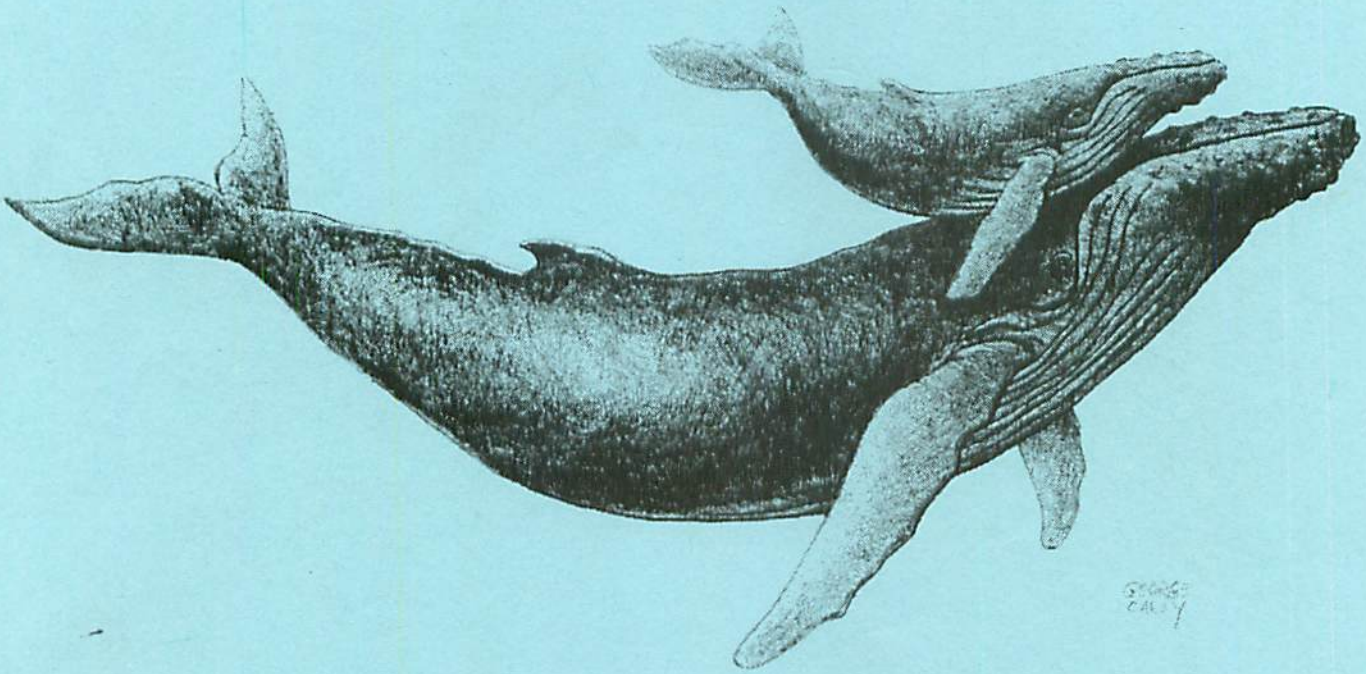
Hawaiian Islands Humpback Whale National Marine Sanctuary

NATIONAL MARINE SANCTUARIES

Final Environmental Impact Statement / Management Plan



A Federal / State Partnership for the Protection of Humpback Whales and Their Habitat

February 1997

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean and Coastal Resource Management
Sanctuaries and Reserves Division
Silver Spring, Maryland

State of Hawaii
Office of Planning
Department of Business, Economic Development, and Tourism
Honolulu, Hawaii

LIST OF ABBREVIATIONS

The Act ..... Hawaiian Islands National Marine Sanctuary Act
APPS ..... Act to Prevent Pollution from Ships
ATOC..... Acoustic Thermometry of Ocean Climate
CDUA ..... Conservation District Use Application, DLNR
COE..... U.S. Army Corps of Engineers
CWA..... Clean Water Act (or, Federal Water Pollution Control Act)
CZMA ..... Coastal Zone Management Act
DAR..... Division of Aquatic Resources, DLNR
DBEDT ..... Department of Business, Economic Development, and Tourism, State of Hawaii
DEIS/MP ... Draft Environmental Impact Statement/Management Plan
DLNR..... Department of Land and Natural Resources, State of Hawaii
DOBOR..... Division of Boating and Ocean Recreation, DLNR
DOC..... U. S. Department of Commerce
DOCARE... Division of Conservation and Enforcement, DLNR
DOD..... U.S. Department of Defense
DOH ..... Department of Health, State of Hawaii
DOI..... U.S. Department of the Interior
DOT..... Department of Transportation, State of Hawaii
EA..... Environmental Assessment
EIS ..... Environmental Impact Statement
EPA ..... U.S. Environmental Protection Agency
ESA ..... Endangered Species Act
EEZ ..... Exclusive Economic Zone
FEIS/MP ... Final Environmental Impact Statement/Management Plan
HAR ..... Hawaii Administrative Rules
HINMSA... Hawaiian Islands National Marine Sanctuary Act
HIHWNMS Hawaiian Islands Humpback Whale National Marine Sanctuary
HINWR .... Hawaiian Islands National Wildlife Refuge
HRS..... Hawaii Revised Statutes, State of Hawaii
IR..... Implementing Regulations
IWC..... International Whaling Commission
KIRC ..... Kahoolawe Island Reserve Commission
MFCMA.... Magnuson Fishery Conservation and Management Act
MLCD ..... Marine Life Conservation District
MMC .....Marine Mammal Commission
MMPA .....Marine Mammal Protection Act
MMS .....Minerals Management Service, DOI
MOU/MOA . Memorandum of Understanding/Memorandum of Agreement
MP/IR .....Management Plan and Implementing Regulations
MP or SMP. Management Plan or Sanctuary Management Plan
MPRSA .....Marine Protection, Research, and Sanctuaries Act of 1972, as amended
NARS .....Natural Area Reserve System, DLNR
NEPA .....National Environmental Policy Act of 1969, as amended
NMFS.....National Marine Fisheries Service, NOAA
NMFS-OE ..National Marine Fisheries Service-Office of Enforcement
NMS.....National Marine Sanctuary
NMSA.....National Marine Sanctuaries Act
NMSP.....National Marine Sanctuary Program
NOAA.....National Oceanic and Atmospheric Administration, DOC
NOS .....National Ocean Service, NOAA
NPDES.....National Pollution Discharge Elimination System
NPS .....National Park Service, DOI
OCRM.....Office of Ocean and Coastal Resource Management, NOS
OCSLA.....Outer Continental Shelf Lands Act
OP .....Office of Planning (Formerly OSP)
OPA .....Oil Pollution Act of 1990
ORMA.....Ocean Recreation Management Area
ORMP.....Ocean Resources Management Plan, State of Hawaii
OSP.....Office of State Planning, State of Hawaii
OTEC.....Ocean Thermal Energy Conversion
PMRF .....Pacific Missile Range Facility
PWSA.....Ports and Waterways Safety Act
RHA.....U.S. Rivers and Harbors Act
SAC .....Sanctuary Advisory Council
SRD .....Sanctuaries and Reserves Division, OCRM
SWG .....Sanctuary Working Group
USCG.....U.S. Coast Guard
USFWS.....U.S. Fish and Wildlife Service, DOI
WESPAC ...Western Pacific Regional Fishery Management Council

Cover Drawing: Courtesy of Mr. George Carey, Sanctuary Volunteer at the Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Maui, Hawaii.

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UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

JAN 31 1997

Dear Reviewer:

In accordance with the provision of Section 102 (2) (c) of the National Environmental Policy Act of 1969, we are enclosing the Final Environmental Impact Statement/Management Plan (FEIS/MP) on the Congressionally designated Hawaiian Islands Humpback Whale National Marine Sanctuary. This document was prepared by the Sanctuaries and Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration, Department of Commerce.

The responsible Federal official for this project is W. Stanley Wilson, Assistant Administrator for Ocean Services and Coastal Zone Management, National Ocean Service, NOAA. Any written comments or questions regarding this FEIS/MP should be directed to the contact person identified below by March 19, 1997. Also, one copy of your comments should be sent to me in Room 5805, U.S. Department of Commerce, Washington, D.C. 20230.

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Thank you for your cooperation in this matter.

Sincerely,

Donna Wieting

Donna Wieting
Acting Director
Office of Ecology and Conservation

Enclosure

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Hawaiian Islands Humpback Whale National Marine Sanctuary

Final Environmental Impact Statement / Management Plan

A Federal / State Partnership for the Protection of Humpback Whales and Their Habitat

February 1997

Sanctuaries and Reserves Division
Office of Ocean and Coastal Resource Management
National Ocean Service
National Oceanic and Atmospheric Administration
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Honolulu, HI 96811-2359

Title: ***Final Environmental Impact Statement and Management Plan for the Hawaiian Islands Humpback Whale National Marine Sanctuary***

Abstract: The Hawaiian Islands Humpback Whale National Marine Sanctuary was designated by the Hawaiian Islands National Marine Sanctuary Act (HINMSA or Act), Title II, subtitle C of the Oceans Act of 1992, Public Law 102-587. The Act requires the Secretary of Commerce (Secretary) to develop a comprehensive management plan with implementing regulations to govern the overall management of the site and to protect Sanctuary resources and qualities. The designated Sanctuary consists of approximately 1300 square nautical miles of Federal and State of Hawaii waters from the high water mark to the 100-fathom isobath contour adjoining the islands of Maui, Lanai and Molokai, including Penguin Bank, the deep water area of the Pailolo Channel, and the waters adjacent to the Kilauea National Wildlife Refuge on Kauai, but excluding the waters within three nautical miles of Kahoolawe. The preferred alternative in this Final Environmental Impact Statement and Management Plan (FEIS/MP) provides that the Congressionally-designated boundary be expanded to include the 100-fathom isobath around the Big Island of Hawaii, eastern Kauai, and portions of Oahu.

As expressed by Congress in the HINMSA, the purposes of the Hawaii Sanctuary are to: (1) protect humpback whales and their habitat; (2) educate and interpret for the public the relationship of humpback whales to the Hawaiian Islands marine environment; (3) manage human uses of the Sanctuary consistent with the Act and the NMSA; and (4) provide for the identification of marine resources and ecosystems of national significance for possible inclusion in the Sanctuary. Consequently, these purposes provide the foundation and focus for what is included in this Final EIS/MP and Implementing Regulations. The Act also requires that the Sanctuary Management Plan shall (1) facilitate all public and private uses of the Sanctuary (including uses of Hawaiian natives customarily and traditionally exercised for subsistence, cultural, and religious purposes) consistent with the primary objective of protection of humpback whales and their habitat, (2) set for the allocation of Federal and State enforcement responsibilities, as jointly agreed by the Secretary and the State, (3) identify research needs and establish a long-term ecological monitoring program with respect to humpback whales and their habitat, (4) identify alternative sources of funding needed to fully implement the plan's provisions, (5) ensure coordination and cooperation between Sanctuary managers and other Federal, State, and local authorities with jurisdiction within or adjacent to the Sanctuary, and (6) promote education among users of the Sanctuary and the general public about conservation of humpback whales, their habitat, and other marine resources.

Alternative elements considered within the FEIS/MP include: boundary alternatives considered by NOAA (e.g., areas of highest concentration, main Hawaiian Islands to the 100-fathom isobath, and/or expand to include waters to the 1,000-fathom isobath); scope of Sanctuary resources (e.g., identify and possibly include other resources now or later); Sanctuary administration (e.g., on-site, advisory councils); and resource protection strategies that include research and long-term monitoring, education and interpretation, coordination with existing resource management authorities, regulation and enforcement. Regulatory options range from relying on existing authorities to protect the humpback whale, to independent Federal regulations to protect humpback whales and their habitat, to a multi-species (ecosystem) regulatory scheme. The preferred boundary alternative as described in this document describes expanding the boundary to include the waters around all the main Hawaiian Islands from the shoreline to the 100-fathom isobath, but not including specified military use areas on Kauai and Oahu, specified commercial ports and small boat harbors since they are not considered humpback whale habitat, and the waters within three nautical miles around Kahoolawe. The management strategies would be applied on a statewide basis. The management plan includes the formation of a Sanctuary Advisory Council (SAC) to advise the Sanctuary Manger on the management of the Sanctuary. The SAC was designed to provide maximum representation of public and private interest groups. The SAC will play an important role in providing the broad-based guidance needed to ensure the Sanctuary's

success. A process is presented to identify additional resources of national significance for possible inclusion in the Sanctuary at some later date.

The Management Plan proposes utilization, and reliance, on existing Federal and State authorities, when possible, to manage activities that may negatively affect humpback whales and their habitat. The Hawaii Sanctuary consultations will be conducted by the National Marine Fisheries Service (NMFS) under an MOU between NOAA's SRD and NMFS to ensure that humpback whales and their habitat are comprehensively protected and managed within existing permitting, and other authorization processes. To provide supplemental protection for humpback whales, the Sanctuary proposes to adopt existing NMFS humpback whale take and approach restrictions as Sanctuary regulations. In addition, the Sanctuary proposes a regulation to ensure greater coordination and to strengthen the long-term protection of the humpback whale's habitat. Any activity not conducted in compliance with the terms or conditions of a required Federal or State permit, license, lease, or other specific authorization for discharging or depositing materials from within the Sanctuary boundary, (or from outside the boundary that enters and injures Sanctuary resources) or for altering the seabed, would be in violation of Sanctuary regulations. This regulation would apply only to those activities which are conducted without or in violation of existing and required Federal and State permits, licenses, leases, or authorizations. This habitat regulation provides a mechanism to fill existing gaps and supplement existing authorities. The regulations will supplement enforcement against certain acts of non-compliance and unlawful activities, thus strengthening overall protection of humpback whales and their habitat.

This document also analyses the environmental and socioeconomic consequences of the preferred alternatives and the other alternatives. The potential socioeconomic impacts range from no change to varying degrees of impacts depending upon which regulatory alternative is selected. The preferred regulatory alternative is anticipated to have no negative socioeconomic impacts on Sanctuary users and positive environmental impacts to humpback whales and their habitat. NOAA is not proposing any Sanctuary restrictions on fishing or fishing activities, is not recommending the imposition of user fees, and is not proposing to issue Sanctuary-specific permits.

Research, data and information collection, information exchange, and long-term monitoring will be very important in trying to better understand the humpback whales, their environmental needs, and impacts to the whales and their habitat. The research program will include baseline studies, monitoring, and analysis and prediction assessments to provide information needed in decision making, resolving management issues, and in funding appropriate management-related research. Interpretive/education programs will be directed at improving public awareness and understanding of the Sanctuary's resources, protection measures, and the need to manage them wisely to ensure their continued viability and abundance.

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Office of Ocean and Coastal Resource Management
National Ocean Service, National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Silver Spring, MD; Honolulu HI; and Kihei, HI

Cooperating Agencies: State of Hawaii
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Department of Business,
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TABLE OF CONTENTS

PAGE

List of Figures viii
List of Tables ix

Part I: Background

Part I Detailed Table of Contents 1
A. INTRODUCTION 2
B. NATIONAL MARINE SANCTUARY PROGRAM 2
1. National Marine Sanctuaries Act 2
2. National Marine Sanctuary Program 3
3. General Benefits and Costs Resulting from Sanctuary Designation 6
4. National Marine Sanctuary System 7
C. HAWAIIAN ISLANDS HUMPBACK WHALE NATIONAL MARINE SANCTUARY 10
1. Designation 10
2. History of Sanctuary Designation Proposal 12
D. CONSULTATIONS 20
1. Endangered Species Act Requirements 20
2. Resource Assessment 20
3. Federal Consistency Determination 21

Part II: Description of the Affected Environment

Part II Detailed Table of Contents 23
A. THE PHYSICAL ENVIRONMENT 27
1. Geographic Setting 27
2. Physical Characteristics 27
B. BIOLOGICAL RESOURCES 34
1. Humpback Whales 34
2. Other Marine Resources of Hawaii 57
C. CULTURAL AND HISTORICAL RESOURCES AND USES 71
1. Native Hawaiian Settlements and Social Patterns 72
2. Aquaculture/Fishponds 73
3. Religious Practices and Artifacts 76
4. Kahoolawe Island 77
5. Submerged Lands 79
6. Traditional Native Hawaiian Uses 79
7. Shipwrecks 79

D. HUMAN ENVIRONMENT AND ACTIVITIES 80
1. Socio-Demographic Profile 80
2. Human Activities 82
3. Institutional Arrangements and Responsibilities 108

Part III: Alternatives

Part III Detailed Table of Contents 129
A. "NO SANCTUARY" ALTERNATIVE 133
1. Background 137
2. Feasibility of a "No Sanctuary" Alternative 134
3. Consequences of Terminating Existing Sanctuary 134
4. Federal Sanctuary Without State Waters 135
B. SANCTUARY ALTERNATIVES 137
1. Boundary Alternatives 137
2. Regulatory Alternatives 157
3. Management Alternatives 173

Part IV: Environmental and Socio-economic Impacts

Part IV Detailed Table of Contents 179
A. INTRODUCTION 181
B. BOUNDARY ALTERNATIVES 181
1. Introduction 181
2. Boundary Alternatives 184
C. REGULATORY ALTERNATIVES 189
1. Introduction 189
2. Fishing Activities 189
3. Impacts of Proposed Regulations 190
D. MANAGEMENT ALTERNATIVES 208
1. Consequences of Removing National Marine Sanctuary Designation 208
2. Consequences of Accepting Status Quo Alternative 208
3. Consequences of Sanctuary Preferred Alternative 210
E. UNAVOIDABLE ADVERSE ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS 215
F. RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY 216
G. RELATIONSHIP BETWEEN THE PROPOSED ACTION AND EXISTING RESOURCE MANAGEMENT PLANS 216
1. Impacts Related to Management Plan Purposes 216
2. Relationship Between Sanctuary Management Plan and Other Humpback Whale and Ocean Management Plans and Programs 217

Part V: Management Plan

Part V Detailed Table of Contents 221
A. INTRODUCTION 223
1. Sanctuary Purposes 223
2. Comprehensive Management Plan 223
3. Sanctuary Goals and Objectives 225
B. SANCTUARY BOUNDARY 228
C. SANCTUARY RESOURCES 229
1. Humpback Whale 229
2. Humpback Whale Habitat 229
3. Other Resources of National Significance 229

D. RESOURCE PROTECTION PROGRAM 231
1. Program Description 231
2. Goals and Objectives 231
3. Sanctuary Regulations 234
4. Enforcement and Surveillance 236
5. Coordination 241
6. Research/Long-Term Monitoring 245
7. Education/Interpretation 253
E. ADMINISTRATION 259
1. Site Administration 260
2. Sanctuary Advisory Council 260
3. Other Federal Agencies 261
4. State, Regional, and County Agencies 261
5. Compatible Uses of the Sanctuary 263
6. Five-Year Review of Management Plan 264
7. Special Use Permits 264
8. Resource Protection: Roles and Responsibilities 266
9. Research: Roles and Responsibilities 268
10. Education/Interpretation: Roles and Responsibilities 269
11. Site Administration: Roles and Responsibilities 270
F. REVENUE AND RESOURCE ENHANCEMENT 271

Part VI: List of Preparers 273

Part VII: List of Agencies and Organizations Receiving Copies of the Final EIS/MP 277

Part VIII: Appendixes 281

Appendix A: Responses to Comments Received on the Draft EIS/MP 283
Public Testimony Matrix 321
Appendix B: National Marine Sanctuaries Act, as amended 331
Appendix C: Hawaiian Islands National Marine Sanctuary Act 347
Appendix D: Sanctuary Advisory Council Charter and members 351
Appendix E: Agreements for Coordinated Management of the Hawaiian Islands Humpback Whale National Marine Sanctuary 361
Appendix F: List of DOD Military Activities in Hawaii 387
Appendix G: Species Profile: Humpback Whale Report #2 395
Appendix H: Background to the Proposed Hawaii Humpback Whale National Marine Sanctuary of 1984 423
Appendix I: Whale Education Programs in Hawaii 425
Appendix J: Bibliography and References 429
Appendix K: Designation Document and Implementing Regulations 447

LIST OF FIGURES

		PAGE
Figure I-1	SRD/OCRM Organizational Chart	4
Figure I-2	Location of National Marine Sanctuaries	7
Figure II-1	Main Hawaiian Islands	27
Figure II-2	Hawaii Surface Winds	30
Figure II-3	Relationship Between Height of Islands and Trade Wind Flow	30
Figure II-4	Hawaii Surface Currents	31
Figure II-5	Sea Surface Tempeatuers	32
Figure II-6	Depth of 20°C isotherm	32
Figure II-7	Worldwide Distribution of Humpback Whales	37
Figure II-8	Humpback Whale Migration Routes and Population Structure	41
Figure II-9	Results of 1993 Humpback Whale Survey Showing 100- and 1,000-fathom isobath	43
Figure II-10	Results of 1990 Survey (Calf Pods Only)	44
Figure II-11	Change in Whale Density (1990 Rate--1977-80 Rate)	44
Figure II-12	Results of 1993 and 1995 Humpback Whale Survey Showing 100-Fathom Isobath Around Kauai and Niihau	45
Figure II-13	Results of 1993 and 1995 Humpback Whale Survey Showing 100-Fathom Isobath Around Oahu	46
Figure II-14	Results of 1993 and 1995 Humpback Whale Survey Showing 100-Fathom Isobath Around Maui, Molokai, Lanai, and Kahoolawe	47
Figure II-15	Results of 1993 and 1995 Humpback Whale Survey Showing 100-Fathom Isobath Around the Big Island	48
Figure II-16	Results of 1993 Aerial Survey, Odontocete Sightings	65
Figure II-17	Resident Population of Islands (1950-92)	81
Figure II-18	Dredged Material Disposal Sites	96
Figure III-1	State waters and the proposed Sanctaury boundary	136
Figure III-2	100-Fathom Isobath Around Kahoolawe Island	138
Figure III-3	Boundary Alternative 1: Congressionally-Designated Sanctuary	140
Figure III-4	Boundary Alternative 2: Major Humpback Whale Concentration Areas	142
Figure III-5	Boundary Alternative 3: PREFERRED--Statewide	144
Figure III-6	Boundary Alternative 3: PREFERRED--Kauai Close-up	145
Figure III-7	Boundary Alternative 3: PREFERRED--Oahu Close-up	146
Figure III-8	Boundary Alternative 3: PREFERRED--Molokai/Lanai Close-up	147
Figure III-9	Boundary Alternative 3: PREFERRED--Maui Close-up	148
Figure III-10	Boundary Alternative 3: PREFERRED--Big Island Close-up	149
Figure III-11	Selected Ports, Harbors, and Small Boat Basins Excluded from the Preferred Boundary Alternative	151
Figure III-12	Boundary Alternative 4: 100-Fathom Isobath Around Main Hawaiian Islands and Kaula Rock	155
Figure III-13	Boundary Alternative 5: 1000-Fathom Isobath Around Main Hawaiian Islands	156
Figure V-1	Hawaiian Islands Humpback Whale National Marine Sanctuary Administration	262

LIST OF TABLES

		PAGE
Table I-1	Changes Made to the Final EIS/MP	18
Table II-1	Major Water Masses of the North Pacific	33
Table II-2	Hawaiian Water Temperatures by Month	33
Table II-3	Calf Pod Sightings by Survey and Region -- All Sightings (1993)	49
Table II-4	Calf Pod Sightings by Survey and Region -- All Sightings (1995)	49
Table II-5	Cetacean Species Found in Hawaii with Results of 1993 Aerial Surveys	63
Table II-6	Monk Seal Sightings in the Main Hawaiian Islands, 1984-93 Reported to the National Marine Fisheries Service	70
Table II-7	Fishponds by Type and Island	74
Table II-8	Fishponds of Maui, Lanai, Kauai, and Molokai	75
Table II-9	Population and Percent Urban	80
Table II-10	Ethnic Diversity, Percentage by County	81
Table II-11	Job Count by Industry, by County	82
Table II-12	Commercial Marine Life Landed by Month/Area, Fiscal Year 1992-93 (lbs.)	83
Table II-13	Commercial Fishers by Month and Area, Fiscal Year 1992-93	83
Table II-14	1993 Landings, Sale, and Value of the Commercial Fishing Catch	84
Table II-15	Marine Life Caught from Penguin Bank Catchment Area by Commercial Fishermen for Calendar Years 1991-92	84
Table II-16	Fishing Methods, Landings, Sale, and value of Catch from Commercial Fishings for 1991 (6/90-6/91) for the Hawaiian Islands	85
Table II-17	Fishing Vessel Activities Within Proposed Boundary on the Big Island (Recreational, Subsistence, Commercial)	85
Table II-18	Charterboat Fishing Revenues and Passengers, by County, 1990	86
Table II-19	Overseas and Inter-Island Shipping, 1989, Freight and Passenger Traffic for Specified Harbors, 1989	87
Table II-20	Visitor Count and Expenditures, by County (1991)	88
Table II-21	Visitor Accommodations by Type, and by County (1991)	88
Table II-22	Ocean Recreation Revenues and Employment by Sub-Sector, 1990	89
Table II-23	Small Craft Mooring Facilities, by Islands, 1991-92	89
Table II-24	State-Registered Vessels, by County	90
Table II-25	Estimated Tour Boat Revenues, by County	91
Table II-26	Characteristics of Recreational Dive Industry, by County	93
Table II-27	Revenues and Employment Produced by Ocean Recreation	93
Table II-28	EPA Hawaiian Ocean Disposal Sites	96
Table II-29	Defense Expenditures in Hawaii [in $ billions]	97
Table II-30	Military Personnel and Dependents, and Acreage Controlled by the U.S. Department of Defense	97
Table II-31	Number of Farms, Farm Acreage, and Value of Crop Sales, by County (1991)	102
Table II-32	Crop Sales in Hawaii [in $ millions]	103
Table II-33	Airports and Heliports, by Control and by Islands, 1991	103
Table II-34	Aircraft Operations, by Type of Aircraft, at Major State-Owned Airports, 1991	104

Table III-1 Summary of Alternatives and Potential Consequences 131

Table IV-1 Summary of Potential Environmental Impacts Associated with Alternatives 182

Table IV-2 Summary of Potential Socio-Economic Impacts Associated with Alternatives 183

Table IV-3 Record of Enforcement Activities for the Protection of Hawaiian Islands Humpback Whales 213

PART I: INTRODUCTION AND BACKGROUND

TABLE OF CONTENTS

PAGE

A. INTRODUCTION 2

B. NATIONAL MARINE SANCTUARY PROGRAM 2
1. National Marine Sanctuaries Act 2
2. National Marine Sanctuary Program 3
3. General Benefits and Costs Resulting from Sanctuary Designation 6
4. National Marine Sanctuary System 7

C. HAWAIIAN ISLANDS HUMPBACK WHALE NATIONAL MARINE SANCTUARY 10
1. Designation 10
2. History of Sanctuary Designation Proposal 12
   a. Initial Proposal: 1977-1984 12
   b. Kahoolawe National Marine Sanctuary Feasibility Study: 1990-1991 12
   c. The Oceans Act of 1992 13
   d. The Draft Management Plan 14
      i. Preferred Alternative 15
   e. The Final Management Plan 17

D. CONSULTATIONS 20
1. Endangered Species Act Requirements 20
2. Resource Assessment 20
3. Federal Consistency Determination 21

A. INTRODUCTION

The Hawaiian Islands Humpback Whale National Marine Sanctuary (Sanctuary) was designated by law in 1992. The Hawaiian Islands National Marine Sanctuary Act (HINMSA or Act) designated the Sanctuary and required the Secretary of Commerce to develop a comprehensive management plan and regulations to implement the designation. This Final Environmental Impact Statement/Management Plan has been developed in accordance with the HINMSA, the National Marine Sanctuaries Act (NMSA), and the National Environmental Policy Act of 1969.

B. NATIONAL MARINE SANCTUARY PROGRAM

1. The National Marine Sanctuaries Act

The National Marine Sanctuaries Act (NMSA) 16 U.S.C. 1431 et seq. authorizes the Secretary of Commerce to designate as National Marine Sanctuaries areas of the marine environment that possess conservation, recreational, ecological, historical, research, and educational, or aesthetic resources and qualities of national significance, and to provide comprehensive management and protection of these areas. The NMSA sets certain designation standards for National Marine Sanctuaries, including determination of national significance; the determination that existing State and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area; a determination that the designation of the area as a National Marine Sanctuary will facilitate the coordinated and comprehensive conservation and management of the area; and, the area is of a size and nature that permits comprehensive and coordinated conservation and management. National Marine Sanctuaries are routinely designated by the Secretary through an administrative process established by the NMSA, including activation of candidate sites selected from the National Marine Sanctuary Program Site Evaluation List. Sanctuaries also have been designated by an Act of Congress, as was the case with Monterey Bay, Stellwagen Bank, Florida Keys and the Hawaiian Islands Humpback Whale national marine sanctuaries.

National Marine Sanctuaries are established for the protection of nationally significant marine resources as well as the long-term beneficial use and enjoyment of these resources by the public now and in the future. To meet these objectives, the NMSA includes the following purposes and policies:

a. To enhance resource protection through comprehensive and coordinated conservation and management tailored to specific resources that complements existing regulatory authorities;

b. To support, promote, and coordinate scientific research on, and monitoring of, the site-specific marine resources to improve management decision - making in National Marine Sanctuaries;

c. To enhance public awareness, understanding, and sustainable use of the coastal and marine environment through public interpretive, educational, and recreational programs; and

d. To facilitate, to the extent compatible with the primary objective of resource protection, public and private uses of National Marine Sanctuaries.

In addition, the NMSA directs the Secretary to consult with appropriate State and Federal authorities and international governments and organizations to insure cooperation. The NMSA contains certain statutory prohibitions and the authority to enforce those prohibitions and

methods for assessing penalties in the event a prohibition is violated. Specifically, the NMSA prohibits the destruction, loss of, or injury to any sanctuary resource managed under the laws or regulations for a sanctuary; the possession, delivery, sale, transport, or shipment of any sanctuary resource taken in violation of the NMSA; interference with law enforcement under the NMSA; any violation of the NMSA, and regulations or permits issued pursuant to the NMSA. The NMSA further provides the authority to recover response costs and damages for destruction, loss of, or injury to Sanctuary resources. The NMSA appears in Appendix B.

The responsibility for carrying out the terms of the NMSA is delegated to the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Office of Ocean and Coastal Resource Management (OCRM), Sanctuaries and Reserves Division (SRD) (Figure I-1). SRD's role in administration and management of the National Marine Sanctuary Program (NMSP) includes preparing management plans for designating marine sanctuaries, and adopting and implementing management practices to protect the conservation, recreational, ecological, historical, research, educational, and aesthetic values of these important marine areas.

SRD, on behalf of the Secretary of Commerce (Secretary), as part of the procedure for designating a National Marine Sanctuary, prepares the terms of the proposed designation; proposed mechanisms for coordination of existing authorities; a draft management plan which includes goals, objectives, management responsibilities, resource studies and programs; cost estimates for the proposed designation; a draft environmental impact statement; an evaluation of the advantages of State/Federal cooperation if all or part of the site falls within State jurisdiction; and the proposed regulations. The Management Plan and the environmental impact statement are typically developed in tandem and issued as one document.

2. The National Marine Sanctuary Program

The NMSP is a national system of 12 sites (Key Largo NMS and Looe Key NMS will be incorporated into the larger Florida Keys NMS upon the effective date of its regulations and final management plan). These sites protect over 13,000 square nautical miles of marine resources, and range in all sizes and shapes from 0.25 to 4,024 square nautical miles. An additional approximately 850 square nautical miles are currently under consideration for designation as National Marine Sanctuaries. Designed to protect natural, cultural, and/or historical features of the marine environment, they are currently found in eight of the twelve recognized biogeographical provinces in U.S. coastal waters.

Many people ask what a National Marine Sanctuary (NMS) is, what its benefits are, and how it will affect them as Sanctuary users. There are no simple answers to these questions because of the varied nature and needs of National Marine Sanctuaries and the purposes of their designation. Sanctuaries can be located in either Federal, State, or territorial waters or some combination thereof. Of the 12 existing sites, 7 encompass some Territorial or State waters within their boundaries. As such, the designation of marine sanctuaries has led to numerous cooperative agreements and partnerships among Federal, State, and local governmental agencies, as well as non-governmental organizations, to comprehensively manage National Marine Sanctuaries and ensure the cooperative attainment of the goals of enhanced resource protection and management. Sanctuaries strive to complement existing authorities and supplement local efforts when more comprehensive and coordinated protection of resources is needed.

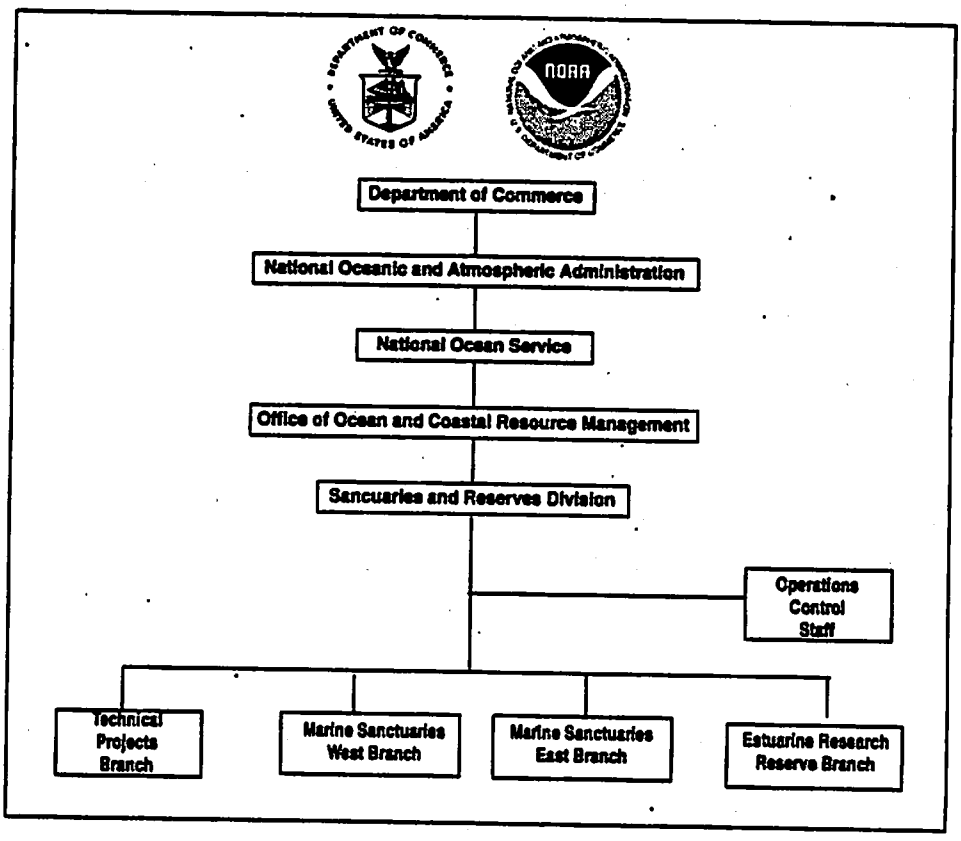


Figure I-1 Sanctuaries and Reserves Division (SRD) Organization

National Marine Sanctuaries are built around the existence of distinctive natural and cultural resources whose protection and wise use would benefit from comprehensive planning and management. Factors which are taken into account in the designation of a National Marine Sanctuary include:

- Natural resource and ecological qualities, including its contribution to biological productivity, maintenance of ecosystem structure, maintenance of ecologically or commercially important or threatened species or assemblages, maintenance of critical habitat of endangered species, and the biogeographic representation of the site;
- Historical, cultural, archaeological, or paleontological significance;
- Present and potential uses that depend on maintenance of the area's resources, including commercial and recreational fishing, subsistence uses, other commercial and recreational activities, and research and education;
- Present and potential activities that may adversely affect the area's qualities, uses, and significance;
- Existing State and Federal regulatory and management authorities and their adequacy to fulfill the purposes and policies of the HINMSA;
- Manageability of the area, including such factors as its size, ability to be identified as a discrete ecological unit with definable boundaries, accessibility, and suitability for monitoring and enforcement activities;
- Public benefits to be derived from sanctuary status, with emphasis on the benefits of long-term protection of nationally significant resources, vital habitats, and resources which generate tourism;

- Negative impacts produced by management restrictions on income-generating activities; and
- Socio-economic effects of sanctuary designation.

Benefits associated with National Marine Sanctuary designation include enhanced protection of special areas for natural, historical, or cultural values through more coordinated and comprehensive management, which supports an appropriate mixture of regulatory and non-regulatory approaches such as research, long-term monitoring, education, interpretation, information dissemination, and enforcement. There are shared benefits among levels of government including financial and logistical resources which may further the achievement of each entity's resource protection or management mandate. Through coordination, cooperation, and resource pooling, cooperating agencies may be able to mutually achieve their objectives in an efficient manner. For example, the Florida Keys NMS is working jointly with other Federal agencies [National Marine Fisheries Service (NMFS), Environmental Protection Agency (EPA), Department of the Interior (DOI), and the Army Corps of Engineers (COE)], State agencies, local governments, and academic institutions to protect the coral reef ecosystem of the Florida Keys. All of these entities have worked together and pooled resources to develop and implement a water quality protection program vital to the marine resources of the region.

Sanctuary designation in some areas has led to the creation of new education, interpretation, and visitor centers, and in other cases has enhanced existing centers. A variety of education and outreach tools are produced by the NMSP to support management goals including brochures, posters, K-12 classroom curricula, on-water programs, and instructional videos. Research and monitoring are conducted in marine sanctuaries to provide long-term data on resource health and to assist in management decision-making. Volunteer programs are vital for sanctuaries to support the education, research and monitoring, and management programs which are established and to provide avenues for local communities to participate in marine resource management.

National Marine Sanctuaries have also played an important role to ensure that when damage has been done to sanctuary resources and qualities, every attempt is made to repair, restore, and/or replace damaged and lost resources. The NMSP works with other agencies in responding to incidents of resource damage to minimize the impacts and to initiate restorative measures as soon as possible. New technologies for restoration and procedures for response have been direct results of sanctuary involvement.

One of the NMSA's policies is to facilitate public and private uses of sanctuaries when compatible with the primary objective of resource protection. As an example, the Sanctuary encourages the continued use of Hawaii's marine waters by commercial and recreational industries and has facilitated workshops between the enforcement officers and the boat captains to increase mutual awareness of each others activities and increase the boaters understanding of the resources and regulations designed to protect these resources. Moreover, the HINMSA provides that the Sanctuary shall facilitate uses of Native Hawaiians customarily and traditionally exercised for subsistence, cultural, and religious purposes. The Sanctuary has worked with various segments of the Native Hawaiian community to develop education materials, research past and present uses of the marine environment, and is working with UH-Sea Grant to develop a Native Hawaiian resource management intern program.

NOAA is also the parent agency of NMFS in addition to the NMSP. NMFS administers the MMPA and ESA, and manages fishery resources in Federal waters and some resources, including certain species of endangered marine wildlife, in both State and Federal waters. Sanctuaries rely on NMFS and state fishery management agencies to establish fishery management measures in marine waters, although in certain circumstances, the NMSP has determined that regulation of certain fishing methods or gear has been needed to protect specific

historic sites or natural resources. Prior to issuing Sanctuary fishing regulations, however, the NMSA requires that the appropriate Fishery Management Councils be provided with the opportunity to prepare such regulations [NMSA, Section 304(a)(5)]. Cooperation with local appropriate fishery management authorities (e.g., state authorities) is also required.

3. General Benefits and Costs Resulting From Sanctuary Designation

The net environmental and socioeconomic effects of designating the Sanctuary and implementing the Sanctuary Management Plan and regulations are expected to be positive. While such effects are difficult to quantify, the goal of the Sanctuary in part will be to maintain or improve the humpback whale habitat, water quality, uses of Native Hawaiians customarily and traditionally exercised for subsistence, cultural, and religious purposes, aesthetics, and tourism without causing any adverse effects. The major benefit of the Sanctuary is the integration of efforts to protect and manage the humpback whale and its habitat and corresponding human activities into one coordinated management regime. Other benefits of designation include: (1) enhancement of research and long-term monitoring; (2) promotion of public awareness of humpback whales and their marine environment; (3) public involvement in the management of the Sanctuary; (4) facilitated coordination of initiatives implemented by existing authorities; (5) formulation of long-range plans that respond to currently unforeseen threats; and (6) supplement existing regulations on activities which either pose a current risk of causing significant damage to humpback whales or their habitat, or that may later prove harmful as use of the area increases. Formal recognition of humpback whales and the habitat value of the their Hawaiian habitat should in itself focus additional attention on this area and thus encourage direct special attention on managing this area so that future generations may enjoy its beauty and rely upon its resources.

NOAA's final Sanctuary regulations will supplement existing Federal and State regulatory regimes to protect humpback whales and their habitat. Human uses in the Sanctuary will not be adversely affected because there will be no new, substantive regulatory restrictions, permits, or authorizations instituted by the Sanctuary. The Sanctuary will work with existing Federal and State authorities to ensure that Sanctuary concerns are addressed within their permit review processes, thereby eliminating the need for additional Sanctuary permits and approvals. Individual agencies administering the their permits or other approvals may or may not choose to accept Sanctuary recommendations. There may be some socio-economic impacts if a Sanctuary recommendation is adopted by a State or Federal permitting agency, but these are expected to be small in comparison to the benefits to the Sanctuary resources.

The Sanctuary regulations will provide additional authority for the Sanctuary to enforce ESA/MMPA approach regulations, and existing discharge and alteration of the seabed restrictions under other relevant laws. Under the NMSA, the Sanctuary can impose higher maximum civil penalties for violations of Sanctuary regulations than is possible under the MMPA or ESA. The maximum civil penalty would likely not be applied except possibly for repeat offenders or particularly egregious offenders. Impacted users would be limited to only those persons subject to the regulations (as opposed to all users of the Sanctuary), and of those, only those persons in violation of Sanctuary regulations. The actual impact on those persons in violation of Sanctuary regulations will be relatively small because enforcement mechanisms are not limited to civil penalties. Rather, oral and written warnings are given routinely in lieu of civil penalties. Further, with interpretive enforcement, users subject to Sanctuary regulations will be educated as to what the regulations are and why they are in place, thus increasing future voluntary compliance and decreasing those potentially subject to civil penalties. Consequently, there will be few impacts to Sanctuary users.

Education and interpretive enforcement focusing on the Sanctuary approach and habitat regulations will result in greater public compliance of the regulations which will benefit

humpback whales and their habitat, thus increasing the experience (enjoyment of the experience as well as recreational and aesthetic experience) of Sanctuary resources for all Sanctuary users. Further, in those instances where a person who violated a Sanctuary regulation was assessed a civil penalty under the NMSA, those civil penalty monies will be returned to the Sanctuary for management and improvement (e.g., education and outreach), as opposed to being deposited in the general U.S. Treasury. Finally, NMSA enforcement will be coordinated with existing State and Federal authorities to minimize the duplication of enforcement efforts, thus minimizing the potential for cumulative effects on those users in violation of Sanctuary regulations. Overall the Sanctuary regulations are intended: (1) to improve resource protection by instituting supplementary regulatory, surveillance and enforcement measures and authority; and (2) to minimize negative socio-economic impacts to human uses, particularly those deemed compatible with the purposes of the Sanctuary. Efforts by the Sanctuary program to educate the general public about Hawaii's marine environment and the diverse array of human uses, particularly those by Native Hawaiians, will help people realize their dependence on a healthy marine environment and encourage them to take a more active role in the stewardship of these resources.

4. The National Marine Sanctuary System

Fourteen National Marine Sanctuaries, including Hawaii, have been designated since the NMSP's inception in 1972 (Figure I-2). They include in order of designation:

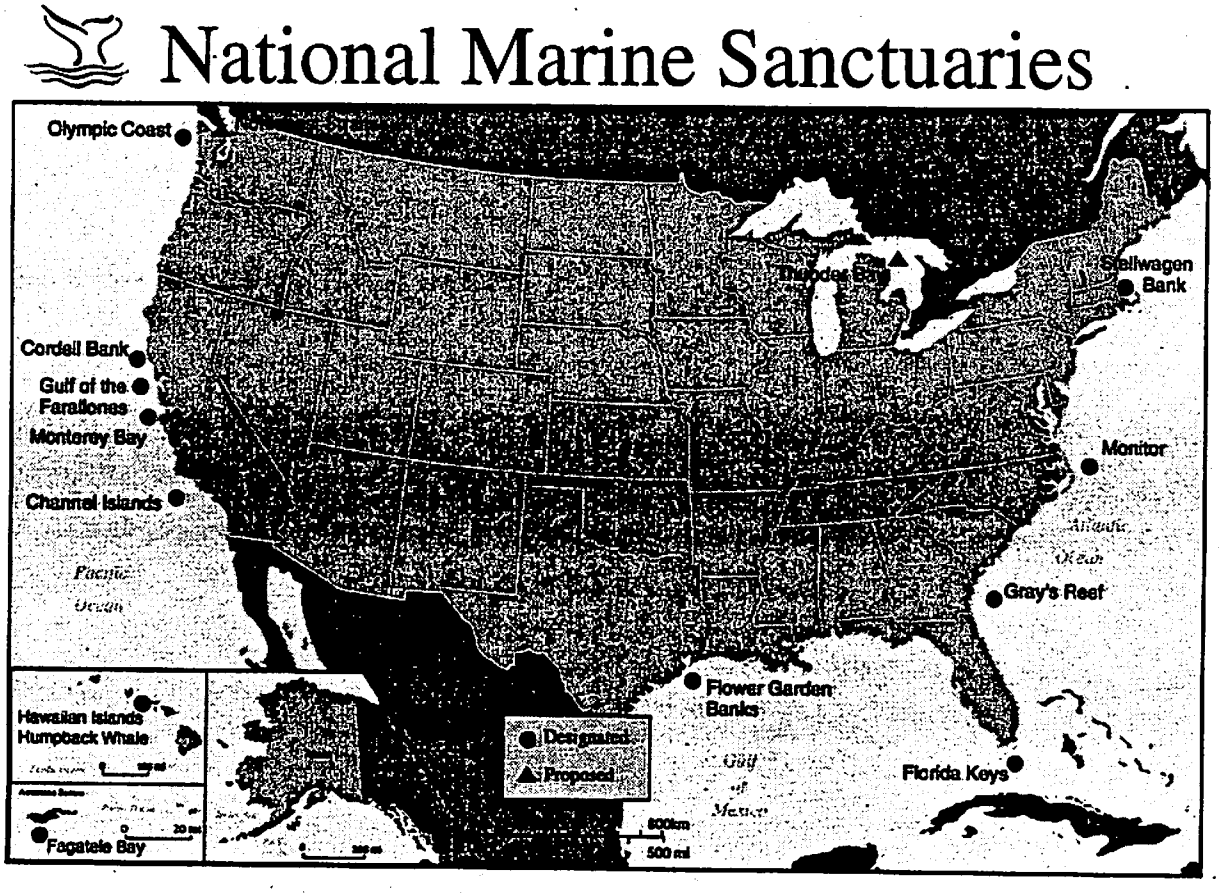
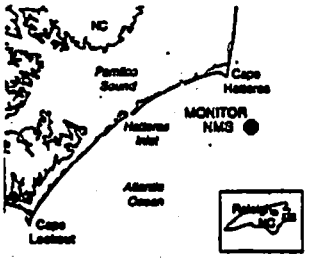


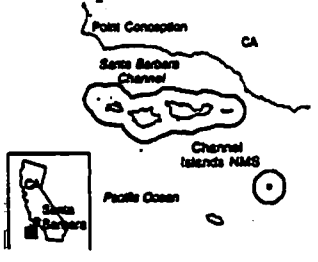
Figure I-2 Location of National Marine Sanctuaries



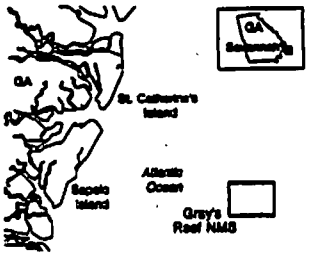
• The ***Monitor*** **National Marine Sanctuary** serves to protect the wreck of the Civil War ironclad, U.S.S. *Monitor*, which sank in 225 ft. of water. It was designated in January 1975, and consists of a one-square nautical mile of water (surface to bottom) located 16 miles southeast of Cape Hatteras, North Carolina. The Sanctuary regulates certain activities which might damage or destroy the historic wreck. The Sanctuary has led to increased knowledge of the Civil War and expanded exhibits in the Mariner's Museum in Virginia. (Federal waters)

• . The **Key Largo National Marine Sanctuary** was designated in December 1975, and provides protection and management to a 100-square nautical mile area of tropical coral reefs and the offshore seabed south of Miami, Florida. The Sanctuary is a seaward extension of the John Pennekamp State Coral Reef Park and includes historical and cultural artifacts and shipwrecks. Regulations are designed to protect the significant natural and cultural features from removal or damage, and has resulted in the installation of a protective mooring buoy system; reef restoration projects from ship groundings; successful attempts to halt black band coral disease; and training for marine protected areas in other parts of the world. (To become part of the Florida Keys NMS; Federal waters).

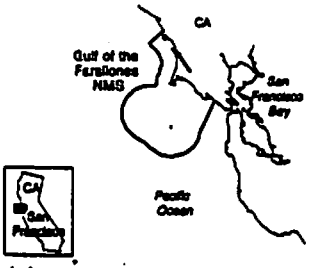
• The **Channel Islands National Marine Sanctuary** was designated in September 1980, and encompasses 1,252 square nautical miles off the coast of Santa Barbara, California. The Sanctuary surrounds the four northern Channel Islands and Santa Barbara Island. It provides protection to valuable habitats for marine mammals, including extensive pinniped and seabird assemblages, and serves as an important migration corridor for gray and humpback whales. The Sanctuary contains rich kelp forests, nearshore and benthic communities, and fisheries resources. The Sanctuary's regulatory focus is on the deposition or discharge of materials, alteration of the seabed, removal or damage of historical or cultural resources, disturbance of marine mammals and seabirds, and exploration and development of hydrocarbon (oil and gas) resources. The Sanctuary is adjacent to and works in close cooperation with the Channel Islands National Park, and has a wide range of education and research programs focusing on the resources within the Sanctuary. (Federal/State waters)



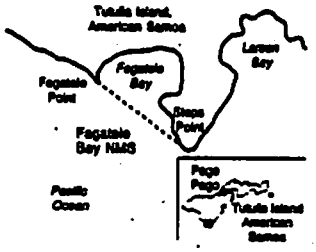
• The **Looe Key National Marine Sanctuary** was designated in January 1981, and consists of a submerged section of the Florida reef southwest of Big Pine Key. The five-square nautical mile site includes a beautiful "spur and groove" coral formation supporting a diverse marine community and a wide variety of human uses. The regulatory and non-regulatory programs are similar to the Key Largo NMS described above. (To become part of the Florida Keys NMS; Federal waters).



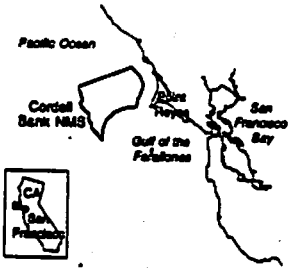
• The **Gray's Reef National Marine Sanctuary**, designated in January 1981, is a submerged live bottom (limestone reef) area located on the South Atlantic continental shelf east of Sapelo Island, Georgia. The Sanctuary encompasses about 17 square nautical miles, and protects a highly productive and unusual habitat for a wide variety of species including corals, tropical fish, and endangered and threatened sea turtles. It also provides migratory passage for the Northern right whale. Regulations prohibit alteration of the seabed, certain methods of fishing (explosives, wire traps), damage or removal of bottom formations, and discharge of substances or materials. (Federal waters)



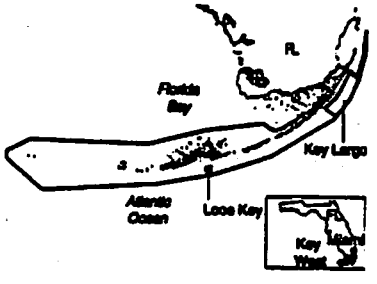
• The **Gulf of the Farallones National Marine Sanctuary** was designated in January 1981, and encompasses 948 square nautical miles off the northern coast of San Francisco, California. The Sanctuary includes important habitats for a diverse array of marine mammals (humpback, blue, and gray whales, dolphins, seals, and sea lions) and the largest concentration of breeding seabirds in the continental U.S., as well as pelagic fish, plants, and benthic biota. Regulations prohibit discharge of substances, alteration the seabed, hydrocarbon exploration and development activities, removal of historical or cultural resources, and restrict commercial vessel and aircraft activities within certain distances of specified biologically sensitive areas. (Federal/State waters)



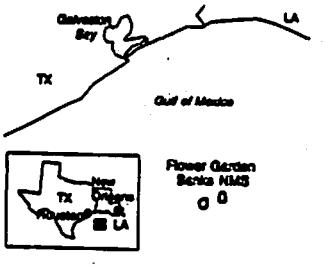
• **The Fagatele Bay National Marine Sanctuary** in American Samoa was designated in April 1986. The 163-acre bay site contains deepwater coral terrace formations in a submerged volcano that are unique to the high islands of the tropical Pacific. The Sanctuary protects habitat for a diverse array of tropical marine flora and fauna, including the endangered hawksbill sea turtle and the threatened green sea turtle. Regulations include fishing restrictions, discharges, and damage or removal of natural, historical, or cultural resources. (Territorial waters)



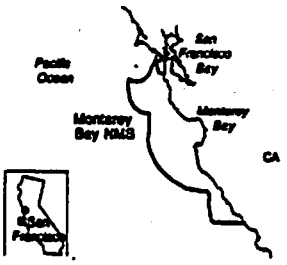
• The **Cordell Bank National Marine Sanctuary**, located approximately 20 nautical miles west of Point Reyes, California, was designated in May 1989. The 397-square nautical mile site surrounds a granitic formation, which provides habitat for an unusual assortment of marine and intertidal species, including colonies of purple hydrocorals. Abundant fish species attract feeding cetaceans and seabirds. Regulations prohibit deposition or discharged substances or materials, removal of or injury to Sanctuary resources, and hydrocarbon exploration and development activities. (Federal waters)



• **The Florida Keys National Marine Sanctuary** was Congressionally-designated in November 1990, and encompasses approximately 2,600 square nautical miles of coral reefs, seagrass beds, and related shoreline habitats of the Florida Keys ecosystem. The existing National Marine Sanctuaries at Key Largo and Looe Key will be incorporated into the Florida Keys NMS. In September, 1996, SRD released a Final Environmental Impact Statement and Management Plan for the site. (Federal/State waters)

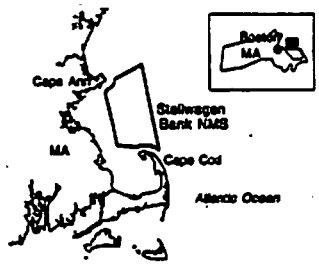


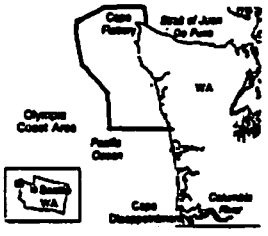
• The **Flower Garden Banks National Marine Sanctuary** encompasses approximately 42 square nautical miles surrounding two separate submerged features, the East and the West Flower Garden Banks, situated in the Gulf of Mexico over 100 nautical miles off the Texas/Louisiana coast. Designated in November 1991, the Sanctuary protects the northernmost coral reefs on the North American continental shelf by providing alternatives to anchoring (installation of mooring buoys), and prohibiting discharges and seabed alterations, hydrocarbon exploration and development activities, and injuring or taking marine organisms. (Federal waters)



• The **Monterey Bay National Marine Sanctuary** was designated in September 1992, and is the largest sanctuary in the national system, consisting of 4,024 square nautical miles off the central California coast. The most significant feature is the Monterey Canyon, the deepest and largest submarine canyon incising the continental shelf of North America. The area is rich in natural resources and serves as a breeding, feeding, and migration area for over 26 species of marine mammals. Significant prehistoric cultural sites as well as over 300 shipwrecks exist throughout the site and coastal area. Regulations include the prohibition of hydrocarbon exploration and development activities, depositing or discharging of substances or materials, taking or damaging Sanctuary historical resources, and the protection of specified biologically sensitive areas. (Federal/State waters)

• The **Stellwagen Bank National Marine Sanctuary**, designated by the Oceans Act of 1992, consists of 638 square nautical miles in Federal waters surrounding the entire Stellwagen Bank. The Bank is highly productive and provides feeding and nursery grounds for more than a dozen cetacean species, including the endangered humpback, northern right, sei, and fin whales. Current commercial whale watching activities involve more than one million visitors to the Bank annually. Mining for sand and gravel and discharging of dredged or other material is prohibited. (Federal waters)





• The **Olympic Coast National Marine Sanctuary** was designated in July 1994, and consists of 2,500 square nautical miles of State/Federal waters off the Washington Olympic Coast. The Sanctuary contains submarine canyons, marine mammals, seabirds, a diverse intertidal community, important fisheries, and serves as a gray and humpback whale migration corridor. Four Native American tribes participate on the Sanctuary Advisory Council (SAC). Significant historical and cultural resources are located both within and immediately adjacent to the sanctuary. (Federal/State waters).

Two additional sites are currently being considered for sanctuary designation: **Northwest Straits**, Washington; and **Thunder Bay**, Michigan. In addition, there are 24 natural resource sites on the Site Evaluation List (SEL) which have yet to be considered. Presence on the SEL does not guarantee a site will become a sanctuary.

C. HAWAIIAN ISLANDS HUMPBACK WHALE NATIONAL MARINE SANCTUARY

1. Designation

The Hawaiian Islands Humpback Whale NMS was designated in 1992 by the Hawaiian Islands National Marine Sanctuary Act (HINMSA) (Title II, subtitle C of the Oceans Act of 1992). In Section 2302 of the HINMSA, Congress made the following findings:

1) The Western Pacific region has many resources and ecosystems of national significance and importance.
2) There are currently no sanctuaries or potential candidates in Hawaii.
3) Hawaii's marine subtropical system is diverse and unique.

4) The Kahoolawe Island National Marine Sanctuary Feasibility Study requested by Congress indicated that biological, cultural and historical resources merited further investigation as to possible sanctuary status.
5) The Kahoolawe Study indicated that additional areas within Hawaii merited consideration and the sanctuary status could enhance resource protection.
6) Waters off the main Hawaiian Islands are important to the endangered North Pacific stock of the humpback whales.
7) The waters considered essential for breeding, calving and nursing of the humpback whale can be damaged or lose their ecological integrity from a variety of disturbances.
8) The Humpback Whale Recovery Plan recommends goals and actions to increase the abundance of the species.
9) In 1982, Hawaiian waters were considered to be an Active Candidate for marine sanctuary designation.
10) Existing regulatory and management authorities are inadequate to provide for comprehensive and coordinated management, which can be provided through the [NMSA].
11) Authority is needed to supplement and complement existing State and Federal regulatory and management programs to provide for comprehensive and coordinated conservation and management.
12) Additional support, promotion and coordination of scientific research and monitoring is essential to the survival of the humpback whale.
13) Education, awareness, understanding, appreciation and wise use of the marine environment are fundamental elements for the protection and conservation of the species.
14) National Marine Sanctuary designation is necessary for the protection and conservation of the humpback whale.
15) The Sanctuary which is designated for the conservation and management of the humpback whale could be expanded to include other marine resources of national significance which may exist within the Sanctuary.

These findings provided the basis for the Congressional designation of the Sanctuary. The objectives of the HINMSA are to: 1) protect humpback whales and their habitat within Sanctuary boundaries; 2) educate and interpret for the public the importance of humpback whales to the Hawaiian Islands marine environment; 3) manage such human uses of the Sanctuary consistent with the HINMSA and the [NMSA]; and 4) provide for the identification of marine resources and ecosystems of national significance for possible inclusion in the sanctuary.

The designation builds and compliments the efforts of NMFS in protecting the humpback whale under specialized Federal authorities, the efforts of the State of Hawaii since it has designated the humpback whale as the State Marine Mammal, and the unparalleled efforts of the County of Maui and its residents over a twenty year period during which they have conducted many activities in support of humpback whale research, education, protection and recovery. Indeed, the Congressional findings recognize the extreme importance of the Hawaiian marine environment to the perpetuation of the species, that there is an important long-term need to protect their habitat, and that the NMSA will provide resources intended to enhance these ongoing efforts. The Sanctuary will primarily rely on these existing efforts to accomplish many of the goals and objectives set out for it to achieve by law. Likewise, the Sanctuary will facilitate and support other on-going efforts by agencies, organizations and the public to enhance protection for and awareness of the humpback whale and its habitat.

While it appears that the population of the North Pacific Humpback Whale has increased, according to stock assessment estimates taken in Hawaii over the last 18 years, researchers and scientists recommend caution be used in making definitive statements regarding population

increase because of unanswered questions about the degree of mixing between humpback whale populations in Japan, Hawaii, and Mexico, the amount of inter-island movements within the Hawaiian Islands, and the different assessment methodologies used over time. Despite potential increases in the overall population, the North Pacific stock of humpback whales remains endangered. NMFS's recovery goal for the North Pacific population is 60 percent of the number of whales existing before commercial exploitation or of current environmental carrying capacity. To date there are only rough estimates of the pre-whaling population (15,000 whales) and little is known about the environmental carrying capacity in the Hawaiian Islands. There is still a great deal to learn about the humpback whale, its Hawaiian habitat, migration dynamics, and how to ensure its recovery. Other efforts in Alaska, as well as national marine sanctuaries along the California coast (Monterey Bay, Gulf of the Farallones, Cordell Bank and Channel Islands) and Washington State (Olympic Coast) will assist in the protection of the whale's migratory and feeding habitats and add to the information base. The HIHWNMS can play a coordinating role within the entire Pacific basin to integrate the monitoring and research efforts on humpback whales to elucidate the migratory patterns of humpback whales. In this capacity the HIHWNMS can integrate Pacific-wide education, monitoring, and research efforts on humpback whales.

2. History of Sanctuary Designation Proposal

a. Initial Proposal: 1977 - 1984

The establishment of a National Marine Sanctuary in Hawaii was first considered in December, 1977, when NOAA received the nomination for a proposed Humpback Whale National Marine Sanctuary in the waters between the islands of Maui, Molokai, Lanai, and Kahoolawe. This four-island area was identified as the principal breeding and calving area for the wintering population of endangered North Pacific humpback whales (*Megaptera novaeangliae*) estimated at that time to be between 600 and 800 individuals.

A workshop with scientists and resource managers was convened in December of that year resulting in the conclusion that a marine sanctuary would be most beneficial to the long-term protection of the endangered humpback whale. The workshop participants concluded that a Hawaii-statewide boundary (shoreline to the 100 fathom isobath) would provide the greatest protection for humpback whales in Hawaii given their distribution and inter-island migrations. The nomination was placed on the NMSP's List of Recommended Areas in October, 1979.

In March, 1982, NOAA declared the site an "Active Candidate" for designation as a national marine sanctuary in accordance with its regulations. Public workshops were subsequently held in Hawaii in April, 1982, to discuss the purpose and evaluate the issues related to management of the Sanctuary. There was considerable opposition to Sanctuary designation due to fears that the Sanctuary would impose additional restrictions on fishing and vessel operations. Based on comments received by NOAA from State and County agencies and the general public regarding the Draft EIS/MP that was distributed in December, 1983 (NOAA/OCRM, 1983), and at the request of the State Governor, further consideration of the site was suspended in early 1984. (For additional information see Appendix H)

b. Kahoolawe NMS Feasibility Study: 1990 - 1991

In October, 1990, in response to recommendations from the State of Hawaii and native Hawaiian groups such as the Protect Kahoolawe Ohana, President Bush directed the Secretary of Defense to immediately discontinue use of Kahoolawe as a weapons range. In conjunction with the presidential directive, Congress established the Kahoolawe Island Conveyance Commission to prepare a report that would identify future jurisdictional responsibilities and uses of the Island and its resources. Congress also directed NOAA (through Conference Report for Public Law 101-515 -- the Commerce, Justice, and State Appropriations Bill) to determine the feasibility of

establishing a national marine sanctuary in the waters around Kahoolawe Island. NOAA was instructed to give special consideration to the effects that a sanctuary would have on the population of humpback whales that inhabit the marine environment around Kahoolawe. NOAA examined the marine resources within three nautical miles around Kahoolawe Island and consulted with Federal and State agencies and the public through a series of public meetings. The results of this assessment and public input were published in a report entitled "Kahoolawe Island National Marine Sanctuary Feasibility Study."

The study indicated that while most research suggests that the waters around Kahoolawe do not appear to support large numbers of humpback whales, there is preliminary evidence of biological, cultural and historical resources adjacent to Kahoolawe which merit further investigation. The study concluded that additional information was needed before the Kahoolawe site could be considered as having resources and uses of special national significance. The study also noted with concern the presence of unexploded ordnance in the waters off Kahoolawe from Navy bombing exercises. The study recommended that additional areas within the Hawaiian Islands be considered as possible components of a multiple-site, multiple-resource NMS. The study also analyzed existing resource management authorities and concluded that a NMS could contribute to enhanced resource management in Hawaii.

c. The Oceans Act of 1992

In 1992, Congress held hearings to consider reauthorization and amendments to title III of the MPRSA. Representatives from the State of Hawaii provided testimony to Congress on the need and desirability of having a Humpback Whale NMS in Hawaii. This testimony, in addition to the findings of the Kahoolawe Feasibility Study, provided the basis for Congressional interest in designation of the Sanctuary.

On November 2, 1992, President Bush signed Public Law 102-587, the Oceans Act of 1992, which made numerous amendments to title III of the MPRSA, including: increasing in the maximum civil penalty from $50,000 to $100,000; adding the authority to establish advisory councils to assist in the designation and management of national marine sanctuaries; adding authority for the Secretary of Commerce to enter into agreements with any non-profit organization to, among others, solicit donations of funds, property, and services to carry out the purposes and policies of Title III of the MPRSA; and citing Title III as the National Marine Sanctuaries Act.

The Oceans Act also designated the Hawaiian Islands Humpback Whale National Marine Sanctuary. The Sanctuary, as designated, lies between 20°30' and 22°20' north latitude and 156°00' and 159°30' west longitude. The Congressionally-designated boundary occupies all contiguous coastal waters between the islands of Maui, Molokai, and Lanai, and extends seaward of these islands to the 100 fathom isobath, a horizontal distance ranging for a few hundred meters seaward of the shoreline on the eastern side of Maui to Penguin Bank, some 24 nautical miles southwest of Molokai. The Sanctuary also includes a small rectangular area, from the shoreline to the 100-fathom isobath adjacent to Kilauea Point on Kauai. The Act allows for boundary modifications necessary to fulfill the Sanctuary's purpose, and identified the waters around the island of Kahoolawe for automatic inclusion as part of the Sanctuary on January 1, 1996, unless the Secretary of Commerce certified the area is unsuitable for inclusion. In December, 1995, the Secretary certified to Congress that the waters around Kahoolawe are unsuitable for inclusion, and therefore, the waters around Kahoolawe are not included in the Sanctuary at this time. The HINMSA was amended in 1996 to provide a process by which the KIRC could request that NOAA include the marine waters within three nautical miles from Kahoolawe in the Sanctuary.

Under the HINMSA and the NMSA, the Governor of Hawaii has the authority to, within 45 days continuous session of Congress beginning on the date of issuance of the *Federal Register* notice containing the final implementing regulations, certify that the Management Plan, regulations, or any term of the plan or regulations is unacceptable. If the Governor makes such certification, the Management Plan, regulation(s), or term(s) thereof will not take effect in State waters within the Sanctuary. The Secretary of Commerce would then make a determination as to whether the Governor's action will affect the Sanctuary in a manner that the goals and objectives of the HINMSA cannot be fulfilled, and if so, the Secretary may terminate the entire designation. NOAA has coordinated and cooperated closely with the State of Hawaii in developing the Sanctuary's Management Plan.

d. The Draft EIS/MP

Section 2306 of the HINMSA requires NOAA to develop a comprehensive Management Plan and implementing regulations to achieve the policy and purposes of the HINMSA, following the procedures specified in sections 303 and 304 of the NMSA. Section 304(a)(2) requires the preparation of a draft environmental impact statement, as provided by the National Environmental Policy Act of 1969 (NEPA). The HINMSA also directs that opportunities be made available for the public to participate in the development of the Management Plan. To satisfy these requirements, as well as those of the NMSA and the NEPA, a series of scoping meetings were held in March, 1993, on each of the main islands and in Washington, D.C. The input received during those scoping meetings was extensive and covered a broad spectrum of issues. The impacts many people wanted addressed were those relating to potential regulatory restrictions on specific industries (e.g., fishing, vessel traffic, tourism). (For a synopsis of the scoping meetings, see the DEIS/MP's Appendix D-1.)

After the scoping meetings, and in cooperation with the Office of the Governor-Office of State Planning, SRD provided funding to support the organization of, and incidental expenses related to, the establishment of a Sanctuary Working Group (SWG) consisting of 50 individuals, representing Federal, State, and county governments, and a diverse array of interest groups. The SWG provided comments on a number of issues, management options, and a Discussion Paper, which was later used to further the public participation process for gathering input into the development of the Draft Management Plan. In March 1994, additional public meetings were held on each of the main Hawaiian Islands to gather additional input and get public reaction to such issues as: 1) the Sanctuary boundary; 2) potential regulations; 3) education and information; 4) research and monitoring; 5) administration; and 6) identification of other resources of national significance for possible inclusion in the Sanctuary. (A summary of the input received at each of those meetings is included in the DEIS/MP's Appendix D-2.)

The public has been sharply divided in their support for the Sanctuary. Those who opposed the Sanctuary were concerned that their access to marine waters may be limited by Sanctuary regulations -- a particularly emotional issue since Hawaii is an insular state and has ongoing Native Hawaiian sovereignty issues to address. Those who supported the Sanctuary saw its value in addressing multiple species in the context of an ecosystem management approach. Those who were undecided were unclear about the details of the Sanctuary such as the composition of the SAC, administration structure and location, and regulations.

Technical consultation meetings were held in February-March 1994, with different experts and interest groups to collect information for the DEIS/MP to establish a better understanding of coordination and cooperation needs and how a Sanctuary can complement and enhance existing efforts. Needs were identified for various marine users, including the military, fishing and boating interests, researchers and educators, and regulatory and enforcement personnel. SRD has attempted to reflect these concerns in the development of the Management Plan.

The DEIS/MP, published in September 1995, stated the following:

- Humpback whales use Hawaiian waters for breeding and rearing their young, and migrate throughout the Hawaiian Islands during this time. Little or no feeding occurs during this time and the whales prefer the shallower warmer waters for their activities. Scientists believe that there is an increase in the number of whales using Hawaiian waters in recent years.

  There are numerous legal protections and management plans afforded to whales, including international treaties promulgated pursuant to the International Whaling Commission, the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), State of Hawaii anti-harassment regulations, and the 1991 Humpback Whale Recovery Plan developed and implemented by NMFS.

- Human activities that could affect humpback whale behavior and whale habitat in Hawaii include: 1) noise from vessels, aircraft, and near-shore construction projects; 2) vessel traffic; 3) disturbance from recreational boating, tour-boating, jet skiing, and parasailing; 4) degradation to the water quality from waste disposal and non-point source pollution from coastal development; and 5) by the physical loss of habitat or activities that may cause whales to abandon their habitat and/or interfere with reproductive behaviors. For most of these activities, additional monitoring and research would be required before determinations could be made on the degree of impact on whales from such activities and any management schemes that would be necessary to help minimize the conflicts and impacts (see DEIS/MP, p. 49).

  There are a number of agencies and pieces of legislation in place offering regulatory protection to the humpback whale and the DEIS/MP identified no regulatory or management gaps in addressing these impacts. Rather, the DEIS/MP cited a lack of coordination among the agencies in management, education, research, monitoring, enforcement, and a larger ecosystem-based framework within which to assess these impacts on a cumulative basis.

- Population, tourism, and uses of the marine environment will continue to increase. Changes in the economy and associated changes in land use patterns resulting from the decline in agriculture will have impacts on the amount and type of runoff into marine waters from land. Both the number of people on the water and the pollutants entering the water from land can affect the suitability of the marine waters for breeding, birthing, and rearing of young whales.

- Hawaiian waters support many resources of national significance other than whales including intertidal communities, extensive shallow and deep water coral reefs, numerous cetaceans and seabird species, and pinnipeds. Marine areas of special significance are protected by State Marine Life Conservation Districts, Fishery Management Areas, and Ocean Recreation Management Areas.

i. DEIS/MP Preferred Alternative

The DEIS/MP proposed the following preferred alternatives for the Hawaiian Islands Humpback Whale National Marine Sanctuary:

Boundary

The preferred boundary includes the area from the shoreline to the 100-fathom isobath depth contour (600 feet) around the following areas of the main Hawaiian Islands: Maui, Lanai, and Molokai, including Penguin Bank and the deep water channels connecting them, the Big Island, eastern Kauai, and portions of north and south Oahu. NOAA did not include the area

within three nautical miles of Kahoolawe Island, select ports, harbors, and small boat basins, and military use areas off Kauai and Oahu.

Regulations

No new regulatory prohibitions were proposed for the Sanctuary. Rather, the Sanctuary will essentially incorporate the following existing restrictions to enhance enforcement effectiveness:

- existing approach and harassment regulations that protect humpback whales promulgated by NMFS under the MMPA and ESA;
- regulations prohibiting discharges into the Sanctuary, or discharges outside of the Sanctuary that subsequently enters the Sanctuary and injures a humpback whale and/or its habitat; and
- regulations prohibiting alteration of the seabed in the Sanctuary.

Future regulations not listed in the scope of regulations would require public notice and comment and, be subject to gubernatorial review and approval.

No mechanisms for requiring independent Sanctuary permits are proposed.

Management

The Sanctuary will be a year-around program (rather than seasonally implemented) that will focus on humpback whales and their habitat.

The Sanctuary will rely on an existing Memorandum of Understanding (MOU) between NMFS and the National Ocean Service (NOS) to undertake enforcement activities in the Sanctuary. Under this MOU, NMFS enforces Sanctuary regulations in consultation with the Sanctuary Manager. NMFS also has an MOU with the U.S. Coast Guard and DLNR-Department of Conservation and Recreation Enforcement which deputizes these other agencies to enforce MMPA and ESA regulations (see Appendix E).

Sanctuary staff will work with the Department of Health (DOH), the Department of Land and Natural Resources (DLNR), EPA, Coast Guard, and COE to cooperatively monitor and enforce existing water quality and alteration of the seabed activities. Sanctuary staff will also consult with the appropriate Federal, State, or county agencies on any violation of discharge and alteration of the seabed requirements and authorities. Ultimately, Sanctuary staff will seek to develop an MOU or other mutual understanding between the Sanctuary Program and other agencies regarding coordinated enforcement activities and actions in Hawaii. The intent of the enforcement program is to achieve voluntary compliance with the regulations through education.

No mandatory user fees are proposed by the Sanctuary Program in the Hawaii Humpback Whale National Marine Sanctuary.

Management Plan

Management Priorities: The Sanctuary will focus on present and potential activities that may adversely affect the whales directly (harassment and disturbance) and those factors that may impact water quality and/or modify the seafloor -- two major components of the whale's habitat.

Research and Monitoring Priorities: The research program will focus on improving the understanding of the relationship between the status of the humpback whale stocks and the quality of their environment.

Education and Outreach Priorities: The education program will focus on raising awareness of the significance of humpback whales and their habitat and other marine resources while promoting public and private uses of the Sanctuary.

Administration

Location: Based on the preferred boundary, the Sanctuary headquarters will be located in Kihei, Maui.

Staffing: Depending on the budget, the Sanctuary will hire a manager, administrative assistant, education coordinator, research coordinator, and other staff as needed. While the Sanctuary will not have its own enforcement presence, SRD will explore the possibility of funding enforcement positions in other agencies such as NMFS, DOH, or DLNR.

Sanctuary Advisory Council (SAC): The SAC, comprised of 25 members with broad statewide representation including researchers, county representatives, and interest groups will serve as an advisory body to the Sanctuary Manager and to NOAA.

e. The Final Management Plan

The DEIS/MP was released to the public in September 1995, initiating a 90-day public comment period that ended on December 15, 1995. Over twenty-five statewide informational meetings were held to assist the public in understanding the proposal and to answer questions and concerns. SRD also held seven formal public hearings throughout the main Hawaiian Islands. In total, over 250 written comments and oral testimonies were received by NOAA during the comment period.

The concerns raised in the comments addressed: boundaries; Kahoolawe; regulations; fishing; enforcement; management/scope; the SAC; research; education; Native Hawaiians; user fees; funding for the program; socio-economic impacts; need for the Sanctuary; the manner in which the Sanctuary was designated; and Federal presence in State waters. The response to these public comments are found in Appendix A, and incorporated into relevant sections of the FEIS/MP, as appropriate.

NOAA's preferred alternatives for the boundary, regulations, and management remain similar to those listed in the Draft EIS/MP. Changes and clarifications were made to respond to public comments. The following section summarizes the modifications, clarifications, or revisions made in the FEIS/MP.

Part I - Introduction: In addition to providing information about the National Marine Sanctuary Program and the history of the Hawaii Sanctuary, Part I has been modified to provide a summary of NOAA's preferred alternative and to identify the significant changes made between the draft and final environmental impact statements.

Part II - Description of the Affected Environment: This part was revised to reflect new or updated information. The most significant changes were made to the section on humpback whales in response to public comments. A new section was added to clarify that the establishment of the Sanctuary does not convey title or ownership to NOAA of Hawaii's submerged lands.

Part III - Alternatives: Parts of the alternatives were modified or clarified to address public comments received on the DEIS/MP. The significant changes relating to the boundary and regulations are noted in the table below.

Part IV - Environmental and Socioeconomic Impacts: This part has been expanded to more clearly portray the impacts between the status quo alternative and the preferred alternative. Particularly, the section describing the regulatory impacts dealing with discharge and alteration of the seabed activities has been expanded to address public comments.

Part V - Management Plan: This part has been modified to reflect specific changes made in parts 1-4 and to further clarify the roles of the various Federal and State resource agencies as they pertain to Sanctuary management.

Appendices: Appendix A contains NOAA's response to comments received on the DEIS/MP. Appendix E contains MOUs regarding the coordination of Federal and State resource agencies for activities that may impact Sanctuary resources.

TABLE I-1: Significant Changes Made to Final EIS/MP

Draft EIS:	Change Made to Final EIS/MP:	Why Change Was Made:
Boundary: "...from the mean highwater mark to the 100-fathom isobath..."	Boundary: "...from the shoreline to the 100-fathom isobath..." was added to boundary definition.	This change clarifies and simplifies the inshore boundary of the Sanctuary. Shoreline is defined as: "the upper reaches of the wash of the waves, other than storm and seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves." The Sanctuary inshore boundary is now consistent with the Coastal Zone Management Program and DLNR definition. As defined, the shoreline is also consistent with DLNR's survey and certification standards.
Boundary:	"cutting across the mouths of rivers and streams..." was added to boundary definition	Clarifies that the preferred Sanctuary boundary does not go up rivers, streams, or other inland water areas.
Boundary:	Listing of Ala Wai small boat basin as a harbor excluded from the preferred boundary.	The Ala Wai small boat basin lies within the preferred boundary. The regulations state specific ports, harbors, and small boat basins are to be excluded.
Regulations:	County regulations and permit processes have been removed from the scope of Sanctuary regulations.	Discharges and alteration of the seabed activities are primarily regulated by Federal and State agencies.
Regulations: Prohibited Activities (1) Approaching, within the Sanctuary, by any means, within 100 yards... (2) Causing a vessel or other object to approach, within the Sanctuary, within 100 yards...	Combined to read: (1) Approaching, or causing a vessel or other object to approach, within the Sanctuary, within 100 yards...	To streamline the language and to be consistent with the list of Activities Subject to Regulation.

TABLE I-1: Significant Changes Made to Final EIS/MP (Continued)		
Draft EIS:	**Change Made to Final EIS/MP:**	**Why Change Was Made:**
Enforcement:	Sanctuary and State roles were clarified regarding the enforcement of Sanctuary habitat related regulations	Clarifies that individual State permit issuing agencies make the initial determination as to whether a State discharge or alteration of the seabed permit has been violated, and would therefore be in violation of a Sanctuary habitat regulation.
Designation Document: Activities Subject to Regulation: f. Operation of a vessel (i.e., watercraft of any description) in the Sanctuary in a manner that may adversely impact any humpback whale or humpback whale habitat;...	Removed from the Scope of Regulation	The scope of regulations now mirror the actual regulations. Consequently, any new proposed regulations will be subject to the full designation process, including public hearing and comment, preparation of the supplemental EIS/MP, and gubernatorial review and approval.
Designation Document: Article VI. Alteration of This Designation "...review by the appropriate Congressional committees, and the Governor of the State of Hawaii, and approval by the Secretary of Commerce..."	"...review by the appropriate Congressional committees, and review and non-objection by the Governor of the State of Hawaii and, review and approval of the Secretary of Commerce..."	To clarify that the Governor will have objection authority over any proposed modification to the terms of designation, which include the boundary and new regulations. If the Governor objects, such modification will not take effect in State waters.
Part II - Description of humpback whales	Discussion of scientific data on humpback whales and their habitat has been significantly updated.	More current information has become available since the Draft EIS/MP was prepared. SRD has incorporated this new data to make the Final EIS/MP more current in its assessment of Sanctuary resources.
Part V - Management Plan. As noted in the NMSA, a review of the Management Plan is required every five years.	Process for this review is outlined in Part V which involves significant participation by the State.	To outline the specific procedures the State and NOAA will follow in undertaking the review.
Part V - Management Plan User Fees and Special Use Permits	Clarification made that there will be no special use permits or user fees in the Hawaii Sanctuary	To clearly state that there will be no special use permits or user fees in the Hawaii Sanctuary. In addition, the NMSA was reauthorized in 1996 to, in part, specifically prohibit user fees in the Hawaii Sanctuary.

Other significant concerns that have been addressed during the completion of the FEIS/MP:

- A Memorandum of Understanding (MOU) between SRD and Hawaii's DOH and DLNR is under development which outlines the mechanism by which NOAA and the State will coordinate the review of applications for State permits to conduct discharge or alteration of the seabed activities which are subject to Sanctuary regulation. A copy of the draft MOU is found in Appendix E of this FEIS/MP.

- SRD and NMFS have developed an MOU concerning permit review and coordinated consultations for activities that may affect humpback whales or their Sanctuary habitat

(Appendix E). SRD and NMFS are also developing another MOU concerning the coordination of their other management activities in the Sanctuary.

- NOAA's Office of General Counsel will develop a civil penalty schedule outlining the range of fines associated with violations of Sanctuary regulations. The civil penalty schedule will be made publicly available.

- The Sanctuary Advisory Council (SAC) has been established and is working to provide advice and recommendations to SRD on the implementation of the Sanctuary (See Part V for more discussion on the SAC.)

In addition to the changes identified above in response to public comments, numerous editorial changes have been undertaken to make the document more "user-friendly," including a reorganization of Parts I and V.

D. CONSULTATIONS

1. Endangered Species Act Requirements

Pursuant to Section 7 of the ESA, the Fish and Wildlife Service of DOI, and NMFS, have been consulted regarding possible impacts on threatened or endangered species that might result from the preparation and implementation of a management plan and regulations as required by the Sanctuary designation. These consultations confirmed that some five endangered (E), four threatened (T) and one candidate species are either known to, or may occasionally, occur in the area; and, that Sanctuary designation is not likely to adversely affect any of these species. The species identified are:

- Hawksbill turtle *(Eretmochelys imbricata)*..... E
- Green sea turtle (*Chelonia mydas*)..... T
- Leatherback sea turtle (*Dermochelys coriacea*)..... E
- Loggerhead sea turtle (*Caretta caretta*)..... T
- Olive ridley *(Lepidochelys olivacea)*..... T
- Hawaiian monk seal *(Monachus schauinslandi)*..... E
- Humpback whale (*Megaptera novaeangliae*)..... E
- Hawaiian dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*).. E
- Newells' shearwater (*Puffinus auricularis*)..... T
- Band-rumped storm-petrel (*Oceanodroma castro cryptoleucure*)..... T(candidate)

2. Resource Assessment

Section 303(b)(3), of the NMSA [16 U.S.C. §1433(b)(3)] requires a resource assessment report documenting present and potential uses of the proposed Sanctuary area, including uses subject to the primary jurisdiction of DOI. The resource assessment, including a description of biological and cultural resources and human uses can be found in Part II of the FEIS/MP. This requirement has also been met through consultations with DOI, NMFS, the Hawaii Office of Planning, and in the development of a report entitled: "A Site Characterization Study for the Hawaiian Islands Humpback Whale National Marine Sanctuary" (University of Hawaii Sea Grant College Program 1994). This Site Characterization Study was useful in providing many significant details described in this FEIS/MP. Interested readers, can receive a copy of this report from one of the Sanctuary offices, the Hawaii Office of Planning, or copies will be distributed to the following public libraries in Hawaii:

Kauai:	Lihue, Kapaa, Waimea, Hanapepe, and Koloa Public Libraries
Oahu:	Honolulu, Hawaii Kai, Waimanalo, and Kahuku Public Libraries
Maui:	Wailuku, Kahului, Hana, Kihei, and Lahaina Public Libraries
Molokai:	Molokai Public Library
Lanai:	Lanai Public Library
Big Island:	Hilo, Kailua-Kona, Keaau, Kealakekua, Kohala, and Waimea Public Libraries

3. Federal Consistency Determination

Section 307 of the Coastal Zone Management Act of 1972, as amended, requires that "[e]ach Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner which is consistent to the maximum extent practicable, with enforceable policies of approved State management programs. A Federal Consistency Determination has been submitted to the Coastal Zone Management Program within the Hawaii Office of Planning (OP). The Hawaii OP will review the consistency determination along with the final Sanctuary management plan and will either concur or object with NOAA's determination that the implementation of the HIHWNMS is consistent with Hawaii's CZMP.

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PART II -- DESCRIPTION OF THE AFFECTED ENVIRONMENT

TABLE OF CONTENTS

PAGE

A. THE PHYSICAL ENVIRONMENT....27
1. Geographic Setting....27
2. Physical Characteristics....27
a. Geology....27
b. Geomorphology/Bathymetry....28
c. Meteorology and Climatology....29
d. Oceanography....31
e. Ocean Chemistry....32

B. BIOLOGICAL RESOURCES....34
1. Humpback Whales....34
a. Natural History....34
i. Species Description and Taxonomy....34
ii. Distribution/Zoogeography....35
iii. Populations and Subunits....36
iv. Habitat Use and Behavior....36
1) Summering Areas -- Feeding....36
2) Migrations....38
3) Wintering Areas -- Reproduction....38
v. Natural Mortality....39
b. North Pacific Population of Humpback Whales....39
i. Use of Feeding and Wintering Areas....39
ii. Abundance and Trends....39
iii. Stock Structure....40
iv. Humpback Whale in Hawaiian Waters....41
1) Historical Presence....41
2) Reproduction....42
3) Singing....42
4) Humpback Whale Distribution....43
5) Humpback Whale Cow-Calf Distribution....49
6) Habitat Use....49
7) Abundance Estimates....50
c. Known and Potential Impacts to Central North Pacific Stock....51
i. Entrapment and Entanglement in Fishing Gear or Mooring Lines....51
ii. Collisions by Ships....52
iii. Acoustic Disturbance....52
1) Disturbance and Noise from Ships, Boats, and Aircraft....52
2) Commercial Whale Watching Boats and Research Boats....53
3) Noise from Industrial Activities (Construction and Dredging)....54
4) Sonars....54
5) Explosions....54
6) Ocean Science Studies (ATOC)....54
iv. Habitat Degradation....55
1) Chemical Pollution (Point and Non-Point)....55
2) Habitat Disturbance....56
d. Protection, Legislation, and Management....56

2. Other Marine Resources of Hawaii 57
a. General Information 57
b. Nearshore Ecosystems 58
i. Shoreline Ecosystems 58
ii. Subtidal Ecosystems 61
c. Cetacean Species Found in Hawaii 62
i. Pacific Bottlenose Dolphins 65
ii. False Killer Whales 66
iii. Spinner Dolphins 66
iv. Spotted Dolphins 66
v. Odontocete Prey Species 67
vi. Predators 67
vii. Odontocete Distribution Trends 67
d. Other Endangered or Threatened Species 67
i. Sea Turtles 67
ii. Hawksbill Turtles 68
iii. Green Sea Turtles 68
iv. Sea Birds 69
v. Hawaiian Monk Seal 69

C. CULTURAL AND HISTORICAL RESOURCES AND USES 71
1. Native Hawaiian Settlements and Social Patterns 72
2. Aquaculture/Fishponds 73
a. Estimate of Number and Distribution 74
b. Fishponds Today 74
c. Implications for the Sanctuary 75
3. Religious Practices and Artifacts 76
4. Kahoolawe Island 77
a. Kahoolawe Island Reserve 77
5. Submerged Lands 79
6. Traditional Native Hawaiian Uses 79
7. Shipwrecks 79

D. HUMAN ENVIRONMENT AND ACTIVITIES 80
1. Socio-Demographic Profile 80
a. Population and Ethnic Make-Up 80
b. Labor Force 81
2. Human Activities 82
a. Fishing (Description of Activities, Numbers Involved, and Economic/Cultural Importance) 82
i. Commercial 82
ii. Recreational 86
iii. Charterboat Fishing 86
iv. Aquarium Fish Industry 86
v. Fishponds and Traditional Uses 86
b. Commercial Shipping 87
i. Economic Contribution 87
ii. Vessel Traffic 87
iii. Hawaii Ports and Harbors 87
c. Tourism 88
d. Ocean Recreation 88
i. Recreational Activities 89
1) Boating 89

2) Surfing....90
3) Swimming....90
ii. Commercial Activities....90
1) Tour Boats....90
2) Thrill Craft....91
3) Competitive Events....92
4) Canoe Racing and Kayaking....92
5) Diving....93
iii. Economic Contributions of Ocean Recreation....93
e. Ocean Waste Disposal....94
i. Water Quality....94
ii. Point Source Discharges....94
iii. Non-Point Source Discharges....95
iv. Ocean Dumping and Dredge Material....96
f. Department of Defense Activities....97
i. Expenditures....97
ii. Activities/Operations in Hawaiian waters....97
iii. Other Military Operations in the Hawaiian Islands....98
g. Energy and Industrial Uses....99
i. Hydrocarbon Resources....99
ii. Ocean Thermal Energy Conversion....100
iii. Geothermal Energy/Underwater Electrical Transmission Cables....100
iv. Marine Hard Minerals....101
v. Sand Resources....102
h. Agriculture....102
j. Aviation....103
k. Research....104
l. Current Education Efforts to Address Management Concerns....105
m. Existing Protected Areas....105
i. Protected Areas....105
ii. Federal Protected Areas....106
1) National Wildlife Refuges....106
2) National Parks....106
iii. State Protected Areas....107
1) Marine Life Conservation Districts....107
2) Fishery Management Areas....107
3) The Natural Areas Reserves System....107
4) Underwater Parks....107
5) Conservation Land Use Districts Protection Subzones....107
6) Other State Marine Protection Areas....107
7) Ocean Recreation Management Areas....107
iv. Private Protected Areas....108
v. Special Protected Areas....108
3. Institutional Arrangements and Responsibilities....108
a. Federal Authorities....108
i. Marine Wildlife Protection and Conservation Authorities....108
1) The Fish and Wildlife Coordination Act....108
1) The Marine Mammal Protection Act....108
2) The Endangered Species Act....110
ii. National Marine Fisheries Service, Southwest Region....110
iii. U.S. Fish and Wildlife Service....112
iv. Marine Mammal Commission....113
v. Marine/Coastal Zone Protection....113
1) The Coastal Zone Management Act of 1972....113

vi. NOAA/Office of Ocean and Coastal Resource Management 114
vii. National Park Service 114
viii. Fisheries Management 114
1) The Magnuson Fishery Conservation and Management Act 114
ix. Marine/Coastal Development 115
1) Federal Water Pollution Control Act 115
2) Rivers and Harbors Act 115
3) The Outer Continental Shelf Lands Act 115
x. Water Quality 116
1) Point and Non-Point Source Discharges 116
2) Dredging and Ocean Dumping 116
3) Vessel Sewage 117
xi. Oil Pollution 117
1) Clean Water Act 117
2) Oil Pollution Act of 1990 117
3) International Convention for the Prevention of Pollution of the Sea by Oil/Oil Pollution Act of 1961/International Convention for the Preservation of Pollution from Ships, 1973 119
xii. Marine Transportation Safety 120
1) The Ports and Waterways Safety Act 120
b. State and County Authorities 120
i. Environmental Impact Statement Law 120
1) Hawaii Coastal Zone Management Act 120
2) Coastal Zone Management Areas 121
3) Areas of Particular Concern and Priorities of Use 121
4) Hawaii Ocean and Submerged Lands Leasing Act 121
5) Protection of Marine and Coastal Species 122
6) Water Quality Standards 122
7) Point-Sources of Pollution 123
8) Non-Point Sources of Pollution 123
9) Oil Pollution 124
10) Ocean Recreation and Coastal Area Rules 124
11) Humpback Whale Approach Regulations 125
12) Ocean Recreation 125
13) Humpback Whale Protected Waters 126
14) Fisheries Regulation 126
15) Other State Marine Protected Areas 127
16) Enforcement of State Regulations 127

This part of the Final Environmental Impact Statement describes the environmental and socio-economic characteristics of the affected area pertinent to the planning for and understanding of Sanctuary management needs. The following sections summarize information about the marine environment, its uses, and its users. Much of the information contained in Part II can be found in "A Site Characterization Study for the Hawaiian Islands Humpback Whale National Marine Sanctuary" (March 1994) prepared for NOAA by the University of Hawaii Sea Grant College Program, School of Ocean and Earth Science and Technology. All references are included in the bibliography located in Appendix J.

A. THE PHYSICAL ENVIRONMENT

1. Geographic Setting

The Hawaiian Archipelago is a group of eight major islands together with 124 islets (some of which are unrelated to the archipelago), shoals, and reefs stretching 2400-km (about 1,490 nautical, or 1,600 statute miles) along a southeast-northwest axis in the North Central Pacific. Lying in the Tropic of Cancer between 154°40' to 178°75'W longitude and 18°40' to 28°25' N latitude, the major islands in order of size are: Hawaii (referred to as the Big Island), Maui, Oahu, Kauai, Molokai, Lanai, Niihau, and Kahoolawe. The State of Hawaii consists of 16,760 sq. km (6,471 sq. mi.) of land; ranges in elevation from sea level to 4,205 m (13,796 ft) at the peak of Mauna Kea on the Big Island; and has 1,207 km (750 mi.) of coastline with 40 sq. mi. of estuaries, harbors, and bays. The major ocean and interisland channels are shown in Figure II-1.

The four counties of Hawaii are: Hawaii, the City and County of Honolulu, Kauai, and Maui. The Hawaiian Islands Humpback Whale National Marine Sanctuary as currently designated exists predominantly within the County of Maui, which is commonly referred to as the "four-island" area consisting of Maui, Molokai, Lanai, and Kahoolawe (see Figure III-2 in the following chapter). Congress also designated as part of the Sanctuary the waters off the shore of the Kilauea National Wildlife Refuge, Kauai. NOAA is proposing to expand the Sanctuary to include the Big Island, eastern Kauai, and portions of Oahu. Hawaii is located some 2,500 nautical miles (4,060 km) from the California coastline and 2,800 nautical miles (4,500 km) from southeastern Alaska, which is considered to be one of the major summer feeding grounds for humpback whales.

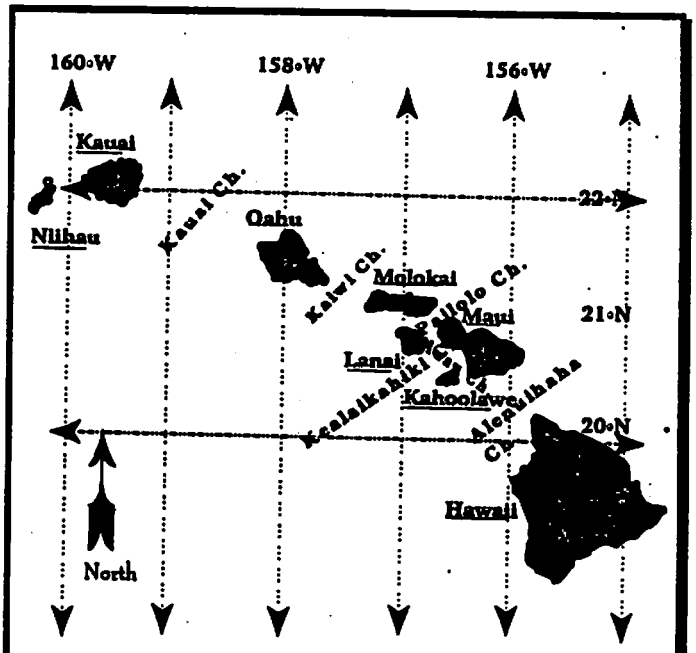


Figure II-1 Main Hawaiian Islands

2. Physical Characteristics

a. Geology

The Hawaiian Islands were formed during the last few million years by the gradual accretion of basaltic lava flows and ejecta. Their geologic features have been formed by successive

periods of volcanic activity interspersed with submergence, weathering, and fluctuations in sea level (Wyrtki 1990). The islands rise 9,100 m above the sea floor, and the Island of Hawaii has a maximum elevation of 4,500 m above sea level [U.S. Environmental Protection Agency (EPA) 1980; Menard 1964].

The volcanic activity that created the Hawaiian Islands formed comparatively gradual mountain masses that rise abruptly from the relatively smooth archipelagic apron of the adjacent sea floor. This apron extends a few tens of kilometers outward from the islands and is peculiar because it slopes slightly upward from the base of the islands. The sea floor at the base of the islands is slightly depressed and forms a moat-type structure around the islands. Beyond the moat is a bulge or arch, apparently formed by the weight of the islands pushing the displaced material outward (Menard 1964).

The islands generally are surrounded by coral reefs and contain numerous bays. Along some of the windward shorelines where perennial streams empty into the ocean, estuarine-like conditions prevail. Abundant rainfall and persistent northeasterly trade winds contribute to the steady weathering of the islands. Sandy beaches are found along the shorelines of all the islands but are best developed on Kauai, the oldest of the main islands, and least developed on Hawaii, where mountain-building and shoreline creation is still occurring. In places throughout the State and in Maui County, there occurs a phenomenon in which there is a net loss of beach volume with a concomitant increase in offshore sand deposits.

There are no known oil and gas deposits within the nearshore area of the State, and manganese nodule deposits and cobalt rich crusts lie far offshore. Sand is the most commercially valuable nearshore mineral with large deposits located in a number of sites.

b. Geomorphology/Bathymetry

The islands of Maui, Lanai, Molokai, and Kahoolawe are the remnants of a single massive volcanic conglomerate formed by at least six major and one minor volcano. During a period of low sea level (in the recent geologic past), these four islands were connected to form a single island called "Maui Nui" [MacDonald et al. 1983; U.S. Department of Commerce (DOC) 1983]. This island had an area of about 5,200 km^2 (about one-half the size of the present island of Hawaii). Extensive periods of erosion, emergence, and subsidence in combination with changes in sea level shaped Maui Nui to its present configuration, drowning the base of the island and creating not one, but four separate islands. The adjoining submerged base of Maui, Lanai, and Molokai ranges in depth from about 30 m to 80 m. Hence, about half of the Congressionally-designated Sanctuary is less than 80 m in depth.

Penguin Bank is noted for major concentrations of humpback whales during their winter stay in Hawaiian waters. The average depth of water over Penguin Bank is about 60 m, but ranges from 50 m to 200 m. There is a lack of information regarding the specific geology of the very near coastal waters (i.e., 100 m to 200 m depths). Observations made from research submersibles at Penguin Bank and in the general vicinity of the Congressionally-designated Sanctuary indicate that at depths of 60 m to 120 m the bottom is composed primarily of sand with occasional outcrops of coarse sediment, limestone talus, limestone holes, and platforms (B. Muffler, Hawaii Undersea Research Laboratory, pers. comm. 1993). In addition, carbonate organisms including red and green calcareous algae, bryozoans, corals, and pen shells have been observed at depths of 40 m to 90 m on Penguin Bank (Agegian and Mackenzie 1989).

Bottom photography off of other coastal sites throughout the State, (e.g., Kahului Harbor, Maui; Nawiliwili, Kauai; Pearl Harbor, Oahu; Port Allen, Kauai; and Hilo, Hawaii) show remarkable similarity at depths of 300 m to 1,600 m. At each site, the bottom is characterized by silty sand and clay with only occasional cobbles, boulders, and rocky outcrops. Whereas these

data reflect conditions slightly beyond the 100-fathom isobath, observations from submersible dives suggest that these characteristics are consistent with the shallow near coastal regions with an increase in the presence of rocky outcrops and coral rubble at the shallow depths.

The nearshore topography of Oahu is characterized by a series of marine terraces. The terraces, which are separated by escarpments, reflect periods of emergence, submergence, and changes in sea level. Specific bathymetric data have not been located for the nearshore areas of the islands of Maui, Molokai, and Lanai. (see insert: Information Gaps). On Oahu, however, the upper level terrace extends seaward to about 60 m followed by a steep escarpment and then a second or intermediate terrace from about 70 m to 120 m. Another steep escarpment is found at this depth and then a gently sloping terrace extends from about 130 m to the 600 m contour (Brock and Chamberlain 1968). Sonic depth recorders indicate a relatively flat or gently sloping bottom at depths near 200 m (100-fathom isobath) (EPA 1980). With few exceptions, the bottom topography from 400 m seaward is very steep and drops almost immediately to the abyssal plains at 4,800 m (2,400 fathoms). Because the submerged coasts of Maui, Molokai, and Lanai probably experienced similar periods of erosion, subsidence, emergence, and changes in sea level, it is proposed that the terraces on Oahu generally reflect similar types of geomorphic conditions.

Information Gaps

While there may be many unique or unusual features found within the designated Sanctuary boundaries, those pertinent to physical oceanography seem to focus on two very distinctive characteristics: bathymetry and eddy circulation. The bathymetry of the area, bound by Maui, Molokai, Lanai, and Kahoolawe, along with the extension of the shallow Penguin Bank southwest of Molokai, represents a unique, semi-enclosed, shallow protected sea in the midst of an expansive ocean. There is almost no information in the published literature as to the specific characteristics of this interisland area.

General physical oceanographic information on the nearshore environment seaward to the 100-fathom isobath is not available. The oceanographic data for waters on the periphery of the four-islands region outside the 100-fathom isobath is limited and somewhat dated. In the future, it may be useful to have a more detailed bathymetric survey using now available side scan sonar systems. This information, along with sub-bottom profiling, might offer insight into the topography that could influence small-scale current systems, sediment types and transport, and ecosystem characteristics and their relation to the distribution or migration patterns of whales within these shallow waters.

Figure III-12 in the following chapter shows the degree of extension of the 100-fathom isobath on all the main Hawaiian Islands. Significant shelves are found around Niihau and Kaula Rock, northern Kauai, the eastern and western shores of Oahu, and the Big Island, whose shelf is greatest along the northwestern shoreline.

c. Meteorology and Climatology

Although the Hawaiian Islands are at the northern edge of the tropics, they have a subtropical climate due to the cool ocean currents and persistent northeasterly trade winds that occur about 80 percent of the time, a condition that accounts in part for the lower diversity exhibited by Hawaiian coral reefs and associated marine communities, relative to other areas in the Indio-Pacific region (DOC 1983). The average wind velocity is between 10 and 20 knots (kt), but velocities over 20 kt for more than a week are not uncommon (Patzert 1970). Ocean temperatures are less than that of other areas at the same latitude and range from 21°C to 29°C (70°F to 85°F). Occasional periods of southerly, or kona, winds may bring storm events.

Winds blow many miles across the Pacific ocean before reaching the Hawaiian Islands. Rainfall occurs when warm, moisture-laden tradewind air is forced up and over mountain peaks causing condensation of atmospheric moisture. The northeastern sides of the islands (the direction of the prevailing winds) are usually the wettest. As the winds descend the leeward slopes, they become warm and dry, thus making the leeward coasts some of the driest in the State. Southerly winds can also bring rains and, in fact, the more serious storms frequently come from the south. Rainfall exceeding 24 inches in four hours has been recorded (Stearns 1967). Annual rainfall over the State varies from 25 cm (10 in) near leeward shores to almost 1,270 cm (500 in) at Mount Waialeale on Kauai. Maximum precipitation usually occurs between altitudes 600 m and 1,830 m (2,000 ft and 6,000 ft). Precipitation is highly variable, however, and is heavily influenced by local topography and the sheltering effects of adjacent islands. This is particularly noticeable on the islands of Kahoolawe and Lanai, which are relatively low and shielded from the trade winds by other islands. Consequently, these islands are very dry and suffer severe wind erosion problems [Blumenstock and Price 1967, Stearns 1967, Blumenstock and Price 1967, DOC 1991, Hawaii Department of Business, Economic Development, and Tourism (DBEDT) 1990].

The importance of the air-sea interaction is evident in an analysis of the meteorological and oceanographic conditions of the Hawaiian Islands. The islands present a formidable barrier to the northeast trade winds. This is particularly true for the island of Hawaii, which presents a solid barrier of approximately 120 km to the winds (Figure II-2) (Patzert 1970). Alenuihaha Channel, between Maui and Hawaii, is bound by mountains higher than those bounding both sides of the Kauai Channel. The "thickness" of the atmospheric layer in which the trade winds are dominant extends to a height of approximately 1,800 m (Patzert 1970). The relationship between the height of the islands and the elevation of the trade wind flow is clearly demonstrated in Figure II-3. (Patzert 1970). The islands are over 1,000 m above the trade wind layer. The other major islands may also serve as a barrier to the wind, but are below the maximum height of the trade winds.

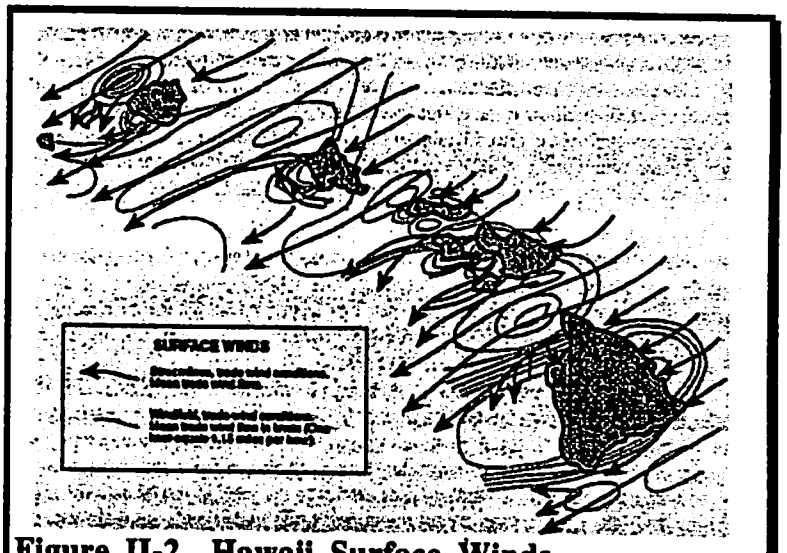


Figure II-2 Hawaii Surface Winds

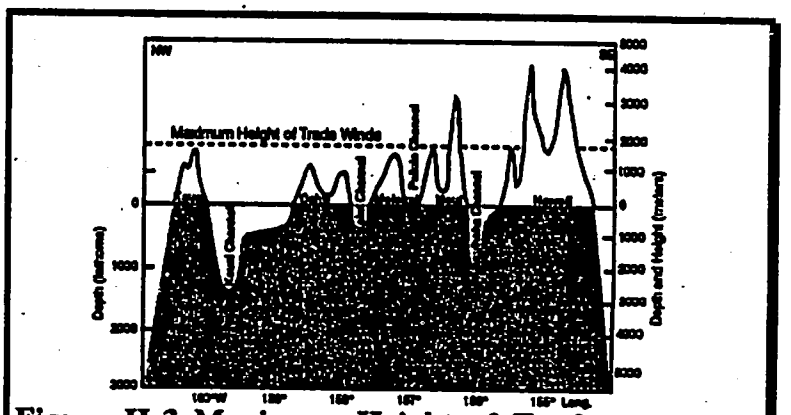


Figure II-3 Maximum Height of Trade Winds

Long-term measurements of winds taken by Honolulu Weather Bureau ship observations clearly show the marked effect on atmospheric circulation imposed by the islands. Wind speeds decrease in the lee of each island, whereas winds in the channels increase in strength. This effect is stronger in the Alenuihaha Channel than in the other channels where velocities of 20 kts to 25 kts

are not uncommon. It has been postulated (Patzert 1970) that the increase in wind velocity is due to the constriction of trade wind flow in the channel by the high mountains on either side, much like the "Venturi effect" of flows through a narrowed opening. Shear effects upon the incident trade winds are also seen in the lee of Hawaii. Cyclonic eddies develop to the north and anticyclonic eddies develop to the south. Atmospheric eddies have been shown to be a permanent feature during trade wind conditions in the lee of Hawaii and may occur in the lee of the other main islands as well, but are likely to be far less intense because the other islands are much lower and smaller than Hawaii.

The presence of atmospheric eddies is also illustrated by the rainfall regime of the Kona coast of Hawaii. As previously mentioned, rainfall throughout most of the islands is considerably greater on exposed windward coasts than on the more protected leeward coasts; however, this is not the case along the leeward coast of Hawaii. Kona receives up to 150 cm/yr (60 in/yr) of precipitation in contrast to other leeward areas that receive less than 50 cm/yr (20 in/yr) (Patzert 1970) because of the blocking effect of the mountains (Mauna Loa in particular) on the trade wind showers. Heavy winds and waves affect boating and vessel activities as well as whale watching during the winter season.

Hours of daylight have been postulated to influence the migration of the humpback whales from polar feeding grounds to tropical calving areas (Dawbin 1977). In Hawaii, there is little variation between the length of the days and nights from one part of the state to another because all the islands lie within a narrow latitudinal band (Blumenstock and Price 1967). Variation in length of day in Honolulu for example, ranges from 13 hr 20 min (without twilight) to 14 hr 10 min (including twilight) at the longest day, and 10 hr 50 min to 11 hr 40 min (with and without twilight) for the shortest day (Blumenstock and Price 1967). This small variation in solar energy from one time of the year to another partially explains the slight changes in seasonal temperatures throughout much of the State. Persistent trade winds are a major factor in moderating the overall climate of the islands.

d. Oceanography

Coastal current measurements off the Hawaiian Islands (Wyrtki et al. 1969; Chave and Miller 1977) suggest a mean velocity less than 20 cm/sec in most cases; however, extreme variability is the rule, not the exception. Water circulation around the islands is driven by a combination of forces including tides, the West Wind Drift, circulation of the Eastern Pacific Gyre, and local wind and eddy systems. The latter have been extensively studied by University of Hawaii oceanographers (Wyrtki et al. 1967; Wyrtki et al. 1969; Wyrtki 1970; Patzert 1970; and Patzert et al. 1970). The main Hawaiian Islands are marked by variable current directions and velocity and the presence of well developed eddies (University of Hawaii, 1983--Figure II-4) with diameters ranging from 50 km to 150 km.

Figure II-4 Hawaii Surface Currents

Most of the eddies are cyclonic (i.e., an anticlockwise spiral) and are present during all seasons. The eddies are relatively shallow and are concentrated in the upper 150 m, well within the depth ranges of the Sanctuary.

Flights with airborne radiation thermometers attempted to map the horizontal distribution and movement of eddies over time by measuring cold spots that form in the center of cyclonic eddies (Figure II-5) (Wyrtki 1970). These measurements identified periods of cooler water between Maui and Kahoolawe (Figure II-6) (Wyrtki 1970); however, it was unclear if these periods were the result of eddies or more likely reflected cool water adverting through the channel between Hawaii and Maui. The nearest to shore that eddies have been measured is 40 km (Patzert 1970). Upwelling has been noted in the central portion of the cyclonic eddies, reflecting a doming character. It should be noted that to date, none of the research on eddies has included the four-island area of the Sanctuary. It is unclear if the eddies persist between the islands or if the wind and resulting current patterns are so modified by the island "shadow-barrier" effects as to eliminate the oceanic component of the eddy close to shore.

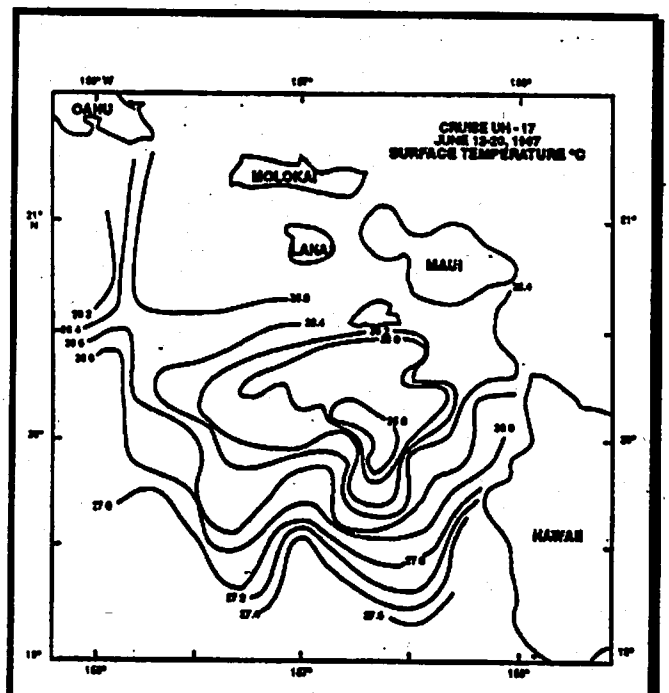


Figure II-5 Sea Surface Temperatures

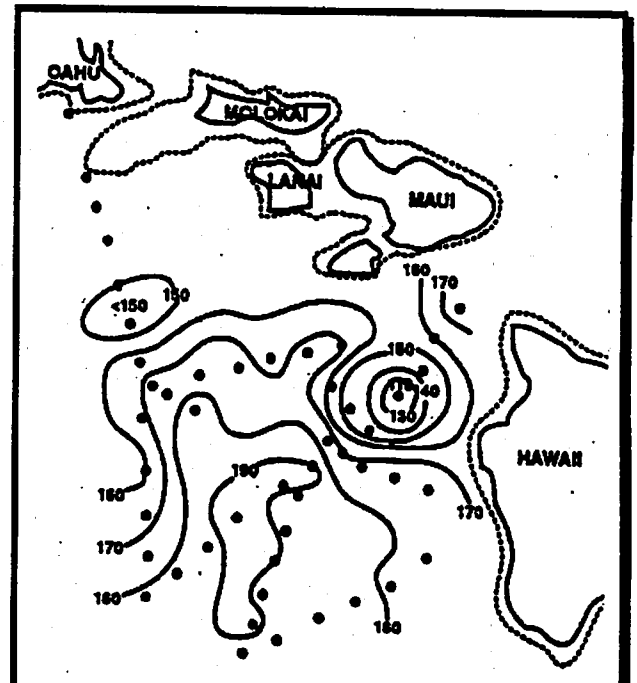


Figure II-6 Depth of 20° isotherm

e. Ocean Chemistry

There are three major water masses around the Hawaiian Islands: the North Pacific Central (NPC), the North Pacific Intermediate, and the Pacific Deep Water (Table II-1) (Sverdrup et al. 1942). Of these, the NPC, which forms the shallow water masses and ranges in depth from 100 m to 300 m, is found within the Sanctuary. This water mass is characterized by temperatures ranging between 10°C and 18°C and salinities of 34.2 percent to 35.2 percent (EPA 1980). The NPC water has the highest salinity of the three, but this is countered by higher temperatures so its relative density is lowest.

TABLE II-1: Major Water Masses of the North Pacific			
Water Mass	*Depth (m)*	*Temperature(°C)*	*Salinity (g/kg)*
North Pacific Central	100-300	18	34.2-35.2
North Pacific Intermediate	300-1,500	10	34.2-34.5
Pacific Deep Water	1,500-bottom	1-2.2	34.6-34.7

Source: U.S. Environmental Protection Agency (EPA), 1980.

According to Patzert (1970), the vertical distribution of salinity between the ocean's surface and 150 m depth, increases slightly to 35.1 percent. The depth of this maximum can vary depending on the presence of a cyclonic eddy when the salinity maximum has been recorded at the surface. This indicates an up-welling of 150 m, completely removing the water of lower salinity at the sea surface.

Variations in Hawaiian surface water temperatures range from a mean minimum of about 21°C (70°F) from January to February to a mean maximum of about 27°C to 28°C (81°F to 82°F) from June to October. Mean monthly maximum and minimum temperatures recorded at Kaneohe, Oahu are illustrated in Table II-2 (Haraguchi, in Hawaii DBEDT 1990). Although these temperatures are likely to differ somewhat from temperatures in the designated Sanctuary, the general monthly trends can be expected to be similar.

TABLE II-2: Hawaiian Water Temperatures by Month		
Month	*Temperature °F* Mean maximum	*Temperature °F* Mean minimum
January	74.7	71.1
February	75.6	70.3
March	76.5	71.8
April	77.7	73.0
May	79.5	74.7
June	81.1	77.7
July	81.1	78.3
August	81.9	79.2
September	81.9	78.4
October	81.1	77.2
November	79.3	74.5
December	75.9	71.4
Annual	78.6	74.8

Source: Hariguchi *in*: DBEDT, 1990.

The depth of the mixed layer varies from 50 m to 140 m (Chave and Miller 1977; Wyrtki et al. 1967). The thermocline extends well beyond 200 m (100 fathoms) and has been reported to extend to depths between 275 m to 365 m in the offshore region (EPA 1980). Stratification is weakest in the winter months and strongest in the summer.

Specific water chemistry data for the Sanctuary area, particularly the inner area between the islands of Lanai, Molokai, Maui, and Kahoolawe, have not been located. However, based on studies conducted in comparable water depths and distances from shore, it is believed that the water chemistry of the outer edge of the Sanctuary is more oceanic than coastal in character. The persistent trade winds, tides, and exceptionally strong currents between and adjacent to the islands encourages maximum mixing and dispersion of nearshore waters. Major inputs from the local land masses are likely to be episodic and may be negligible along the borders of the Sanctuary. General

approximations of the water chemistry based on measurements taken at a nearshore site off Oahu (Chave and Miller 1977), suggest that dissolved oxygen is high, perhaps supersaturated in the surface waters, ranging from 5.4 ml/L at the surface to 5.7 ml/L at 100 m. At 300 m depth off Oahu, these values decreased to 5.0 ml/L. A similar distribution pattern for pH was noted off Oahu, in December, 1976, where values in the surface waters averaged 8.1 and increased to 8.2 between 25 m and 50 m depths. A decrease of 7.9 was noted at 300 m. The pH values were markedly lower at the same site during April 1977. Values of pH averaged 7.6 at the surface, increasing to 7.7 between 100 m and 150 m depth, and then decreased to 7.6 at 400 m. In sea water, pH generally ranges from 7.5 to 8.4.

B. BIOLOGICAL RESOURCES

1. Humpback Whales

The focus of the Hawaiian Islands Humpback Whale National Marine Sanctuary is, as the name suggests, the humpback whale (*Megaptera novaeangliae*), an endangered marine mammal. *Megaptera novaeangliae* (or "long wings" of "New England") elicits a great deal of popular admiration because of its size and long pectoral fins; the fact that it can often be observed from shore or in nearshore areas; its often spectacular aerial displays; and its long, mystical vocalizations that can be heard by divers or acoustical instruments in the water. This section summarizes information about the humpback whale to inform the reader of its characteristics, status and distribution, habitat use, activities which can affect or adversely impact the whale, and management considerations. (A more comprehensive description can be found in Appendix G).

a. Natural History

i. Species description and taxonomy

Humpback whales occur throughout the world in both coastal and open ocean areas. They typically migrate between tropical and sub-tropical latitudes and temperate to polar latitudes. The former areas are occupied during winter months when the whales engage in mating and the females bear their young. Humpback whales are not known to extensively feed in the wintering grounds, although opportunistic feeding has been observed. Polar areas are occupied in the spring, summer, and fall months when feeding occurs.

Prior to commercial whaling, the worldwide population of humpback whales is thought to have been in excess of 125,000. Between 1905 and 1960, intense commercial whaling operations targeted the humpback whale worldwide. In 1966, treaties under the International Whaling Commission (IWC) protected humpback whales from further harvesting by whaling operations. While the exact population numbers on humpback whale abundance and distribution are unknown, humpbacks are probably the fourth most numerically depleted species of the large whale family (following the northern right whale, blue whale, and bowhead whale) [National Marine Fisheries Service (NMFS) 1991]. In 1984, it was estimated that perhaps no more than 10,000 to 12,000, or about 10 percent of the estimated initial worldwide population, existed (Braham 1984). Recent revelations from the Russian President for Ecology and Health, confirming that the Soviet Union was illegally killing thousands of endangered humpbacks and other great whales in the southern Hemisphere and perhaps the North Pacific and North Atlantic during the 1960's after the ban had been in effect, bring further doubt about the world population (Yablokov 1994).

The humpback whale is one of six species listed in the Family of whales known as *Balaenopteridae*. This family is divided into two genera, *Balaenoptera* and *Megaptera*. The genus *Megaptera* includes a single living species, *Megaptera novaeangliae* or Humpback Whale. The distinguishing features which separates this genus from other whales in this family is the presence of unusually long flippers (about 1/3 total body length), a more robust body, fewer throat groves

(14-35), more variable dorsal fin, and utilization of very long (up to 30 minutes), complex, repetitive vocalizations (Payne and McVay 1971) during courtship (NMFS 1991). The name *Megaptera* means "great wing" and refers to the very large flippers of humpback whales. All six species within this family have but four fingers within their flippers; the middle or third finger is missing (Tinker 1988).

The body length of humpback whales may vary somewhat in different geographical areas. The maximum recorded length of a humpback whale was measured at 18 m by Winn and Reichley (1985). The National Marine Mammal Laboratory recorded a mean length for physically mature humpback whales killed off California at 14.5 m or approximately 47.5 ft. (females) and 13.5 m or approximately 44 feet (males) (NMFS 1991). The heaviest humpback whale measured was a 14 m female at 43.9 metric tons (Nishiwaki 1959). The body color of these whales is generally dark above and is characterized by white pigmentation on the flippers, flukes, sides, and ventral surface. Researchers identify individual humpbacks by photographs of the black and white pigment patterns on the underside of the flukes and by individually variable features (NMFS 1991).

ii. Distribution and Zoogeography

Distribution of humpback whales is global, though it is less common in Arctic waters. Seasonal migrations of humpback whales occur between low latitude wintering areas used for mating and calving, and high latitude summer feeding areas (Calambokidis et.al. 1996). There is little evidence that northern and southern hemisphere populations significantly mingle. The populations of the two hemispheres are effectively isolated by patterns of latitudinal seasonal migration associated with feeding (in polar waters) and breeding (in warm low latitudes), which are out of phase by 6 months. However, there is suggestive evidence based on results of biopsy studies which indicate that transoceanic genetic exchange has occurred among North Pacific and Southern Ocean populations of humpback whales based on similarities in mitochondrial DNA sequence (Baker et al. 1993, 1994). In addition, direct observational evidence suggests a possible geographical overlap of southern and northern hemisphere whales in Costa Rican waters (Acevedo and Smultea 1995).

Humpback whales are generally considered to inhabit waters over continental shelves, along the edges of continental shelves, and around some ocean islands and atolls (NMFS 1991). Concentrations of animals occur repeatedly in some areas. In the North Pacific, summer feeding areas include: the Alexander Archipelago, southeast Alaska; Prince William Sound, Alaska; and in the eastern Aleutian Islands and portions of the Bering Sea (Darling and McSweeney 1984). Dohl (1982) reported several hundred animals feeding off central California. Winter areas in the North Pacific include the Bonin, Ryukyu, and Mariana Islands, the main Hawaiian Islands, and along the west coast of Baja California and mainland Mexico, near the offshore area of the Revillagigedo Islands (Rice 1978). In the western North Atlantic humpbacks feed over the continental shelf and along the coast of Iceland, southwestern Greenland; the Newfoundland and Labrador coasts, the Gulf of St. Lawrence and the Gulf of Maine. Feeding areas in the eastern North Atlantic include the British Islands north as far as Bear and Spitsbergen islands and as far east as Novaya Zemlya. The Lesser Antilles, Virgin Islands, Puerto Rico, and the Dominican Republic are wintering areas for the western North Atlantic population. The eastern North Atlantic population winter in areas around the Cape Verde Islands, west Africa to southern Morocco (NMFS 1991). Southern Pacific populations of humpbacks interchange between Antarctic feeding grounds and breeding areas along the coast of western Australia, Queensland, New Caldonia -- Loyalty Islands -- New Hebrides, Fiji and Lau Islands, Tonga, Niue, and the Cook Islands (Winn and Reichlely 1985). Populations of southern Atlantic humpbacks winter in coastal areas of Argentina and Brazil, Angola, Gabon, Sao Tome and Principe (NMFS 1991).

iii. Populations and Subunits

Observations of marked individuals suggest that major oceanic populations of humpbacks are divided into a number of distinct subpopulations which are not separated by obvious geographical barriers (Katona and Beard 1990, Baker et. al 1986 and 1990). At present there is no way to determine how unique and isolated a population must be before it is considered a "stock." Differences in the timing of breeding provide a particularly important criterion for distinguishing between populations of humpbacks in the northern and southern hemispheres because they imply that a barrier exists to gene flow between these two populations (Dizon et al. 1992).

Stocks of whales have been defined by morphological differences of various types: color patterns, body size, shape, and skeletal characteristics. Variation in the coloration of humpback whales has been used to characterize different stocks in the southern hemisphere (Winn and Reichlely 1985). Researchers have reported that some southern hemisphere humpback whales have extensive white lateral coloration. Such extensive white lateral coloration has not been reported for northern hemisphere whales (Nishiwaki 1959, Glockner and Venus 1983).

Morphological differences between two or more populations probably represent underlying genetic differences, and analyses of DNA and morphology should provide similar evidence (Dizon 1990). Observations of continued seasonal return of individual whales identified during their first year of life suggests that fidelity to a specific feeding ground is the result of the calf's early migratory experience (Baker et al. 1987 and 1993, Clapham and Mayo 1987). Matrilineal fidelity within feeding groups may enhance cooperative feeding systems. For humpback whales, cooperation during feeding could be optimized by forming a structured stock in which individuals feed among closely related individuals but breed among distantly related or unrelated individuals (Baker et al. 1986). Patterns of mtDNA and nuclear DNA in North Pacific humpback whales have revealed significant differences, particularly among feeding areas (Calambokidis et al. in press). Significant differences were found in mtDNA halotypes between 38 biopsied whales in southeastern Alaska and 20 from central California, suggesting the genetic exchange rate between California and Alaska to be less than 1 female per generation (Baker et al. 1990 and 1994, Calambokidis et al. in press, Small and Demaster 1995). These results further suggest that population structures among humpback whales appear to be based on matrilinear fidelity to feeding areas.

To facilitate management of humpback whale population units, NMFS (1991) uses the term "stocks" to refer to groups of whales using geographically distinct winter ranges for reproduction; and the term "feeding aggregations" for groups using geographically distinct summer ranges for feeding. Some reproductive stocks appear to be comprised of whales from several feeding aggregations (Baker et. al 1987, Clapham and Mayo 1987, NMFS 1991). Thirteen humpback whale stocks have been identified worldwide (NMFS 1991, Marine Mammal Commission 1995). Four stocks of humpback whales are found seasonally in U.S. waters. These are the western, central, and eastern North Pacific stocks and western North Atlantic stock (Marine Mammal Commission 1995). Figure II-7 (NMFS, 1991) illustrates the different stocks, their preferred summer, wintering, or year around habitats, and general migrations routes.

iv. Habitat Use and Behavior

1) Summering areas -- Feeding

Humpback whales feed while on the summer range, which is usually located over a continental shelf at latitudes between approximately 40° to 75°. Sea surface temperatures may vary between very low temperate conditions 2°C near the edge of pack ice in western Greenland at 64°N to higher temperatures at 21°C about 42°N in Massachusetts Bay (NMFS 1991).

Principal prey species include small schooling fish, such as sand lance, capelin, mackerel, and anchovy, as well as krill. Humpback whales probably feed whenever and wherever suitable sized concentrations of prey are encountered (NMFS 1991).

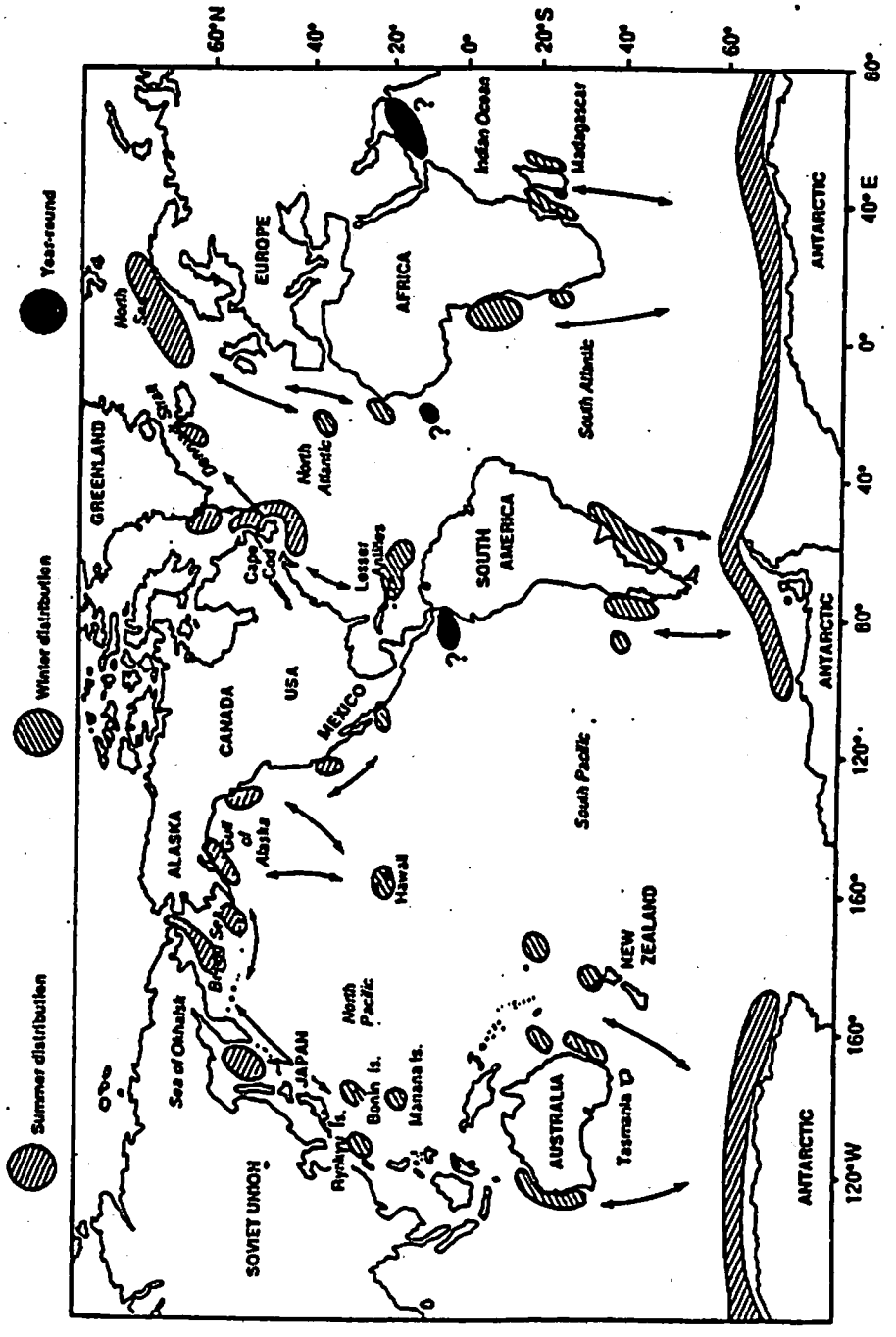


Figure II-7 World-wide distribution of humpback whales (NMFS 1991)

Humpback whales, engage in a wide variety of feeding behaviors. Observations of feeding behavior reported include: bubblenetting (Jurasz and Jurasz 1979, D'vincent et al. 1985, Hain et al. 1995), surface rushes and lunge feeding by humpbacks in the western North Atlantic (Watkins and Schevill 1979), lobtail feeding, and using the water surface as a barrier to prevent the escape of prey (Weinrich et al. 1992). Descriptions of feeding behaviors are usually limited to what can be observed at or near the surface. Hain et al. (1995) described an additional behavior of humpback whales apparently bottom feeding and prey flushing on burrowed northern sand lance in Stellwagen Bank off Massachusetts. It has been suggested (Jurasz and Jurasz 1979, Watkins and Schevill 1979, and Hain et al. 1995) that various prey species or densities elicit different feeding strategies and behaviors. For more mobile and evasive species, or for more efficient feeding in lower densities, more sophisticated methods may be advantageous.

Observations of feeding in wintering areas suggest that feeding may not be entirely confined to so-called feeding grounds. In the northern hemisphere, occasional feeding of humpback whales on known breeding grounds has been reported. In the North Atlantic, in Smana Bay (Dominican Republic), Baraff et al. (1991) reported feeding behavior by a single animal which repeatedly formed bubble clouds and exhibited surface lunges (Gendron and Urban 1993). In the North Pacific, one vertical lunge by a subadult humpback whale was observed off Maui, Hawaii (Salden 1989). A single humpback whale was also observed bubble-net feeding near the surface in the southern portion of the Gulf of California in March 1989 (Gendron and Urban 1993). Observations of juvenile humpback whales feeding near the mouth of Chesapeake Bay was reported during the months of January through March 1991 and 1992 (Swingle et al. 1993). These observations indicate that humpback whales occasionally feed while on their breeding grounds and this opportunistic activity may vary according to locality and food availability.

2) Migrations

Long distance migrations of humpback whales occur seasonally between low latitude wintering areas used for mating and calving and high-latitude feeding areas. Discovery tags used by commercial whalers to mark individual whales provided the first direct evidence of connections between summer and winter assemblages. However, information obtained from the tags were limited and the tags had a tendency to injure or kill the animal (Winn and Reichley 1985). In the western North Atlantic and the central and eastern North Pacific it was noted that individual whales consistently migrate to one of several discrete coastal regions where they feed during the summer and fall. These repeated sightings of photographically identified individuals provided further evidence about the beginning and end points of the migratory destinations of humpback whales (Darling and McSweeney 1984, Baker et. al, 1986, Katona and Beard 1990, and NMFS 1991).

Using observations of peak concentrations of whales along the migratory route, Dawbin (1966), estimated that humpback whales migrate at a rate of 15° latitude (900 nautical miles) per month. Clapham and Matilla (1990) reported migration speeds for two individuals migrating between the Greater Antilles and Massachusetts Bay at a rate of 14.8° and 21° latitude per month.

3) Wintering Areas -- Reproduction

During the winter months humpback whales congregate to give birth and presumably mate in shallow waters near islands and continental coastlines in lower latitudes (usually between about 10° and 35° latitude). Sea surface temperatures in these areas vary from 25°C in waters around Hawaii (Herman 1979, NMFS 1991) to 28° C in the West Indies (NMFS 1991).

Female humpbacks produce one calf on average every 2.4 to 2.8 years (Chittleborough 1965, Baker et. al 1987, Clapham and Mayo 1987). Therefore reproductively active females constitute a limiting resource. Males appear to compete for reproductive access to females in surface active pods. Competition between males appears to escalate from low-level agonistic

threats and displays to high-level agonism involving physical combat (Tyack and Whitehead 1983, Baker and Herman 1984). Social sounds produced during these agonistic pods may function as acoustic threats between males (Tyack 1983, Silber 1986). Juveniles presumably do not participate in reproductive activities until they reach sexual maturity, usually at age 4 to 6 years. Known juveniles have been reported on the outskirts of primarily adult "surface active groups" in breeding areas (Matilla et al. 1989, Swingle et al. 1993). Little information though, exists on the activities of juveniles during this time.

Long complex songs produced primarily by lone, relatively stationary males is a common occurrence on the breeding grounds and is presumed to be a component of the humpback mating system (NMFS 1991, Frankel et al. 1995). The exact function of songs produced by males on the wintering ground is not known.

v. Natural Mortality

A review of literature for the humpback whale recovery plan (NMFS 1991) revealed how little is known about the natural mortality in humpback whale populations. Factors which may contribute to natural mortality include parasites, predation, red tide toxins, and ice entrapment (NMFS 1991). Clapham and Mayo (1987) suggest it is possible that mortality in humpback populations is highest during the time between birth and arrival in high latitudes, and that a calf surviving its first few weeks of life has a relatively good chance of reaching sexual maturity.

b. North Pacific Population of Humpback Whales

i. Use of Feeding and Wintering Areas

In the North Pacific humpback whales feed over the continental shelf and in numerous deep water sounds and channels from California along the Pacific rim to Japan (Jurasz and Jurasz 1979, Darling and McSweeney 1984). The historic summering range of humpback whales in the North Pacific encompasses coastal and inland waters around the Pacific rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk (Small and Demaster 1995).

Humpback whales in the North Pacific use three primary wintering areas (Rice 1974, Johnson and Wolman 1984). These consist of the waters near Mexico, Hawaii, and Japan. In Mexico, humpback whales winter off the southern tip of Baja, around the Revillagigedo Archipelago, and in coastal areas off mainland Mexico. In Hawaii, humpback whales primarily winter in waters less than 100 fathoms deep around the main Hawaiian Islands (Herman and Antinoja 1977, Rice and Wolman 1978). In Japan, humpback whales utilize areas near the Bonin and Ryukyu Islands (Rice 1978). In addition, Stieger et al. (1991) reported observations of humpback whales wintering off the coast of Costa Rica.

ii. Abundance and Trends

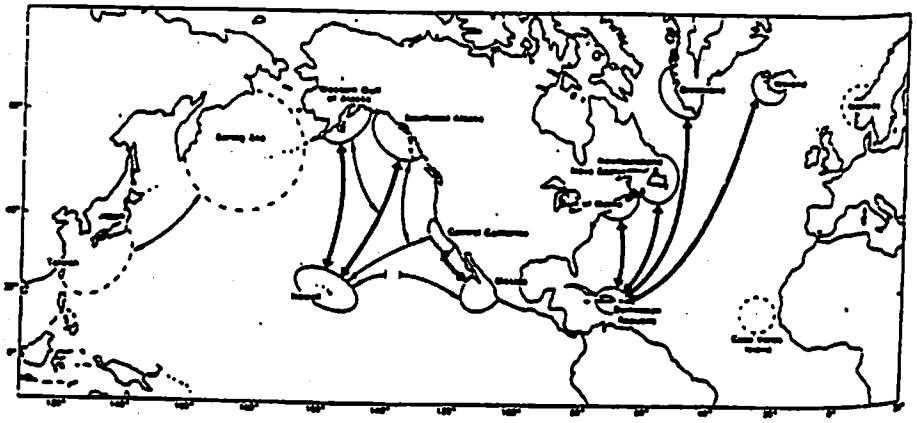
The size of the north Pacific humpback whale population was estimated earlier to be approximately 10 percent of the species' pre-whaling abundance (Rice 1978, Wolman 1978). Prior to the 1970s, most of the information concerning the natural history of humpback whales came from harvested specimens primarily in the southern oceans (e.g., Chittleborough 1954, 1955; Dawbin 1966). During the past two decades the focus of research has shifted to field studies of free-ranging specimens aided by the use of natural markings on the flukes to identify individuals. Analysis of photographs of these natural markings (primarily variations of black and white pigment found on the ventral surface of the flukes) have contributed substantially to the understanding of the population structure, social ecology, and reproductive patterns of this species.

Efforts to estimate the numbers of humpback whales in regions throughout the North Pacific using capture-recapture statistics based on photoidentification is currently underway. However, the current abundance estimate is considered unknown because the stock has been increasing for the past twelve years (Small and Demaster 1995).

iii. Stock Structure

Kellogg (1929), using the observations of early whalers, suggested that humpback whales in the north Pacific were divided into an American and Asian stock. He proposed that the Asian stock wintered in tropical waters south of Japan and traveled north to feeding areas in the Sea of Okhotsk and along the Kamchatka Peninsula. The American stock was thought to breed in the waters off the west coast of Mexico and travel northward along the coast of North America to feeding grounds in the Gulf of Alaska, the Bering Sea, and near the Aleutian Islands. At that time, there was no evidence of exchange between the American and Asian stocks. Recently, however, Darling (1991) reported a resight of a humpback whale seen in the waters surrounding Ogasawara, Japan, as well as the island of Kauai. Recent analyses of humpback whale songs recorded in the wintering grounds off Mexico, Hawaii, and Japan also support the possibility of cross-Pacific exchange (Helweg et al. 1993) since some "themes" (recurring features of song) were found common to all three wintering regions. The Hawaiian wintering grounds were apparently not known to Kellogg, nor to other authors discussing the north Pacific humpback whales (Nishiwaki 1966).

More recent photographic identification data, focused primarily on the habitats in the central and eastern north Pacific, have revealed patterns of exchange between southern wintering areas in Hawaii and Mexico, and northern feeding areas in the waters surrounding the Farallon Islands off the central California coast, southeastern Alaska, and western Gulf of Alaska (Perry et al. 1988). In contrast to migration from winter to summer regions, cases of movement from one summer feeding area to another are rare. Based on these patterns of movement, Baker and others (1986) proposed that humpback whale groups in the north Pacific are best described as "structured stocks" that consist of several feeding herds which intermingle to breed on one or more wintering grounds. The relationship between and among the various stocks of humpback whales has been better elucidated by genetic research conducted over the past 10 years (Small and Demaster 1995; Baker et al., 1994; Calombokidis et al., in press). Figure II-8 illustrates the different stocks, their preferred summer, wintering, or year around habitats, and general migration routes in the North Pacific.



* The migratory destinations and population structure of humpback whales in the North Pacific and western North Atlantic oceans, based on observations of marked individuals. Regions encircled by a solid line are defined by current observations of seasonal return by naturally marked individuals. Regions encircled by a broken line are defined by historical patterns of distribution during periods of commercial whaling. Arrows connect seasonal habitats visited by individually identified whales but do not necessarily indicate migratory routes. Thick arrows connect regions with known strong migratory interchange and thin arrows connect regions with weak migratory interchange. The broken line connecting Hawaii and Mexico indicates the probable presence of an intervening seasonal migration to a feeding ground by individuals sighted on both winter grounds in alternate years (from Baker et al. 1990 and 1993).

Figure II-8 Humpback whale migration routes and population structure

iv. Humpback Whales in Hawaiian Waters

1) Historical Presence

Pacific whalers have sighted humpback whales in Hawaiian waters since the 1840's, but there are no written records (from the Western world) of whales existing in Hawaii before this time. Herman (1979) suggests that humpback whales may have not "arrived" in Hawaiian waters until the mid-1800's. The Native Hawaiian language does not specifically name humpback whales in chants or stories, however, they are known as *kohola* (Pukui and Elbert 1986). Unlike humpbacks, sperm whales (*Physter macrocephalus*), have long been part of Native Hawaiian lore and are called *palaoa*. Only the *alii* (kings) could approach sperm whale carcasses, and the bones were used only by the highest chiefs. Sperm whales never became part of the everyday family gods (*aumakua*), possibly because the whales were too large, and most family gods were relatively the same size as humans. Moreover, whales were never hunted by Native Hawaiians as a major source of food, so their importance in sustaining the culture was less than other species which were utilized. There is a Native Hawaiian chant of creation called the *Kumilipo*, which mentions the *kohola* as one of the creatures that was created.

Over the last 25 years, researchers have noted the tendency for humpback whales to congregate in shallow-water banks and island areas during the winter breeding season (Chittleborough 1965, Herman and Antinoja 1977) with peak abundance occurring approximately between mid-February and mid-March (Baker and Herman 1981, Herman et al. 1980, Forestell and Mobley 1991). Because humpback whales are not known to extensively feed during the winter breeding season (Dawbin 1966, Tomilin 1967), this shallow-water preference is not likely based on prey availability. Other authors have conjectured that: (1) shallow, inshore waters offer greater protection from predators such as sharks, which is of particular concern for calves (Baker 1985); or (2) warmer waters require less of an expenditure of metabolic energy, which is

particularly important during a period of fasting (Brodie 1975). There are relatively large expanses of shallow water (less than 100 fathoms or 600 feet deep) surrounding the main Hawaiian Islands.

2) Reproduction

The social behavior of the whales while in the wintering waters is presumably related to reproduction, since calves are born during the winter season and gonadal activity in both males and females increases in the winter months (Chittleborough 1954, 1955, Nishiwaki 1959). It appears that the mating system is polygynous or promiscuous (Mobley and Herman 1985), characterized by complex acoustic displays (i.e., 'songs'), and vigorous physical competition among males. Female humpbacks generally give birth to a single calf at two- to four-year intervals (Baker et. al 1987, Glockner-Ferrari and Ferrari 1984, Clapham and Mayo 1987), although some females may give birth two years in a row. The calf remains with its mother for approximately one year (Chittleborough 1954). Current rates of neonatal mortality are unknown, but of great importance to assessments of the rate of recovery of the species (Perry et al. 1990). Mother-calf pairs are frequently accompanied by a third whale, an "escort" (Herman and Antinoja 1977). The escorts appear to be consorting with the mother in order to mate with her, and intense aggression among escorts and "intruding" whales has been observed (Tyack and Whitehead 1983, Baker and Herman 1984, Mobley and Herman 1985). Although not all females ovulate post-partum, enough may do so to warrant the attention of males (Herman and Tavolga 1980, Tyack 1983). It is generally difficult to determine the gender of humpback whales in the field, however, in those cases where discrimination has been possible, singers and escorts have proven to be males (Glockner-Ferrari and Ferrari 1984, Baker and Herman 1984).

3) Singing

Long, complex "songs," first identified by Payne and McVay (1971) and by Winn and Winn (1978) are heard throughout the humpback's winter grounds. Singing peaks during the winter months (Helwig 1993). Occasionally, songs are heard in the late fall in high latitudes or along the migratory route (Frankel et al. 1995). Songs consist of a set of themes produced in a consistent sequence (Payne and McVay 1971, Frankel et al. 1995). Within a season, the songs of all singers typically have the same sequence of themes. During the season, the song continuously evolves as new changes are introduced (Payne and Payne 1985). The exact function of songs produced by males on the wintering ground is not known. The singer is normally a lone whale, however some whales sing while in groups (Baker and Herman 1984) and some sing while swimming (Frankel et al. 1989). Singers have also been observed to stop singing and join with cow-calf pairs, and sing while escorting (Tyack 1981, Darling et al. 1983, Frankel et al. 1989, Helweg et al. 1993). Concurrent singing by many whales may be a form of communal display by males (Herman and Tavolga 1980) which, in addition to other functions, may help to synchronize ovulation in females with the presence of mature males (Baker and Herman 1984). Sound-playback experiments have indicated that songs probably function as an advertisement rather than an attractant because playbacks of song rarely produced approach by whales. Other sounds that may indicate the presence of a female (Alaskan feeding call and Hawaiian social sounds) were more likely to cause whales to approach the playback source (Tyack 1983, Mobley et al. 1988).

Current studies of humpback song by Frankel and others (1989) modeled on the procedures developed by Clark, Ellison, and Beeman (1986), utilize a linear array of hydrophones to track vocalizing whales (singers) by their sounds (Frankel et al. 1989). Recent findings from acoustic-array work suggest that the initial distance between singers is one determinant of whether other singers will increase, decrease, or maintain their separation distance (Helweg et al. 1993). These results indicate that maintaining spacing among males is one function of song, as first suggested by Winn and Winn (1978), and that the biologically effective distance of song is approximately 6 km (Frankel et al. 1991). Based on a review of accumulated evidence it has been proposed that a dual function of song is that it serves to establish spacing among individual singers

approximately 6 km (Frankel et. al. 1991). Based on a review of accumulated evidence it has been proposed that a dual function of song is that it serves to establish spacing among individual singers and as a means of advertisement to females (Helweg et. al. 1993). Data collected by Frankel et. al. (1995) using passive acoustic location techniques in combination with more traditional visual techniques to study humpback whale behavior on the wintering grounds of Hawaii, appears to support this hypothesis. The separation distance between singers (mean 5.1 km) was found to be significantly greater than that between nonsinging singletons (mean 2.1 km), supporting the hypothesis that song functions to maintain spacing between singers (Frankel et. al. 1995).

4) Humpback Whale Distribution

Earlier aerial surveys (Herman et. al. 1980, Baker and Herman 1981, Forestell 1989, Mobley and Bauer 1991, Forestell and Mobley 1991) suggested that the majority of humpback whales were found in the shallow waters (<100 fathoms) of the main Hawaiian Islands, though extensive surveys in deeper waters were not conducted. Analyses of pod locations in the four-islands and Penguin Bank regions revealed that whales were not distributed homogeneously throughout the 100-fathom isobath but were generally found in more shallow water (modal depth=27 fathoms) (Forsyth et. al. 1991). More recent surveys have concentrated in waters exceeding 100 fathoms and have found that approximately 74 percent of all humpback whales are found within the 100-fathom isobath (Mobley et. al. 1993) (Figure II-9). The fact that 26 percent of all sightings were in deep waters suggests that past surveys, with efforts concentrated in waters less than 100 fathoms, may have underestimated the number of whales present.

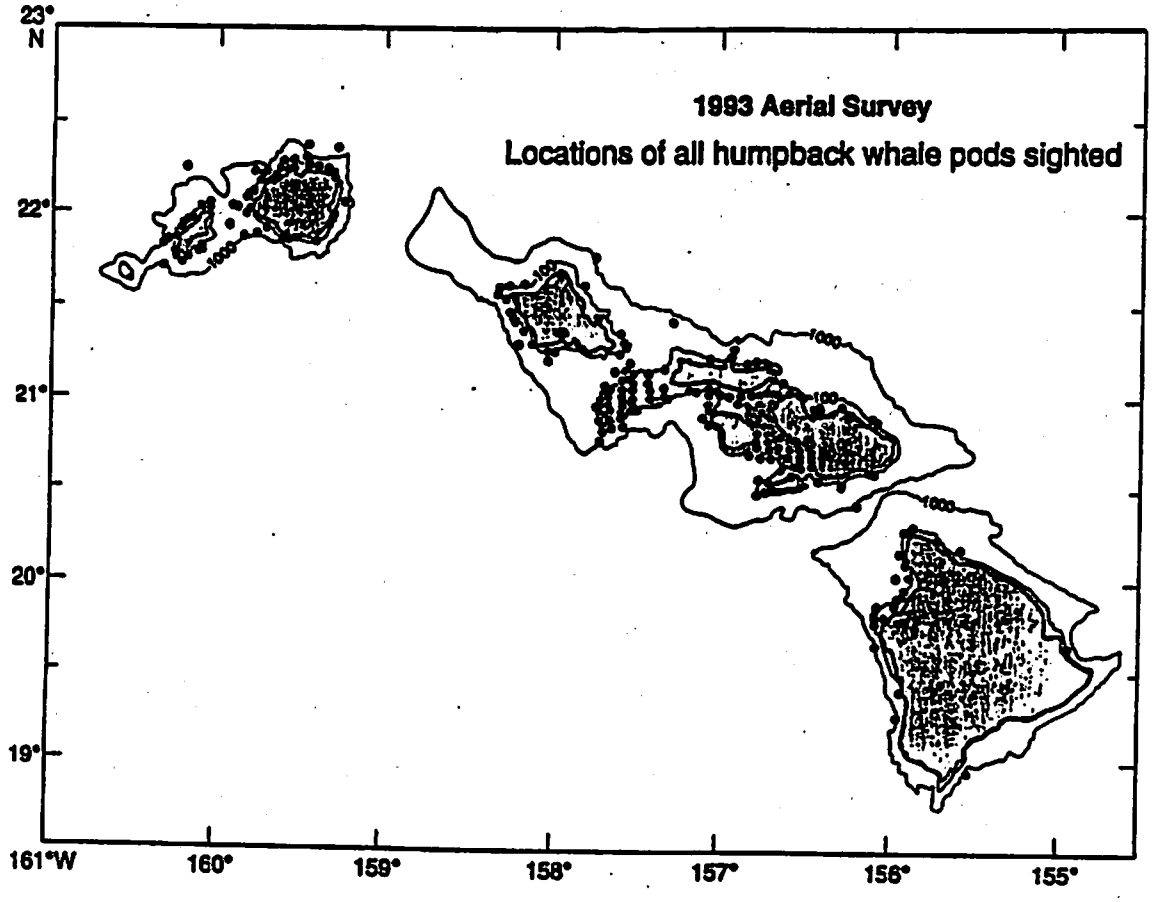


Figure II-9 Results of statewide 1993 humpback whale survey (Mobley et al. 1993)

The earlier surveys (1977-80) showed wintering humpbacks to be concentrated in the waters of the four-islands and Penguin Bank regions (Herman and Antinoja 1977, Herman et al. 1980, Baker and Herman 1981). The majority of pods containing calves were also found in these areas (Figure II-10). Replication of this earlier effort during the 1990 season (Mobley and Bauer 1991) showed that these regions were still preferred by adults and calves, but revealed substantially increased sighting rates around the islands of Niihau and Kauai (Figure II-11). Densities of calf pods around the Kauai/Niihau region remained low, however, with only the Oahu island region lower among the total of five regions. Arranged in order of decreasing sighting rates those islands as follows: Penguin Bank, four-islands region, Kauai/Niihau, Hawaii, and Oahu.

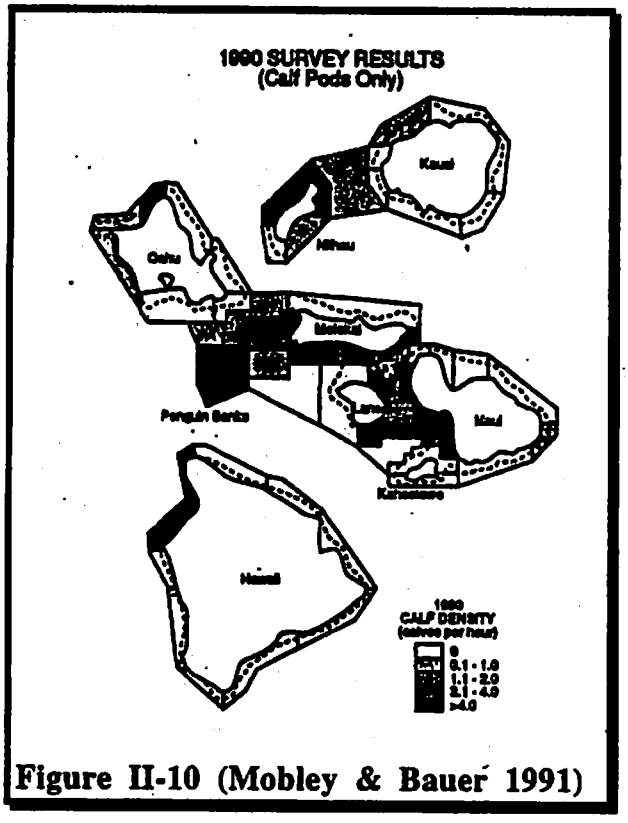


Figure II-10 (Mobley & Bauer 1991)

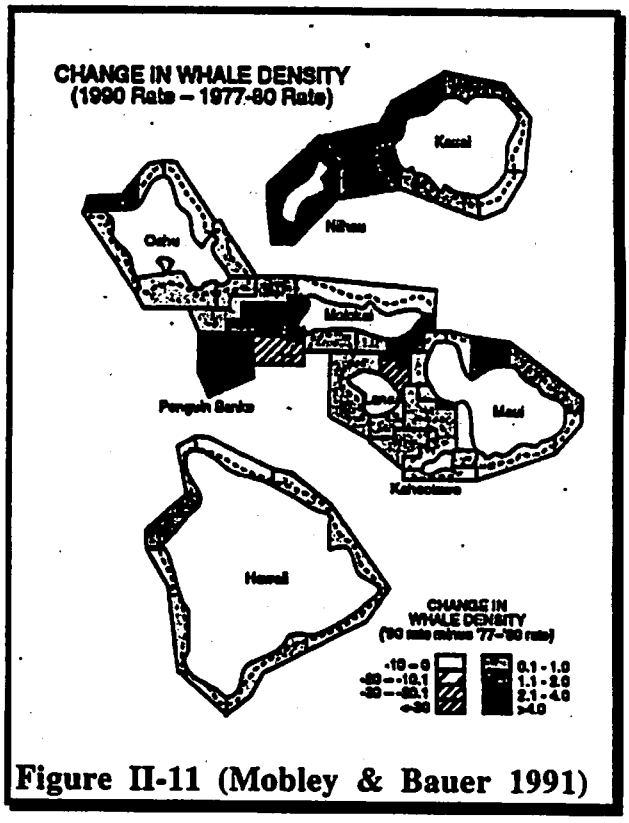


Figure II-11 (Mobley & Bauer 1991)

The 1993 aerial survey results support the findings of earlier surveys with regard to the descriptions of inshore waters as preferred habitat for humpback whales (Herman and Antinoja, 1977, Herman et al. 1980). Figures II-12 through II-15 show all 1993 and 1995 humpback whale sightings by region and by year (Mobley et al. 1996). The number of humpback whale sitings doubled from 1993 to 1995. This difference is more than expected based on the 39% increase in effort during 1995 (primarily in the vicinity around Kahoolawe), and also may be due, in part, to better seastate conditions during the 1995 survey (Mobley pers. comm.). As shown, there is a clear preference for inshore waters less than 100 fathoms in depth, despite more recent efforts to locate whales in deeper waters (Mobley et al., in press). During the 1993 aerial survey, 74 percent of all humpback whale sightings occurred in waters less than 100 fathoms, with only 20 percent of effort within this depth stratum (Mobley et al. 1994). The fact that the remaining 26 percent of humpback whales were found in deeper water suggest that earlier surveys which primarily surveyed waters less than 100 fathoms likely undercounted the wintering population (Mobley et al. 1994). Information on the use of habitat areas within the Hawaiian Islands by humpback whales is described below.

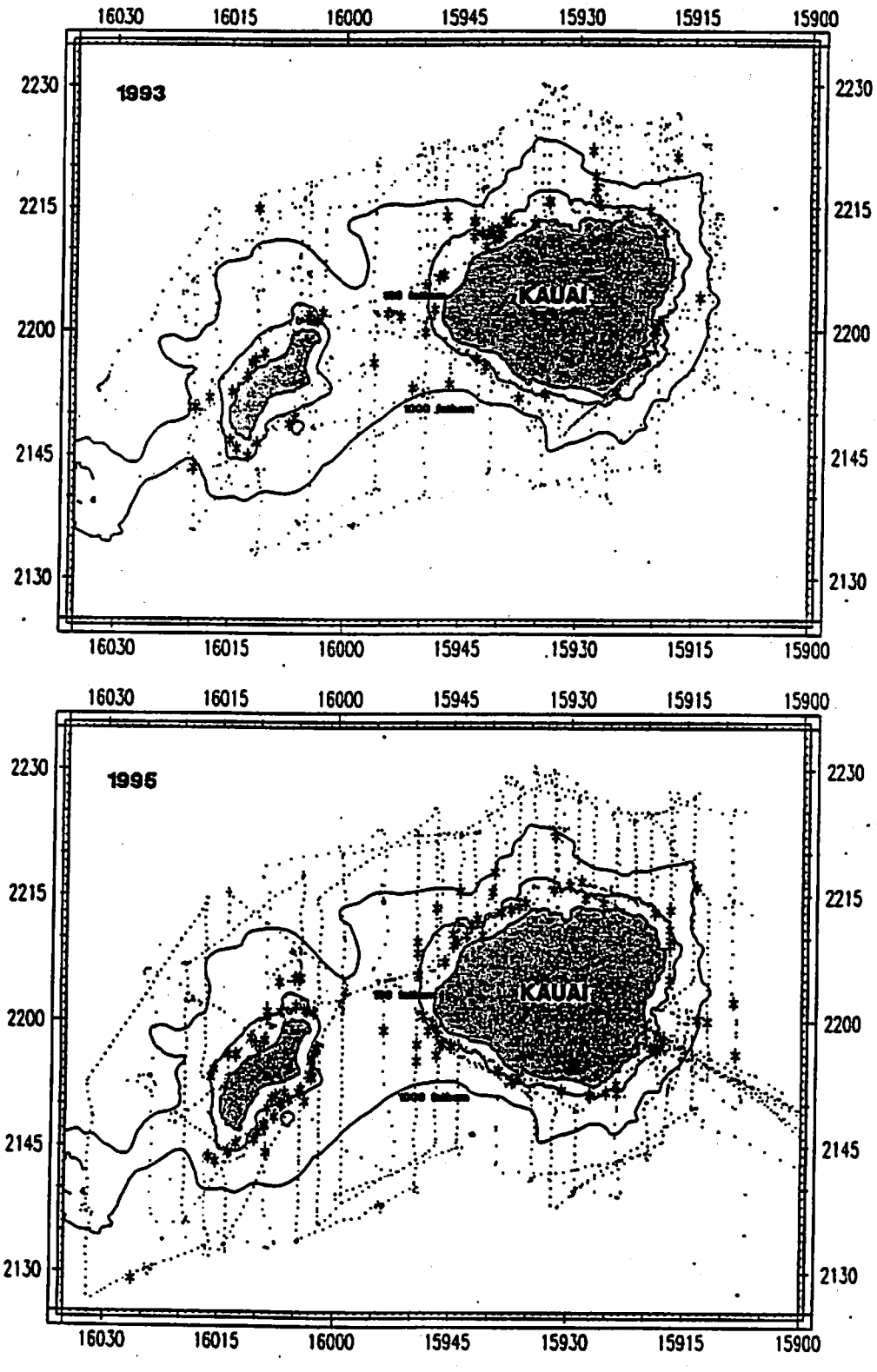


Figure 1. Humpback whale sightings (asterisks) and aerial survey effort (dots) for 1993 and 1995, Kauai area.

Figure II-12 Humpback whale sightings for 1993 and 1995 (Mobley et al. 1996)

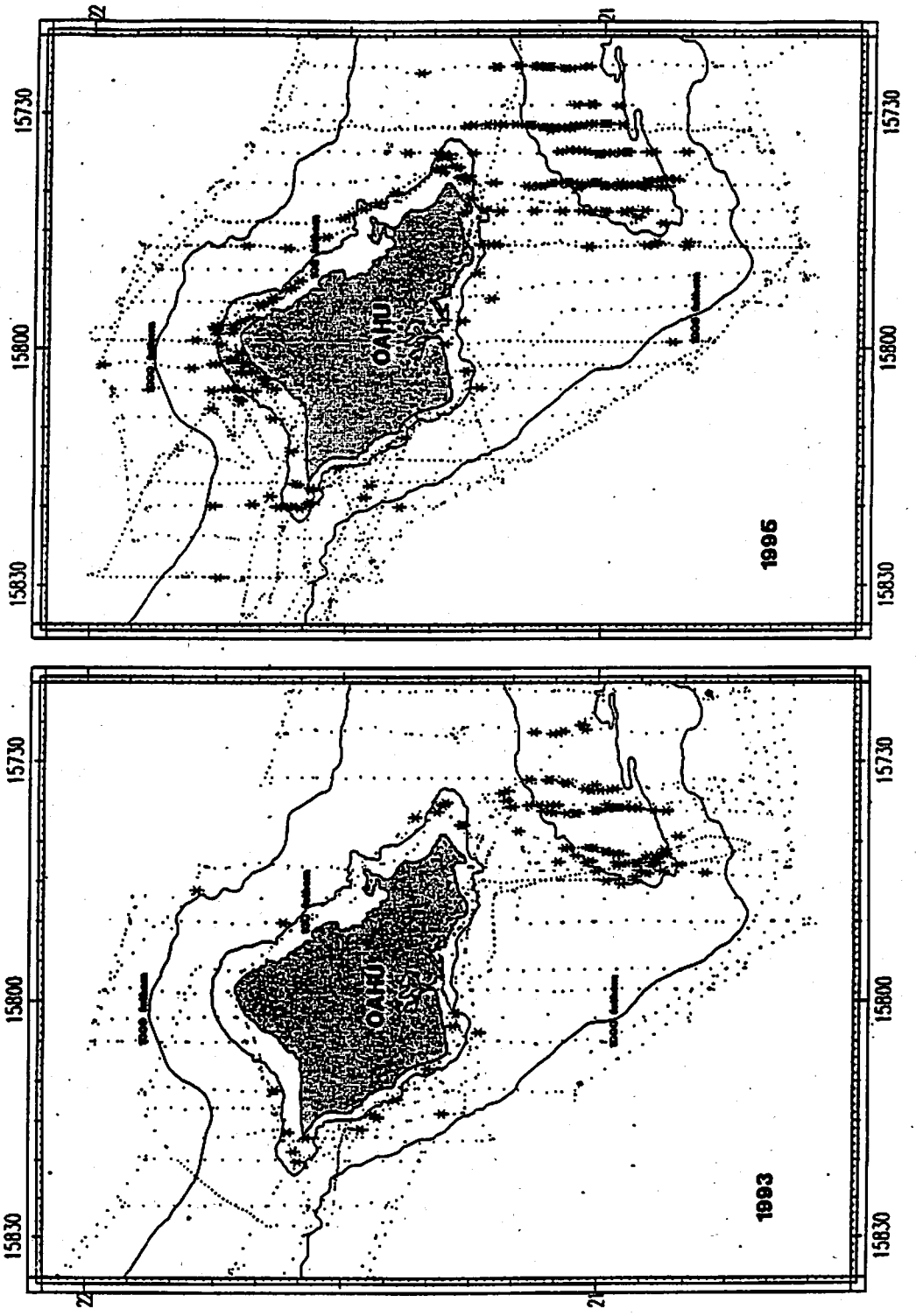


Figure 2. Humpback whale sightings (asterisks) and aerial survey effort (dots) for 1993 and 1995, Oahu area.

Figure II-13 Humpback whale sightings for 1993 and 1995 (Mobley et al. 1996)

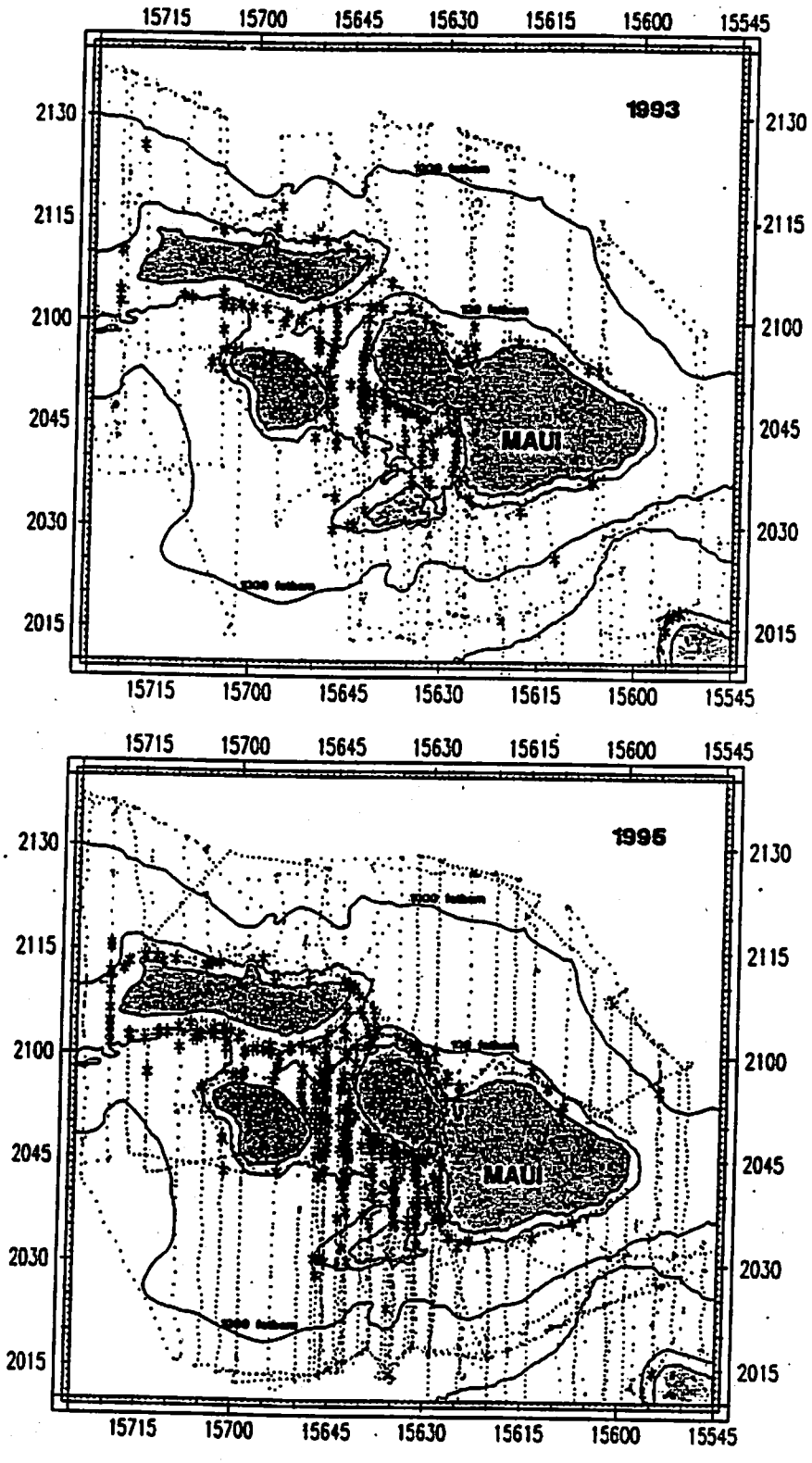


Figure 3. Humpback whale sightings (asterisks) and aerial survey effort (dots) for 1993 and 1995, Four Island area.

Figure II-14 Humpback whale sightings for 1993 and 1995 (Mobley et al. 1996)

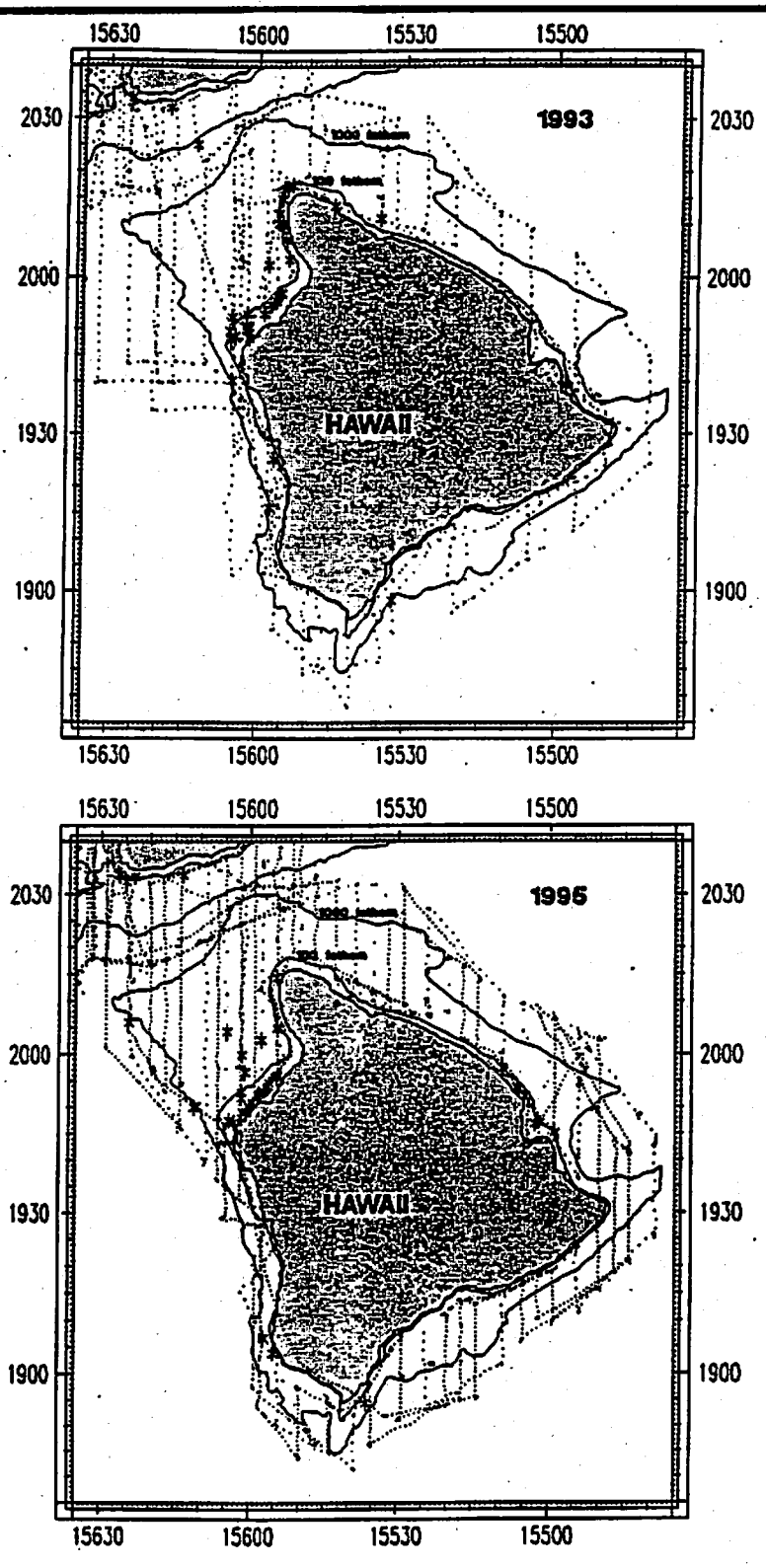


Figure 4. Humpback whale sightings (asterisks) and aerial survey effort (dots) for 1993 and 1995, Big Island area.

Figure II-15 Humpback whale sightings for 1993 and 1995 (Mobley et al. 1996)

5) Humpback Whale Cow-Calf Distribution

Mobley et al. (in press) reports that calves comprised only 5.2 percent of all whales seen in 1993 and 4.5 percent of all whales seen in 1995. This is lower than the typical 7-8 percent reported in previous surveys (Herman and Antinoja 1977, Herman et al. 1980, Mobley and Bauer 1991). During the 1990 aerial surveys, all pods sighted were orbited to determine pod composition. For this reason, the 1990 results provide a more reliable indication of the number of calves present in recent years, as well as the regions preferred by pods with calves (Figure II-10). Of the 361 whale pods observed (where pod composition could be confirmed), 79 (22 percent) contained calves. Sixty-eight percent of all calf pods observed were seen in the four-islands and Penguin Bank regions. Based on these data, Mobley and Bauer (1991) described these regions as preferred calving grounds, probably because of the greater expanses of available shallow water (less than 100-fathoms). During 1993 and 1995 few pods were orbited to confirm pod composition and it is likely that calf pods may have been undercounted during these surveys (Mobley et al. in press) (Tables II-3 and II-4).

Table II-3: Calf Pod Sightings by Survey and Region -- All Sightings (1993)

	Region					
Survey	Kauai/ Niihau	Oahu	Penguin Bank	Four Island	Big Island	Total
1	3	0	0	4	3	10
2	0	0	3	5	0	8
3	1	0	0	3	1	5
4	1	1	6	5	0	13
Totals	5	1	9	17	4	36

Source: 1993 ATOC Report, Page 15.

Table II-4: Calf Pod Sightings by Survey and Region -- All Sightings (1995)

	Region					
Survey	Kauai/ Niihau	Oahu	Penguin Bank	Four Island	Big Island	Total
1	1	0	2	6	2	11
2	3	0	2	16	1	22
3	3	2	4	8	1	18
4	1	5	0	5	1	12
Totals	8	7	8	35	5	63

Source: Mobley, pers. comm.

Note: When density of calf pod sighting is used (whales/nautical mile surveyed) then both Penguin Bank and the Four Island region show the highest density of calf pods (Mobley, pers. comm.).

6) Habitat Use

Humpback whales are coastal species while on their wintering grounds (Herman and Antinoja 1977). Highest densities of whales and calves are typically reported in the four island area (Maui, Molokai, Kahoolawe, and Lanai) and Penguin Bank (Herman and Antinoja 1977, Herman et al. 1980, Baker and Herman 1981). Forsyth et al. (1991) found that whales in the Penguin Bank and Maui regions were located at a mean depth of 51.4 fathoms. Recent aerial survey data showed that 74 percent of all pods were seen in waters less than 100 fathoms deep (Mobley et al. 1993).

Previous studies also suggest humpback cows with a calf appear to predominate in shallow, generally sheltered or coastal water, while adults occur mostly in deeper, more exposed water (Herman et al. 1980, Whitehead and Moore 1982, Matilla and Clapham 1989). Data collected near the Big Island during 1988 and 1989 suggest that temporal and spatial distributions of whales differed with group size and composition (Smultea 1994). During afternoon hours and throughout the day late in the breeding season, groups containing a calf occurred in significantly shallower water and nearer to shore than did groups without a calf. Between-group distances were also found to be significantly greater for groups with a calf than distances between all other groups. These temporal and spatial differences may suggest that adults without a calf may use deep water to facilitate breeding behavior while maternal females may use shallower water to avoid harassment and injury to calves from sexually active males, turbulent offshore or deep sea conditions, or predators (Smultea 1994). Adults may prefer deep water to facilitate surface-active breeding behavior and propagation of song. Frankel et al. (1995) found that 50 percent of singers were located in water deeper than 100 fathoms suggesting that the proportion of singers found in deep water is higher than for other classes of whales. Clapham et al. (1992) reported that mature females, probably estrous, or pre-estrous, can be reliably found in large surface active or combative pods farther offshore than mothers and calves. Therefore, Frankel et al. (1995) suggests that the region frequented by mature females without calves contains the prime singing areas.

Movement of humpback whales among different sub-areas within a wintering ground appears extensive, although the pattern and extent of this movement is unknown for whales wintering off the Hawaiian Islands. Earlier reports from aerial surveys over the islands of Hawaii, Maui, Molokai, Oahu, and Kauai (Baker and Herman 1981) found peak abundance off each island was staggered temporally through the season from Hawaii to Oahu. These studies concluded that whales moved through the islands in a general northwesterly direction starting from the island of Hawaii. However, timing of peak abundance off Kauai was anomalous from the overall trend and appeared to be independent from the other islands. Baker and Herman (1981) suggested that Kauai might therefore represent a semi-isolated sub-population, with the deep 125 mile-wide Kauai Channel acting as a partial barrier between Kauai and the other islands (Cerchio in press). Six individual whales moved from Hawaii to the Maui region and one from Maui to Oahu, supporting a general northwest movement trend (Baker and Herman 1981). Darling and Morowitz (1986) reported five cases of whales moving from Maui to Hawaii, refuting a northwest trend, and presented evidence suggesting that the majority of the population was present off Maui through the peak season. More recent studies of movements of whales between Hawaii and Kauai between 1989 and 1991 photographically identified 1,702 individuals, with 40 individuals being captured off both islands including 15 cases of within-year recaptures (Cerchio et al. 1991, Cerchio in press). Of the 15 documented transits between islands, nine whales traveled northwest from Hawaii to Kauai and six whales traveled southeast, originating off Kauai suggesting a similar degree of movement in both directions (Cerchio in press). More scientific research is needed to determine the extent of inter-island movement in Hawaii.

7) Abundance Estimates

Of the known wintering and summering areas of humpback whales in the north Pacific, the Hawaiian Islands are considered to contain the largest seasonally-resident population. Earlier shipboard surveys of the coastal waters of the Hawaiian Islands by NMFS during the winter seasons of 1976–79 (Rice 1978; Wolman 1978) produced estimates of between 550-790 whales (mean estimate 650). More recently, mark and recapture techniques have been applied to analyses of fluke identification photographs that estimated 1,407 whales (95 percent confidence limits 1,113 and 1,701) as having visited the Hawaiian Islands during a four-year period, from 1980 to 1983 (Baker and Herman 1987; NMFS 1991). Because these estimates were produced using different abundance estimation techniques, they are not directly comparable and, therefore, cannot be relied on to suggest population increase.

Mobley and Bauer (1991), comparing sighting rates of pods seen in the winter seasons of 1977–80 with those seen in 1990 using identical methods, found significant increases across the 10 to 13-year period. The authors concluded that either there had been an increase in the size of the north Pacific population, *or* that a greater proportion of the north Pacific population is wintering in Hawaiian waters.

Aerial surveys performed during the 1991 season by Forestell and Mobley (1991) using modified line transect methods, estimated that 1,584 whales were present in coastal Hawaiian waters on the peak date for that season (Feb. 22, 1991). This survey series, however, was limited primarily to waters within the 100-fathom isobath.

The results of the 1993 survey series yielded an abundance estimate of 669 whales, with a confidence interval of 536-835 (Mobley et al. 1993). This estimate refers to the number of animals that were likely to be at the surface at the time of survey, but does not reflect the number of whales below the surface. Shore station results taken from a sample of over 600 surfacings from the north shore of Kauai [1993 Acoustic Thermometry of Ocean Climate (ATOC) Marine Mammal Research Project, unpublished data] show whales to be at the surface 19 percent of the time. The study estimates the population as roughly 3,000 whales, although this estimate may vary pending more reliable estimates of whale surface time.

c. Known and Potential Impacts to Central North Pacific Stock

Human activities and projects can directly affect humpback whale behavior through physical disturbance, and indirectly through habitat modification by, e.g., reducing the water quality. Scientists generally agree that human activities, in water depths of 60 m to 100 m, can be disruptive to whale behavior (Tinney 1988). The extent of the disturbance depends on the location, type, and frequency of the activity. The scientific community is not in full agreement on the extent of these impacts because there is limited empirical data.

The Humpback Whale Final Recovery Plan (NMFS 1991) notes that the known and potential impacts of human activities on whales in the Pacific include subsistence hunting, incidental entrapment or entanglement in fishing gear, collision with ships, and disturbance or displacement caused by noise and other factors associated with shipping, recreational boating, high-speed thrill craft, whale watching, air traffic, or nearshore or in-shore construction. The report also states that "introduction and/or persistence of pollutants and pathogens from waste disposal; disturbance and/or pollution from oil, gas or other mineral exploration and production; habitat degradation or loss associated with coastal development; and competition with fisheries for prey species..." have negative impacts on whales as well (NMFS 1991).

i. Entrapment and Entanglement in Fishing Gear or Mooring Lines

Impacts of fishing, in terms of competition for prey species, may only be a concern in areas where humpback whales feed, such as Alaska. Entanglement is a less likely conflict in areas where whales are not known to feed such as Hawaii. In Hawaiian waters deeper than 20 m, fishermen do not regularly use large nets. There is no trawling or drift gill netting allowed in Hawaiian waters. As a result, there have been few reported cases in Hawaii of humpback entanglement in fishing nets. Only a few reports of humpback whale entanglements in fishing gear are known (G. Nitta, 1994, pers. comm.). In one case a mother and calf were entangled in a shore-deployed float line. Both were released alive by the U.S. Coast Guard (USCG). Another humpback was recorded entangled in a long line gear north of the Hawaiian Archipelago. Humpback entanglement in mooring buoy lines has been observed in at least two instances. In one case, a humpback whale was found by PMRF staff off Kauai entangled in a mooring buoy, but was cut loose and released unharmed by the Navy. During the 1995 winter season, a juvenile

humpback was cut loose from mooring lines off Kihei, Maui by the USCG. After release, the injured whale remained in the nearshore area and was subsequently attacked and killed by several tiger sharks (G. Nitta and A. Tom, pers. comm.). In 1996, several reports of humpback whale entanglements occured during the whale watch season in the waters off Kauai and the Big Island (A. Tom, pers. Comm.).

ii. Collisions with Ships

As ships get larger and faster, and if the numbers of vessels increase, the incidence of encounters can be expected to increase (NMFS 1991). Glockner-Ferrari and Ferrari (1987) note that the number of physical injuries to calves, juveniles, and adult humpback whales as a result of collisions with boats has increased in Hawaiian waters. It has also been noted that humpbacks seem less likely to react overtly to vessels when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984, 1986). If such whales either accommodate to disturbance (Beach and Weinrich 1989) or pay less attention to ships when actively feeding they would have increased risk of collision. In the spring of 1996, a humpback whale calf was reportedly struck and killed by a unknown vessel off the west Oahu coast (G. Nitta pers. comm.).

iii. Acoustic Disturbance

Noise has also been identified as a potential disturbance to whales (Tinney 1988; Bauer and Herman 1986; Atkins and Swartz 1988). The impact of noise depends on three factors: loudness, frequency (tonal pitch), and continuity (noise changes in frequency or direction). Myberg (1990) stated that the responses of whales to noise in general varied according to ambient noise, ongoing activity, and individual species. Studies in Alaska have shown that erratic noises are particularly disturbing to whales (Tinney 1988).

1) Disturbance and noise from ships, boats, and aircraft.

Scientists have observed whales to avoid low-flying aircraft and surface vessels and areas near dense human habitation or disturbance (Herman et al. 1980; Tinney 1988). Tinney noted that commercial whale-watching, jet skiing, boating, aircraft operations, military activities, and scientific research can all elicit behavioral responses in whales. Responses to overflights by cetaceans may include visually tracking the aircraft and can result in premature diving, swimming away from the disturbance, and adults protecting the young by getting between the disturbance and the calf (Tinney 1988). The avoidance to aircraft and boats can be in response to the noise that boats or aircraft produce or their physical presence or motion. Studies have shown that whales phonate at ranges of 12 Hz to 30 kHz (Tinney 1988). Such a range overlaps with those sounds produced by aircraft and has the potential for masking normal sounds produced by whales. The severity of reaction varies across species and with environmental conditions, such as the depth of water and the wave conditions. The shallower the water, the more likely the sound is going to be reflected from the bottom, and the longer it is propagated and perceived by the whales. At angels greater than 13° from the vertical, much of the incident sound may not be heard underwater, especially in calm conditions or deep water since most will be reflected. Rougher seas provide water surfaces at angles more conducive for sound propagation (Richardson et al. 1995).

Responses of humpback whales to overflights are varied. Shallenberger (1978, in Richardson et al. 1985) has observed disturbances provoked by aircraft circling at 305 m but none at 152 m. The size of the group of whales may be related to the response to an overflight: single whales and small groups showed fewer defensive responses than larger groups (Herman et al. 1980 in Richardson et al 1995). Groups composed of all adults tended to engage in evasive maneuvers while adults surrounded calves in mixed age pods. Defensive behavior included bubble blowing, protective movements by mothers toward calves, and threatening tail movements (Bauer and Herman 1986).

Concern over the impacts of boating activities on whales has been growing since a 1977 report by Wolman and Jurasz. Another study (Herman et al. 1980) indicates that human activities may influence distribution of whales in Hawaii. On rare occasions humpback whales reportedly "charged" toward the boat and "screamed" underwater, apparently as a threat (Payne 1978). Concerns over vessel and whale interaction centers on two questions: (1) what is the immediate response by whales to an approaching boat?, and (2) what are the long term changes to distribution and abundance patterns of the entire whale population from boating activities?

The effects of vessel traffic on whale behavior have been shown directly using shore station observation of whales at varying distances from vessels (Bauer 1986; Baker et al. 1982; Baker et al. 1983), as well as indirectly through demonstrations of negative distributional effects with vessels based on aerial survey results. Bauer (1986), observing whales in the waters off Maui, examined a variety of behavioral variables and found changes in respiration rates, dive times, and general activity levels with increasing proximity of vessels. Baker and others (1982, 1983; Baker and Herman 1989) noted similar responses in southeastern Alaskan waters and showed patterns of "horizontal avoidance" (i.e., faster swimming with fewer dives) when vessels were 2,000 m to 4,000 m away, and "vertical avoidance" (i.e., longer dive times) when vessels were from 0 m to 2000 m away. Although, these studies did not indicate how long these behavioral changes persisted.

Forestell (et al. 1990) states, "there are reliable data which indicate that unpredictable, high-speed movement of any motorized vessel within 0.4 km of whales may cause short-term changes in behavior, such as respiration rate or movement direction". The same study confirms that humpback whales avoid the Lahaina area of Maui, "in all likelihood because of the density of human activity." (Forestell et al. 1990). Several studies in the Hawaiian wintering grounds suggest that mother-calf pairs became proportionately less frequent close to shore when recreational boating was increasing (Glockner-Ferrari and Ferrari 1985, 1990; Salden 1988). Although, these studies were not able to determine whether the link with boats was causal.

Reactions of humpbacks to vessels vary considerably and there is presently no indication that any one type of boat has a greater effect on whales, except possibly large vessels, such as cruise ships (Baker et al. 1983); large military or seismographic vessels (Tyack 1989); or the small and highly maneuverable thrillcraft (Green 1990).

2) Commercial Whale Watching Boats and Research Boats

Since whale watch trips and scientific research trips frequently operate at locations where humpback whales aggregate for feeding or reproduction, it could be feared that such activities might displace whales from important habitat. This does not appear to have happened during more than a decade of intensive commercial whale watching near Cape Cod Bay, Massachusetts (NMFS 1991). Humpbacks remain there for extended periods and return annually, despite exposure to many ships, fishing vessels, and whalewatching boats (Beach and Weinrich 1989; Clapham et al. 1993). Humpbacks that are approached slowly and steadily, following established guidelines for whalewatching, show no "adverse reactions". However, those approached within <30m, or via aggressive boat maneuvers, show various changes in behavior (Richardson et al. 1995). Watkins (1986) noted that humpbacks in this area have become less responsive to vessels since whalewatching became common, but they tend to be silent when near boats. Recently, some humpbacks, mainly young animals have begun to approach slow-moving whalewatch vessels. Some occur in busy shipping lanes, and some are struck by vessels (Richardson et al. 1995). The situation as described above, however, may be different in Hawaii and the cumulative effects of whalewatch boats, scientific research boats, recreational, and commercial boat traffic on humpback whales needs to be assessed. To provide for better protection for humpback whales and to minimize effects of increasing vessel traffic on humpback whales in Hawaiian waters, NMFS

published a interim rule in 1987, under the ESA (52 FR 44912) establishing a 100-yard approach limit for vessels (or people), a 300-yard vessel approach limit in cow/calf areas, and a 1000-foot overflight limit. A final rule was published by NMFS in January 1995 (60 FR 3375) which retained the 100-yard vessel approach limit and 1000-foot overflight limit, but eliminated the cow-calf areas and the 300-yard distance requirement.

3) Noise from Industrial Activities (Construction and Dredging)

Construction activities in the water or at or near the water's edge may cause whales to abandon an area (Shallenberger 1978; Herman 1979). Water-dependent construction activities frequently involve loud noises or vibrations associated with blasting, dredging, and filling which could result in displacement, injury, or mortality of humpback whales (Townsend 1991; NMFS 1991). Turbidity, and the discharge of pollutants or resuspension of other sediments may result from these activities as well. While the actual physical loss of habitat may be small in comparison to the total habitat available, secondary effects associated with harbors, ramps, moorings, and hotels; development of tourism focusing on watching whales; degradation of water quality resulting from increased surface runoff (agricultural, industrial, and residential); and sewage effluent from land and vessels, may likely have irreversible consequences on the distribution and reproductive success of humpback whales (Nitta and Naughton, 1989). These nearshore activities may especially affect cows and newborn calves who may be found in waters less than 10 fathoms deep.

4) Sonars

Ships and larger boats routinely use fathometers, and powerful side-looking sonars are common on many military, fishing, and bottom-survey vessels. Use of active sonars in commercial whaling after World War II often caused strong avoidance by baleen whales (Richardson et al. 1995). The emitted pulses reportedly tended to scare baleen whales to the surface (Reeves 1992). Reactions to 3.3 kHz sonar pulses caused wintering humpbacks whales to move away, and 3.1-to 3.6 kHz sonar sweeps increased swimming speeds and track linearity (Maybaum 1990, 1993). Watkins (1986) states humpback whales often react to sounds at frequencies from 15 Hz to 28 kHz, but not to pingers and sonars at 36 kHz and above. It should be noted that these short-term observations provide no information about long-term effects on whales.

5) Explosions

Underwater explosions are common during marine construction and demolition, and during some military operations. Little is known about behavior of humpback whales near explosions. Recently, humpbacks in a Newfoundland inlet was exposed repeatedly to large explosions in subbottom rock (Richardson et al. 1995). Charge size was usually 200-2000 kg. Humpbacks were common within 10 km of the blast site. Whales ~2 km from the blasts showed no obvious reactions. It is not known whether the nonresponsive whales had habituated before observations, began, or if any of them had suffered hearing damage. However, two dead humpback whales with severe mechanical damage to the ears were found near the blast site. The two whales probably were killed by the blasts, but it is not know how close they were to the explosions.

6) Acoustic Ocean Science Studies

Acoustical oceanographers and other underwater acousticians project nonexplosive low frequency sounds into the sea to study sound propagation and ocean properties affecting propagation. This type of work has been done for many years. Recently, it has become controversial because of the possible effects on marine mammals. Few specific data are available on reactions of marine mammals to these sounds. When low frequency sounds are used for ocean

science research, they are usually projected into the deep sound channel, where propagation is efficient (Richardson et al. 1995). During the Heard Island Feasibility Test in the southern Indian Ocean sighting rates for medium and larger-sized whales, mainly pilot, beaked, and balaenopterid whales were lower during than before transmissions. The transmitted sounds may have elicited avoidance by some whales, especially beaked whales and especially in the area visible from the source vessel itself. Sperm and pilot whales ceased calling within 36 hours after transmissions ended. Some large whales however, remained in the general area during transmissions. Reactions of marine mammals during the low frequency sound transmissions during the Heard Island Feasibility Test were considered inconclusive due to low sample size, lack of statistically significant differences, and inability to determine if whales were reacting to the ships in addition to reacting to the transmitted sounds (Richardson et al. 1995).

More recently, scientists at the Scripps Oceanographic Institute have proposed a new acoustic project called Acoustic Thermometry of Ocean Climate (ATOC) in the Pacific Ocean. The ATOC program involves sending acoustic signals from two transducers, one located in the vicinity of the Pioneer Seamount off the coast of California, and the other to be located off the north shore of Kauai. By receiving these signals at passive listening arrays located around the Pacific Rim, the average temperature of deep-ocean water columns can be calculated. According to scientists at Scripps, if global warming is a reality, the temperature of the ocean will reveal it more reliably than monitoring atmospheric temperature differences. The California ATOC source has been operating since October, 1995, and the Kauai source is scheduled to commence operations sometime this fall. A Marine Mammal Research Program (MMRP) was set up by Scripps to investigate the effects of the low-frequency sounds produced by ATOC on marine mammals. The purpose of the ATOC MMRP, designed to be independent of the ATOC project, is to determine: a) the baseline abundance, distribution and behavior of marine mammals in the vicinity of the ATOC source (with special focus on endangered humpback whales); and b) whether the ATOC transmissions produce any changes in these parameters. The ATOC MMRP has brought together some of the most experienced marine mammal scientists in the country to focus on these assessments. Research will be carried out for the next several years. These studies should provide important data on the effects of low-frequency noise on marine mammals.

v. Habitat Degradation

1) Chemical pollution (point and non-point)

The overall impact of pollution on habitats used by humpback whale is not known. Water quality degradation resulting from increased sewage effluent (containing toxic materials or daughter products from pesticides, heavy metals or chlorines), pollutants (toxins, heavy metals, pesticides, pathogens) associated with surface runoff (agriculture, industrial, and residential), and the leaching of vessel hull anti-fouling compounds in enclosed harbors (e.g., tributyltin) may adversely affect the distribution and physical well-being of humpback whales using nearshore waters (Nitta and Naughton 1989). These pollutants, in high enough concentrations, may affect the health of the whales (UH Sea Grant, 1994). Untreated sewage dumped from vessel holding tanks and pumped from municipal outfall during periods of overflow, such as storms and plant malfunctions, are sources of many infectious agents, viral, bacterial, and mycotic, to which cetaceans have shown a definite susceptibility (Dailey, 1985). Although specific data from Hawaii are absent, concentrations of organochlorine pesticides, heavy metals, and PCB's have been reported in humpback whale tissues from Canadian, United States, and Caribbean waters (Taruski et al., 1975). In addition to the Humpback Whale Recovery Plan, other researchers agree that pollution from ships or shore can be a problem for whales (Tinney 1988). Additional concerns include pollution from cruise ships, military activities, use of driftnets, development of geothermal energy, sand mining activities, and development of harbors and resort facilities (Forestell et al. 1990).

2) Habitat Disturbance

Scientific studies have indicated some general tendencies of whales to avoid areas of dense human habitation, such as Oahu, and the area of Maui around Lahaina. (Herman et al. 1980 and Forestell and Brown, 1992). The surveys of Herman, Forestell, and Antinoja (1980) also showed sudden decreases in whale density for the waters off Lahaina Roadstead, an area of heavy vessel utilization. Forestell (1989) noted the same negative distributional trend for the Lahaina area as well as the waters adjoining the Keawakapu boat ramp on the Kihei coast of Maui during the 1985 breeding season.

Comparisons between earlier aerial surveys (1977–80) with those of 1990 offer mixed evidence regarding vessel effects (Mobley and Bauer 1991). Sighting rates (number of whales/hour of survey) increased in the majority of subregions examined across the 10- to 13-year period, including those areas previously described as showing negative distributional effects (waters off Lahaina and Kaanapali); however, those regions showing the greatest increases from the 1977–80 to the 1990 surveys were all characterized as leeward areas with low levels of vessel traffic (Mobley and Bauer 1991). Mobley and Bauer hypothesized a "spill over" effect into these less utilized coastal regions, suggesting that densities of whales in the four-islands and Penguin Bank regions had reached some threshold level and whales were moving into other waters with less traffic. It should be emphasized that factors other than vessels may account for these recent distributional changes. A more comprehensive research study determining the impacts of vessel and vessel traffic on humpback whales will be a priority area during the implementation of the Sanctuary Management Plan.

Aerial survey data from Forestell and others (1985) and Forestell (1989) indicate that "human impact on distribution patterns appeared to be highly localized, dynamic, and reversible." Forestell, et al. (1990) suggest that all boats operating regularly between Maui and Lanai are essentially the same from a whale's perspective. There is no evidence that the whales differentiate between a whale watch boat, a charter fishing boat, a privately owned recreational boat, or a parasail boat. Any of these types of boats can bother a whale, and any of them may be ignored by a whale. What the boat is doing, and how many of them there are, is probably more important than what kind of boat it is (Bauer and Herman 1986).

The authors also suggest that because whales move throughout the nearshore waters of the main Hawaiian Islands and humans engage in such a wide variety of activities in these same waters, there is a "complex and dynamic set of interactions [that] requires a comprehensive, state-wide monitoring and management plan" (Forestell et al. 1990).

In summary, scientific opinion and evidence suggest that human activities that could affect humpback whale behavior and whale habitat include entanglement in fishing nets and long lines (which are not applicable in Hawaii); noise from vessels, aircraft, and construction projects; shipping; disturbance from recreational boating, tour-boating, jet skiing, parasailing; degradation to the water quality from waste disposal and non-point source pollution from coastal development; and by the physical loss of habitat or activities that may cause whales to abandon their habitat and/or interfere with reproductive behaviors in Hawaii. For most of these activities, additional monitoring and research would be required before determinations could be made on the degree of impact on whales from such activities and any management schemes that would be necessary to help minimize the conflicts and impacts.

d. Protection, Legislation, and Management

Humpback whales first received protection in 1966 when the International Whaling Commission placed a moratorium on all commercial whaling. In addition, all marine mammals within the U.S. and territorial waters are currently protected by the Marine Mammal Protection Act

of 1972 (MMPA), as amended. The MMPA established a moratorium, with certain exceptions, on the taking of marine mammals in the U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States. NOAA's National Marine Fisheries Service (NMFS) is charged with the interpretation and administration of this act. Humpback whales are also protected by the Endangered Species Act of 1973 (ESA), as amended. NMFS is also the primary resource agency charged with administration of the ESA for marine species, and in 1991 released the Humpback Whale Recovery Plan pursuant to the ESA. The Recovery Plan established specific objectives for the conservation and recovery of humpback whales in U.S. waters. Humpbacks are further protected in Hawaiian waters by Federal and State anti-harassment regulations, enforced by NMFS (Federal Register 1987, amended by MMPA 1994, and HAR Title 13, Subtitle 11, §244-40) and the State of Hawaii. These regulations established a minimum approach distance of 100 yards for all Hawaiian waters. Violators are subject to fines or imprisonment or both.

2. Other Marine Resources of Hawaii

While humpback whales and their habitat are the only designated Sanctuary resources at this time, the HINMSA requires that the Sanctuary provide for the identification of marine resources and ecosystems of national significance for possible inclusion in the Sanctuary (see Part III - Alternatives and Part V for the process of considering other resources). Section 2302 of the HINMSA contains three findings pertaining to other marine resources: (1) the Western Pacific region has many resources of national significance and importance; (2) Hawaii's marine subtropical ecosystem is diverse and unique; and (3) the Sanctuary, designated for the conservation and management of the humpback whales and their habitat, could be expanded to include other resources of national significance which may exist within the Sanctuary. Recommendations received from the public at meetings concerning other marine resources have ranged from not including any more resources to including all small cetacean species (dolphins); false killer and pilot whales; sea turtles; Hawaiian monk seals; nearshore and offshore coral reef systems; sea birds; large shark species; invertebrates; areas of natural beauty (Na Pali Coast); culturally important areas; historically and anthropologically significant areas; and the entire marine ecosystem. The following section describes some of the marine resources in Hawaii. This section is intended to merely describe some of Hawaii's other marine resources that can be found in the Sanctuary and serve as a list of species proposed for future inclusion in the Sanctuary.

a. General Information

The Hawaiian Islands are one of the most remote group of islands in the world. This isolation has played a major role in the development of the archipelago's shallow marine communities. The origin of most Hawaiian inshore marine species is the Indo-West Pacific Faunal Region (Gosline and Brock 1960; Maragos 1977; Kay 1979; Bailey-Brock 1987), the center of which is in the region of the Malaysian Peninsula and the Philippine Islands. With distance and isolation from this source, many species common elsewhere on Central Pacific reefs are absent in Hawaii. This reduction or attenuation in species with distance from the source has resulted in a proliferation of species (i.e., endemics) in many of the taxa that have successfully colonized the islands (Zimmerman 1948). Some groups such as the reef fishes are represented by a large percentage (29 percent) of endemic species (Gosline 1955; Randall 1987). Briggs (1974) attributes the high degree of endemism among marine organisms in Hawaiian waters to a long, stable climatic history as well as to the considerable geographic isolation. Endemism in the Hawaiian marine fauna is almost entirely restricted to the species and subspecies level of the taxonomic hierarchy (Kay 1977). Endemic species comprise about 20 percent of the mollusks (Kay 1967), 20 percent of the shallow-water asteroids and ophiuroids (Ely 1942) and 40 percent of the Alpheid shrimps (Banner and Banner manuscript).

Because of the isolation and northerly geographic setting (resulting in relatively low water temperatures), the shallow Hawaiian marine fauna is considered to be relatively low in species diversity as compared to other tropical areas in the Pacific. There are about 450 species of inshore fishes (Gosline and Brock 1960; Randall 1980) and 40 species of 58 corals (Maragos 1977) in Hawaiian waters. Many of the shallow-water invertebrates have a greater diversity of species; the Mollusca are represented by about 1,000 species (Kay 1979), the Polychaeta by about 243 species (Bailey-Brock 1987) and the Bryozoa by about 200 species (Soule et al. 1987).

Comparison of the number of shallow-water species of corals, mollusks, echinoderms, and fishes recorded from Hawaii with those found in other island groups to the south of the Hawaiian Islands illustrates the attenuation. In Hawaii, there are 15 genera of corals compared to 53 genera in the Federated States of Micronesia (Maragos 1977). Kay (1967) records about 1,000 species of mollusks in Hawaii and 2,500 species in the Ryukyu Islands, 90 echinoderms are known from Hawaii and 345 from the Philippines (Clark and Rowe 1971), 450 species of fishes are known from Hawaiian inshore waters, and over 1,000 species from shallow-water habitats in the Federated States of Micronesia and vicinity (Myers 1989).

In general, benthic marine habitats are considered in three distinctive zones: littoral, sublittoral, and the deep sea. The littoral zone is often subdivided into a littoral fringe where marine and terrestrial organisms co-exist but marine forms dominate, and the eulittoral zone where marine species adapted to or requiring alternating conditions of submersion and emersion are found (Lewis 1964). In the Hawaiian Islands, the tidal range is only about 1 m; thus, the eulittoral zone is not usually very extensive. Impinging waves may modify the extent of the eulittoral zone by effectively submerging shoreline areas that are usually above the high-water mark thereby obscuring otherwise clear zonation.

b. Nearshore Ecosystems

Hawaii's nearshore environment is divided into shoreline and subtidal ecosystems.

i. Shoreline Ecosystems

The littoral fringe is that area of the shoreline fringed by the seaward edge of maritime vegetation, composed in Hawaii primarily of naupaka (*Scaevola*), hau (*Hibiscus*) and sea heliotrope (*Messerschmidia*). The zone is above the reach of the waves and tides but is markedly affected by salt spray. Two regions are distinguishable: an upper region that is often localized in occurrence and characterized by broken limestone or basalt boulders, and a lower region of more or less continuous rocky substrate of cemented limestone or basalt (Emery and Cox 1956). In the upper region where boulders are covered by a canopy of maritime vegetation and the undersides are characterized by conditions of high humidity, at least six species of mollusks and one isopod are commonly found. Seaward of the boulder region the shoreline is dominated by two littorine species, one of which is from the Indo-West Pacific and the other is endemic to Hawaii. Both of these species require access to the ocean in order to complete their life cycles. Just seaward of this, but above the reach of the waves, a common nerite (pipipi, *Nerita picea*) and two grapsid crab species are found.

Where basalt outcrops extend seaward from the shore, extensive areas of water-leveled benches, vertical cliff faces, and boulder beaches are prominent features of the coastline on all the high islands. The shoreward portions of benches and beaches are part of the littoral fringe, but the seaward sections are alternately exposed and immersed by tides twice daily and scoured by waves seasonally. On basalt benches the highest level of wave action is marked by a line of the alga akiaki (*Ahnfeltia concinna*). Below the *Ahnfeltia* is a variety of frondose algae that covers the substratum with increasing density on approaching the sea. This section is, in turn, succeeded seaward by a broad band of pink coralline algae (*Porolithon*), and the interface between the shore and the sea is

marked by a mix of other algal species. The dominant mollusks seaward of the akiaki are the opihi (*Cellana exarata*), and in the *Porolithon* zone the larger yellow-foot opihi, *Cellana sandwicensis* are found as well as the single urchin, *Colobocentrotus atratus*. The frontal slope of the substratum is riddled with borings from sea urchins (*Echinometra oblongata* and *E. mathaei*) as well as from a number of mollusks. Two species of blennies (including the paoo or *Istiblennius zebra*) are found in this habitat.

The pattern described represents the broadest expression of eulittoral zonation found in Hawaii, and it is variously modified on vertical cliff faces, and in sheltered coves and bays. On vertical cliff faces, the *Ahnfeltia* zone and the succeeding frondose algal zone are absent, with the littorines and nerites of the littoral fringe merging directly into the *Porolithon*-encrusted zone. In sheltered coves and bays, especially where there are intrusions of brackish ground water, the Native Hawaiian oyster (*Ostrea sandvicensis*) will encrust vertical surfaces between the littoral fringe and the subtidal. Where sufficient coverage of water occurs, there is an assemblage of fishes that forage over this substrate including herbivores such as the amaama or mullet (*Mugil cephalus*), the kupipi (*Abudefduf sordidus*), carnivores such as the papio (various species of the family Carangidae), aholehole (*Kuhlia sandvicensis*) and a number of wrasses or hinaleas (Labridae).

Calcareous or carbonate shorelines are dominant features of the coastlines of all the major islands except Hawaii. Solution benches are one form of the calcareous or carbonate shoreline. Topographically, solution benches resemble atoll reef flats, consisting of sea level platforms extending from 1 m to 30 m seaward from the shore. The benches are separated from shore by a raised, sharply pitted limestone zone and a nip (an indentation at the base of the vertical section). Seaward of the nip, the flat-topped surface is densely matted with an algal turf. At the sloping outer edge, calcareous algae and to a lesser extent, corals, contribute to the structure of the bench. Because of its height above sea level, the surface of the bench may be exposed at low spring tides for periods of as long as four hours.

The biota of calcareous shorelines is distinguished from that of basalt shorelines by its cover of thick algal turf. In and among the turf are numerous small invertebrates including polychaete worms, mollusks (cones, cowries, miters) and sea urchins. Both the flora and fauna are conspicuously zoned. The pools of the pitted zone, which are in effect the littoral fringe, are inhabited by small littorines and fishes including the paoo (*Istiblennius zebra*) as well as juveniles of several fish species (mamo - *Abudefduf abdominalis*, kupipi - *A. sordidus*, aholehole - *Kuhlia sandvicensis*). In deeper depressions on the bench that permanently hold water, a much greater diversity of invertebrates and fishes will be found.

Tide pools occur on sea level basalt outcrops, some are formed by depressions in the water-leveled benches, and others are formed by massive boulders fronting the sea and on the benches of calcareous shorelines. Physical conditions in marine pools vary with exposure to the sea. Tide pools that are farthest from the sea undergo striking variations in temperature and salinity, whereas those at the seaward edge exhibit essentially marine conditions. The most exposed pools are characterized by sand substrates bound by cyano-bacterial mats. Few marine species are found here because of the extreme conditions; among those present, however, are several species of mollusks, crabs, and fishes. Seaward pools are progressively more densely turfed with a variety of algae, and the diversity of mollusks, polychaetes, crustaceans, echinoderms, and fishes increases. Many of these seaward pools serve as a nursery habitat for a number of marine fishes including the aholehole (*Kuhlia sandvicensis*), the mamo (*Abudefduf abdominalis*), kupipi (*A. sordidus*), manini *Acanthurus triostegus*), and kumu (*Parupeneus porphyreus*).

Sandy beaches form another distinctive shoreline in the high islands. In general, sandy shorelines are characterized as low, sloping beaches backed by a wall or raised coral platform. Sand is composed of calcareous remnants from foraminifera, mollusk shells, echinoderm, and

coralline algal fragments except on Hawaii, where beaches are composed of black sand and olivine (Moberly *et al.* 1965).

Hawaiian beaches may be subdivided into three zones: (1) an upper beach including the vegetation line; (2) a mid-beach between the high-tide line and the vegetation line, its extent dependent on slope and tide; and (3) the lower beach that is continuously awash by waves. The biota of sandy beaches is associated with both sand grain size and beach slope. The biota of the upper beach is characterized by amphipods, isopods, and ghost crabs which burrow in the area (Fellows 1966). Ghost crabs are also found in the mid beach slope area and the lower beach slope is characterized by the mole crab (*Hippa pacifica*), spionid polychaetes and four species of the gastropods (*Terebra* spp.; Miller 1970).

Fronting many of these different shoreline types are fringing reefs. In general, Hawaiian reefs are not as well developed or diverse as reefs of other Pacific islands, again due to the relative isolation of the archipelago and its geographic position at the northern extreme of coral reef development; thus, water temperature serves to retard coral growth and development. More than one-half of the shoreline of the older islands of the chain (i.e., Kauai, Oahu, Molokai, Lanai, and Maui) is fringed by coral reef. The reefs are wide, shallow platforms extending as much as 300 m seaward from the shore. The reef platforms are typically subtidal, usually between depths of 1 m to 3 m below mean sea level, although occasional sections may be exposed at low spring tides. The reef flats are predominately sand, coral rubble, and coralline algae. Crustose coralline algae are the dominant reef builders on Hawaiian reefs with coelenterate corals being relatively unimportant in the overall fringing reef habitat (Littler 1973). Coral growth is probably best developed along the frontal edges of the reef flats or in adjacent (seaward) deep water areas.

Reef flat assemblages are perhaps the most diverse of those occurring along Hawaiian shorelines partly because of the extended period of time they are submerged. Reef flats have a variety of habitats including solid substrates of calcareous algae and corals, stands of frondose algae, rubble, and sand patches. Because of the variety of habitats, the distribution of reef organisms is patchy; where there are sand patches, infaunal organisms such as mollusks, echinoderms, and polychaetes occur; where there is rubble or living coral, a multitude of other species including fishes are found.

Often estuaries are found where freshwater streams enter the ocean. Estuaries are defined as river valleys inundated by marine waters and receiving freshwater input on the landward side; estuaries may also occur as the tidal portions of streams. In the Sanctuary, Cox and Gordon (1970) note the following areas with estuarine characteristics: Molokai: Halawa Stream and Bay, Pelekunu Bay, and the fishponds of South Molokai; Maui: Maliko Bay, Kahului Harbor, Kahakuloa Bay, Honokohau Bay, Honolua Bay, and the estuarine bays of the northeast coast of east Maui including Honomanu, Makaiwa, Waipio, Hoolawa, Pilale, and Kuiaha.

Estuarine ecosystems support an endemic fauna of about 38 species. Most of these species are euryhaline and most are derived from marine rather than fresh water ancestors (Timbol 1972). Typical estuarine endemic fishes include the oopu (*Awaous genivittatus*), oopu nakea (*A. stamineus*), aholehole (*Kuhlia sandvicensis*), and the mollusk, the hihiwai (*Neritina granosa*). Estuaries are also the primary habitats of a few highly sought-after food species such as the introduced Samoan crab (*Scylla serrata*), and they are the nursery for a number of inshore marine fishes such as the amaama (*Mugil cephalus*), awa (*Chanos chanos*), kaku (*Sphyraena barracuda*), aholehole (*Kuhlia sandvicensis*), and papio (several species of the family Carangidae). Many estuaries in Hawaii are now affected by the invasion of exotic species such as the Tahitian prawn (*Macrobrachium lar*) which tend to replace the native biota.

Although estuaries do not comprise a large, well defined ecosystem type in the boundaries of the Sanctuary, they remain an important habitat type. Despite low rainfall along much of the

coastline of the Sanctuary (e.g., west Maui), many small, intermittent streams may serve as important nursery habitat albeit, the availability of this habitat is transitory. Related to the usual estuarine habitat are mangroves. Mangroves were introduced on Molokai in 1902 and on Oahu in 1922. On both islands there are several developed stands that now exhibit many of the characteristics attributed to mangrove swamps in other tropical areas, but the Hawaiian stands lack the extensive flora and fauna of typical large mangrove stands because of their recent development (Walsh 1963). Recent attempts have been made to control and otherwise remove mangroves from wetland areas (e.g., Kaloko-Honokohau National Historical Park on the Kona coast, the Nuupia Ponds Wildlife Management Area on Mokapu Peninsula, Oahu) where they are eliminating open water habitat that serves as critical foraging grounds for threatened and endangered waterbird species such as the kukuluaeo or Hawaiian Stilt (*Himantopus mexicanus knudseni*).

ii. Subtidal Ecosystems

In addition to coral communities associated with fringing reefs, corals extend subtidally to depths of at least 50 m in Hawaiian waters, although the greatest development of these reefs is at depths from a few meters down to about 30 m. Prime examples of coral community development may be seen on submarine surfaces of recent lava flows off the coast of Maui and in the waters between Maui and Molokai. Coral communities are well developed around the islet of Molokini where commercial dive tours thrive. As discussed, coral communities are better developed where they are protected from high wave activity; thus, the leeward (western) coasts often have well-developed examples; however, coral communities are a characteristic of all subtidal areas with appropriate hard substratum around all of the islands. Hawaiian coral communities show a zonation that is related primarily to wave exposure and indirectly to depth. The three assemblages are described below.

A *Pocillopora meandrina* assemblage is associated with coastlines where there is considerable wave action and a basalt boulder or limestone/lava pavement in depths from about 1 m to about 12 m; occasionally the *P. meandrina* assemblage will be found down to depths of about 30 m. *Pocillopora meandrina* is one of the first coral species to colonize new substrates whether they are lava (Grigg and Maragos 1974) or from anthropogenic sources (concrete, etc., Brock unpublished). This coral species is dominant in the shallow waters at Molokini Islet and at many sites around Lanai, Kahoolawe, and Maui islands. The *P. meandrina* assemblage is often interspersed with other species of corals such as *Porites lobata* and *Monitopora verrucosa*, soft zoanthid corals such as *Palythoa tuberculosa* and *Zoanthus* spp., and the sea urchins, or wana, *Echinometra*, *Echinothrix*, and *Tripneustes*.

More than 50 species of fishes are routinely encountered in the *Pocillopora meandrina* zone (Hobson 1974, Gosline 1965). Included in this group are moray eels or puhis (Muraenidae); squirrelfishes or alaihis and mempachis (Holocentridae); aholehole (*Kuhlia sandvicensis*); aweoweo (*Priacanthus cruentatus*); upapalus (Apogonidae); nenue (*Kyphosus bigibius*); commercially important goatfishes including moano (*Parupeneus multifasciatus*), weke (*Mulloides flavolineatus*), kumu (*Parupeneus porphyreus*), and occasionally the munu (*P. bifasciatus*) fishes (Pomacentridae); wrasses or hinaleas (Labridae); palukaluka (*Scarus rubroviolaceus*); surgeonfishes including the api (*Acanthurus guttatus*), manini (*A. triostegus*), maikoiko (*A. leucoparieus*), pakuikui (*A. achilles*), maiii (*A. nigrofuscus*), maiko (A. nigroris), black kole (*Ctenochaetus hawaiiensis*), kole (*C. strigosus*), maneoneo (*Zebrasoma velifrum*), umaumalei (*Naso lituratus*) and kala (*N. unicornis*); gobies and blennies (Gobiidae and Blenniidae), and a number of smaller species. Other species often encountered in the *Pocillopora meandrina* zone include the omilu (*Caranx melampygus*), papios (family Carangidae), lai (*Scombroides lysan*), amaama (*Mugil cephalus*), nehu (*Stolephorus purpureus*) as well as needlefishes and halfbeaks (Belonidae and Hemiramphidae).

Just seaward and slightly deeper of the *Pocillopora meandrina* assemblage is the zone dominated by *Porites lobata*. Where wave activity is not significant, *Porites lobata* usually grows as a rough hemisphere attaining sizes in excess of 4 m in diameter. This species lays down annual growth bands much like a tree thus the age of individual colonies may be determined (Knutsen et al. 1972). *Porites lobata* has a radial growth of about 1 cm/yr and will attain an age of close to 200 years (Grigg 1982). In bays where wave activity may be light, the zonation of *Pocillopora meandrina* and *Porites lobata* may be less obvious; in these situations, *P. lobata* may be much more abundant than *P. meandrina*. *Porites lobata* is successful in populating almost any consolidated area from shallow depths down to 30 m but will modify its growth form in response to physical conditions of the environment (Maragos 1972). Where there is surge, the coral is usually flat and strongly encrusting; in deep or more protected waters, the coral occurs as a large lobate hemisphere. A number of other coral species are found in the *P. lobata* assemblage including *P. meandrina*, *Montipora verrucosa*, *M. patula*, *M. verrilli*, *M. flabellata*, *Porites compressa*, and a host of lesser species (*Fungia scutaria*, *Leptastrea* spp. *Cyphastrea* spp.).

The diversity of fishes encountered in the zone of *Porites lobata* is greater than that seen in the *Pocillopora meandrina* zone. The difference in diversity may be related to the greater depth and diversity of habitats available in this zone. Gosline (1965) reports 90 species from this biotope; Hobson (1974) notes that most species seen in his study of coral reef fish communities of the Kona, Hawaii coast were present in this coral rich habitat. Brock (1990a; 1992a,b,c; 1993a,b,c) has recorded more than 60 species of fish from the biotope in which *Porites lobata* dominates on Oahu, Maui, and the Big Islands of Hawaii.

In general, seaward of the *Porites lobata* zone or biotope is the biotope of *Porites compressa* whose dominated assemblages are usually found at depths below 8 m to 10 m down to about 30 m. *Porites compressa* colonies form fragile thickets that may cover hundreds of square meters of substratum. Because of its delicate structure, *P. compressa* is usually found in deep water or is situated in locations that are relatively protected from the impact of storm waves. Protected locations include bays as well as the leeward (west) coasts of the larger islands (here West Maui). Again, many of the shallow-water invertebrates and fishes recorded from the Hawaiian Islands are found in this zone. Most of the commercially important inshore fishes and invertebrates are encountered in the biotope of *Porites compressa* and much of the fishing effort today is focused in the biotopes of *P. lobata* and *P. compressa*.

In deeper waters at depths greater than 25m, large boulders and coral rubble dominate the bottom, while hard corals and benthic algae are either absent or their presence greatly reduced. Well-developed terraces and "drop-offs" have been reported at depths of 50, 60, and 75m and are associated with some of the most abundant and economically valuable fisheries in the State. Commonly found, for example, are bottom-dwelling carnivores such as the hapu'upu'u or grouper (*Epinephelus quernus*) and species of snappers or lutjanids including uku, o`paka`paka, ehu, onaga, and where sandy bottoms occur, the kona crab (*Ranina ranina*).

Little is known about biological assemblages occurring at depths greater than 100 fathoms. Scientific research and limited commercial harvesting, however, has revealed the presence of precious corals such as the gold (Gerardia sp.), bamboo (isididea), and pink (Corallium sp.) as well as stocks of deep water caridean and penaeid shrimp. Commercial exploitation of these deep-water resources occurs within the waters of the Sanctuary (DOC, 1984).

c. Cetacean Species Found in Hawaii

The order Cetacea (dolphins and whales) consists of two suborders: Odontocetes (toothed cetaceans) and Mysticetes (baleen whales). Generally, a useful distinction between them is one of size since the great whales are all Mysticetes, with the exception of the sperm whale, an Odontocete.

Shallenberger (1981) identified 24 species of cetaceans (five Mysticete and 19 Odontocete species) in Hawaiian waters on the basis of stranded specimens or field observations (see Table II-5). Nitta (1988) documented all cases of stranded cetaceans recorded between the years 1936 and 1988 which comprised 17 of these species. From both sets of data it is clear that of the Mysticete species, only the humpback whale (*Megaptera novaeangliae*) can be considered seasonally resident. Sightings of the remaining four Mysticete species (Bryde's, finback, minke, and right whales) were so rare as to be considered anomalous.

Of the Odontocete species shown in Table II-5, five were identified on only one or a few instances and are similarly designated as anomalous. The remaining 14 species are designated as rare, uncommon, or common in order of increasing occurrence. Of the eight species of Odontocetes identified during the 1993 surveys of Hawaiian waters (see Figure II-16), four were found within the 100-fathom limit (spinner dolphins, spotted dolphins, bottlenose dolphins, and false killer whales) and thus would likely fall within the jurisdiction of the current proposed marine sanctuary boundaries. It should be noted, however, that because most of the species listed in Table II-5 are wide-ranging, other Odontocetes would likely be found within the proposed sanctuary limits as well. Data from Shallenberger (1981) concerning these four species are summarized below. Additional pertinent data from the 1993 aerial surveys are also included.

TABLE II-5: Cetacean Species Found in Hawaii with Results of 1993 Aerial Surveys*

Common (*Scientific*) Name	Observations	Frequency	Depth of '93 sightings (fathoms)	
			<100	>100
MYSTICETES:				
Fin whale (*Balaenoptera physalus*)	stranding (1)	Anomalous		
Bryde's whale (*B. edeni*)	field obs (few)	Anomalous		
Minke whale (*B. acutorostrata*)	field obs (1)	Anomalous		
Humpback whale (*Megaptera novaeangliae*)	field obs (many)	Common	yes	yes
Right whale (*Balaena glacialis*)	field obs (1)	Anomalous		
ODONTOCETES:				
Sperm whale (*Physeter macrocephalus*)	field obs (many)	Uncommon	no	yes
Bottlenose dolphin (*Tursiops gilli*)	field obs (many)	Common	yes	yes
Spinner dolphin (*Stenella longirostris*)	field obs (many)	Common	yes	yes
Spotted dolphin (*Stenella attenuata*)	field obs (many)	Common	yes	yes
Striped dolphin (*Stenella coeruleoalba*)	stranding (13)	Rare		
Rough-toothed dolphin (*Steno brednaensis*)	field obs (many)	Common		
Common dolphin (*Delphinus delphis*)	field obs (1)	Anomalous		
Whitesided dolphin (*Lagenorhynchus obliquidens*)	field obs (1)	Anomalous		
Risso's dolphin (*Grampus griseus*)	field obs (2);	Rare		
Pygmy sperm whale (*Kogia breviceps*)	stranding (8)	Uncommon	no	yes
Dwarf sperm whale (*Kogia simus*)	field obs (1)	Anomalous		

Killer whale (*Orcinus orca*)	stranding (1)	Anomalous		
False killer whale (*Pseudorca crassidens*)	field obs (many)	Common	yes	yes
Pygmy killer whale (*Feresa attenuata*)	field obs (many)	Uncommon		
Melon-headed whale (*Peponocephala electra*)	field obs (many)	Uncommon		
Pilot whale (*Globicephala macrorhynchus*)	field obs (many)	Common	no	yes
Goosebeaked whale (*Ziphius cavirostris*)	stranding (2)	Rare	no	yes
Densebeaked whale (*Mesoplodon densirostris*)	field obs (1)	Rare		
Bottlenose whale (*Hyperoodon ampullatus*)	field obs (1)	Anomalous		

* Table adapted from Table 1 of Forestell & Brown (1992) that was based primarily on Shallenberger (1981). Stranding results are for period 1936-87 as taken from Nitta (1987). Results of 1993 survey were added from unpublished data. Frequency is noted in decreasing magnitude as follows: common, uncommon, rare, and anomalous.

1993 Marine Mammal Survey

Previous surveys in Hawaii reported only on the locations of humpback whales (Herman and Antinoja 1977; Rice and Wolman 1978; Herman et al. 1980; Baker and Herman 1981), thus, until recently, there were no data from systematic surveys which included Odontocete species. The most extensive marine mammal survey performed to date in Hawaiian waters was conducted during February and March, 1993 as part of a baseline assessment designed to detect the impact of the ATOC transmission on resident marine mammal species (Mobley et al. 1993; Forestell et al. 1993). ATOC was designed by the Scripps Oceanographic Institute to detect global warming trends using low frequency sound. A series of four aerial surveys were conducted during 1993 primarily to assess the abundance and distribution of humpback whales, though locations and group compositions of all marine mammal species seen were also documented. The surveys were designed to conform to line transect techniques, which permit abundance estimates to be projected from sighting data (e.g., Burnham, Anderson, and Laake 1980).

Surveys during the 1993 series were conducted from single-engine overwing aircraft equipped with radar altimeters and global-positioning system devices (GPS). These instruments were used to determine the location and altitude of the plane and, when combined with the sighting angle, to determine the position of marine mammal pods by use of a clinometer. Precise distance estimation is an essential ingredient of abundance estimation.

Unlike previous surveys in Hawaiian waters, the majority of the 1993 effort was concentrated in waters deeper than 100 fathoms (see Figure II-16). Effort was distributed as follows: less than 100 fathoms-23 percent, 100-1,000 fathoms-42 percent, greater than 1,000 fathoms-35 percent.

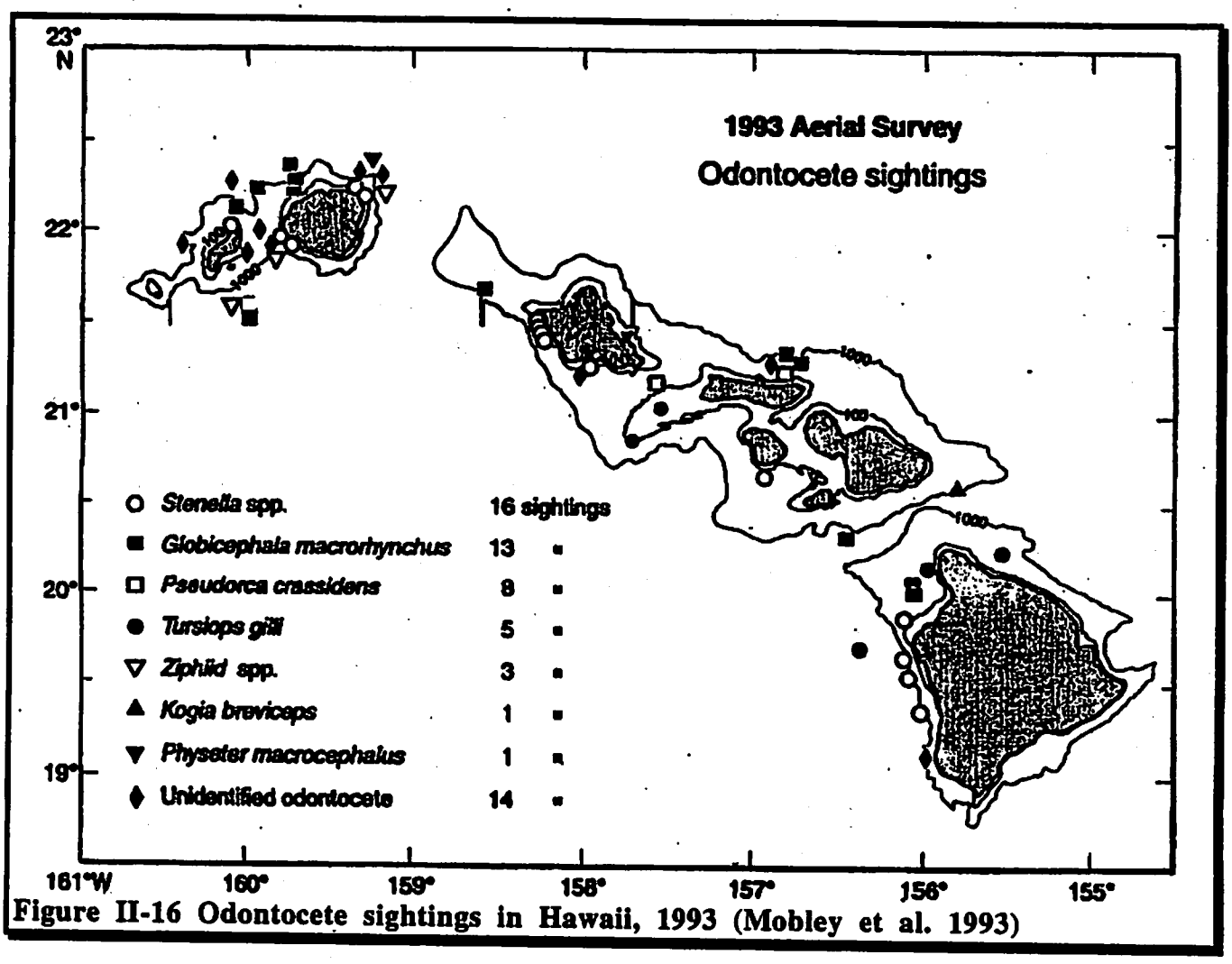


Figure II-16 Odontocete sightings in Hawaii, 1993 (Mobley et al. 1993)

i. Pacific Bottlenose Dolphins

Pacific bottlenose dolphins (*Tursiops gilli*), typically larger and more powerful than their Atlantic counterparts (*Tursiops truncatus*), are found throughout the Hawaiian archipelago including the northwestern islands. Shallenberger (1981) notes they are found mostly along the edges of banks or shelves, usually along the 50- or 100-fathom isobaths where upwelling from deep water occurs. Pod sizes typically range from single individuals and small groups of three to 10 animals to large groups of 100 or more individuals (Shallenberger 1981). They feed on numerous species of fish, squid, shrimp, and other crustaceans (Leatherwood 1975; Leatherwood, Caldwell, and Winn 1976). Bottlenose dolphins adapt readily to captivity and a number of them have been kept and bred successfully at Sea Life Park and other oceanaria.

During the 1993 survey groups of bottlenose dolphins were sighted on five occasions during the 1993 survey in waters ranging from less than 100 to more than 1,000 fathoms. The mean observed pod size was 15.4 individuals.

ii. False Killer whales

False killer whales (*Pseudorca crassidens*) are found throughout the world's temperate to tropical oceans, but are found most often in tropical and subtropical waters (Shallenberger 1981). Their habitat ranges from shallow (<100 fathoms) to deep water (>1,000 fathoms) and their distribution appears to be related to concentrations of prey. They typically travel in large pods, often exceeding 100 individuals, and frequently swim in broad formations, a possible mechanism for finding food. Squid beaks have been found in their stomach contents and they have been observed feeding on mahimahi (*Coryphaena hippurus*) and yellowfin tuna (*Thunnus albacares*) (Shallenberger 1981).

Eight Pseudorca groups were sighted during the 1993 aerial surveys in waters ranging from less than 100 to 1,000 fathoms. Mean pod size was 28.6 individuals.

iii. Spinner Dolphins

Spinner dolphins (*Stenella longirostris*) are members of the genus Stenella that includes spotted dolphins (*S. attenuata*), striped dolphins (*S. coeruleoalba*), and the Clymene dolphin (*S. clymene*). Spinners, so named because of their tendency to "spin" while breaching or leaping from the water, are found throughout the tropical Pacific, Atlantic, and Indian Oceans (Baker 1987). In Hawaii, they are located throughout the island chain and show distributional patterns related to physiography, prey distribution, sea state, water depth, bottom topography, and turbidity (Norris et al. 1985). They are commonly found in large groups consisting typically of 50–100 individuals, though larger groups have been seen (Shallenberger 1981).

Spinner dolphins have been intensively studied, particularly near Hawaii Island (Norris and Dohl 1980; Norris et al. 1985; Ostman and Driscoll 1991; Wursig, Cipriano, and Wursig 1991). Spinners typically show predictable home ranges, foraging at night for food in deep water (400 m-2,000 m) where the deep scattering layer (DSL) rises closer to the surface than normally occurs during daylight hours. Prey species for the Hawaiian spinners are not as well documented as for other regions but are believed to include at least two species of squid (*Abralia estrostrica* and *A. trigonura*) and several species of fish (particularly myctophids) (Shallenberger 1981). During the day they typically return to bays and inshore regions to rest and socialize and to avoid predation by pelagic sharks (Norris and Dohl 1980; Wursig, Cipriano, and Wursig 1991). Spinner dolphins were positively identified on eight occasions during the 1993 survey series in waters between 100-1,000 fathoms in depth. Mean pod size was 50 individuals. Six additional observations were designated as *Stenella* species that were likely to have been either spinner or spotted dolphins. These occurred in waters ranging from less than 100 fathoms to greater than 1,000 fathoms.

iv. Spotted Dolphins

Spotted dolphins (*Stenella attenuata*) are common in Hawaiian waters and are frequently confused with spinner dolphins since they are similar in size and habitat. Most of what is known about spotted dolphins is derived from the eastern tropical Pacific and Japanese waters due to their association with the purse seine tuna industry. Spotted dolphins and related species have been inadvertently slaughtered as a result of purse seine fishing practices in these regions.

Spotted dolphins are typically found in the leeward coastal waters and offshore banks of all Hawaiian Islands, as well as channel regions. Shallenberger (1981:53) writes, "Due to the normally large herd size and the frequencies of observation, it is likely that spotted dolphins are the most numerous Hawaiian cetacean (in terms of numbers of individuals)". Similar to spinner dolphins, spotted dolphins have their own characteristic aerial behaviors including very high jumps, long low jumps, and tail walks (Shallenberger 1981). Shallenberger noted that very little research has been performed on this species in Hawaiian waters. During the 1993 aerial survey,

spotted dolphins were positively identified in just one case, a group of five individuals, in waters less than 100 fathoms.

v. Odontocete Prey Species

What little is known of the feeding habits of Odontocete species in Hawaii has been gleaned from examinations of stranded specimens, occasional field observations, and from generalizations based on more extensive literature for other regions. Shallenberger noted that a significant portion of the diet of smaller Hawaiian cetaceans is made up of epipelagic and mesopelagic fish and squid. Primarily, this includes myctophid fish, some of which migrate at night to within 200 m of the surface, and several species of squid which also show vertical diurnal migrations, including *Abralia trigmura* and *A. astrostica*. Shallenberger underscores the importance of squid to Odontocete diets by noting that virtually every stranded specimen examined contained squid beaks in its stomach contents. The myctophid species of fish are also commonly found in Hawaiian cetaceans (Shomura and Hida 1965). Local fish species of likely importance include: opelu (*Decapterus pinnulatus* and *D. maruadsi*) and akule (*Trachurops crumenophthalmus*). Shallenberger reported that larger cetaceans have been observed eating mahimahi (*Coryphaena hippurus*), yellowfin tuna (*Thunnus albacares*), and skipjack tuna (*Katsuwonus pelamis*). These species are all commercially important and their relative availability can be assessed using catch statistics (Shallenberger 1981).

vi. Predators

Information relevant to Odontocete predation has been primarily anecdotal (Shallenberger 1981), though more recent observations have occurred. Sharks have been observed to feed on live cetaceans in other oceans (e.g., Leatherwood, Evans and Rice 1972; Leatherwood et al. 1973, and more recently off Kihei, Maui (G. Nitta and A. Tom, pers. communication). In spring 1995, a juvenile humpback whale became entangled in a mooring buoy line. Upon release by the USCG, the injured whale remained in shallow water where tiger sharks (*Galeocerdo cuvieri*) repeatedly attacked and consumed portions of the whale (G. Nitta and A. Tom, pers. communication). Other accounts exist of unidentified cetacean remains in the stomach contents of tiger sharks harvested in Hawaii, but it is not known whether the animals were alive or dead when eaten. Additional indirect evidence of shark attacks on cetaceans occurs in the form of crescent-shaped scars on the bodies of living specimens. Hawaiian cetaceans are also frequently seen with the small circular scars characteristic of non-predatory "cookie cutter" sharks (*Isistius brasiliensis*). These small bites generally heal and are not known to be fatal. Occasional visits by killer whales (*Orcinus Orca*) could also result on some predation on calves, but none have been observed thus far.

vii. Odontocete Distribution Trends

Eighty-one percent of the Odontocete pods sighted during the 1993 aerial surveys were found in waters deeper than 100 fathoms. Thirty-eight percent of the sightings were in the vicinity of Kauai and Niihau. Interestingly, the areas favored by humpback whales, the four-islands (Maui, Lanai, Molokai, and Kahoolawe), and Penguin Bank regions showed the lowest incidence of Odontocete sightings. The *Stenella* species, in particular, showed a tendency to locate along the 100-fathom isobath, as described by Shallenberger (1981).

d. Other Endangered or Threatened Species

i. Sea Turtles

Five species of marine turtles are found in the waters around the Hawaiian Islands: green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), and the olive ridley (*Lepidochelys olivacea*)

(Des Rochers 1992). Leatherback, loggerhead, and olive ridley turtles are not known to nest in the Hawaiian Islands and are rarely seen in Hawaiian waters (Balazs 1978). Hawksbills nest on the main Hawaiian Islands primarily on several sand beaches on the island of Hawaii and on the east end of Molokai (Hawaiian Sea Turtle Recovery Team 1992). The green sea turtle is the most commonly found turtle throughout the Hawaiian Island chain. More than 90 percent of the breeding and nesting of green turtles occurs at French Frigate Shoals in the Northwestern Hawaiian Islands (NWHI), although a substantial population resides and returns to the waters within Maui and Kauai Counties.

ii. Hawksbill Turtles

The hawksbill turtle is an endangered species under the ESA [U.S. Fish and Wildlife Service (USFWS) 1992]. Information on the life history and ecology of hawksbill turtles in the Hawaiian Islands is lacking, although these sea turtles were well known to the pre-contact Hawaiian people (Hawaiian Sea Turtle Recovery Team 1992). The Hawaiians did not value the hawksbill as a food item possibly because of its periodic toxicity due to the turtle's dietary habits. According to Balazs (pers. comm. 1993) no more than 15 nesting sites are recorded each year. The nesting period extends from July through November (Hawaiian Sea Turtle Recovery Team 1992). The most consistently used nesting sites are Kamehame Point on Hawaii and at the river mouth of Halawa Valley on Molokai. The NWHI appear to be unfavorable breeding and nesting grounds for the hawksbill turtle.

iii. Green Sea Turtles

The green sea turtle, listed as threatened under the ESA, is a long-range migrant breeder that spends most of its life foraging and resting in nearshore benthic habitats (Balazs, Forsyth, and Kam 1987). Historically, green sea turtles nested on beaches throughout the Hawaiian archipelago, but today rarely outside the NWHI (Des Rochers 1992). The breeding season at French Frigate Shoals, which is the main nesting area within the NWHI, lasts for about five months from May through September (Hawaiian Sea Turtle Recovery Team 1992).

There are numerous sightings of green sea turtles in the waters off Maui County including Honokowai, Maliko Bay, Olowalu, Kahului Bay, and Palaau Bay on Molokai. Between 1948 and 1973, the Island of Maui reported the highest percentage of commercial captures of sea turtles (Balazs 1980). Today, many turtles congregate in the warm water discharge from the power plan in Kahului Bay, possibly to increase their metabolism (Balazs 1980). Kahoolawe and Lanai have only occasional and rare sightings of the green sea turtles, although they may have served as important nesting grounds for green sea turtles in the past. Polihua Beach (Lanai) is the most documented area for green sea turtles nesting on the main Hawaiian Islands; however, there have been no recent observations or sightings of sea turtles at Polihua, perhaps as a result of human use and erosion along the shoreline (Balazs 1980). According to Balazs (1984), Polihua Beach may serve as the best possibility for any future experimental restocking of sea turtles. The largest population of green sea turtles is located near Lanai at Keomuku and Kuahua (Balazs 1984). USFWS (1989) reports that green sea turtles have been seen in the off-shore waters of Kauai and are known to nest in the sandy bays along the coast of Kilauea Point and other areas along the southeast coast.

There are insufficient data to estimate the historical number of green sea turtles in the Hawaiian Islands. Surveys of nesting turtles at French Frigate Shoals since 1973 provide a current estimate of 750 total mature female green turtles (Hawaiian Sea Turtle Recovery Team 1992). Because 90 percent of all green sea turtle nests are found on French Frigate Shoals, the total mature female population is probably less than 900 throughout the Hawaiian Islands.

Green turtles feed primarily on benthic algae which is generally restricted to shallow depths. They have been reported to feed on 56 species of algae and nine species of vertebrates (Des Rochers 1992). Green turtles have been known to bask or rest on beaches (Balazs, Forsyth, and Kam 1987), although terrestrial basking is rare among sea turtles and has been exhibited by only a few populations of green sea turtles in the Pacific. In Hawaii, basking behavior seems to be limited to beaches in the NWHI (Balazs, Forsyth and Kam 1987).

Most adult green turtles reside in the nearshore waters of the main Hawaiian Islands due to the abundance of preferred marine vegetation, the availability of suitable habitat for resting, and the presence of oceanic currents that carry juveniles towards the main islands (Balazs, Forsyth, and Kam 1987). Major resident areas are at depths greater than 20 m but generally not exceeding 50 m. These areas include: Kau and North Kohala Districts (Hawaii); Hana District and Paia (Maui); north and northeastern coastal areas bordering the Kalohi and Auau Channels (Lanai); south coastal areas between Kamalo and Halena (Molokai); Kailua and Kaneohe Bays, northwest coast from Mokuleia to Kawailoa Beach, south and southwest coast (Oahu); Princeville, Na Pali Coast, and the south coast from Kukuiula to Makahuena Point (Kauai) (Des Rochers 1992).

iv. Seabirds

Before the arrival of the first Polynesians in the Hawaiian Islands, there were as many as 110 species of endemic birds throughout the Hawaiian archipelago. Between the time of the arrival of the first Polynesians and the arrival of Captain Cook in 1778, an estimated 40 species may have become extinct (Hawaii Audubon Society 1989). Since the arrival of the Europeans in the Islands, another 22 species have become extinct (Hawaii Audubon Society 1989). The dramatic increase in the number of extinctions has been due to the introduction of foreign plants and animals.

Today, 22 marine bird species can be found throughout the Hawaiian chain, mainly in the NWHI (Hawaii Audubon Society 1989). Of the 30 species of Native Hawaiian birds listed as endangered or threatened by USFWS, only one is commonly found in the vicinity of the Sanctuary, the Hawaiian dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*).

The Hawaiian dark-rumped petrel has been observed on the Islands of Kauai, Lanai, Hawaii, and Molokai. Once Oahu's most numerous seabird, the dark-rumped petrel is now mainly confined to the Haleakala Crater on Maui (Berger 1981). There are barely 400 to 600 pairs of petrels in the Hawaiian Islands (Sheila Conant, pers. comm. 1993). These marine birds return during their breeding season (March-October) to nest at elevations between 7,200 and 9,600 feet, the only bird species in Hawaii that nests at such high altitudes (Sheila Conant, per. comm. 1993). Petrels spend most of their time at sea, feeding on squid, fish, and crustaceans. They come ashore only to nest and raise their young. It is possible that Maui and the other Hawaiian Islands are merely a stop-over for breeding and nesting. No observations have been conducted.

v. Hawaiian Monk Seal

The Hawaiian monk seal (*Monachus schauinslandi*) was listed as endangered throughout its range on November 23, 1976. Counts have been made at the atolls, islands and reefs where they haul out in the northwest Hawaiian Islands since the late 1950s. By 1982, the population had declined to half of its 1957-1958 level, estimated at 3,500 seals (Altonn 1991). Since the mid-1980's, beach counts have declined at five percent per year. NMFS estimates that currently there arebetween 1,300 - 1,400 animals (Gilmartin, pers. comm. 1994; J. Naughton, pers. comm. 1996). The number of births declined significantly at all five major breeding locations in 1990, followed by some recovery in subsequent years. However, the number of births has not reached the level observed in the mid-to-late 1980's, and is not expected to in the near future because of the high losses of immature seals at French Frigate Shoals and mobbed seals at Laysan and Lisianski Islands.

Breeding populations of the Hawaiian monk seal occur almost exclusively in the NWHI. Monk seals are most abundant on Kure Atoll, Pearl and Hermes Reef, Lisianski Island, Laysan Island, French Frigate Shoals, Necker Island and Nihoa Island. A small population of at least a dozen monk seals which have been reported from the island of Niihau and the offshore islet of Lehua. These animals have taken up residence since the mid to late 1980s (J. Naughton, pers. comm.).

Hawaiian monk seals are vulnerable to human disturbance on pupping and haulout beaches, entanglement in marine debris, incidental take in commercial fisheries, possible die-offs from disease and naturally occurring biotoxins, male mobbing of female seals, and shark predation. Exploitation of the Hawaiian monk seal began shortly after 1814, when the Russian explorer Lisianski reported that he observed them in the NWHI (Hiruki and Ragen 1992). The monk seal served as a valuable source of oil, pelts, and food for sealers and sailors. Commercial activity and most incidental taking ended by the late 1800s after seal populations had been decimated (Hiruki and Ragen 1992). Most, if not all, taking by humans stopped once the seal was listed as an endangered species.

Since Lisianski's exploration, there have been two major population declines in the monk seal's history. One, in the 1800s, occurred as a result of extensive sealing and the second, between the 1950s and 1970s was due primarily to human disturbance of the seal's breeding areas (NMFS, 1991). The latter period resulted in a 50 to 60 percent reduction of the seal population (Ragen 1993). Birth count monitoring began in 1983 at the breeding islands. From 1983 to 1988 the number of recorded births increased from 162 to 224. In 1989, the count decreased, and in 1990 only 143 births were observed -- the lowest number of births ever recorded (NMFS, 1991; Altonn 1991).

Monk seals are extremely sensitive to human activity disturbances, and are rarely seen in the main Hawaiian Islands. Seal births were observed on Kauai in 1988 and on Oahu in 1991 (Gilmartin, pers. comm. 1994). Monk seals have also been reported basking along the beaches of the Main Hawaiian Islands, including Maui, Kahoolawe and Oahu (Tanji 1992, 1993). Both incidents verify that the main Hawaiian Islands continue to serve as temporary resting grounds for the monk seal. An additional small population of at least a dozen monk seals took residence near the island of Niihau and the offshore islet of Lehua in the middle to late 1980s. A list of monk seal sightings reported to NMFS in the main Hawaiian Islands since 1985 is contained in Table II-6.

TABLE II-6: Monk Seal Sightings in the Main Hawaiian Islands, 1984–93 Reported to the National Marine Fisheries Service

Year	*Kauai*	*Oahu*	*Maui*	*Molokai*	*Lanai*	*Kahoolawe*	*Hawaii*
1984	1	9	-	9	-	-	-
1985	1	2	3	1	-	-	-
1986	3	10	5	-	5	1	5
1987	35	13	-	-	-	-	1
1988	31	11	1	1	-	1	-
1989	45	11	2	1	-	-	-
1990	6	19	3	2	-	1	1
1991	1	39	7	-	1	2	1
1992	2	37	6	1	-	1	4
1993	3	14	7	1	-	-	6

Source: National Marine Fisheries Service (NMFS) *Monk Seal Recovery Plan*

The first Hawaiian Monk Seal Recovery Team, appointed in 1980, submitted its final recovery plan to NMFS in 1982. The plan, which includes a comprehensive research and management plan for the recovery of the Hawaiian monk seal, was published by NMFS in March 1983. The objectives of the plan were to (1) identify and mitigate the natural factors causing the decline in the seal populations; (2) characterize seal habitat; (3) assess monk seal populations; (4) document and mitigate effects of human activity; (5) implement appropriate management actions leading to conservation and recovery; and (6) develop educational programs. The plan outlines the tasks necessary to meet the objective and assigns the tasks to appropriate Federal and State agencies. A new recovery team was appointed by NMFS in 1989. After the new team's first meeting in 1989, recommendations were submitted to NMFS. Recommendations included research programs, data analyses, the Kure Atoll Head Start Project, the male mobbing problem, population monitoring, recovery actions at Midway Island, the repair of research facilities at Tern Island, and priorities for the 1990 field season. The team has recommended placing observers aboard long-line swordfish vessels operating near the Northwest Hawaiian Islands. In December, 1993, the point at which Hawaiian monk seals may be considered recovered was discussed. The new recovery team concluded that the 1983 recovery plan still provides a useful guide to overall recovery needs. Instead of producing a new plan, the team recommended updating the 1983 plan with results of subsequent annual program reviews.

In summary, the marine waters around the Hawaiian Islands contain a variety of ecosystems (shoreline to subtidal) and species (algae, invertebrates, fish, marine mammals, seabirds, sea turtles), many of which are unique to the Hawaiian Islands. In designating the Sanctuary, Congress found that this region has many resources of national significance and importance, and that the marine ecosystem is diverse and unique. Inclusion of these resources in the Sanctuary would heighten public and agency awareness of the importance of these resources and expand the scope of the Sanctuary's management, education, research and resource protection programs (research, long-term monitoring, education, outreach, enforcement). The Final EIS/Management Plan summarizes some of these marine resources that have been identified by the public and other agencies for possible inclusion in the Sanctuary. More detailed information about these resources and the various Federal, State, and county management regimes is needed before the Sanctuary can proceed with its mandate to identify other resources for inclusion in the Sanctuary. Part V.C.3 of the Management Plan identifies a process to include the public, the Sanctuary Advisory Council (SAC) and the State in assessing whether other resources should be included in the Sanctuary.

C. CULTURAL/HISTORICAL RESOURCES AND USES

Resources of national significance may include cultural and historical resources such as those of Native Hawaiians. In addition, the Sanctuary Management Plan is required by law to facilitate Native Hawaiian uses customarily and traditionally exercised for subsistence, cultural, and religious purposes. This section will explore some of the ways Native Hawaiians have traditionally interacted with the ocean and how those interactions could affect the Sanctuary or Native Hawaiian uses. Major issues of Hawaiian sovereignty and rights are being addressed legally and politically in Hawaii today. The Sanctuary will not generally address these larger issues, but will attempt to "facilitate" customary and traditional uses as they relate to management of Sanctuary resources consistent with the primary objective of resource protection, and to establish a process for possible inclusion of appropriate cultural/historical resources as Sanctuary resources. In addition to facilitating Native Hawaiian uses, the Sanctuary must generally facilitate all public and private uses consistent with the primary objective of resource protection.

A more thorough description of traditional uses of the Hawaiian marine environment can be found in Chapter 6 of the Sanctuary Site Characterization Study (University of Hawaii Sea Grant, 1994). Hawaiians used the ocean for fishing, aquaculture, trade, transportation and communication as well as religious practices. Since the Sanctuary narrowly focuses on humpback

whales and their habitat, the Sanctuary will not directly address fishing issues (i.e., regulation of commercial, recreational, and traditional fisheries). However, the Sanctuary will address issues that may have indirect effects on fishing activities (i.e., proposals for the placement of artificial reefs, etc.). This section focuses primarily on aquaculture, including traditional marine fish ponds and religious sites which are found seaward of the high water mark.

1. Native Hawaiian Settlements And Social Patterns

The early Hawaiians arranged their land and seascapes to reflect their ideas of natural and social order. Each island was called a *mokupuni* or *moku*. *Mokupuni* were further divided into *moku-o-loko* [*moku*], such as Ewa or Waianae on Oahu. These interior island divisions were portioned into *ahupuaa*, *ili*, and smaller parcels which were worked and farmed by *ohana*, or extended family units. The *ahupuaa* was the basic socio-economic land unit. Generally, the *ahupuaa* was a pie-shaped segment of land with its apex at the summit of the central mountain ridges of an island and its wider base at the shore and beyond into ocean fishing grounds. An *ahupuaa*'s boundaries were usually delineated by natural features such as a ridge line separating two valleys. Thus, the valley of Kahana constituted one *ahupuaa* of the *moku* of Koolauloa on the northeastern side of the island of Oahu. Hawaii's place names and property laws still reflect these land divisions today.

The Hawaiian *ahupua`a* is a traditional ancestor of the modern-day watershed concept. The court of the Hawaiian Kingdom described the ahupua`a principle of land use in the case of In Re Boundaries of Pulehunui, 4 Haw. 239, 241 (1879) as follows:

> A principle very largely obtaining in these divisions of territory [*ahupua`a*] was that a land should run from the sea to the mountains, thus affording to the chief and his people a fishery residence at the warm seaside, together with the products of the high lands, such as fuel, canoe timber, mountain birds, and the right of way to the same, and all the varied products of the intermediate land as might be suitable to the soil and climate of the different altitudes from the sea soil to the mountainside or top.

The Hawaiians consider the land and ocean to be integrally connected and that the *ahupua`a* also include the shoreline, as well as the inshore and offshore ocean areas such as fishponds, reefs, channels, and deep sea fishing grounds. *Ahupua`a* were further divided into subzones, in both the land areas and the sea areas.

Mauka - land areas	Makai - sea areas
kuahiwi, mountain range	*pu`eone*, sand edge, inshore dune, sand bar
wao akua, forests of the gods	*po`ina nalu*, point where the waves break
wao kele, rain forests	*kai kohola*, reef lagoon
wao kanaka, forests acccesible to man	*kai pualena*, yellowish sea at the mouth of a stream
wao la`au, inland forest region	*kai ele*, dark sea
kahawai, place having water, valleys	*kai uli*, deep blue sea
ko kula uka, upland slope	*kai popolohua mea a Kane*, purplish-blue, reddish
ko kula kai, seaward slope	brown sea of Kane, far reaches of the
ko kaha kai, shoreline	immeasureable sea

Source: Hawaii Non-Point Pollution Control Program (OSP 1996)

Within the *ahupuaa*, everyone had access to various resources, from the sea to the upland forests. People living at or near the shore often exchanged fish or nearshore produce for upland products with their relatives who lived farther inland. Pre-contact Hawaiian society was highly structured

and hierarchical according to ascribed social status based on ranking senior and junior lineage. Lilikala Kameeleihiwa has conceptualized the Hawaiian system of social hierarchy as a triangle:

> On each main island, a single *Moi* [King] at the apex of the society served as an intermediary between the *Akua* and the rest of *Ka Lahui* [the Nation]. Several levels of subordinate *alii nui* and *Kahuna Nui* were followed by more numerous and lesser ranking *alii* and *kahuna* who acted as *konohiki*. These people created a buffer between the *Moi* and the vast majority of *makaainana* who made up the foundation of the society.
>
> Those at the top were *kapu*, or sacred, and possessed of *mana* [spiritual and political power]. Those at the bottom were *noa*, common or free from *kapu* and, by extension, without the necessary *mana* . . . to invoke a *kapu* -- although even a common fisherman, if successful, had some *mana*. Those in between were on a sliding scale, having less *mana* the farther down the triangle they slipped and the farther away they fell from high lineage (Kameeleihiwa 1992:45–46).

This hierarchical system of social organization ensured that the Hawaiian nation lived in harmony with the spiritual and physical world (Kameeleihiwa 1992:25–26). Within the ancient Hawaiian social and economic systems of hierarchy and land division were the concepts of *malama aina* (caring for the land) and *pono* (harmony, balance). The Hawaiians believed they were related to the land and that the *aina* (that which feeds) was their mother, and the plants that sustained them, particularly *kalo* (taro), were elder siblings. This was also true for the sea. Many contemporary Hawaiians continue to live by these precepts, or are returning to traditional ways as a means of recasting their cultural heritage in today's world.

This summary provides only a brief glimpse of ancestral Hawaiian social and religious structures. It is important to recognize that Hawaiian cultural concepts of resource use such as *pono* and *aloha aina* (love of the land) differ significantly from contemporary western concepts.

2. Aquaculture/Fishponds

Aquaculture is an important historical use of the marine environment. According to Kikuchi (1973), "fishponds existed nowhere else in the Pacific in types and numbers as in prehistoric Hawaii". Summers (1964) states that marine fishponds are found nowhere else in Polynesia. Indeed, the practice of mariculture may have originated in Hawaii (Costa-Pierce 1987).

Historical evidence indicates that fishponds were introduced on Oahu prior to the thirteenth century by settlers from the Society Islands (Kikuchi 1973). The earliest aquaculture systems were probably composed of natural bodies of water, weirs, dams, fish traps, and artificial fish shelters (Kikuchi 1973). By the fourteenth century, true fishponds were being developed throughout the Hawaiian Islands (Kikuchi 1973).

The Hawaiians built different types of fishponds to take advantage of a range of geographic and aquatic conditions. According to Kikuchi (1973), "the trend was to utilize practically all available bodies of water of some size in the construction and evolution of fishponds". The different fishponds that evolved for use in fresh, brackish, and marine waters have been classified into six main types (DHM 1990).

Type I: *loko kuapa* — a coastal marine fishpond artificially enclosed by a seawall;
Type II: *loko puuone* or *hakuone* — an isolated shore fishpond usually formed by the development of a barrier beach building a single elongated sand ridge parallel to the coast;
Type III: *loko wai* — a freshwater fishpond located inland from the shoreline;

Type IV: *loko ia kalo* or *loko loi kalo* — fishpond that uses an irrigated taro plot as an inland water pond for the raising of fish;
Type V: *loko umeiki* — a fishtrap similar in shape and construction to a *loko kuapa* with many stone lanes leading into areas enclosed by nets; and
Type VI: *kaheka* and *hapunapuna* - a natural pool or a holding pond.

a. Estimate of Number and Distribution

Estimates vary as to the number of fishponds that were built in the Hawaiian Islands. Costa-Pierce (1987) estimates there were 360 at the time of European contact; Kikuchi (1973) reports that 449 fishponds were constructed; and DHM Inc. (1990) lists 488 fishponds in its fishpond inventory.

The location and distribution of the type of fishponds throughout the inhabited islands seems to be geographically determined. For example, on the island of Molokai, which has a protected, shallow reef along its southern coastline, more *loko kuapa* were constructed there than anywhere else in the islands (Costa-Pierce 1987). On the island of Hawaii, where the shoreline drops off too precipitously for construction of large walled ponds, inland upstream freshwater ponds were built (Hudson 1932). The type and location of known fishponds are listed in Table II-7 with Type I and Type V being the most relevant.

TABLE II-7: Fishponds by Type and Island

Type	*I*	*II*	*III*	*IV*	*V*	*VI*	*II/VI*	*?1*	*Total*
Niihau		1							1
Hawaii	21	61	14	1	1	30	3	8	138
Maui	11	12	7			8		6	44
Lanai	1				3				4
Molokai	44	12	2		13			3	74
Oahu	70	22	78		4			4	178
Kauai		16	13	7				14	50
Total	147	124	114	7	21	38	3	35	489

?1= Unsure of type Source: DHM Inc. 1990; Kikuchi 1973.

b. Fishponds Today

With the population decline in the second half of the nineteenth century, much of the Hawaiian integrated farming system fell into disuse and disrepair. Native Hawaiians largely abandoned the practice of extensive aquaculture in favor of a Western-style food consumption patterns and the fishponds were left unmaintained. Coastal development for tourism and for residential purposes in the twentieth century, especially since statehood, has led to the destruction of many of the ancient fishponds.

Apple and Kikuchi (1975) conducted a visual survey of the coast of the main Hawaiian Islands and found only the remains of 157 fishponds. Of the 157, only 56 could be considered for possible restoration (Table II-8). Madden and Paulsen (1977) conducted a study of 67 fishponds and found that only 28 were still in sufficient repair to be used for mullet (*Mugil cephalus*) and milkfish (*Chanos chanos*) culture. Costa-Pierce (1987) reported that by 1987 there were seven ponds in use for commercial and subsistence purposes.

TABLE II-8: Fishponds of Maui, Lanai, Kauai, and Molokai				
Name	Location (Ili, Ahupuaa, TMK)	Size (acres)	Type	Owner
MAUI FISHPONDS – HANA DISTRICT				
Haneoo	Haneoo/1-4-08:2 (Loko-nui;BPBM 50-Ma-A15-9)	11.2	I	P
Kuamaka	Haneoo/1-4-08:4 (Loko-iki;BPBM 50-Ma-A15-8)	1.3	I	P
LANAI FISHPONDS				
Lopa	Kaohai/4-9-03;9 (BPBM 50-La-A1-13)	0.8	I	P
KAUAI FISHPONDS				
Kee	Haena/5-9-08:18	3	II	S
Kanoa	Hanalei/5-5-01:2	4	III	P
(nameless)	Wailua/4-1-03:16	3	II	P
Alekoko	Niumalu/3-2-01:1	32	III	P
(nameless)	Koloa/2-6-06;2 (Hoai; BPBM 50-Ka-B4-15)	4	II	P
(nameless)	Lawai/2-6-02:1 (Lawai Kai)	2	III	P
Nomilu	Kalaheo-kai/2-3-10:2	4	III	P
MOLOKAI FISHPONDS				
Kainaohe	Kaamola/5-6-05:22	17	I	P
Ualapue	Ualapue/5-6-01:1	22	I	S
Kalokoeli	Kamiloloa/5-4-02:14	28	I	S
Kupeke	Kupeke/5-7-06:1	30	I	P
Niaupala	Kaluaaha/5-6-08:8	34	I	P
Alii	Makakupaia/5-4-06:23	27	I	H
Kaope-a-Hina	Kaluaaha/5-7-09:1	19	I	P
Keawanui	Keawanui/5-6-06:8	54	I	P
Pahiomu	Keonokuino/5-5-01:10	20	I	S
Kihaloko	Ahaino II/5-7-06:22	5	I	P
Kulaalamihi	Honomuni/5-7-04:34	4	I	P
Waihilahila	Kailiula/5-7-06:27	4	I	P
Kanoa	Kawela/5-4-03:23	50	I	P
Kipapa	Keonokuino/5-5-01:8	10	I	S
Kalokoiki	Wawaia/5-6-08:20	6	I	P
Kamahuehue	Kamalo/5-5-02:5	37	I	P
Piopio	Mapulehu/5-7-08:77	17	I	P
Puhaloa	Manawai/5-6-04:29	6	I	P

Key: P = Private; S = State of Hawaii; and H = Hawaiian Home Lands
Source: Apple and Kikuchi 1975

The Governor's Task Force on Molokai Fishpond Restoration produced a recent report which recommended that the State of Hawaii assist to physically rebuild all of the State-owned Native Hawaiian fishponds on Molokai at the rate of two fishponds per year for a period of five years. (May 1993).

c. Implications for the Sanctuary

Fishponds are an important archaeological feature and a link with Hawaii's past. A number of the fishponds judged by Apple and Kikuchi (1975) to be repairable are found in coastal areas adjacent to the Sanctuary. Restoration of exemplary fishponds and the development of a Sanctuary education program revolving around their history, construction, and use may be appropriate.

Because restoration requires the types of activities that are regulated by a variety of existing agencies (i.e., discharging, depositing, alteration of the seabed), close coordination among the Sanctuary, Federal, State and local agencies, and Native Hawaiian interest groups, such as the Governor's Task Force on Moloka`i Fishpond Restoration, would be necessary.

The Maui Sanctuary office is located adjacent to the 1.5 acre Loko kuapa fishpond, the largest remaining fishpond in South Maui. The Sanctuary has worked with local Native Hawaiians to produce a brochure describing the fishpond and how it was used by Native Hawaiians. The Sanctuary, at the request of the local community, began compiling information on how to renovate and restore the Loko kuapa fishpond.

3. Religious Practices and Artifacts

The Hawaiian culture, conditioned by an animistic philosophy of life, viewed humankind as being in harmony with Nature. Hawaiians, according to Beckwith and Luomala (1970), "worshipped nature gods, and these gods entered to a greater or less extent into all the affairs of daily life." This study continues, "much that seems to us wildest fancy in Hawaiian story is to him [the Hawaiian] a sober statement of fact as he interprets it through the interrelations of gods with nature and with man." Just as the sea was an extension of the land, beliefs about the spirit world were an extension of the real world.

Many of Hawaii's myths and legends relate to the sea. In the legend of Ai Kanaka, the priest Kamalo is wronged by the Moi of Mapulehu and seeks retribution from the shark god Kauhuhu. In turn, Kamalo is instructed to collect a number of red fish to prepare as an offering on the day that Kauhuhu comes to deal out punishment to the offender (Forbes 1907). In other stories, the Hawaiian deities are appeased by sacrifices of white fish, red fish, eels, or other sea creatures.

One of the supreme Hawaiian deities, Ku, takes the form of Kuula or Kuula-Kai (Ku, or "abundance in the sea") as the special deity of fishermen (Beckwith and Luomala 1970). According to legend, Kuula was a man who resided in Hana, Maui, and possessed miraculous power in directing and controlling fish (Thrum 1907). Upon his death, Kuula passed into the realm of the deities and his son Aiai begins to build altars to honor his father (Beckwith and Luomala 1970; Titcomb 1972). These altars, known as *koa*, are found along all the major islands. Emory (1969) describes a *koa* on the island of Lanai:

> *"A typical and authentic koa stands at water's edge on the sandy point of Honuaula. The irregular platform of stone and coral is six feet high, surmounted by low altar 6 by 12 feet, littered with shells, fish bones, and fresh crabs. At the back of the koa is an enclosure containing pine timbers suggestive of a recent shack."*

One can see from Emory's description that this *koa* and some others are still in use today.

An important religious practice connected with marine areas and fishing is the belief in the transmigration of the soul of a dead relative into certain species of fish (or other animals), or the animation of certain species by a departed one's soul. These ancestral personal deities, called *aumakua*, took the forms of sharks, eels, octopus, limpets, or other types of marine organisms (Titcomb 1972; Khil 1978; Kawaharada 1992). The *aumakua* were family guardians that were worshipped with daily prayer and by offerings of food in return for bringing good luck during fishing and other important undertakings (Titcomb 1972). Fishermen would not capture any species that were *aumakua* to their families. Violating the *kapu* against taking one's *aumakua* was thought to bring about severe punishment.

4. Kahoolawe Island *(Kohemalamalama O Kanaloa)*

Kahoolawe Island is extremely important from a traditional, cultural, and religious point of view to Native Hawaiians, and has been designated a *State of Hawaii Island Cultural Reserve* as well as a *National Archeological District.* A diverse array of cultural, archeological, historical and environmental resources provide opportunity for greater scientific and cultural learning as well as practicing traditional and contemporary Native Hawaiian culture. The importance of Kahoolawe is best summarized in the Kahoolawe Island Conveyance Commission's 1993 Final Report to Congress (KICC 1993), which states, "Kahoolawe serves as a cultural resource, particularly for Native Hawaiians, because it links past traditions with contemporary practices. It is a place where cultural practices, including religious ceremonies, continue to be observed and where legends and traditions continue to survive, often in place names and the oral traditions relating to the island."

Much of what is known about the culture and traditions of Kahoolawe was recorded in an oral tradition called *mele.* Mele included songs, chants, and genealogical recitations (Aluli and MacGregor, 1991). However, archeological and historical reports also reveal past uses and provide insight into the culture. Kahoolawe Island contains the remains of numerous fishing shrines (*ko'as*) and several temples (*heiaus*), and stone alters (*ku'ula*) used to propitiate the fish deities and assure good catches within its coastal area. These terrestrial artifacts have traditionally been used as land markers to define the areal boundary of an individual's fishing grounds, or the boundary within which certain species of fish could be caught. Ongoing archeological evaluations are studying the nature of these land-based artifacts, as they relate to and have been used in the traditional Hawaiian land and sea management practice of *ahupua'a.*

While the terrestrial sites are not included in the Sanctuary boundary, some of the archeological sites are located in underwater caves. There have been reports of "resource raiding" and looting by divers. Cultural, historical, and archeological sites have not been identified at this time as Sanctuary resources. However, any increased surveillance or enforcement as part of Sanctuary management initiative could assist the KIRC in minimizing destructive activities.

The NMSA requires the Secretary of Commerce, in consultation with the State of Hawaii, to make an annual certification as to whether the waters within 3 nautical miles of Kahoolawe are suitable for inclusion in the Sanctuary. In December 1995, the Secretary, in close coordination with the State of Hawaii and the KIRC, certified that these waters are not suitable for inclusion in the Sanctuary. These waters contain unexploded ordnance from Navy activities that pose a safety risk to users of the area. As part of the 1996 NMSA reauthorization, the annual certification requirement by the Secretary was removed and replaced by a process that would allow the State of Hawaii and KIRC to nominate the waters around Kahoolawe for possible inclusion in the Sanctuary. NOAA would have to determine if these waters are suitable for inclusion and then initiate the Sanctuary designation process, including public meetings and governor review, before including these waters in the Sanctuary.

a. Kahoolawe Island Reserve

Act 340, Session Laws of Hawaii (SLH) 1993, established the Kahoolawe Island Reserve, by adding chapter 6K to the Hawaii Revised Statutes (HRS). Act 340 provides for the transfer of the island reserve to the sovereign Native Hawaiian entity upon its recognition by the United States and the State of Hawai'i. Management of the reserve is overseen by a seven-member commission. The reserve is to be used exclusively for the preservation and practice of all rights customarily and traditionally exercised by Native Hawaiians for cultural, spiritual and subsistence purposes; preservation and protection of its archeological, historical and environmental resources; rehabilitation, revegetation, habitat restoration, and preservation; and education.

Due to imminent peril to public health and safety, based on the presence of unexploded ordnance and hazardous material on the islands and in surrounding waters, the Board of Land and Natural Resources (BLNR) and the Kahoolawe Island Reserve Commission (KIRC) adopted emergency rules, effective May 6, 1994, to September 6, 1994, for the Kahoolawe Island Reserve [section 91-3(b), HRS, and section 13-1-35, Hawaii Administrative Rules (HAR)]. The U.S. Navy has used the island as a military target since 1941 and has an established danger zone which includes the waters extending two miles from the shoreline. Access into the area is restricted in recognition of the substantial amount of unexploded and hazardous materials present on the island and in the adjacent waters (CFR 763 and CFR 334.1340).

Title X (Public Law 103-139, 107 STAT. 1418, 1479, 1484) authorized the conveyance and return of the island to the State and required the U.S. Navy to remove unexploded ordinance and environmentally restore the island. On May 7, 1994, the island of Kahoolawe was conveyed to the State of Hawai'I from the U.S. Navy. The imminent threat to public health and safety will continue to exist until the reserve has been cleared of unexploded ordnance and hazardous waste.

On August 18, 1994, the Hawaii Administrative Rules were amended to include formal rules for the Kahoolawe Island Reserve (HAR, Title 13, Subtitle 12, Chapter 260). The rules divided the reserve into two zones: zone A includes all of the upland areas, including the waters from the shoreline to a depth of 20 fathoms, and zone B includes the waters from a depth of 20 fathoms out to 2 miles from the shoreline. The following uses are prohibited within the reserve:

- No person shall enter the reserve for any purpose, or operate, leave unattended, beach, park, anchor, or moor vessels or any other water craft, or use the reserve except in cases of emergency or as provided in this chapter.
- No person shall remove or attempt to remove any aquatic life, mineral, or vegetation from the reserve, except as provided in this chapter.
- No person shall engage in any activity which shall include but not be limited to: fishing from shore, fishing by trolling or drifting, bottom fishing, spear fishing, net or trap fishing, diving surfing, swimming, snorkeling, and walking in shallow waters within the reserve, except as specifically provided.
- No commercial activities shall be allowed within the reserve, except for vessels transiting the island reserve that are engaged in intra-state, inter-state, or foreign trade.

The following uses are permitted within the reserve:

- Fishing by trolling, where the vessel remains underway at all times, shall be allowed within Zone B on two weekends per month, as noticed by publication in the Local Notice to Mariners issued by Commander Fourteenth Coast Guard District.
- Escorted access to the reserve for the purpose of the following uses may be permitted by written authorization of KIRC, and as necessary, subject to final approval by the U.S. Navy:
  1) Customary and traditional Native Hawaiian cultural, spiritual, and subsistence use in areas deemed safe;
  2) Activities for the preservation, protection, and restoration of cultural, archaeological, and historical sites;
  3) Rehabilitation, revegetation, habitat restoration, and preservation; and
  4) Educational activities.

There is a maximum penalty of $1,000 for each offense, including forfeiture of license and slips.

Source: Fact Sheet on Status of Kahoolawe - Kahoolawe Island Reserve Commission, June 1994

5. Submerged Lands

The establishment of the Sanctuary in no way conveys, or intends to convey, to NOAA any title or ownership of Hawaii's submerged lands. These lands, including those known as ceded lands, continue to be held in trust by the State of Hawaii. The Sanctuary will exist as a co-steward of the Sanctuary and its resources. Should the status of the submerged lands change at some time in the future (i.e., lands are conveyed to a sovereign Hawaiian nation), the Sanctuary will work with the appropriate entities to redefine its role if necessary.

6. Traditional Native Hawaiian Uses

Section 2306 of the HINMSA directs NOAA to develop a Sanctuary Management Plan that, among others, "facilitates all public and private uses of the Sanctuary (including uses of Hawaiian natives customarily and traditionally exercised for subsistence, cultural, and religious purposes) consistent with the primary objective of the protection of humpback whales and their habitat." NOAA has not promulgated any regulations that would independently prohibit, restrict or regulate fishing, subsistence gathering or any other access to the water or the Sanctuary resources. NOAA will work with the Native Hawaiian community to develop joint education and research projects that facilities their use of the marine environment and increases the general public's understanding of their practices and culture.

7. Shipwrecks

The Hawaii Maritime Center has a list of over a hundred vessels which have been shipwrecked since 1796. Some of the ships have been salvaged or floated and a complete inventory of locations is not known. The number of historical shipwrecks that lie within the Sanctuary boundary is presently not known. At this time, shipwrecks are not considered as Sanctuary resources, but may be added under the process for identifying "other resources of national significance" through the designation process outlined in the Management Plan. Under the Abandoned Shipwreck Act (ASA) of 1988, (P.L. 100-298) the State Historic Preservation Officer (SHPO) is given the responsibility to inventory and manage historic resources such as shipwrecks. Likewise, under the National Historic Preservation Act of 1966 (NHPA), Federal agencies must inventory, assess, and nominate to the National Register of Historic Places any historic/archeological properties on public lands or, in the case of Hawaiian waters, on submerged or bottom lands.

In summary, the marine waters around the Hawaiian Islands contain a variety of cultural (settlement patterns, religious practices, resource management practices) and historical (archeological sites, oral traditions, fishponds, shipwrecks) resources unique to the Hawaiian Islands. Inclusion of these resources in the Sanctuary would heighten public and agency awareness of the importance of these resources and expand the scope of the Sanctuary's management and resource protection programs (research, long-term monitoring, education, outreach, cultural awareness, and enforcement). The Final EIS/MP summarizes some of these cultural and historical resources. More detailed information about these resources, and consultation with Native Hawaiian groups and the various Federal, State and County management regimes is needed before the Sanctuary can proceed with its mandate to identify other resources for possible inclusion in the sanctuary. Part E.6. of the Management Plan identifies a process to include the public and the SAC in assisting the Sanctuary with this assessment.

D. HUMAN ENVIRONMENT AND ACTIVITIES

This section provides information on the users and uses of the marine environment of Hawaii, and the social and economic context for Sanctuary planning and management. Trends indicate continued growth in population, tourism, and uses of the marine environment. Shoreline growth and development will continue for the most part with some limitations and control required by county master plans and ordinances. Hawaii's infrastructure (water, sewer, coastal highways, etc.) will experience increased demand for electricity, oil and other sources of energy, which often require ocean/shoreline location. Changes in agricultural uses along with shifts in land use patterns will provide new challenges for Hawaii; sediments escaping agricultural lands into streams and the ocean may be substituted by urban runoff. New technologies in recreational vessels creating faster boats, and personal submersibles and increased boating density will place new strains on the whale population, especially cow/calf pairs seeking some seclusion during the critical first few months after birth. Heavy use of some famous areas such as Hanauma Bay and Molokini Shoals will increase the demand for new and little used areas bringing human and whale use into more potential conflict. These challenges, and as yet unforeseen challenges, will require the Sanctuary to be flexible in meeting the challenge of protection as well as facilitating uses of the ocean environment.

1. Socio-Demographic Profile

a. Population and Ethnic Makeup

The estimated resident population of the State of Hawaii as of 1992 was 1,159,600. Population breakdown by county is listed in Table II-9. Approximately 75 percent of the population resides on the island of Oahu in the City and County of Honolulu; 11 percent in the County of Hawaii; 9 percent in Maui County (including the islands of Maui, Molokai and Lanai); and 5 percent in Kauai County (including Niihau). According to the 1990 Census, 89 percent of Hawaii's population lives in urban areas. However, there is considerable variation by county, ranging from 96.4 percent urban in Honolulu to 55.2 percent in Kauai.

TABLE II-9: Population and Percent Urban

	Resident Population	Percent Urban
State	1,159,600	89
Honolulu	864,800	96.4
Maui	109,000	77.90
Hawaii	130,500	60.8
Kauai	55,300	55.2

Source: *Hawaii State Data Book*, 1992

Figure II-17 shows how the population has grown since the 1950's. Hawaii currently experiences a population growth rate of two percent.

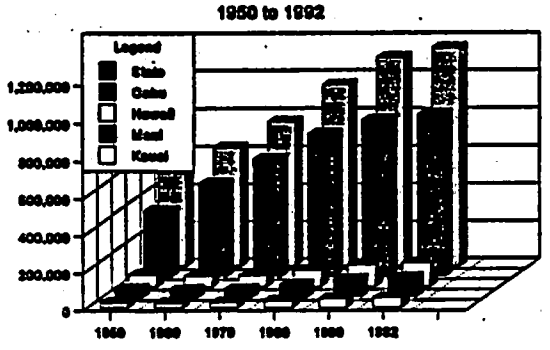


Figure II-17 (DBEDT 1993)

There is considerable ethnic variety, with no single group in the majority, as is shown in Table II-10.

TABLE II-10: Ethnic Diversity, Percentage by County

	State	Honolulu	Maui	Hawaii	Kauai
Caucasian	24.1	25.1	21.6	22.2	18.4
Japanese	20.4	21	17.4	19.3	18.4
Mixed, Part-Hawaiian	18	15.7	24	26.5	24.3
Mixed, Non-Hawaiian	17.5	17.4	17	18.2	19
Filipino	11.3	10.6	15.8	10.2	17.3
Chinese	4.7	6	0.8	0.8	0.6
Black	1.5	1.9	0.2	0.3	0.2
Korean	1.1	1.3	0.7	0.3	0.4
Hawaiian	0.8	0.5	2.3	1.6	1
Puerto Rican	0.3	0.2	0.6	0.4	0.2
Samoan	0.3	0.4	-	0.2	0.10

Source: *Hawaii State Data Book*, 1993 update.

b. Labor Force

The civilian labor force averaged 568,000 in 1992 and Statewide unemployment was 4.2 percent. The unemployment rate varied from a low of 3.2 percent on Honolulu to 8.4 percent on Kauai, reflecting the economic dislocation resulting from Hurricane Iniki (1992). Ocean industries alone employed 18,000 persons and generated $2.9 billion in revenues in 1992 (MacDonald and Deese, 1994). The industry is forecast to grow at 4.5 percent per year over 1992-1998, generating annual revenues of $3.8 billion and employment of about 20,250 in 1998 (MacDonald et al, 1995).

Table II-11 shows that Hawaii's economy is dominated by the service sector: 26.7 percent of the jobs are in the hotels and other services industry; 23.0 percent are in the wholesale and retail trade industry; 18.4 percent are in local, State, and Federal government; and 6.4 percent are in the

finance, insurance, and real estate industries. Transportation, communication and utilities provide 7.3 percent of the jobs, and the nonagricultural self-employed make up 6.6 percent of the jobs. Construction provides 5.7 percent of the jobs, manufacturing provides 3.5 percent and agriculture provides 2.3 percent.

TABLE II-11: Job Count by Industry, by County

	State	Honolulu	Maui	Hawaii	Kauai
Construction	33,500	25,350	3,200	3,700	1,300
Manufacturing	20,400	15,200	2,150	2,250	800
Transportation	32,800	27,300	NS	NS	NS
Communication and Utilities	10,600	5,850	NS	NS	NS
Trade	136,350	102,150	14,050	13,050	7,150
Finance, Real Estate and Insurance	37,500	30,550	3,250	2,400	1,400
Hotels	40,600	19,950	9,500	6,600	4,550
Other Services	117,700	96,800	8,600	8,200	4,100
Federal Government	34,000	32,400	450	800	350
State & Local Government	75,000	57,600	5,900	8,300	3,200
Agriculture	13,700	3,150	3,050	6,150	1,450
Non-Agriculture, self employed	39,000	26,600	4,000	6,050	2,400
Total	591,250	445,100	57,200	60,050	29,050

NS = Not Shown Separately Source: *Hawaii State Data Book*, 1992

2. Human Activities

a. Fishing

Fishing has always been an important economic and recreational activity in Hawaii, with social and cultural implications outweighing economic impacts. In pre-contact times Hawaiians were adept at exploiting nearshore and intensive use of the ocean for food, tools and religious offerings. Subsequent influxes of immigrants have continued the intensive use of the ocean for food and recreation. The 1992 estimated total consumption of fish in Hawaii was 70.5 million pounds (mlbs), of which 30.4 mlbs. with an estimated value of $62 million were caught commercially; 29.9 mlbs. with a market value of $70 million were net imports; and 10.2 mlbs. were caught by recreational fishers (MacDonald and Deese, 1994). Reported commercial landings have increased over the past few years. Almost 13.5 mlbs. were landed in 1989, 15.4 mlbs. in 1990, and 22.3 mlbs. in 1991. This increase has, to a large degree, been driven by the growth in the longline fishery industry. In 1992 an estimated 70 percent of the total commercial landings were from the longline fleet, which is restricted to fish located more than 50 to 75 miles from shore.

i. Commercial Fishing

It has been estimated that 13 percent (1.4 mlbs) of the 1980-1990 mean annual commercial landings, 10.8 mlbs., were caught "inshore" (within 3 miles of the Main Hawaiian Islands); 66 percent (7.2 mlbs.) were caught "nearshore" (between 3 to 20 miles); and the rest, 21 percent (2.2 mlbs.), were caught beyond 20 miles. The inshore commercial landings are dominated by the catch of Akule (29 percent), Opelu (18 percent) and Ahi (10 percent).

Table II-12 lists the monthly inshore catch for the fiscal year 1992-93 by island and county. The first four months of whale season (November '92 - February '93) were low catch months; however the last two months, March and April '93, were the third and fourth best months of the year. Honolulu leads the counties with the largest annual catch. The smallest annual catch was in Kauai's waters despite the fact that Kauai had the top three catch months (March, April & May, 1993). Table II-13 lists the number of fishers reporting catches by month and by county.

TABLE II-12: Commercial Marine Life Landed by Month/Area, Fiscal Year 1992-93 (lbs.)

	6/92	8/92	9/92	10/92	11/92	12/92	1/93	2/93	3/93	4/93	5/93	6/93	Total
Kauai	12849	26910	5344	5573	2412	5281	9862	6322	92288	65622	75619	41831	349913
Niihau	NA	NA	874	NA	NA	NA	NA	NA	288	2529	NA	2048	5739
Kauai County*	12849	26910	6218	5573	2414	5281	9862	6322	92576	68151	75619	43879	355652
Oahu*	46256	43587	44220	49714	47699	46327	35648	42044	33026	40389	44683	40279	513872
Penguin Bank	5127	3253	3637	7350	6119	7463	10464	7935	4365	7455	08921	9923	89012
Molokai	2555	1154	1973	1671	1949	3497	3709	4390	1208	2547	1811	2680	29144
Lanai	1430	1787	6201	1972	590	1089	1316	2269	1199	1681	2250	768	22552
Maui	19907	16585	12230	8212	3960	5088	6510	11501	3633	3649	11390	27881	130547
Channel	6456	6816	7540	13045	7348	11736	8095	7561	6183	4467	6203	7011	92462
Kahoolawe	4062	1290	607	1644	180	182	1499	755	1302	2268	1086	1509	16384
Maui County*	39537	30885	32189	33894	204146	29055	31593	34411	17890	22057	38662	49772	380101
Hawaii*	45674	61820	43558	54943	27545	27058	18440	24322	35185	28494	34258	68494	469791
TOTAL	144316	163202	126185	144124	97802	107721	95543	107099	178677	159101	193222	202424	1719416

* Note: County numbers are subtotals of island numbers.

Source: Personal Communication, Hawaii Department of Land and Natural Resources (DLNR), Division of Aquatic Resources (DAR), March, 1994.

TABLE II-13: Commercial Fishers by Month and Area, Fiscal Year 1992-93

	6/92	8/92	9/92	11/92	12/92	1/93	2/93	3/93	4/93	5/93	6/93	Total
Kauai	58	42	26	17	22	21	38	40	36	46	60	45
Niihau	NA	NA	5	NA	NA	NA	NA	NA	4	11	NA	12
Kauai Co	58	42	31	17	22	21	38	40	40	57	NA	57
Oahu	125	134	167	187	160	126	114	132	113	115	123	101
Penguin B.	21	15	22	34	29	31	38	44	26	45	47	35
Molokai	21	10	19	18	17	15	16	18	5	20	20	22
Lanai	18	18	18	17	8	12	15	14	16	12	16	14
Maui	50	44	70	61	48	36	39	61	50	54	63	53
Channel	37	40	49	62	44	56	50	43	41	38	40	43
Kahoolawe	18	11	8	18	6	4	15	16	16	12	13	12
Maui Co	165	138	186	210	152	154	173	196	154	181	199	179
Hawaii	142	148	141	173	130	137	117	123	137	135	146	150
TOTAL	490	462	525	587	464	438	442	491	444	488	528	487

Source: DLNR-DAR, March, 1994

The commercial fishing catch from Maui represents nearly 3 percent of the State total. Molokai and Lanai each contribute 0.25 percent and 0.11 percent, respectively (Table II-14). Although the catch from these islands is small compared to that of the rest of the State, these fisheries are an important economic activity for resident fishers.

TABLE II-14: 1993 Landings, Sale, and Value of the Commercial Fishing Catch

Island	*Lbs. landed (% of State total)*	*Lbs. sold*	*Value ($)*
Hawaii	3,666,169 (14%)	3,516,948	$6,002,218
Maui	435,115 (2%)	342,106	$894,581
Lanai	26,825 (0.1%)	23,339	$56,630
Molokai	52,001 (0.2%)	41,660	$94,066
Oahu	20,232,589 (81%)	19,926,382	$52,272,031
Kauai and Niihau	517,933 (2%)	439,194	$1,002,495
Total	**24,930,632(100%)**	**24,289,689**	**$60,322,021**

Source: DBEDT State of Hawaii 1994.

Penguin Bank, located west of Molokai, is noted for its fishery productivity. Fishers from Oahu as well as Maui County use Penguin Bank. Catch reports from the Penguin Bank area for the calendar years 1991 and 1992 are shown in Table II-15. These data indicate that 202,144 lbs. of all fish were landed in 1991, with a total value of $641,265. In 1992, 157,556 lbs. of all fish were landed from the Penguin Bank catchment area with a total value of $500,010. The data below show that pelagics, including tunas, billfishes, mahimahi, ono, and others comprise about one-half the catch. Benthic fish, including deep bottomfish, accounted for about 40 percent of the total catch.

TABLE II-15: Marine Life Caught From Penguin Bank Catchment Area by Commercial Fishermen for Calendar Years 1991-92

	CALENDAR YEAR 1991			CALENDAR YEAR 1992		
FISHERIES	*lbs. landed*	*lbs. sold*	*value ($)*	*lbs. landed*	*lbs. sold*	*value ($)*
Pelagic	99,351	93,966	160,234	70,569	66,097	113,809
Benthic	78,458	75,402	343,352	67,047	64,324	285,685
Coastal/Pel	176	174	341	266	183	346
Reef	1,897	1,663	3,990	1,015	789	1,912
Other	22,262	22,057	133,348	18,659	18,659	98,258
Total	202,144	193,262	641,265	157,556	150,052	500,010

Source: DLNR 1993.

In its *1992 Annual Report on Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region*, the Western Pacific Regional Fishery Management Council (WESPAC 1993) notes that for commercial fishing in the Penguin Bank, Maui/Molokai/Lanai bottom fishing grounds, catch per unit effort over the past several years remains highly variable. A comparison of recent data to information from the 1940s and 1950s indicates a decline in catch per unit effort for individual species. This decline is least apparent in opakapaka and most apparent in ehu (WPRFMC 1993).

Data on State-wide fish catches by gear type indicate that after longlining (which is prohibited within 50 miles of the Main Hawaiian Islands), the most effective methods are handlining, trolling, aku pole and line, and net (see Table II-16).

TABLE II-16: Fishing Methods, Landings, Sale, and Value of Catch From Commercial Fishing for 1991 (6/90-6/91) for the Hawaiian Islands			
Methods	*lbs. landed*	*lbs. sold*	*value($)*
Longline	14,150,055	13,872,919	36,316,227
Handline	2,689,274	2,577,860	6,196,570
Trolling	2,936,552	2,516,372	4,431,943
aku pole and line	1,274,451	1,274,385	1,710,584
Net	758,189	707,223	1,171,927
Trap	331,914	328,481	3,317,380
Other	101,212	81,280	208,302

Source: DLNR 1991.

Nets are most often used along reef faces, on the open coast, and in embayments as both fixed gillnets and surround nets. Some bullpen nets are used in areas that are flat and open. There are no trawl fisheries in Hawaii. Table II-17 shows an example of the types of fisheries, gear types used, and how vessels are used, for example off the Kona Coast of the Big Island (Tanaka, 1994, pers. communication).

Hawaii has a statewide system of Fish Aggregating Devices (FADs) located for the most part between the 100- and 1,000-fathom isobath. FAD-associated fishing accounts for more than a million lbs. of fish (ahi, aku, au or marlin, mahimahi, and ono [Department of Land and Natural Resources (DLNR), Hawaii Fisheries Plan 1990-1995]. The FAD is composed of spheres attached by a chain and mooring line to concrete block anchors.

TABLE II-17: Fishing Vessel Activities Within Preferred Boundary on the Big Island (Recreational, Subsistence, Commercial)			
FISHERY	*Target Species*	*Gear Types*	*Vessel Usage*
Akule	Akule	Handline, Net	Drift, Sea Anchor
Bottom Fish	Lehi, Opakapaka, Onaga, etc.	Handline, Electric Reel	Drift, Anchor
Crab	Kona Crab	Net	Drop Off, Pick Up
Lobster	Spiny Lobster	Traps, Net	Drop Off, Pick Up
Nehu (Baitfish)	Nehu	Net	Surround, Pick Up
Opelu	Opelu	Handline, Net	Drift, Sea Anchor
Palu-Ahi	Ahi, Aku	Handline, Rod & Reel	Drift, Sea Anchor, Anchor
Reef Fishing	Menpachi, Aweoweo, Moana, etc.	Handline Rod & Reel	Drift, Anchor, Slow Troll
Spearfishing	Same as above	Spear, Net	Anchor
Trolling	Ahi, Aku, Mahimahi, Ono	Handline, Rod & Reel	Medium Speed Troll
Tropical Reef Fish	Various Reef Fish	Traps, Net	Anchor

Source: L. Tanaka, Big Island fisherman, pers. communication, April 1994

The State of Hawaii requires a fishing license only for commercial fishers; those who catch and sell fish. In 1990, DLNR-Division of Aquatic Resources (DAR) issued 3,532 licenses: 3223 to residents, 309 to non-residents, and 23 permits for licenses to fish in the Northwestern Hawaiian Islands. It has been estimated that of the 3,223 resident licenses, 140 to 290 are for the