'd)

Ten Year Schedule of Outdoor Recreation Projects

	Funding Agency	
	Navy	FWS
<u>Year 6</u>		
• Review and update refuge interpretive brochure as required	8,000	2,000
• Provide quarterly presentations relating to island wildlife		1,000
• Conduct bi-monthly nature tours		1,000
• Facilitate availability of scuba diving equipment	5,000	
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 6 TOTAL	14,000	4,000
<u>Year 7</u>		
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Review and revise above regulations		1,000
YEAR 7 TOTAL	1,000	4,000
<u>Year 8</u>		
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 8 TOTAL	1,000	3,000

TABLE V-2 (cont'd)

Ten Year Schedule of Outdoor Recreation Projects

	Funding Agency	
	Navy	FWS
<u>Year 9</u>		
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Facilitate availability of scuba diving equipment	5,000	
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
• Evaluate the above regulations		1,000
YEAR 9 TOTAL	6,000	4,000
<u>Year 10</u>		
• Provide quarterly presentations relating to island wildlife		1,500
• Conduct bi-monthly nature tours		1,500
• Enforce regulations for taking of fish, shellfish, and corals	1,000	
YEAR 10 TOTAL	1,000	3,000

TABLE V-3

Project Costs - Outdoor Recreation

<u>PROJECT</u>	<u>FUNDING</u>	
	Navy	FWS
<u>Interpretive Display</u>		
• Develop, produce, and install interim display		12,000
• Evaluate location for permanent display		500
• Develop plans for permanent interpretive display structure		2,000
• Acquire materials and construct display structure	15,000	
• Develop, produce, and install permanent display		20,000
<u>Interpretive Brochure</u>		
• Develop refuge brochure		15,000
• Review and determine printing requirements for brochure		2,000
• Print and distribute refuge brochure	8,000	
• Revise and reprint brochure as needed	8,000	2,000
<u>Interpretive Slide Shows and Tours</u>		
• Provide quarterly presentations relating to island wildlife		9,500
• Conduct bi-monthly nature tours		10,000
<u>Scuba Diving</u>		
• Facilitate the availability of equipment for scuba and skin diving	20,000	
<u>Recreational Fishing</u>		
• Establish and enforce regulations for taking of fish, shellfish, and corals	10,000	1,000

TABLE V-3 (cont'd)
Project Costs - Outdoor Recreation

<i>PROJECT</i>	<i>FUNDING</i>	
	Navy	FWS
<u>Recreational Fishing (cont'd)</u>		
• Review and revise regulations		4,000
	<hr/>	<hr/>
SECTION TOTAL	61,000	78,000