NORTHWESTERN HAWAIIAN ISLANDS

2 OF 5

G.H. BALAZS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Office of Endangered Species
P. O. Box 50167
HONOLULU, HAWAII 96850

April 25, 1978

Mr. George H. Balazs
University of Hawaii at Manoa
Hawaii Institute of Marine Biology
P. O. Box 1346
Coconut Island
Kaneohe, Hawaij 96744

Dear George:

Thanks for the data abstracts about the reproductive ecology of green turtles at French Frigate Shoals. It's real good information.

I don't think I'll ever get around to writing up all the tagging and measurements we took. If you are interested in it, let me know.

Best Regards,

Gene

Eugene Kridler
Endangered Species Coordinator

IN REPLY REFER TO

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Branch of Theoretical Geophysics
345 Middlefield Road
Menlo Park, California 94025

September 5, 1968

Mr. E. H. Bryan, Jr., Manager
Pacific Scientific Information Center
Bishop Museum
Honolulu, Hawaii

Dear Mr. Bryan:

On behalf of Dr. R. R. Doell and me, I would like to thank you once again for your help in obtaining maps and information concerning the Leeward Islands. The maps especially proved to be invaluable and of reasonably good quality.

Our trip to Nihoa and Necker Islands with Mr. Kridler and Mr. Sincock, U.S. Bureau of Sport Fisheries and Wildlife, was very successful and we were able to obtain the rock samples needed for our study. Landing proved to be much easier than expected as the seas were unusually calm. We were able to spend four days on Nihoa and two days on Necker.

You expressed some interest in rumors of military debris on the two islands and we can verify that these rumors are indeed true. The enclosed photographs show most of what is left on Nihoa. Mr. Kridler and Mr. Sincock spent some time disposing of an additional half-dozen or so rusty 55 gallon drums by throwing them into the sea. Several of these drums had rusted out on top, collected water, and become death traps for unwary birds. Other than the debris shown in the two photographs, Nihoa appears to be in fine shape.

The situation on Necker Island, however, is quite different. We found extensive remains of a military camp on Bowl Hill and on the flat ridge extending to the east. These remains include a half-full drum (55 gallon) of gasoline, an old triangular platform and standard (?), a tent platform measuring about 12-15 feet square, several cases of unopened rations (now rusted), and a rather extensive tin-can dump. Obviously the military had made no effort to clean up their disgraceful mess. Apparently, this debris is from an Air Force operation of several years ago--Mr. Kridler knows the details if you are interested.

In addition to the camp debris, there is bomb damage on Necker. Dr. Doell and I counted four distinct bomb craters in the vicinity of Annexation Peak and there are other pits that are probably due to bombs as

well. Some of these craters still contain what appears to be bomb fragments and all are near stone platforms. In fact, one heiau had suffered a direct hit. In addition, we found 50 caliber bullets (apparently fired from an airplane) and there is an unexploded bomb on the NE end of Northwest Cape. Unfortunately, we neglected to take our polaroid camera and so did not get any photos on Necker for you.

We thoroughly enjoyed our visit to Nihoa and Necker. Both Dr. Doell and I especially liked Necker because of the magnificent scenery available from any view and the well developed and numerous heiaus.

Thank you again for your help. We look forward to seeing you again on one of our trips to the islands.

Sincerely,

G. Brent Dalrymple

G. Brent Dalrymple
Geologist

Nihoa debris (1968)

4/5
RIRALL
LNY
WGG
JJP

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P.O. BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:

APR 1 1983

Mr. Susumu Ono
Chairman and Member
Board of Land and Natural Resources
State of Hawaii
Post Office Box 621
Honolulu, Hawaii 96809

Dear Sus:

My staff and I have taken the opportunity to review the February, 1983 "Proposal for a Multi-Resource Fishery Support Base at Tern Island, French Frigate Shoals," prepared by the Division of Aquatic Resources. We appreciate the opportunity to review the document and provide comments.

I have attached two separate lists of comments for your consideration. I have taken this approach because our input focuses on two distinct topics, the fishery-related issues (including economics) and the refuge-related issues (including Tern Island operation). However, our reservations about the economic feasibility of the proposal are of direct relevance to the consideration of refuge-related impacts of the project. With any proposal involving activities within a national wildlife refuge, the benefits and costs both economic and environmental, must be carefully considered.

While the discussion in the proposal is comprehensive, it lacks treatment of some important specifics that will relate directly to the assessment of potential effects on threatened and endangered species. Among the details lacking are (1) the location of the proposed mooring/anchorage sites, (2) frequency of vessel traffic to and from Tern Island, (3) storage requirements on Tern Island, (4) description of the mothership, (5) the proposed schedule for mothership/fishing boat activities at French Frigate Shoals, (6) measures to mitigate risks and direct impacts of oil, sewage, lights, and other pollutant spills, and (7) the course of action during severe south and west winds.

The proposal thoroughly addresses the unique values of French Frigate Shoals to threatened and endangered Northwestern Hawaiian Islands wildlife, to seabirds, to reef species and, particularly, to scientific research. No human intrusion is without risk to these values. Our goal is to minimize that risk through careful scrutiny and subsequent management of all activities, including our own. We share your interest and enthusiasm regarding the potential for expanded but sustainable harvest of fishery resources in the Northwestern Hawaiian Islands. Our caution stems from recognition of our responsibility to protect fish and wildlife resource values.

We welcome the opportunity to work with your staff in further review and consideration of this proposal. The questions of economic feasibility, need for additional fishery support at French Frigate Shoals and direct/indirect impacts on refuge wildlife need more thorough evaluation. Consideration must also be given to the feasibility/desirability of a Midway fishery support facility as an alternative to the proposed Tern Island mothership proposal. It would be appropriate to thoroughly review recent catch records of fishing vessels utilizing the Northwestern Hawaiian Islands, as they more likely reflect actual conditions than do the generalized predictions of the 1979 Fisheries Development Plan. I suggest you also provide working Northwestern Hawaiian Islands fishermen the opportunity to review this proposal.

I hope our comments are useful to you. I look forward to meeting with you and your staff for further review and discussion.

Sincerely yours,

Dale T. Coggeshall
Pacific Islands Administrator

Enclosure
cc:
WPRFMC
NMFS - Shomura
Gates

Tern Island Mothership Proposal
(February, 1983)

A. Economic/Fishery related comments:

1) Conversion of single purpose fishing vessels to multi-fishery operations is an expensive proposition with its own associated economic risks. (page 3)

2) There is considerable evidence that the local market could not accommodate a mothership's load of frozen products without severe price depression. This catch would not be competitive on the international frozen seafood market where trawl fisheries and other fisheries would keep the price to Hawaiian fishermen prohibitively low. (page 5)

3) Recent history of lobster fishing activities in the eastern half of the archipelago provide little indication that spiny lobster would be "one of the most feasible target species" on the first leg of a fishing trip to French Frigate Shoals. Experienced lobster fishermen are switching to other resources or seeking lobster elsewhere (e.g. Johnston Atoll). (page 5)

4) The prediction that "white meat" fishes would sell on the frozen fish market at $1.25-2.50/pound is improbable if recent history is any indication. Fresh ono in any quantity brings $2.50-3.00/pound and frozen ono brings in less than half of that. Other less desirable species, such as ulua, will return even less. (page 6)

5) The conclusion that frozen ono, mahimahi, white ulua and butaguchi would provide sufficient economic return is questionable. Of these, only white ulua can be taken in quantity east of French Frigate Shoals and it, like the others, can be rapidly fished out with increased pressure. Also, no mention is made of the implications of ciguatera on the development of this fishery. (page 7)

6) There is little evidence to support the belief that fish aggregating devices would substantially enhance the sustained yield of ono in the Northwestern Hawaiian Islands. Ono are caught on the edges of submerged banks in the Northwestern Hawaiian Islands. Individual fishing vessels have already experienced a substantial decrease in catch per unit effort when fishing for ono. FAD's would likely accelerate this outcome without increasing the overall yield substantially. (page 8)

7) Again, reference to a "high price" for frozen ono is unsupported by fact. Also, the discussion of 5000# of ono taken in November-December 1982 can hardly be used as an economic argument, given the low return to individual fishermen. The fact that fish were caught near Nihoa is an argument for a Main island-based fishery, rather than a support station at French Frigate Shoals. (page 8)

8) The discussion relating to shark fishing provides ample evidence why it should not be seriously considered in the argument for support facilities in the Northwestern Hawaiian Islands. (page 9-10)

9) The suggestion is made that the conflict between trap fishing and bottomfishing/trolling can be resolved simply by reducing the number of traps carried. This suggestion ignores the very real economic consideration that a minimum number of traps are necessary to justify the time and effort necessary in deployment and retrieval. Also, storing traps at the Tern Island station would require either an unlimited supply of traps or frequency shipment back to Honolulu so that these fishing boats could harvest lobster on the return leg to French Frigate Shoals. (page 13)

10) The conclusion that private enterprise would find the operation of a French Frigate Shoals mothership operation economically attractive is debatable. Some contend the overhead of such an operation would limit the fishermen's profit margin to a point where marketing his own fish would be more attractive. (page 14)

11) Frequent reference is made to the Fisheries Development Plan (1979) to justify additional support capability at French Frigate Shoals. Yet, more recent data from Tripartite studies and actual fishing operations provide reason to question the validity of yield projections for some species, including lobster, bottomfish and some pelagic species, such as ono. These data also provide cause to avoid generalization about the "relative abundance and fearlessness" of fish in the Northwestern Hawaiian Islands, at least as it applies to the potential for commercial fisheries development. (page 2, section 2)

12) Several vessels currently fishing in the Northwestern Hawaiian Islands experience a time in transit to and from French Frigate Shoals at about five days rather than the eight stated in the proposal. These vessels could spend more time fishing in the more productive areas west of French Frigate Shoals if they had an opportunity to offload fish and take on supplies and fuel at Midway. This seems compatible with use of the Midway facility to support albacore operations. Fishermen now operating vessels in the Northwestern Hawaiian Islands oppose the view that Tern Island is an "ideal site for a fisheries support station" beyond the level of support currently provided by Fish and Wildlife Service. (page 3, section 2)

13) The document implies that fishery operations out of Tern Island in mid-century were highly successful, but no supportive data are provided. (page 5, section 2)

B. Refuge/Tern Island-related comments:

1) The proposed mooring area does not provide safe haven when strong south and west winds are blowing, as often occurs when low pressure areas move over the shoals. In fact, the area can prove to be particularly hazardous during these conditions. (page 4)

2) Given the constraints imposed by measures to avoid disturbances to wildlife, Tern island could hardly provide much in the ways of "recreation" to fishing boat crews. (page 11)

3) The mothership owner and fishermen involved in the operation would require a Special Use Permit from Fish and Wildlife Service to operate within refuge waters. (page 14)

4) The conclusion that the Tern island station will "continue to be a focal point for research logistical support" is not a self evident fact. Fish and Wildlife Service continues to evaluate various long term management options from the island. High operating costs and the need to limit disturbance to wildlife are both factors which will enter into the decision making process. (page 16)

5) It is unclear how fishing vessels involved in the proposed two leg fishery would provide substantially lower cost support of research than presently occurs. It is also unlikely that the mothership operation would reduce the use of the Tern island airstrip. Inevitably, flights for parts, supplies, crew transport and emergency evacuation would increase. The current schedule of flights for staff changes and fresh food supplies would not be likely to change. (page 17)

6) It should be noted in reference to sooty tern "control" on Tern island that the current Fish and Wildlife Service program to reduce the air strike hazard focuses on the alteration of nesting habitat in critical areas. The sooty tern population has been allowed to increase since Coast Guard operation because use of smaller aircraft makes it possible without significant risk to human safety. (page 19)

7) Shark and ulua fishing as a management measure to reduce predation on turtles and seals is not under serious consideration by Fish and Wildlife Service at this time. These species are all part of the atoll ecosystem, and, within the refuge, derive protection from refuge regulations. A major reason why French Frigate Shoals has attracted so much attention as a site for ecological research is the absence of recent consumptive take of fishery resources, at any trophic level.

8) Legal protection for turtles, seals and other refuge wildlife does not, in itself, insure protection or freedom from harassment. Enforcement of and respect for regulations are necessary as well. (page 20)

9) Reference to "intensive" use of Tern island for research support should be put into perspective. The station has provided a platform from which various marine studies have taken place, as well as a site for specific on island bird and seal studies. Most of the marine studies have also been undertaken at other atolls and islands, working from other platforms. It should be noted that the number of researchers and their activities at French Frigate Shoals have been stringently regulated to minimize disturbance to refuge wildlife. The population of personnel at the station has rarely exceeded half the the number of Coast Guard personnel prior to July, 1979, and has typically been less than five. Note also that the approximate acreage of Tern island is 37 acres, not 57 acres. The latter figure has been cited frequently in various publications including some Fish and Wildlife Service reports. (page 22)

10) Nearly four years of operation of the Tern island station by the Fish and Wildlife Service make it possible to evaluate with some confidence the demands that continued use of the facility for research and refuge management would put on the station. On the contrary, the frequency and intensity of fishery use of the facility under the mothership scenario would be more difficult to predict. (page 23)

11) The precise location of the "outside channel" for proposed boat anchorage is unclear in the document. The hazards of frequent boat activity within the French Frigate Shoals lagoon and the direct impacts of anchor placement and dragging on reef ecosystems would need to be fully assessed. (page 24)

12) The document mentions the need for "limited storage" on Tern island but does not specify what would be stored and how frequently boats would move in and out of the Tern island dock space to place and retrieve supplies and personnel. (page 26)

13) The document states (page 26) that potential impacts of the proposed operation on threatened and endangered species "have been considered", but this consideration is not included in the proposal. As this subject is of major relevance to evaluation of the proposal by Fish and Wildlife Service, the absence of treatment in the proposal is a serious omission.

14) The document indicates that "fishing boats are allowed to anchor in the shallow lee of French Frigate Shoals for shelter." This statement needs clarification. Unless involved in supply operations, boats are not authorized anchor within refuge waters. However, Part 26.26 (Title 50, CFR) makes it legal to seek temporary shelter within the refuge in emergency conditions. The Service is also currently

reviewing a proposal to establish a mooring bouy within French Frigate Shoals to enhance security of vessels seeking to avoid rough weather and to reduce impacts of anchoring activities under these conditions. (page 5, section 2)

15) It would be useful to clarify the description of the operational equipment on Tern island that appears in this document. In particular, it should be noted that while facilities/equipment have been maintained in a restorable condition, the operation has been scaled down to meet the needs of the smaller complement of personnel and the minimize operational cost. Additional demand for space, electrical power, water or other equipment/facilities related to the fishery support scenario would require additional expenditures and possibly, additional staffing. (page 6, section 2)

16) The reference to "some monk seals" on Tern island should also be clarified. The number of seals using the island has risen dramatically since LORAN station closure. On any particular day, it is now common for the island to host as many or more seals than any one of the other principal hauling islets at French Frigate Shoals.

17) The document states that the Service's biological opinion on a proposed test fishery station "simultaneously sanctified a single use of Tern island among all of the alternatives considered by the 1979 Fish and Wildlife Service Tern Island Study." In actuality, the current operation addresses the intent of virtually all the primary options considered in the Tern Island Study by (1) supporting research, (2) restricting activities on major portions of the island to encourage wildlife use, (3) supporting Northwestern Hawaiian Islands fishery operations through transport of supplies and personnel, radio communication and emergency evacuation. It should also be noted that the Tern Island Study was designed to evaluate immediate management options. Longer term uses of the island will continue to be evaluated through the Service's master planning process, relying in large part on additional data and experience gained since the Service occupied the facility. (page 9, section 2)

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN
DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

March 15, 1983

cc: RDT-FYI
*D(AWR-Gilmore)-FYI
ES-HNL
RWR-HNL
*Regl. Solic. - FYI
*w/EIA copy

Mr. Dale Coggeshall
Pacific Islands Administrator
U.S. Fish & Wildlife Service
300 Ala Moana Blvd.
Honolulu, Hawaii 96850

Dear Mr. Coggeshall:

As you are aware, we intend to submit a Tern Island fisheries base proposal to the Department of the Interior, and we would appreciate your review and comments on the draft proposal (enclosure). Copies of the draft have also been transmitted to the Governor and the Hawaii Fisheries Coordinating Council members for their review and input.

I would appreciate receiving your comments on the draft by March 28. If you have any questions, please call Henry Sakuda at 548-4000.

Yours truly,

SUSUMU ONO, Chairman and Member
Board of Land and Natural Resources

enclosure

DRAFT

PROPOSAL FOR A MULTI-RESOURCE FISHERY SUPPORT BASE

AT TERN ISLAND, FRENCH FRIGATE SHOALS

Division of Aquatic Resources

Department of Land and Natural Resources

State of Hawaii

February 1983

ABSTRACT

The State of Hawaii proposes to develop a multi-resource fishery in the Northwestern Hawaiian Islands (NWHI) by locating a mothership/barge fishery support station near Tern Island, in French Frigate Shoals. We envision a two-phase fishing trip scenario utilizing a variety of gear to target several species. Fisheries suitable for the frozen market would be caught by vessels on the outward bound phase (Honolulu to NWHI) and unloaded at the mothership/barge which will store the frozen catch for later transshipment to Honolulu and provide supplies, fuel, and provisions for the catcher boats. Species for the fresh fish market will be targeted on the return phase (NWHI to Honolulu). Although the mothership/barge will be anchored near Tern Island, the island itself, which is administered by the U.S. Fish and Wildlife Service, would serve as a recreational area for fishing crews, emergency evacuations, and for gear storage. The optimum vessel size and the anticipated fleet size are projected in the Tern Island use proposal. Resource management, vessel design, and required fishing gear and knowledge are addressed along with the mothership/barge operation, arrangements, and integration of the fishery support base operation with wildlife refuge and research needs. The conservation of the wildlife and natural values of the NWHI are carefully considered.

TERN ISLAND FRENCH FRIGATE SHOALS
NORTHWESTERN HAWAIIAN ISLANDS
STATE OF HAWAII

STATEMENT OF PROBLEM

The Hawaii Fisheries Development Plan[1], completed in 1979, pointed to the Northwestern Hawaiian Islands (NWHI) as a key area for expanding the State's fishing industry. Further growth and substantial contribution of this industry to Hawaii's economy depend upon a cost-effective strategy for harvesting the fisheries resources of the NWHI. Developing the fisheries potential of this region is dependent on fishing operation logistics as well as its fish stocks. At present, the logistical constraints and costs of fishing operations in the NWHI are impeding expansion, despite the growing interest in Hawaii's distant-water fisheries. A major expense of vessels is the cost of fuel used in traveling to and from distant-water fishing grounds. Depending on the northern extent of fishing activities in the NWHI area, transit (non-fishing) times to and from the main islands range between 6 and 10 days.

The State of Hawaii encourages the development of fisheries in the NWHI to the extent that the industry can be supported by the resources and in a manner that does not diminish the unique wildlife values of the NWHI. A "multi-resource" approach seems to be the most prudent course of action for fisheries development in the NWHI because of the inherent limits of available natural fish stocks.

---

[1] Hawaii Fisheries Development Plan. State of Hawaii. Department of Land and Natural Resources. 1979.

Tern Island is proposed by the State of Hawaii to serve as the location for a support base because of its location with respect to fishing operations in the southern reaches of the Northwestern Hawaiian Islands and its importance in the logistical support of scientific research, especially for threatened and endangered wildlife species listed by the Federal government. The specific nature of both activities has to be considered in assessing the need for support facilities and services at Tern Island.

TERN ISLAND FISHERY SUPPORT SCENARIO

After several years of distant-water fisheries exploration in the NWHI, it seems that single-species fisheries, even for high-value products like lobster tails, will remain highly unstable due to the high sensitivity of large fishing vessel profitability to catch rates and market prices. However as a component of multi-resource operations, the spiny lobster fishery, in conjunction with bottomfish and other fisheries, may be conducted with less risk. Few Honolulu-based fishing vessels operating in the NWHI are converting to multi-fishery operations in order to more effectively expand their limited time and effort over a variety of resources (spiny lobster, deepsea shrimp, bottomfish, pelagic species) and thereby reduce economic risks.

The effectiveness and profitability of different combinations of vessel sizes and gear types depend on weather conditions, market demand and price for alternative target species, seasonality, catchability, and storage life of various species, boat design and seaworthiness, fishing expertise of the

Development of large-scale NWHI fisheries based on single species (e.g., spiny lobster) and conducted by vessels in the 80 to 130 foot-plus length range appears doubtful. However, recent fishing activities and exploratory fishing surveys indicate that the fisheries potential may be sustained on a profitable basis with the use of vessels in the 50 to 70-foot length class that harvest a diversity of resources, including pelagic fish, bottomfish, and spiny lobster. This strategy requires the use of smaller multi-gear vessels, a diverse resource base, and a NWHI fishery-support base for effective operation of such vessels. If it were profitable over the long term for large vessels (80 feet plus) to focus exclusively on single, high-value species (e.g., spiny lobster), then support considerations for distant-water fisheries might not assume much importance. Vessels as small as 40 feet in length are known to make fishing trips to the southern reaches of the NWHI, but their operations are severely weather-restricted.

The State of Hawaii is assessing the feasibility of using Midway as a fishery-support base for domestic albacore tuna trollers and conceivably for other fisheries that occur north of the main Hawaiian Islands. A different type of support base is needed at a location more advantageous for vessels which harvest fresh fish and high-value frozen products (e.g., spiny lobster tails) in the more southern reaches of the NWHI. The logistic and strategic considerations relating to the smaller group of vessels is entirely different from the larger vessels which would use Midway as a transshipment base for frozen products, especially albacore, and requires consideration apart from the Midway fishery support base.

captain and crew, and the optimum use of vessel working space and holding capacity. Abundance of the alternative fish stocks, their tolerance to heavy harvesting and capacity for replenishment would set a limit on the overall scale of operation (i.e., the total amount of fishing capacity) that can be exerted to achieve sustained yield and profitability over the long term. The most feasible combinations of vessel size, target fish species and product forms, and fish harvesting and handling strategies are reviewed below.

Optimum Vessel Size

The optimum vessel size for fishing the southern and central reaches of the NWHI , based on fuel-efficiency, on deck working space, and fish holding capacity, seems to be in the 50 to 70-foot length range. Obviously, larger vessels (80-100 feet length class) would be preferable for equipment and deck space, but this advantage is greatly offset by greater fuel and overhead expenses. The design of the vessel to achieve maximum fuel efficiency to utilize the variety of fishing gear and target species, and to promote safety is considered to be as important as the size of the vessel. The vessel must be seaworthy to capably withstand gales and possibly even hurricanes. A fishery base at Tern Island could serve as an emergency haven for vessels to weather severe storms, make emergency repairs, or evacuate sick or injured crew members.

Fishing vessel cost and earning studies being conducted by the Hawaii Division of Aquatic Resources suggest that the profitability of the NWHI fishery could be increased if vessels, on the first phase (leg) of the trip from the main islands to the NWHI, were to target on species that could be

stored onboard and offloaded at the mothership in frozen form, and on the return phase (leg) of the trip to home port, fish primarily for the fresh fish market. Such a fishing strategy could be implemented by establishing, off Tern Island, a mothership/barge support operation which would store frozen products for periods of up to 60 days and deliver them to Honolulu for sale in local and international frozen seafood markets. The mothership/barge would also provide ice, fuel, and bait for return trips of the fishing vessels. If the harvesting activities of the fishing vessels' first leg of the trip (main islands to NWHI) were sufficient only to cover its operating costs, the vessels could make their profit by fishing for the fresh fish markets on the return leg. The two trip legs are discussed individually below.

First Leg (Main Islands to NWHI)

One of the most feasible target species on the first leg of the fishing trip into the NWHI is spiny lobster (Panulirus spp.), which could be fished at Necker Island, Maro Reef, and other areas which currently produce the bulk of the spiny lobster catch in the NWHI. Spiny lobster catches are apparently not affected by seasonal availability of the resource; however, rough weather during the winter months adversely affects trapping activities.

The market in Hawaii for live lobster is limited, and most of the current fishing activity in the NWHI is by vessels that process and freeze lobster tails on-board for the international market. In order to accomplish on-board processing, the vessels carry bulky equipment, including a high pressure pump, a brine box, a blast freezer which freezes the lobster tails at -40 degrees C at the end of each day, and a storage freezer which holds the product at -20 degrees C. Not only is there considerable investment in such processing

equipment, but space requirements may preclude participation in other fisheries. However, space requirements can be reduced by limiting the scale of fishing and onboard processing efforts. A "portable" blast-freezing unit can be mounted on the vessel and 80-100 traps can be used rather than 500 traps, to reduce the space required for storing the traps, lines, floats, and weights. The smaller number of traps could be reset more frequently than is the current practice. The critical gear requirement for a lobster boat would be a large hydraulic puller and line spools on a boom. Lobster tails frozen on the vessel would have a shelf life of up to one year, so there would be no urgency of transporting them to market after they are properly processed. They could be offloaded onto a mothership-tendership stationed off Tern Island to make space for fish to be taken on the return leg of the trip.

At present, there is little demand in the Hawaii market for local fish in frozen form. However, much of the filleted local fresh fish purchased for the tourist trade is frozen for short periods by the hotels and restaurants themselves. Restaurant buyers are becoming increasingly aware of the need to accumulate inventories of the popular "white meat" fish species whose availability and price in the Hawaii fresh fish market is highly erratic. With a skillfully-developed marketing program, it should be feasible to sell rapid-frozen ono (wahoo), mahimahi (dolphinfish), white ulua (jack), butaguchi (jack), and possibly other "white meat" species for restaurant use at prices ranging from $1.25 to $2.50 per pound. The marketing of fresh and rapid-frozen fish requires careful integration and planning so that wholesalers can continue to supply restaurants with fresh products when available, at a price well above rapidly-frozen products, with the latter offering the ability to build an inventory and stabilize prices at times when

there are severe shortages of fresh fish. An integrated marketing system could lead to a two-tiered market (an exclusive restaurant market for high-priced fresh fish and a broader-based market for previously frozen whole or filleted fish) for ono, mahimahi, and selected species of bottomfish taken in the NWHI.

With greater development of Hawaii markets for rapid-frozen ono, mahimahi, white ulua, butaguchi, and possibly other species, trolling and bottomfishing would become economically-feasible alternatives for the first leg of the fishing trip. It may be possible to combine bottomfishing, trolling, and trapping, as long as the trap fishery is of limited scale and does not require all of the deck space. In order to engage in all three fisheries, it will be necessary to have a broad range of fishing expertise represented in the captain and crew.

Bottomfishing and trolling are highly compatible activities in terms of vessel size, gear, and catch holding systems, and most commercial bottomfish boats operating in the Northwestern Hawaiian Islands already engage in both fisheries. The basic requirement of these fisheries is hydraulic line pullers of the gurdy or pinch-puller type. For most of the year, the troll catch is not substantial enough to warrant trolling as the exclusive fishing method, except in the fall and winter months, when ono is seasonally abundant. The placement of fish aggregating devices (FADs) by the State of Hawaii[2] in strategic NWHI locations to aggregate troll-caught fishes will play an

[2] Hawaiian Fish Aggregating Buoys. State of Hawaii. Department of Land and Natural Resources. 1983.

important role in the harvesting of ono and other pelagic species. Trolling vessels would not only increase their catch per unit effort with the FADs but would also save on fuel consumed in searching for fish. Probably the many small banks that are scattered throughout the NWHI chain themselves serve as natural aggregators of fish. However, FADs could be installed on the larger bank areas to enhance catch. It is estimated that no more than 5 FADs could be placed in the region between Necker Island and Maro Reef.

The catch composition around the FADs will be affected by seasonality of species, with aku (skipjack), ahi (yellowfin tuna), and mahimahi more abundant in the summer, ulua and ono more abundant in the fall. The freezer storage life of all these species is 6 months to one year. However, many of the tunas are not in demand in frozen form, except by the cannery and would probably have to be sold at cannery prices. The billfishes would also bring a low price in frozen form. In order to concentrate on species such as the ono (most likely to bring a high price if rapid-frozen) trolling in the fall months would be most effective. During November and December 1982, U.S. West Coast albacore trolling vessels wintering over in Hawaii caught more than 5,000 pounds of ono from the NWHI. Much of this catch was taken from around one U.S. Coast Guard weather raft placed off Nihoa Island. Trolling for ono in the fall and winter, and mahimahi and ulua in the summer around the FADs could alternate with bottomfishing in shallow depths for white ulua and butaguchi in the summer.

Deepsea shrimp (Heterocarpus spp.), sharks, and skipjack tuna (aku) are among the other resources of the Northwestern Hawaiian Island which have value as frozen products. Under present economic and marketing conditions, however, their potential is limited. A fishing vessel equipped with the basic deck gear (hydraulic pullers, boom and line rollers) for lobster trapping could switch to shrimp trapping by exchanging lobster trapping gear for shrimp trapping gear. However, the Hawaii market for chilled or frozen whole shrimp is very limited. The best market for whole, individually quick-frozen shrimp appears to be Japan, where a sweet-tasting shrimp similar in appearance and taste to Heterocarpus spp. is consumed. Market development is required to make shrimp trapping an economically feasible alternative for the first leg of fishing trips into the NWHI. Rough weather may adversely affect the trapping of shrimp to a greater degree than the trapping of spiny lobster. Without on-board freezing capability, shrimping would have to be limited to a short distance from market because of the perishability of the fresh product. If not frozen or processed within 2-4 days after capture, Heterocarpus shrimp get mushy and the head section turns black. Whole frozen shrimp has a storage life of 3-4 months.

Sharks are relatively abundant in the Northwestern Hawaiian Islands, especially in the summer months, and could be captured incidentally around the fish aggregation devices or by longlining in shallow depths. Sharks can yield a variety of products and their sale could help offset fuel and other operating costs. Freezing appears to improve the quality of shark meat, so there is no barrier to marketing a frozen product. However, the history of

shark fisheries, including shark control programs conducted around the main Hawaiian Islands, indicates that once a steady market develops for particular shark commodities, local shark populations are rapidly decimated and catch rates decline dramatically after only short periods of fishing pressure. Sharks are especially vulnerable to overfishing because of their long gestation period and relatively few offspring per female. Although sharks are an unavoidable by-catch in several types of NWHI fisheries, the unstable catch rates in any shark fishery does not encourage any investment in harvesting and processing equipment specifically to produce shark products at this time. However, future market conditions might improve the profitability of a commercial shark fishery operation. Small and medium size sharks seem more suitable than large sharks as the resource base of such an operation. Shark meat would be the main product together with the fins of marketable size, and possible shark liver oil.

Due to the current oversupply of canned light meat tuna in the world market, present cannery prices for frozen aku and ahi do not provide much incentive for the expansion of the Hawaii pole-and-line tuna fishery into distant waters. The existing pole-and-line fleet relies on selling a large proportion of the aku catch in the local fresh fish market for relatively high prices. Unfortunately, air shipment of fresh aku from Tern Island to Honolulu would not be economical. The limited shelf life of fresh aku also prohibits such shipment. The under-utilized aku resource of the NWHI may be harvested by U.S. purse seiners, but such vessels have large carrying capacities and would not need a support base near Tern Island. However, if cannery prices for light meat tuna improve, and if suitable long-distance pole-and-line boats and baitfish are available, then the Tern Island base may be utilized for transshipment of frozen aku and ahi to the cannery.

Second Trip Leg (Tern Island to main Hawaiian Islands)

After completing the first leg of a fishing trip into the Northwestern Hawaiian Islands, a vessel would offload frozen lobster tails and/or whole frozen fish at a mothership/barge moored off Tern Island. Lobster traps could also be offloaded to free deck space for the return trip to home port. The crew might spend a day of rest and recreation on Tern Island. Ice, bait, provisions, diesel fuel and alternative fishing gear could be transferred from the tender ship to the fishing vessel for the return trip.

The return leg of the fishing trip would be devoted, to the maximum extent feasible under anticipated market conditions in Honolulu, to harvesting fresh fish. Bottomfishing and trolling are the most feasible combination of fishing methods for this leg. Catches of opakapaka (pink snapper) and other bottomfish decline around the main Hawaiian Islands in the summer months, with a consequent rise in fresh fish prices. The availability of opakapaka in the NWHI appears to be somewhat less seasonal. Nevertheless, the best bottomfishing strategy in the NWHI is to land a mix of bottomfish species, to avoid flooding the local fresh fish market with any single species. Although red snappers are more abundant in the main islands' fishery during the winter months, good prices during the holiday season provide an incentive for bottomfishing in the NWHI. However, stormy weather at this time of the year reduces the number of fishing days which are possible. Ono, ahi, and other troll-caught fishes are alternatives for the second leg of winter fishing trips to the NWHI. Strategically-placed fish aggregation devices could play a major role in the catch per unit effort and fuel consumption in the troll fishery. If brined and well-iced after capture, most species of bottomfish

have a storage life of up to 12 days, compared to a storage life of up to 5 days for small ahi and ono. Thus, the basic fishing strategy for the second leg of the trip would be to focus on bottomfish initially and troll in the last 4-5 days of the trip.

LIMITATIONS ON NWHI FISHERIES

Several limitations on the scale of the described multi-resource fisheries must be recognized at the outset:

Resource Management

Bottom-dependent resources, such as spiny lobster and bottomfish, respond rapidly to fishing pressure, and local populations of pelagic species, such as ono and sharks, can also be fished down to uneconomic levels of catch in a relatively short time. For sustained production and profitability, the fisheries resources of the NWHI will require that development and management proceed in tandem. A first approximation of the potential annual yield of spiny lobster, bottomfish, and ono resources in the region between Necker Island and Maro Reef suggests that only about 1,500 vessel-days of fishing effort can be supported on a sustained basis. If each vessel participating in the multi-resource fishery fished 150 days each year in the southern reaches of the NWHI, only 10 full-time vessels could be supported. Thus, the fishery support operation at Tern Island should be sized for approximately 10 boats in the size range previously described.

Combinations of Gear and Fishing Expertise

Although bottomfishing and trolling gear are highly compatible, the combination of trapping with bottomfishing and trolling presents a problem of adequate working deck space for all these options. This problem can probably be solved by reducing the trap fishing effort (i.e., the number of traps carried) and perhaps by storing traps at the Tern Island fishery base in order to make space for bottomfishing/trolling effort on the return leg of the fishing trip. It is unusual to have expertise in both the lobster trap fishery and bottomfishing represented in one captain or crew, but this problem can be overcome by organizing a crew with diverse fishing backgrounds. At least one vessel is already combining the three fishing methods in the southern reaches of the NWHI.

Vessel Design

Fishing trips into the NWHI can be very hazardous for any vessel not seaworthy (in terms of size or design) for the severe gales that occur in that region. It is highly advantageous for vessels to have a design which maximizes fuel efficiency and allows efficient fishing while at anchor or drifting.

FISHERY SUPPORT NEEDS

The fisheries development scenario presented earlier relies on a mothership/barge support operation which would be water-based. A

suitable vessel would be moored at a designated anchorage area offshore of Tern Island to supply fresh water and fuel to fishing vessels which enter the area to offload frozen fish and lobster tails. In addition, the mothership would supply ice and perhaps bait for the return trip to home port in the main Hawaiian Islands. The most suitable site for mooring and anchorage and catch transfer point lies south of Tern Island, in the lee of prevailing trade winds.

The mothership could be operated by six individuals having skills varying from diesel engine and refrigeration maintenance to paramedic. The owner of the mothership operation would receive a percentage of the ex-vessel revenue from the sale of the products handled (much like the fee charged by Hawaii fish dealers for providing marketing services in the main Hawaiian Islands). Thus, the mothership would be an entirely private enterprise. The owner would be required to obtain a use permit from the State of Hawaii. This use permit would include conditions of use of Tern Island agreed to in a cooperative management agreement between the Federal government (i.e., Secretary of the Interior) and the State. It is unlikely that more than five or six vessels would be anchored or moored at French Frigate Shoals at any one time.

The mothership would incorporate a suitable barge carrying freezer containers maintained by the ship's generators at -30 degrees C. At intervals of 50 or 60 days, the barge could be towed to Honolulu for distribution of the containerized products. The barge should also be able to handle ten 20-foot freezer containers with a combined 120-ton capacity for blast-frozen products.

Ideally, the mothership would have adequate diesel and freshwater capacity to supply fuel and water to 5 to 10 boats in the 50-70 feet length range (perhaps 50,000 gallons of diesel fuel and 10,000 gallons of freshwater carrying capacity. The mothership should be equipped with a desalinator (run by the ship's generators) capable of producing 1,000 gallons of freshwater per day. As an alternative, the fishing vessels themselves could install smaller reverse osmosis desalinators with a capacity of 200 gallons of freshwater per day.

INTEGRATING FISHERY SUPPORT WITH RESEARCH SUPPORT

The implementation of the various fishery options at French Frigate Shoals would vary considerably depending upon how much research and wildlife protection activities are integrated with the fishery support options. The scenario of development of a fishery support facility at French Frigate Shoals (Tern Island) will also vary depending upon the details of research and wildlife protection plans. Research and fishery options share many component logistical requirements to support personnel, and to this extent, the resulting environmental impacts of shared research and fishery support actions can be expected to have much in common when these options are compared. It should also be noted that facilities to support fishing crews' rest and recreation on Tern Island and vessel mooring in the lagoon at French Frigate Shoals for all of the various options (research/education tours/controlled recreation/fishery support) are not necessarily mutually exclusive, although limitations on space, energy and water supplies, wastewater capacity, and other life support systems on Tern Island and on the vessels may determine the extent to which various options are compatible with each other.

Although scientific research in the Northwestern Hawaiian Islands may have peaked with the Tripartite Northwestern Hawaiian Islands investigations, research will certainly continue, and may even expand, for certain endangered/threatened species listed by the Federal government. Although Hawaiian monk seal research in the French Frigate Shoals area may be limited to avoid adverse effects on the seal population there, Tern Island will continue to be the focal point for research logistical support, at least in the southern and central reaches of the NWHI.

The Hawaiian Monk Seal Recovery Plan identifies an ambitious research program, but starting and completion dates for some of the research tasks have not been indicated because of several major problems in planning. One of these is the high cost of vessel charters, which makes access to much of the seal population impossible with a low funding base in the program. For example, a 23-day charter in 1982 to transport personnel between islands, provide access to Pearl and Hermes Reef for 4 days, and resupply the field camps, cost over $41,000. With the departure of the Coast Guard from Tern Island, scientists are presently transported by private charter aircraft or charter surface craft. The existence of a fishery support base near Tern Island to service commercial fishing vessels offers possibilities for scientists to be transported to the NWHI at a lower cost than is now possible by privately-chartered aircraft or boats. There is even the possibility that fishing vessels could, between legs of fishing trips, be chartered to support research expeditions from Tern Island to other areas of the NWHI. Reliance on

fishing boats in NWHI research is not the only possible source of savings to the Federal government. Rather than resupply scientific base camps with private airplane or boat charters, the regular movement of fishery-support barges or tenderships between Honolulu and Tern Island would offer an opportunity to move supplies more inexpensively than is now possible. Greater reliance on fishing and fishery-support vessels to support scientific research would reduce the use of the airstrip at Tern Island. This is desirable because dense populations of seabirds, especially sooty terns, present a dangerous situation to landing and departing aircraft.

History of Research Use

Research has had and continues to have a long and rather illustrious history with respect to the Northwestern Hawaiian Islands (NWHI). Amerson[3] records more than 80 separate visits to French Frigate Shoals between 1859-1969 for scientific purposes. These studies led to the publication of 100 research papers including virtually all major groups of organisms. Additional studies of geology, oceanography, hydrography and climatology also stand out in the record of research visits to French Frigate Shoals.

Intensive natural history studies of the NWHI was started in 1963 when the Pacific Ocean Biological Survey Program (POBSP) began and continued

[3] Amerson, A.B., Jr. (1971). The Natural History of French Frigate Shoals, Northwestern Hawaiian Islands. Atoll Res. Bull. 150, 383 p.

1968. POBSP investigators alone spent 203 days at French Frigate Shoals during this period. U.S. FWS biologists began repeated visits to French Frigate Shoals in 1964 for repetitive wildlife studies. More recently, French Frigate Shoals has been the principal study area for investigations of green sea turtle biology, and one of several sites in the NWHI for studies of the Hawaiian monk seal. From 1973 to 1979, one green sea turtle specialist alone made 22 trips to French Frigate Shoals, with each trip lasting five days or longer.

Fisheries research in the NWHI began in 1948 with the initiation of the Pacific Ocean Fisheries Investigation and most recently has occurred under a formal tripartite agreement between the National Marine Fisheries Service (NMFS), the U.S. Fish and Wildlife Service (U.S. FWS), and the State of Hawaii Department of Land and Natural Resources (Hawaii Division of Aquatic Resources). The University of Hawaii through its Sea Grant College Program, with matching funds from the State's Marine Affairs Coordinator, joined the tripartite agreement in 1977. The major objective of the five year joint investigation is fishery and wildlife resource assessment for the purpose of managing potential fishery resources in the NWHI and protecting unique wildlife and their habitats.

Much of the tripartite agency and Sea Grant research of the NWHI has been based out of Tern Island. As of mid-1979, the Honolulu Laboratory of the NMFS was given responsibility for research on Hawaiian monk seals and green sea turtles and has used Tern Island extensively for this purpose. The U.S. FWS has undertaken research on seabirds based on Tern Island. Tern Island supports a greater diversity of nesting seabirds than any other islet in

French Frigate Shoals, and French Frigate Shoals itself exhibits a greater diversity of seabirds than any other atoll in the NWHI.

One particular seabird species is worth special note. The Sooty Tern was recorded on Tern Island by the "tens of thousands" prior to reconstruction of the island in 1942. A May 1974 estimate of the sooty tern population on Tern Island was 50,000 birds. As a result of hazards to Coast Guard aircrafts using the island, the U.S. FWS authorized a program of harassment of sooty terns and destruction of their eggs in order to control their populations and to discourage their nesting on Tern Island. In a two-week period in March 1976, the Coast Guard reported that 33,445 eggs were destroyed, but the program was unsuccessful in causing the birds to leave the island.

Resource inventories and assessments of the NWHI were the major undertakings of the joint tripartite agency investigations during the first half of the agreement period. During the second period of the joint investigations, French Frigate Shoals was selected as a model to be intensively studied because the atoll is the most representative of all of the NWHI. The importance of French Frigate Shoals has long been recognized in the scientific community and considerable scientific attention has recently been directed thereto.

The Hawaiian green sea turtle population is genetically distinct from other green sea turtle populations in the Pacific. Over 90% of all reproduction of this population occurs at French Frigate Shoals. The green

sea turtle rookery at French Frigate Shoals is by far the largest in the United States. Islets at French Frigate Shoals that host nesting turtles include, in decreasing order of usage: East, Whale-Skate, Trig, Tern, Gin and Little Gin. East and Whale-Skate host 80-90% of the nesting turtles at French Frigate Shoals and turtle nesting does not involve the entire land area of the islet. Turtle nesting on Tern Island occurs only along the beaches of the islet. It is possible that fishing for the large ulua and sharks will benefit the turtles by removal of a prime predator of both adult and young sea turtles.

The Hawaiian green sea turtle was formally listed as a "threatened" species under the Endangered Species Act on September 1978. The Hawaii green turtle population thus received full federal legal protection. The green sea turtles also receive full legal protection by the U.S. FWS while inside the boundaries of the refuge, independent of their recent protected status under the Endangered Species Act. In view of the legal protection afforded by various pertinent laws and regulations, it is reasonable to assume that intentional harassment of turtles is not likely.

Monk seals have been listed as endangered species since November 1976 under the National Endangered Species Act. All monk seals are also fully protected by the Marine Mammals Protection Act and by the regulations of the Hawaiian Islands National Wildlife Refuge. A "critical habitat" for monk seals was proposed by the Marine Mammal Commission in the NWHI. The monk seal also receives protection from the State of Hawaii's Endangered Species Act. In addition, while in the refuge boundaries, the monk seal is also given protection under both State and Federal regulations.

In decreasing order of importance, most breeding populations of monk seals are confined to French Frigate Shoals, Laysan, Lisianski, Pearl and Hermes, Kure, Midway and Necker. Most of these islands, except for French Frigate Shoals, and Nihoa and Necker, have shown a declining beach count of monk seals over the past 25 years. By way of contrast, the beach counts of monk seals at French Frigate Shoals have increased at least sixfold over the last 25 years. In 1982, the latest count of monk seals at French Frigate Shoals was 295 animals, while the total beach count for the NWHI as a whole was 561. Recent increases in the beach count of monk seals at Tern Island have apparently occurred since the Coast Guard left in 1979.[4] It is possible that shark fishing will have a beneficial effect on monk seals by removal of a prime predator of young and adult seals.

Aside from the monk seals, the only other regular marine mammal residents of the NWHI are bottlenose and spinner porpoises. These can be found in the atoll lagoons and in the pelagic waters offshore. The porpoises, while not on the threatened or endangered list, are protected by provisions of the Marine Mammal Protection Act. The humpback whale (Megaptera novaeangliae) is an occasional visitor to the NWHI and is an endangered species protected under the Endangered Species Act and the Marine Mammal Protection Act. Its main breeding grounds are in the main islands and it seldom ventures into the NWHI.

There are very few native land plant species on Tern Island. When the Navy reconstructed Tern Island in 1942, practically all the existing

[4] Gilmartin, W.G., and Monk Seal Recovery Team. Draft Recovery Plan for the Hawaiian Monk Seal, Monachus schauinslandi. December 1982.

vegetation was eliminated on the island. Most of the plant species now on Tern Island are exotics introduced by man. There are no threatened or endangered flora on Tern Island. Similarly, there are very few endemic species of insects and reptiles on Tern Island. Most of the existing Tern Island species have been accidently introduced by man and none are threatened or endangered.

Besides providing on-island research support for threatened green sea turtles and endangered monk seals, Tern Island has been used intensively by Sea Grant and tripartite agency personnel for research programs on reef and shelf benthic ecology of the NWHI, for trophic analysis of shallow-water reef communities, for lobster growth and population dynamics studies at French Frigate Shoals, and for primary and secondary productivity studies to be used for ecological modeling. The tripartite studies that have used Tern Island for research support purposes are winding down and the research results will be presented at a symposium on the final Status of Resource Investigations in the Northwestern Hawaiian Islands in May of 1983.

Research biologists are not the only scientists that have used Tern Island. Prolonged visits by representatives of the Defense Mapping Agency, the Atomic Energy Commission, and the Pacific Missile Range have been made to Tern Island for defense related research. The National Weather Service has obtained weather data from Tern Island since 1943 with the cooperation of the Coast Guard. The island has been continuously inhabited by military personnel since its construction from an 11 acre sand spit to a 57 acre landing strip used to ferry planes and military supplies to Midway during World War II. The

U.S. Coast Guard has operated a Loran-A station at French Frigate Shoals since 1944, first at East Island and after 1952, at Tern Island. In June 1979, the Coast Guard discontinued operations at Tern Island, and their personnel departed. The island's physical plant has an existing capacity to support about 20 people. The U.S. FWS has kept a small maintenance staff permanently on the island since the Coast Guard's departure.

The extent to which existing living quarters, diesel generators, fuel storage, and refrigeration systems on Tern Island need to be restored and maintained will depend more on the projected use of the island as a research support base for scientists than as a rest and recreation area for fishing crews. The only anticipated use of Tern Island itself by fishing vessel crews would be for rest and emergencies. Crews could come ashore for a short period to use living quarters, recreational facilities, and consume fresh food stored in refrigerators operated by the existing diesel-powered generators. Fishing crews could, if necessary, limit their visits to the island to day-trips and carry food and beverages for these trips on ice in coolers. Scientists, on the other hand, might visit the island for a period of several days and would require the use of the existing living quarters, as well as the operation and maintenance of diesel generators which power the lighting and refrigeration systems on the island. The extent of generator operation will determine the frequency with which diesel fuel supplies stored in shoreside tanks need to be replenished. A shallow-draft fuel barge could transfer fuel to these tanks, but the number of such transfers per year cannot be determined without firmer projections of the future use of Tern Island to support monk seal and other wildlife research.

All fishing vessels and support barges can be anchored in the outside channel to reduce onshore boat landings. Transport from these vessels to the island can be accomplished using a shallow-draft landing barge. Reliance on a shallow-draft boat will eliminate the need for dredging of the channel to clear coral heads which presently restrict access by deeper-draft boats.

Although situations may arise which require the emergency evacuation of fishermen or scientists from Tern Island, the existing airstrip need not be used for routine movements of personnel between the main Hawaiian Islands and the NWHI. Greater reliance on fishing vessels and fishery-support barges to move researchers and supplies will not only reduce the use of the airstrip but will also reduce costs to the Federal government of supporting research in the NWHI. The cost of air shipping fresh fish landed at Tern Island by small aircraft to Honolulu is believed to be economically prohibitive ($1.00/lb. or more), and the development scenario is based entirely on surface shipment of frozen seafoods.

SUMMARY

A fishery development scenario is presented which proposes to optimize the harvesting of fishery resources in the NWHI by using multi-purpose small (50-70 ft. length) vessels utilizing multiple resources. By harvesting multiple resources, the economic risk of single-species marketing and possible overharvesting of NWHI fisheries resources can be avoided. A fishing trip consisting of two phases (legs), each aimed at different segments of the seafood market, will maximize the fishing time and reduce inefficiency. The

fishermen can catch species suitable for the frozen seafood market such as spiny lobster, ono (wahoo), mahimahi (dolphinfish), ulua (jacks), deep sea shrimp (Heterocarpus spp.), shark, and other "white meat" fish on the first leg from the main islands to the NWHI. A mothership/barge anchored off Tern Island could store the frozen catches and supply fuel, water, provisions, and alternative fishing gear to the catcher boats. The mothership could transship the frozen catch to markets in the main islands at regular intervals. The fishermen could catch species suitable for the fresh seafood market such as bottom fish (primarily snappers), ono, mahimahi, and tuna, on the second leg back to the main islands. The fresh and frozen seafood markets should be carefully developed and integrated to ensure stable prices for the fishermen.

Various limitations that could affect the fisheries of the area could include plans for management of the resources, the need for a wide range of expertise in the captain and crew and the variety of fishing gear required to conduct a multi-resource fishery, and the vessel design, with regard to economy, multi-purpose use, and to withstanding rough weather conditions. All these constraints will limit the number of fishermen that will enter the multi-resource fishery as envisioned here.

The mothership/barge should be moored offshore of Tern Island near the boat channel and should be largely self-sufficient. It could contain fuel and water storage, provisions, living quarters for the operators, power generators, freezing containers, and limited repair capacity. The barge with frozen storage capacity could be tied up to the mothership to receive the

frozen catches of the fishing boats and to provide transshipment capability to the main islands. The fishery support base can be operated by a private contractor with a use permit from the State, with revenues to be collected from the users of the base.

Recreational facilities for the fishing crews and limited storage capacity could be made available on Tern Island. The use of aircraft to support the fishery base is not anticipated except in the case of emergencies.

Research on wildlife and resources in French Frigate Shoals could be supported by and integrated with the fishery support base operations. Logistical support is one of the major problems in maintaining a research station on such an isolated outpost as Tern Island. The fishery support operation could provide transportation of personnel and supplies, and cooperative research compatible with fishing operations can be implemented.

Although not detailed in this proposal, the potential impacts of expanded fishery operations in French Frigate Shoals on threatened and endangered species in the Refuge have been considered. The scenario and support base have been designed with the conservation and the protection of the unique and rare wildlife of the NWHI in mind.

In conclusion, the establishment of a fishery support base near Tern Island is a logical and feasible step in the fishery development of the State of Hawaii. Since most of the potential for fishery development does reside in

the NWHI, the area near Tern Island is the ideal location for supporting the extension of bottomfish, lobster, shrimp, and pelagic fisheries to the NWHI. Rationality and good planning will be required for fishery development to maximize benefits without adverse impacts. This proposal is a major step in that direction.

BACKGROUND ON TERN ISLAND

Geographic Setting

The expansive marine geography of the Hawaiian islands attests to the large potential for fisheries development as well as to the difficulties in realizing that development potential. The Hawaiian Archipelago stretches some 1,523 miles across the central expanse of the Pacific Ocean (Figure 1) from the island of Hawaii in the southeast to Kure atoll in the northwest. The high, rocky islands in the southeast from Niihau and Kaula to the island of Hawaii are normally considered to comprise the State of Hawaii, but the State's jurisdiction also extends all the way to Kure Island, making Hawaii one of the longest states in the Union. The islands from Nihoa to Kure make up the Northwestern Hawaiian Islands (NWHI). The Hawaiian Archipelago also contains extensive reefs, shoals, and seamounts. It ends in the northwest with a group of submerged volcanoes that merge with the Emperor Seamounts. The 200-mile Fishery Conservation Zone (FCZ) that envelops the Hawaiian Archipelago (Figure 2) encompasses 648,000 square miles of ocean space, an area larger than Alaska. The size of the FCZ is indicative of the opportunities for the domestic development of the fisheries potential in the region.

Several major distinctions can be drawn between the main Hawaiian Islands, that is the populated high islands from Hawaii to Niihau, and the NWHI which stretch from Nihoa to Kure. The distinction of the NWHI is their

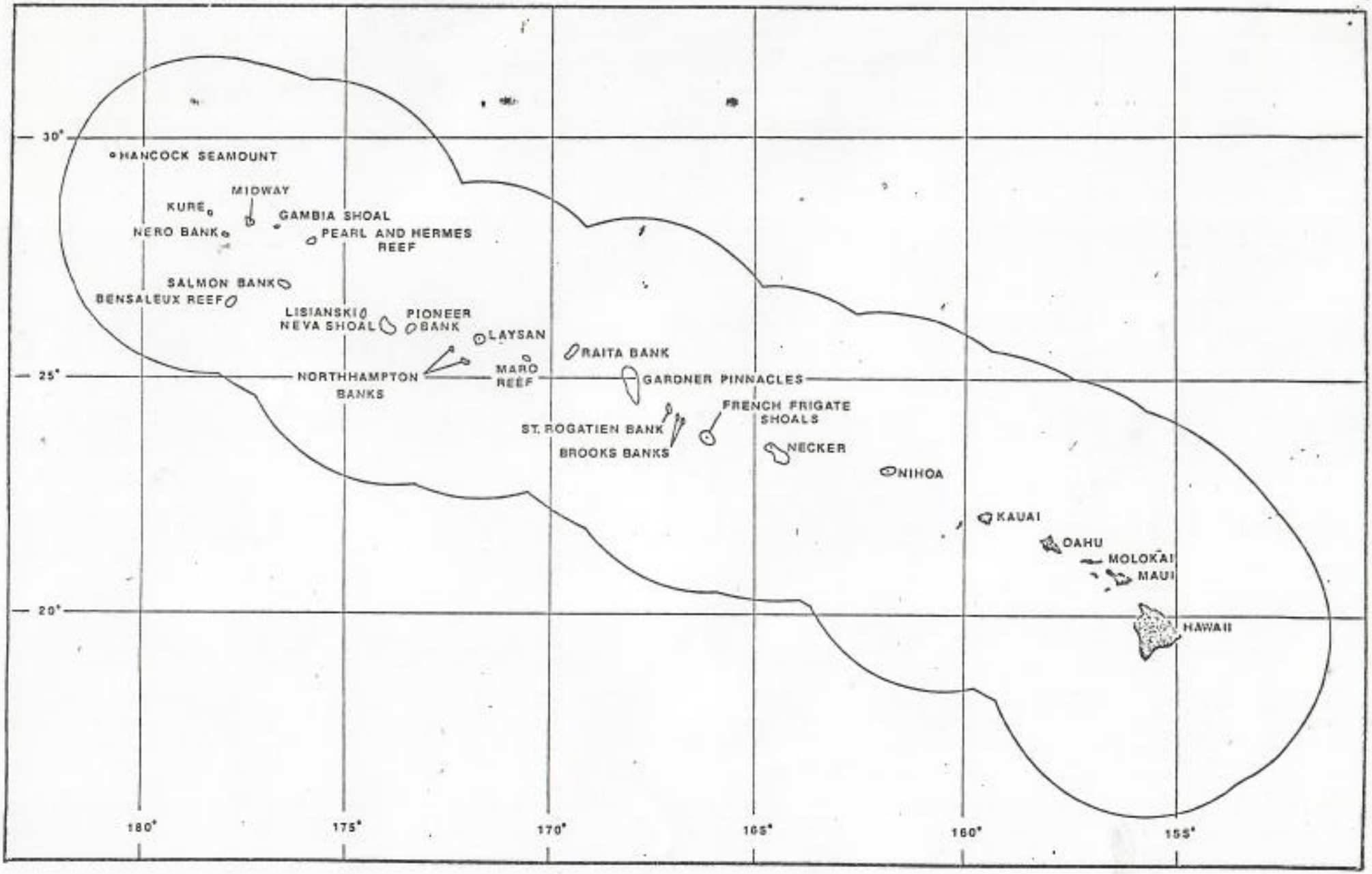


Figure 1. The Hawaiian Archipelago and the 200 mile Fishery Conservation Zone

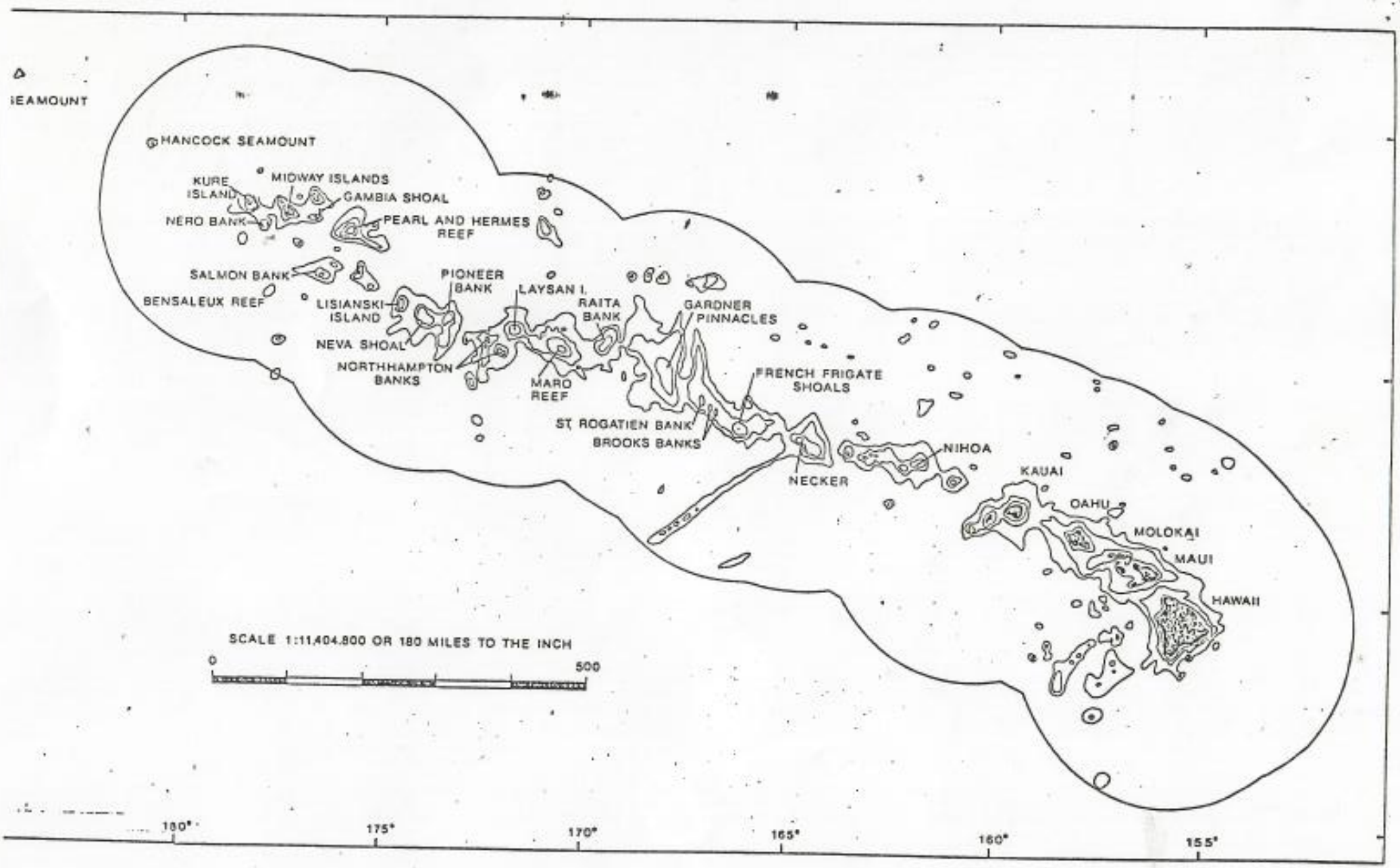


Figure 2. The banks and contours to 1000 fm of the Hawaiian Archipelago and the ; within the FCZ.

remoteness from population centers of the main Hawaiian island, their general lack of human inhabitants, and the fact that almost all of the islands are "off-limits" refuge for wildlife.

The islands themselves are windswept, pounded by the sea, and are largely untouched by the works of man. Midway Island, a naval defense installation, and Tern Island, formerly a naval airfield and a Coast Guard LORAN station, are the only exceptions. The principal differentiating feature in the fishery environment of the two areas is the relative ease of accessibility to the resource. Inshore waters and offshore banks of the main Hawaiian islands have been, and continue to be, subject to fairly intense fishing pressure by commercial, sport, and subsistence fishermen, and the fish in these areas tend to be wary and less abundant as a result. This situation contrasts sharply with the relative abundance and fearlessness of the same species in similar habitats in the NWHI or on isolated coasts of the main islands. This is one of the reasons for looking at the NWHI as a very promising area for expansion and growth of the State's fisheries. The other reasons are that the U.S. FCZ surrounding the NWHI is about twice as large as that of the main Hawaiian islands, and there are more and larger banks and other fishery habitats in the NWHI than in the main Hawaiian islands.

The State of Hawaii Fisheries Development Plan (1979) estimates that the vast ocean waters surrounding the Hawaiian Archipelago could sustain a catch of a variety of commercially important species that approaches ten times the current average of local landings. The plan estimates that about 50 additional million pounds of fish worth over 30 million dollars annually,

ex-vessel, could be taken within 10 years and as much as 85 million pounds within 20 years. Much of this potential is concentrated in the NWHI within commercially feasible reach from Tern Island.

The 1200-mile long ocean area between Kauai and Midway Island presently lacks any outposts that could provide support to Hawaii's nascent distant-water fleet. At present, very few Hawaii-based fishermen have been able to fish, in a cost-effective manner, the distant waters of the NWHI. For example, it takes about a total of eight days for Honolulu boats to get to and return from fishing grounds near French Frigate Shoals. Such "in transit" time amounts to considerable costs in fuel and a drain on productive fishing time and human energy. Present costs of operation, danger, and inconvenience combine to largely preclude fishing beyond Maro Reef for lobsters, shrimp, kona crabs and for the virtually untapped deepsea and inshore bottomfish that are known to exist in the further reaches of the NWHI. The economic feasibility of successfully deploying more fishing effort in the NWHI, whether for tunas or white flesh fish species and crustaceans, is dependent on the availability of shoreside support facilities to move provisions for vessels and crews into the area and catches out of the area.

Tern Island, located within French Frigate Shoals, lies at the midpoint of the Hawaiian Archipelago. It is situated about 600 miles northwest of Honolulu and approximately 800 miles southeast of Midway. Tern Island's central location and its existing facilities make it an ideal site for a fisheries support station in the central reaches of the NWHI.

History

French Frigate Shoals (FFS) was discovered by Comte de La Perouse in 1786, when his two ships nearly ran aground on the atoll. In 1859, Lt. John M. Brooke of the U.S.S. Fenimore Cooper took possession of the FFS for the United States. A number of ships visited FFS in the following years, taking birds, seals, turtles, and various other resources. Others visited the islands unintentionally, becoming victims of the coral reefs. In 1895, the islands were claimed by the new Republic of Hawaii.

In 1909, prompted by extensive damage to birdlife on some of the NWHI, President Theodore Roosevelt set aside all the NWHI (except Midway Island) by Executive Order No. 1019, as the Hawaiian Islands Reservation birdlife preserve. In 1940, by Executive Order No. 2416, the Hawaiian Islands Reservation became the Hawaiian Islands National Wildlife Refuge and was put under the administration of the U.S. Department of Interior.

Beginning in 1928, the Navy explored FFS for military use and began extensive seaplane exercises in the lagoon in 1932. After the Battle of Midway (in 1942), the Navy occupied Tern Island and turned it into an airfield by using dredged material to add to the area and shape of the island. The Navy used Tern Island as an emergency airfield and defense outpost until 1946, when the base was inactivated. In 1948, the Navy turned Tern Island over to the Territory of Hawaii, although the Navy had occupied Tern Island without the permission of the Territory of Hawaii, or the U.S. Fish and Wildlife Service which had been given responsibility for the Hawaiian Islands National Wildlife Refuge.

The Territorial government gave permission for various fishing companies to use Tern Island as a fishery base as early as 1946. The fishermen enjoyed such good fishing success that aircraft were used to ferry fish from Tern Island to Honolulu. Although some successful transshipments were made, the ventures finally came to an end by 1959. However, a few fishing boats continued to utilize the fishing grounds around FFS through the present time, returning to Honolulu to unload their catch.

The U.S. Coast Guard had been operating a LORAN navigational aid station on East Island in FFS since 1944, but moved the station to Tern Island in 1952 under license from the Territory of Hawaii. In 1961, a Pacific Missile Range facility was established on Tern Island for tracking missiles and satellites. However, by 1963, the tracking facility was closed and activity on the island returned to a routine level. The Department of Interior questioned the legality of the Coast Guard presence on Tern Island in 1965; subsequently the Coast Guard concluded a use permit with the Department for Tern Island in 1966. In 1979, the LORAN station was abandoned by the Coast Guard, and turned over to the U.S. Fish and Wildlife Service (USFWS) which maintains the facilities on the island on a caretaker basis.

Since the USFWS took over Tern Island, use of the island by non-FWS personnel has been restricted to visiting scientists and the occasional official visitor. Although fishing boats are allowed to anchor in the shallow lee of FFS for shelter, no landings are permitted on the islands of the Refuge. The USFWS has maintained the facilities at a usable level, but

increasing numbers of seabirds on the island have made it dangerous to land large aircraft on the airstrip. Occasional supply ships and small planes are now the only current carriers to the island.

Physical Description

Tern Island is one of 12 islets sitting atop a crescent shaped coral atoll of French Frigate Shoals (Figure 3). In 1941, Tern Island was an 11 acre sand spit, home for thousands of sooty terns and some turtles and monk seals. In 1942, this minor 11 acre islet was converted to an aircraft carrier-shaped airstrip for ferrying Navy planes and military supplies to Midway. The Navy enlarged Tern Island five fold to 57 acres to become a reconstructed island landing strip almost 1 km long (Figure 4). The new land was created from coral materials dredged to form a ship channel and turning basin, and a seaplane landing strip. Steel sheet pilings surround each end of the island and extend along the west-northwest side of the island. Four buildings, fuel and water tanks, a small boat davit, and a tennis-basketball court are situated on the western third of the island (Figure 5). A 77m-wide runway, composed of packed, fine crushed coral, extends the length of the island. Electrical power generators, a fresh water catchment and storage system, and five large fuel tanks are available on the island (Figure 6). At one time, Tern Island even had a "Playboy Club" to entertain bored, homesick, and forlorn Coast Guard corpsmen that manned a LORAN station there. A 40m communications antenna stands witness to events of the past. It also presently witnesses thousands of sooty terns, some monk seals, and green sea

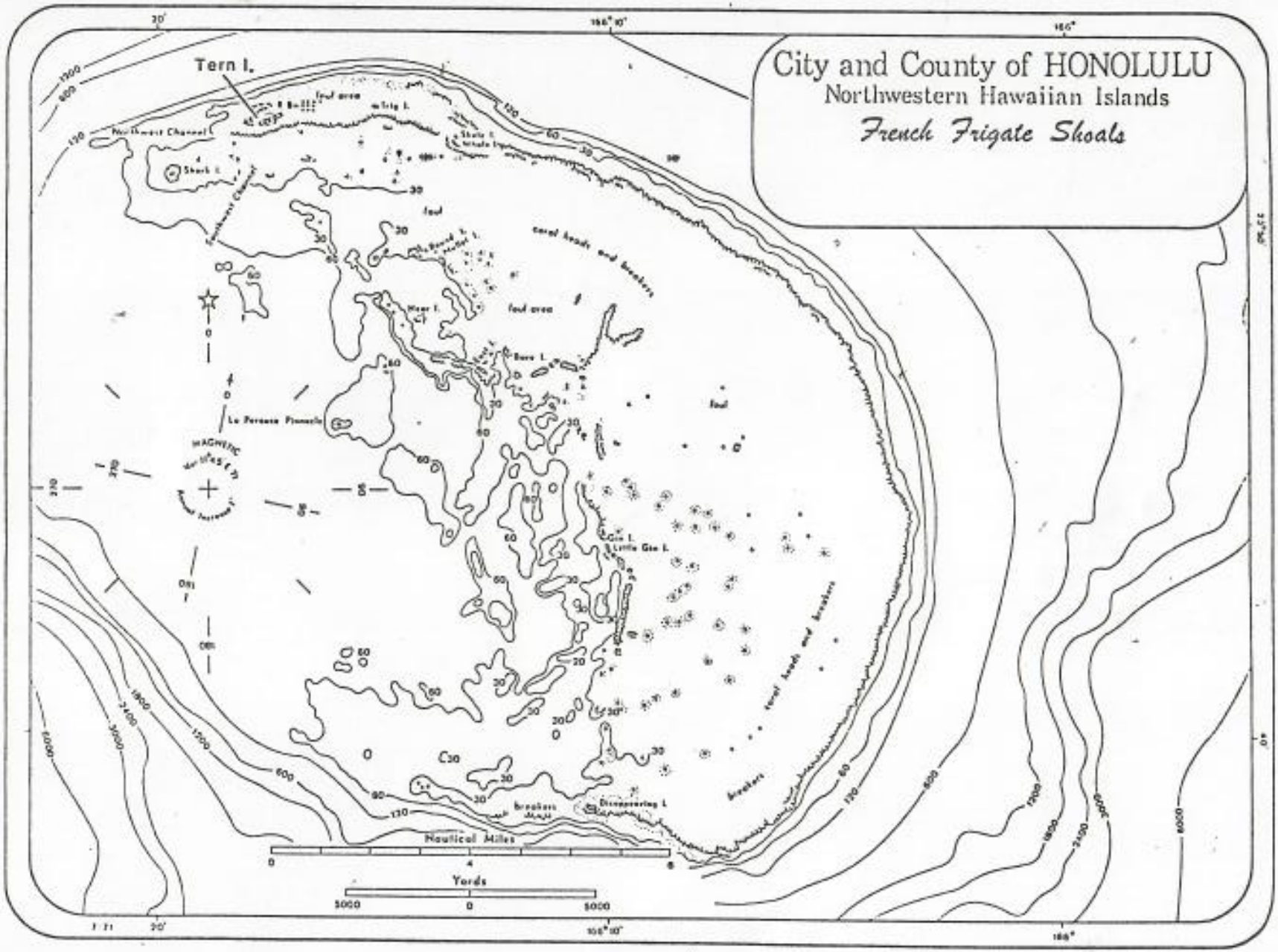


Figure 3. Tern Island is in the northwest corner of French Frigate Shoals
from Grace, J. M. ed., 1974. Marine Atlas of Hawaii: Bays and Harbors
University Press of Hawaii, Honolulu - Sea Grant - MK-74-01

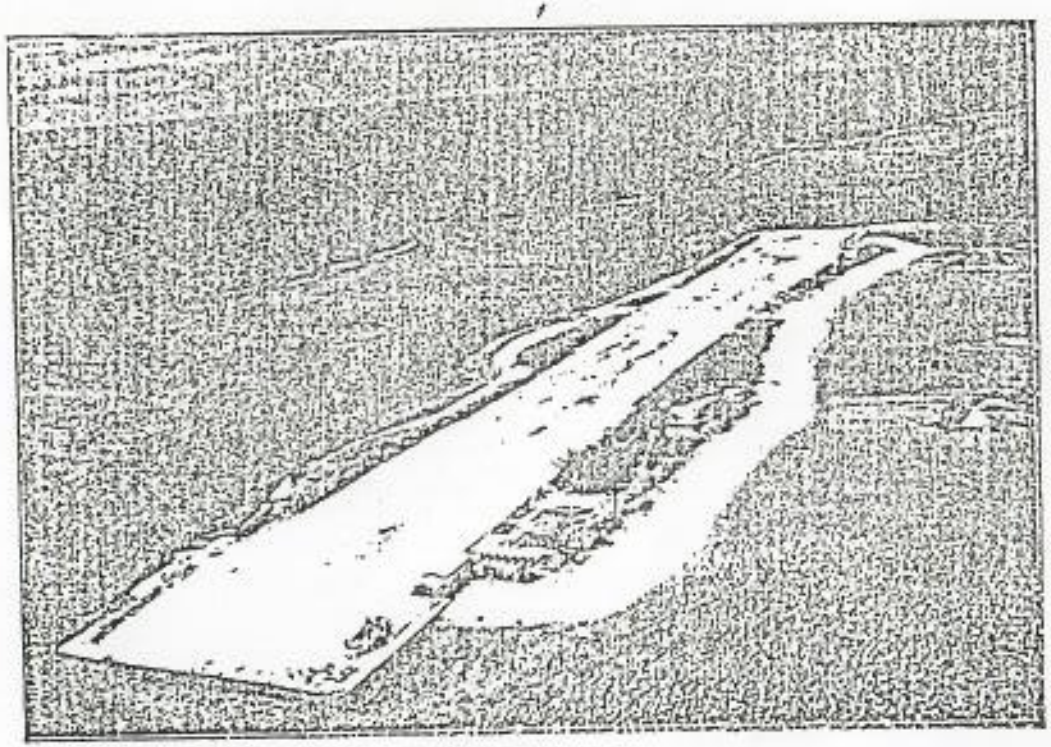
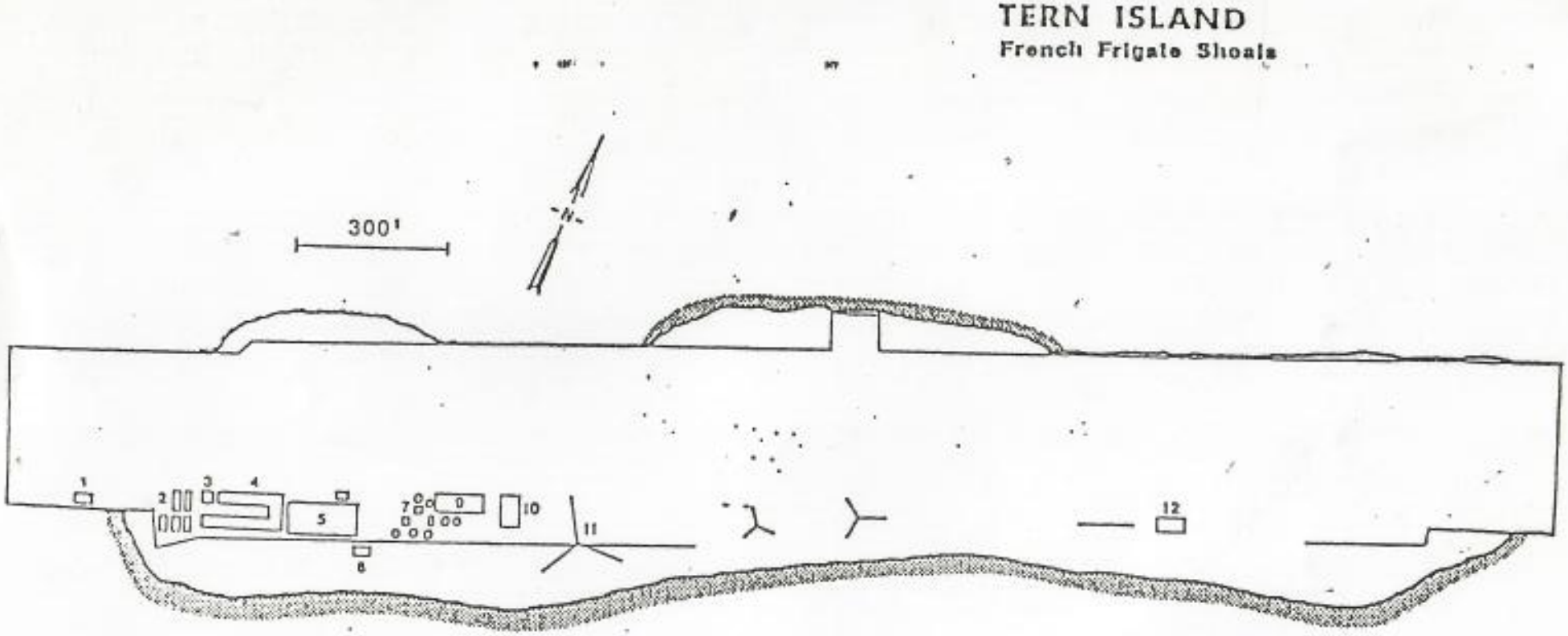


FIGURE 4. TERN ISLAND - DREDGED CHANNEL AND TURNING BASIN ARE AT WEST END IN FOREGROUND. (FWS FILE PHOTO)



1. Boat House
2. Fuel Oil Storage Tanks
3. Garage
4. Barracks-Subsistence Bldg.
5. Recreation Court
6. Playboy Club
7. Pump House
8. Fresh Water Tanks
9. Signal Power Bldg.
10. Old Signal Power Bldg.
11. Loran-A Transmitting Antenna
12. Storage Building

FIGURE 5. TERN ISLAND - EXISTING STRUCTURES AND FACILITIES.

turtles, and the daily activities of a small U.S. Fish and Wildlife Service (FWS) caretaker complement maintaining the facilities at a custodial level of operations.

Alternative Uses Of Tern Island

In June of 1979, the U.S. Fish and Wildlife Service (FWS) released a report which provided a preliminary evaluation of alternative uses of Tern Island. The study was prompted by Coast Guard plans to abandon the LORAN station at Tern Island. The alternative uses considered in the study included:

1. Conversion of existing facilities, or a portion of the existing facilities, to a research station administered and operated by the FWS, which would support general wildlife, threatened and endangered species, coral reef ecology and natural area ecosystem research.

2. A similar research station but operated by another agency or jointly with FWS.

3. Conversion of existing facilities or addition to existing facilities to be used as a commercial fishery support station.

4. Modification or abandonment of existing facilities to achieve maximum indigenous wildlife uses.

5. Combinations of the above 4 options that became apparent during the course of the study.

During December of 1979, the Chairman of the State of Hawaii Board of Land and Natural Resources submitted two proposals to the FWS concerning use of Tern Island facilities for research and fishery support purposes and for implementing a joint State/Pacific Tuna Development Foundation project for assessing the baitfish potential of French Frigate Shoals. On March 23, 1981, the FWS responded to the State's requests by transmitting a Biological Opinion prepared by the National Marine Fisheries Service (NMFS) which concluded that the "actions" requested by the State would likely jeopardize the continued existence of endangered and threatened species. The Opinion stated that the proposed use of Tern Island for fishery support was incompatible with the needs of monk seals and green sea turtles. To justify this conclusion, NMFS cited the declines of monk seals at Kure and Midway Islands as being attributable to human harassment and to indirect impacts from activities such as construction and beachcombing. Mention was made that with the Coast Guard's abandonment of the LORAN station, and with the beaches of Tern Island left undisturbed, monk seals have once again begun utilizing Tern Island. The Opinion speculates that green sea turtles may also begin to use Tern Island beaches as a nesting site and basking area in the future if human activity levels remain the same (custodial caretakers and intermittent researchers) or decrease.

The Opinion, in effect, temporarily squashed the State's 1979 proposal for the combined use of Tern Island for supporting fisheries and research

programs in the NWHI. The Opinion simultaneously sanctified a single use of Tern Island among all of the alternative considered by the 1979 FWS Tern Island Study: Modification or abandonment of existing facilities to achieve maximum indigenous wildlife use.

Jurisdiction

There is a long-standing dispute between the State and the Department of Interior over the jurisdiction of the Hawaiian Islands National Wildlife Refuge. The State essentially claims all submerged lands and waters of the NWHI, while the USFWS claims emergent lands and adjacent nearshore waters for inclusion in the HINWR. The State wishes to utilize the fisheries resources of the area in a controlled fashion while preserving the environment, the unique wildlife, and protect the threatened and endangered species of the NWHI. The USFWS desires to maintain the refuge areas in as undisturbed a condition as possible, in able to restore endangered and threatened species.

Justification For The Current Proposal

The initial thrust in proposing the establishment of a fishery support station at Tern Island was provided through direct contacts in 1978 between Governor George Ariyoshi and Secretary of Interior, Cecil Andrus. These discussions were prompted by the U.S. Coast Guard's intention of terminating its LORAN station at Tern Island in 1979. The governor expressed his concern on the possibility of the U.S. Fish and Wildlife Service dismantling key support facilities at Tern which could be used for fishery support following Coast Guard's departure from the island. As a result, in February 1979

Secretary of Interior Andrus assured the governor that the Interior Department will not take any action that would foreclose the option of establishing a fishery support station on Tern Island.

In December 1981 Senator Wadsworth Y.H. Yee sent a letter and supporting documents to the Department of Interior requesting a review of the adverse Biological Opinion issued by NMFS on the 1979 state proposals, and addressing the legal and jurisdictional issues concerning Tern Island. Under-Secretary of Interior Donald P. Hodel replied in March, 1982, stating that he would be glad to consider a cooperative agreement between the Department and the state for fishery support at Tern Island without raising the jurisdictional issue and ensuing litigation, if the State would submit a detailed proposal to Interior.

A new proposal was prepared in response to Hodel's invitation, containing a detailed scenario of proposed fishing operations within the NWHI using Tern Island as the location for a fishery support mothership. The proposal will not address the jurisdictional issue, and a review of the impact on the refuge and threatened/endangered species will be postponed until a Section 7 consultation under the Endangered Species Act is required.

Conclusion

Hawaii is pressured by the deteriorating state of the economy to expeditiously further its Constitutional goal of self-sufficiency. It needs to diversify its "tourism/sugar/and defense spending" economic base. The State is keenly interested in expanding its fisheries and developing new

industries with the utilization of the fishery resources of the NWHI. A fishery support base near Tern Island is central to the implementation of the Hawaii Fisheries Development Plan (1979) and to the needs and wishes of Hawaii's fishing industry. Unfortunately, any utilization of the fishery resources of the NWHI brings with it a perceived threat of altering the ecosystem of the wildlife refuge and jeopardizing the lives of its rare and unique wildlife. The State of Hawaii does not subscribe to that particular point of view. It believes that both utilization of the fisheries and wildlife preservation can be assured and properly balanced. Allowing the reasonable use of Tern Island for fishery support will assure that we will be able to effectively have both.

For the Protection of Hawaii's Native Wildlife

HAWAII AUDUBON SOCIETY

P. O. Box 5032
Honolulu, Hawaii 96814

July 15, 1976

Mr. Lynn A. Greenwalt
Director
U. S. Fish and Wildlife Service
Washington, DC 20240

Mr. Palmer Sekora
Refuge Manager
Hawaiian Islands National Wildlife Refuge
U. S. Fish and Wildlife Service
Hawaiian Life Building
1311 Kapiolani Blvd, Rm 606
Honolulu, HI 96814

Mr. Eugene Kridler
Office of Endangered Species
U. S. Fish and Wildlife Service
Hawaiian Life Building
1311 Kapiolani Blvd, Rm 606
Honolulu, HI 96814

Gentlemen:

In April of 1976 the Hawaii State Legislature adopted two resolutions (SCR 64 and SR 257), which are attached. The resolutions seem to be directed to the U. S. Department of the Interior, and might be interpreted as a request to open the shallow waters and lagoons of Pearl and Hermes Reef, French Frigate Shoals, and Maro Reef to commercial fishing. This is not obvious when one first reads the resolutions because they seem to imply that none of the waters in Hawaii's northwest chain (i.e., the Hawaiian Islands National Wildlife Refuge) are open to commercial fishing, whereas the three areas specifically mentioned above are the only part of this area not open to such fishing.

It is our understanding that these three areas are also the subject of a boundary dispute between the State of Hawaii and the Department of the Interior, U. S. Fish and Wildlife Service, which currently has jurisdiction over the areas as they are considered part of the Refuge. Apparently the State feels that only the actual land areas (above low water mark) of the Refuge should be under federal jurisdiction.

The Hawaii Audubon Society and the National Audubon Society were very much involved in the 1963 controversy over the refuge. At that time a strong movement by conservationists helped to keep the Refuge under federal jurisdiction, rather than having it revert to the State of Hawaii. It appears now that another controversy has arisen, this time over the Refuge boundaries. Apparently the State of Hawaii feels that only the land area should be included in the Refuge and that surrounding waters, as well as lagoons should come under State jurisdiction. If this were to happen, of course, it might open the way for serious disturbance to the atoll ecosystems by commercial fishing activities.

For the Protection of Hawaii's Native Wildlife

HAWAII AUDUBON SOCIETY

P. O. Box 5032
Honolulu, Hawaii 96814

The Hawaii Audubon Society feels that one of the most important reasons why boundaries should not be changed is that the present Refuge boundaries provide protection for the entire atoll ecosystems, rather than just their terrestrial portions. Animal life on the atolls is completely dependent on the surrounding reef ecosystems and nearshore waters, and protection of these areas is essential if we are to retain what now constitute truly spectacular and unique examples of undisturbed atoll ecosystems. Several species of endangered birds, as well as the endangered Hawaiian monk seal and the endangered green sea turtle have their entire (or a unique Hawaiian portion thereof in the case of the turtle) breeding grounds in parts of the Hawaiian Islands National Wildlife Refuge.

For the sea turtle, French Frigate Shoals, whose lagoon is a disputed area, is its only Hawaiian breeding ground. The Hawaiian monk seal breeds on several of the atolls in the Refuge. This animal has been said (Karl Kenyon, 1975, Defenders of Wildlife:497-499) to be unable to adapt to the presence of man. To consider allowing commercial fishing near breeding populations of these animals seems highly inappropriate. Serious, albeit unintentional, disturbance and damage to these animal populations could result from fishing activities.

Populations of endangered birds (i.e., Laysan Duck, Nihoa Millerbird, Nihoa Finch, Laysan Finch) occur at very low numbers, especially the Laysan Duck, in the Refuge. Although commercial fishing does not appear to pose a direct threat to these birds, one must consider the consequences of increased sea vessel traffic, and, especially the possibility of shipwrecks. Should rats or cats be accidentally introduced on any of the islands because of shipwreck or carelessness, it is quite likely to mean extinction of all these species and that serious damage to other avian populations could result.

The difficulty of enforcing what will have to be strict regulations on the activities of fisheries personnel should be considered. The areas in question are so isolated that significant harm to animal populations could take place before officials were alerted to problems. In other words, we would have to agree to take great risks, something the Hawaii Audubon Society is unwilling to sanction.

Very little has been said about the value of preserving the reef and lagoon ecosystems intact. At present Haunama Bay on Oahu is the only stringently protected reef area in Hawaii. Reefs in the Refuge present a unique scientific opportunity to study undisturbed systems. Unless the economic gain to be had from fishing these areas is great, it seems very shortsighted not to protect these last remnants of undisturbed Hawaiian coral reefs. We have not even had time to assess the damage being done to reefs in the main islands because of the aquarium fish trade.

Although we are reluctant to make predictions about what might happen, we would like to point out that past history of commercial fishing in the Refuge has not been good. First of all, it was probably a major cause of the endangerment of the Hawaiian population of the green sea turtle. According to George Balazs (1975, Defenders of Wildlife:521-523), in 1959 alone, the last year sea turtle harvesting was profitable, a commercial fishing company destroyed 25% of the

For the Protection of Hawaii's Native Wildlife

HAWAII AUDUBON SOCIETY

P. O. Box 5032
Honolulu, Hawaii 96814

nesting females present for that year's breeding season. Of course, turtle harvesting on a commercial scale is no longer permitted, but this not to say that turtle populations would not suffer from illegal activities. Increasing the flow of human traffic in the Refuge certainly increases the chances that such activities could occur.

There is virtually no data to indicate what the effect of commercial fishing might be on the Refuge's magnificent populations of breeding sea birds. Studies are now underway to investigate this point, among other things. No decisions about opening commercial fisheries in the area should even be considered before this study is complete and available to the public.

In view of the foregoing, the Hawaii Audubon Society opposes both releasing boundary dispute areas from federal jurisdiction to the State of Hawaii, as well as opening these areas for commercial fishing. The Hawaiian Islands National Wildlife Refuge has been the site of many human errors, prompted by economic motives, in the realm of conservation (i.e., ecosystem and species preservation) in the past. Recently, under the protection of the U. S. Fish and Wildlife Service, it has enjoyed a respite from disturbance unequalled since man first landed on the atolls. The Hawaii Audubon Society strongly urges that this protection continue unchanged, or increased, if changed at all.

Thank you for your attention to this matter.

Sincerely,

Sheila Conant

Sheila Conant, Ph. D.
President
Hawaii Audubon Society

Assistant Professor
Department of General Science
University of Hawaii

cc: Mr. Paul Howard
Western Region Representative
National Audubon Society

THE NEW YORK TIMES, FRIDAY, DECEMBER 10, 1982

U.S. Agrees to Turn Management Of Wildlife Refuge Over to Texas

By PHILIP SHABECOFF
Special to The New York Times

WASHINGTON, Dec. 9 — Interior Secretary James G. Watt today announced an agreement with the State of Texas turning over management of a Federal wildlife refuge on Matagorda Island in the Gulf of Mexico to the state, a move opposed by conservationists.

Mr. Watt said the ownership of the 19,000-acre preserve would be transferred from the General Services Administration to his department's Fish and Wildlife Service and thus retained by the Federal Government. He also said that as part of the agreement a 24,000-acre state-owned section of the island would be included in the National Wildlife Refuge System.

The Interior Secretary said the agreement provided "conservation easements" requiring the state to manage for conservation purposes the thousands of acres of state-owned tidelands on the island that are used by endangered whooping cranes. The agreement, he said, "is designed to preserve the natural characteristics and wildlife values of Matagorda Island."

Conservationists to File Suit

The department's announcement said the agreement requires that the state use Federal management principles in the refuge. It added that the pact ends a seven-year dispute between the state, the Fish and Wildlife Service and the General Services Administration.

But a spokesman for Defenders of Wildlife, a conservation group, said today that his organization and the Sierra Club planned to file suit in Federal Court next week to block the arrangement.

Steven Parcells, assistant director of Defender of Wildlife's wildlife refuge program, said the group was opposing state management of the refuge because the "track record" of the Texas Parks and Wildlife Department was poor. He said the department was required by law to manage Matagorda Island for recreation rather than wildlife protection.

Sees Threat to Whooping Crane

"Under this agreement, the Fish and Wildlife Service would lose the ability to enforce Federal wildlife laws on the refuge," Mr. Parcells said. He added that the absence of Federal enforcement would constitute a threat to the whooping cranes and other wildlife on the island.

Mr. Watt, however, said the "natural resources of Matagorda Island will be protected and enhanced" by the addition of the state lands to the refuge system.

The Federal property on the island, once an Air Force bombing range, had been managed by the Fish and Wildlife Service as part of the Aransas National Wildlife Refuge on the mainland. It will now be separated from that refuge, which will continue as a Federally owned and operated facility.

Aransas and Matagorda are part of the wintering ground of nearly 80 of the rare whooping cranes.

Sea Frontiers
NOV-DEC 1982

Deepwater Shrimps
A New Pacific Fishery

by James F. Schlais

Although described scientifically from a specimen dredged during the 1873–1876 voyage of H.M.S. *Challenger*, the deepwater caridean shrimp *Heterocarpus laevigatus* remained virtually unstudied for a century. This shrimp's potential as a fishery item was discovered less than a decade ago. Now it appears that at the right depth, about 300 to 400 fathoms, in the tropical Pacific, this species may live in great numbers, potentially supporting a fishery worth many millions of dollars a year.

Tasting like a combination of shrimp and lobster, this new seafood has begun appearing on the menus and fish counters of restaurants and supermarkets in Hawaii during the past year. Promoted as Hawaiian deep-sea shrimp, *H. laevigatus*, along with its close cousin *H. ensifer* (which is taken in fewer numbers), represents an entirely different group from the penaeid shrimp that are taken in the Gulf of Mexico and that make up more than half of the shrimp landed by American fishermen. The Hawaiian species range in size from the length of a finger to "jumbos" about 7½ inches long, and live in a variety of habitats from rocks to mud and rubble. After initial exploratory studies, biologists Paul Strusaker and Donald Aasted concluded, in 1974, that the *Heterocarpus* populations are a probable "unexploited resource of considerable magnitude."

7½ inches = 19 centimeters

Caught in a Trap

Nearly all the Hawaiian deep-sea shrimps now marketed come from a single source, the catcher-processor vessel *Easy Rider Too*. The 126-foot, steel-hulled ship, skippered by Gary "Skip" Naftel, is not the average Hawaiian fishing sampan limited to a ten-day fishing trip. The $2.5 million vessel acts as a mother ship capable of servicing up to five other fish boats and returning to port with a packaged product ready for the consumer. For decades Japanese, Russian, Norwegian, and other major fishing nations have worked catcher-processor vessels, but only now are such designs being used in the United States. *Easy Rider Too*'s twin 960-horsepower diesel engines, a fuel capacity of 50,000 gallons, and a 225-ton-capacity fish hold allow her to go on two-month-

126 feet = 38.4 meters
50,000 gallons = 189,265 liters

All photographs by the author

FLAGSHIP OF A NEW FISHERY, Easy Rider Too *is the source of most Hawaiian deep-sea shrimps. Vast quantities of these shrimps, which taste like a combination of shrimp and lobster, are believed to live in waters 300 to 400 fathoms deep.*

long fishing voyages to Hawaii's bountiful Leeward Islands fishing grounds, 500 miles from port.

Another feature of this ship, unusual for either Hawaiian or worldwide commercial fishing operations, is that nine of her 18-member crew are women. First mate Laura Raabe, who has a degree in electromechanics, began working for Naftel five years ago aboard his original fishing and research vessel, *Easy Rider.* This boat is well known to the Hawaiian oceanographic community, having participated in research on coral reefs, fish distributions, humpback whales, and sharks.

For decades, shrimpers in the Gulf of Mexico have scooped up penaeid shrimp by dragging huge, baglike nets over a smooth ocean floor. The rugged bottom of most of the tropical Pacific makes trawling difficult or impossible, however, so *Easy Rider Too* catches *Heterocarpus* with baited rectangular traps. Made of steel-bar frames covered with galvanized-wire screen and wrapped in burlap, the traps have funnel-shaped entrances similar to lobster traps. Unlike spiny lobsters, which can be caught with several kinds of bait, deepwater shrimps are more finicky, preferring oily fish such as mackerel. A trap

500 miles = 805 kilometers

baited with 3 pounds of fish may bring in 30 pounds of shrimp.

Out at sea, as many as 150 traps, strung 30 fathoms apart along a heavy-duty polypropylene line, are dropped one by one over the stern, with the ends of the line tied to buoys. Down time on the ocean floor depends on the weather, processing backlog, and other factors, but usually lasts one or two days. If the traps are left down longer, cannibalism may occur, although it is less likely than with spiny lobsters. A hydraulic cherry-picker crane on board hauls up the traps, which may contain a total catch of 3,500 pounds of shrimp. The technique is new, and the crew tries different trap configurations, types of bait, and lengths of bottom time. The technique does not work well on extremely rough bottoms strewn with boulders and pinnacles. There, fewer but larger traps may be the answer.

3 pounds = 1.36 kilograms; 30 pounds = 13.6 kilograms

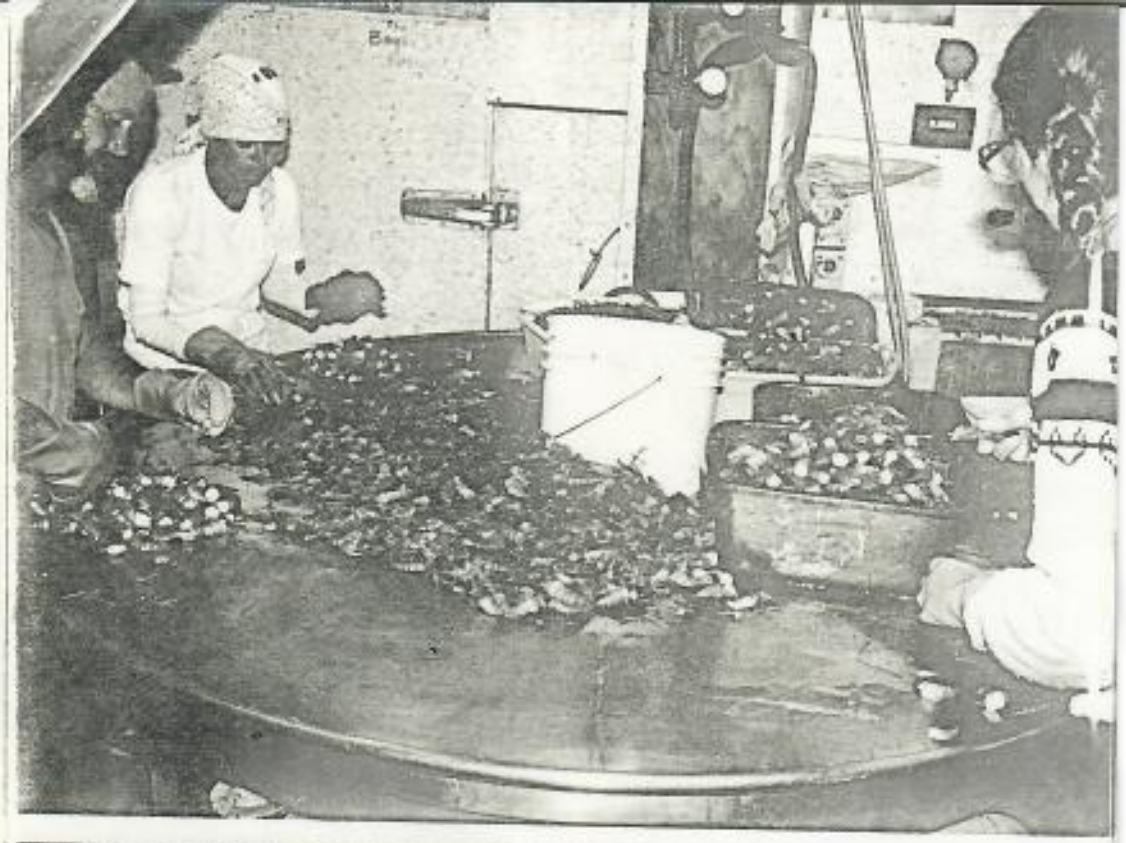
TRAPS FOR DEEPWATER SHRIMPS *are constructed by the crew (left) prior to a two-month stay at sea. Below, a nylon bag full of shrimp is lifted out of the hold, where it was stored in brine chilled to 32°F until the catch could be processed.*

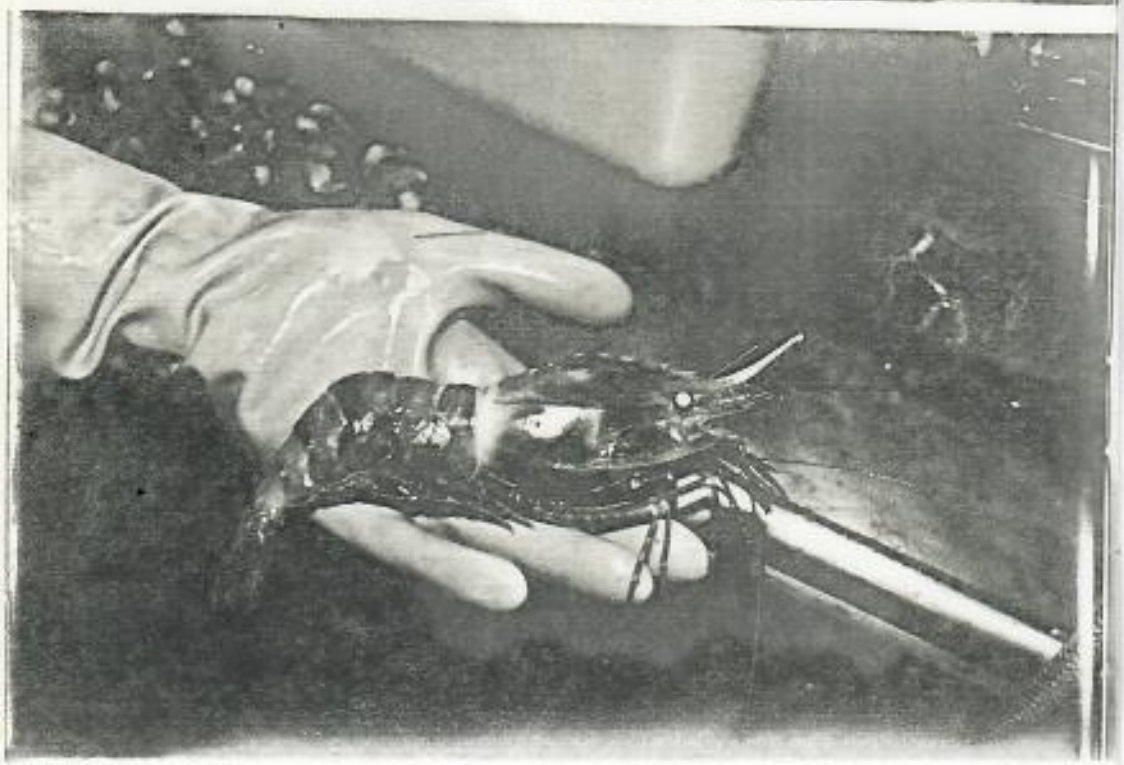
An Oceanic Crop

Dr. Murray Dailey, a marine biologist who took leave from California State University at Long Beach to study the shrimp, has emphasized the experimental nature of the fishery. With most developing fisheries, the federal government has already explored potential populations, catch, and size limits. With *H. laevigatus*, however, there is little background information. At present, the only established commercial fishery for *Heterocarpus* is for *H. reedi* off Chile and Peru, where trawling produces about 10,000 tons annually. Dailey's goal is to learn how to safely manage the new fishery, much as a crop is managed on land. What size can be taken? When do the shrimp reach breeding age? How many breeding individuals are necessary to maintain a stable population? These are some of the questions that need to be answered. Migratory patterns, common to many crustaceans, also have to be investigated.

Heterocarpus abounds in Hawaiian waters, but more studies are needed

3,500 pounds = 1,590 kilograms





ABOARD THE MOTHER SHIP, Easy Rider Too, *shrimps are sorted and tailed by crew members, then boxed and frozen — a product ready for sale. Since parts of the shrimps cannot be utilized, processing at sea saves space otherwise wasted in bringing the whole animals back to market.*

to outline its complete Pacific range. Dailey believes that the shrimp are plentiful throughout the entire tropical Pacific, as long as the depth is right — about 300 to 400 fathoms. They could be taken by fishermen in small boats and become a much needed new source of income in Micronesia and the trust territories. Preliminary estimates peg the potential fishery area of the tropical Pacific at 250,000 square kilometers, with possible annual yields of 1 to 10 tons per square kilometer.

Packaged at Sea

Fishing for the deepwater shrimps on *Easy Rider Too* is big business. On long trips out, she services two other boats, *Mokihana* and *Easy Rider*. The overhead for a two-month fishing trip for the three boats, including fuel, payroll, bank payments, supplies, gear repairs, and new equipment, runs $287,000 per month.

The catch is processed on board right through to the finished product, which must meet Food and Drug Administration and Hawaii Health Department standards. As the traps are pulled one by one from the ocean, the contents are dumped on a large deck table, where crew members quickly sort out the crabs, eels, and other creatures caught incidentally, and send the shrimps down a chute to be bagged in nylon mesh and put in a hold filled with brine-chilled to 32°F. This helps revive them (the water they live in is about 36°F) and arrests bacterial growth. In the processing room, the shrimps are tailed and sorted by hand into five sizes, given a 60-second dip in a 5-percent chlorine solution to kill bacteria, drained, and packaged in 5-pound boxes. To improve shelf life, each box is dipped in a corn syrup/seawater glaze, then stored in a cascade-system blast freezer that can freeze 300 pounds of shrimp tails to -30°F in four hours. On two-month trips, the fleet hopes to take 240,000 pounds of shrimp, which will be reduced on board to 80,000 pounds of tails. On two-day trips, shrimps to be sold fresh the next day are stored in the cold brine. At the Honolulu marketplace, shrimp currently brings about $6.50 per pound.

Cooking shrimp is much like cooking most crustaceans. Unlike lobster or prawn, however, the dark anal vein, or gastrointestinal tract, of *Heterocarpus* is reduced and does not have to be removed. The shrimp can be steamed, broiled, sautéed, or even eaten raw, Japanese style, as sashimi. The worst thing one can do is overcook it. "Just lightly sauté in garlic and butter, with a touch of white wine," say those who have tried it, "and ummm!" □

250,000 square kilometers = 96,525 square miles

32°F = 0°C; 36°F = 2.22°C; 5 pounds = 2.3 kilograms
300 pounds = 136 kilograms; -30°F = -34.44°C
240,000 pounds = 108,860 kilograms
80,000 pounds = 36,290 kilograms

Vol. 162
No. 3
Sept
1982

ROOSEVELT COUNTRY

T.R.'s Wilderness Legacy

By JOHN L. ELIOT
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by FARRELL GREHAN

A DEAD SEAL, of all things, had been fished out of New York Harbor and exhibited for the curious at a Broadway market one day in 1865. It was spied by a small boy, who tingled "with every possible feeling of romance and adventure." With a ruler he solemnly measured the creature. He finally begged its skull, and thus an ambitiously christened Roosevelt Museum of Natural History was born.

That seal ignited a long fuse. The explosion of action that followed transformed the nation. When the dust settled after Theodore Roosevelt left the White House in 1909, his zeal for natural history—and for a fledgling cause called conservation—had enriched the public domain by approximately 230 million acres, a patchwork of protection three-fifths the size of Alaska.

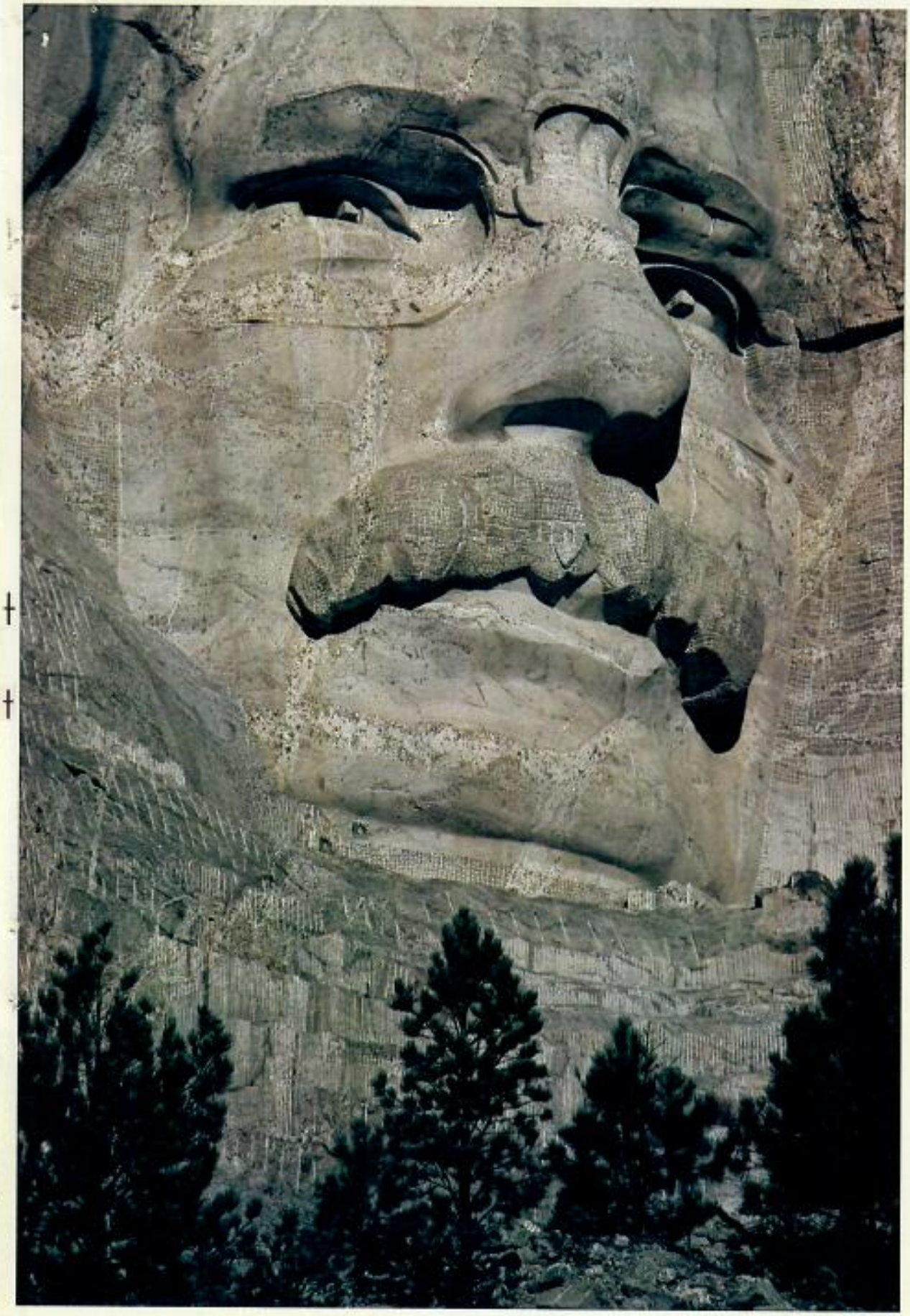
The ebullient slash of his pen quadrupled the existing forest reserves and proclaimed the first federal wildlife refuges, more than 50 of them. The number of national parks doubled; the first 18 national monuments came into being. The U. S. Reclamation Service was inaugurated to irrigate about three million acres in the arid West, and tens of millions of mineral-bearing acres also fell under Roosevelt's cloak (map, pages 346-7).

"I hate a man who would skin the land," he bristled. He railed against corporate "timber thieves," and argued that "a live deer in the woods will attract . . . ten times the money that could be obtained for the deer's dead carcass." Again and again he preached, "Conservation of our natural resources is the most weighty question now before the people of the United States."

The bombast may seem familiar, coming from an inexhaustible wellspring of energy whose better known accomplishments have become familiar political folklore. Rough Rider. Trust-busting wielder of the big stick. Ramrod of the Panama Canal. Bull Moose reformer. Militarist. Peacemaker. Author. Cowboy. Naturalist. Hunter. Conservationist.

Of those many facets, the last two may never be reconciled by many people with an undying image of "bloody Teddy" and his trophies. Nor is the vast gulf between hunter

A figure larger than life, *President Theodore Roosevelt secured a niche in South Dakota's Mount Rushmore partly for his little-known role as a conservationist. From 1901 to 1909 "T. R." set aside about 230 million acres of national forests, wildlife refuges, and other lands—an achievement that is still a worthy yardstick.*



***Buffalo weathers winter** in Yellowstone. In the 1890s Roosevelt helped win a tough protection law for Yellowstone and its wildlife when the national park was suffering neglect and abuse. As President he aided in reestablishing buffalo in Oklahoma, Montana, and North Dakota. Of the slaughter by market hunters, he*

National Geographic, September 1982

lamented, "Never before . . . were so many large wild animals of one species slain in so short a space of time." In the West, T. R. hunted buffalo and many other animals—partly for meat, partly for the chase, and also to gain knowledge of their behavior, which made him one of the nation's foremost field naturalists.

and nonhunter ever likely to be bridged.

By John Burroughs, it was. "I have never been disturbed by the President's hunting trips . . . ," wrote the ardent naturalist, a longtime friend. "Such a hunter as Roosevelt is as far removed from the game-butcher as day is from night."

"T. R." (he detested "Teddy!") did nothing without enthusiasm, and he studied animals and demanded their protection as vigorously as he hunted them. C. Hart Merriam, a famed biologist and one of the founders of the National Geographic Society, observed, "If his major interests had not been diverted into . . . politics, he would have been one of America's foremost naturalists."

Around him Roosevelt gathered a who's who of such early conservationists—eminent men like John Muir, forester Gifford Pinchot, and the best biologists and naturalists of the day. He hiked with them, sent them specimens, and argued with them. Together they made his boyhood museum come alive.

The landscapes of the Roosevelt legacy often reflect the man who bequeathed them. He cut his teeth on the country in the badlands of North Dakota, a tortured landscape of buttes and ravines honored after his death as Theodore Roosevelt National Park.

IN THE TOWN OF Little Missouri, rank cowhands taunted a bespectacled "Eastern punkin-lily" who stepped off the train in September 1883. He was a feisty young New York assemblyman, and he had buffalo on his mind. He was going to shoot buffalo while there were still buffalo left to shoot. He drove his cowboy guide crazy for a week, riding and slogging and sleeping in the muck of an endless rain, chirping, "By Godfrey, but this is fun!" When he finally got his bull, he did a war dance around its carcass.

Roosevelt had shot one of the very last buffalo in Dakota Territory, and a few years later surely realized it. "No sight is more common on the plains than that of a bleached buffalo skull," he wrote in 1885.

He labored on his book *Hunting Trips of a Ranchman* in the pine cabin of a cattle ranch known as Chimney Butte or Maltese Cross that he bought into on that first trip. Relocated eight miles north of its original site, the ranch house now stands near Park Service headquarters in Medora.

"That desk was Roosevelt's," said chief interpreter Micki Helickson, showing me through the cabin, "but it probably came from Elkhorn, his second ranch. The isolation of Elkhorn was more conducive to his writing." Over his lifetime T. R. wrote up a storm of more than 35 books, some 150,000 letters, and countless periodical pieces.

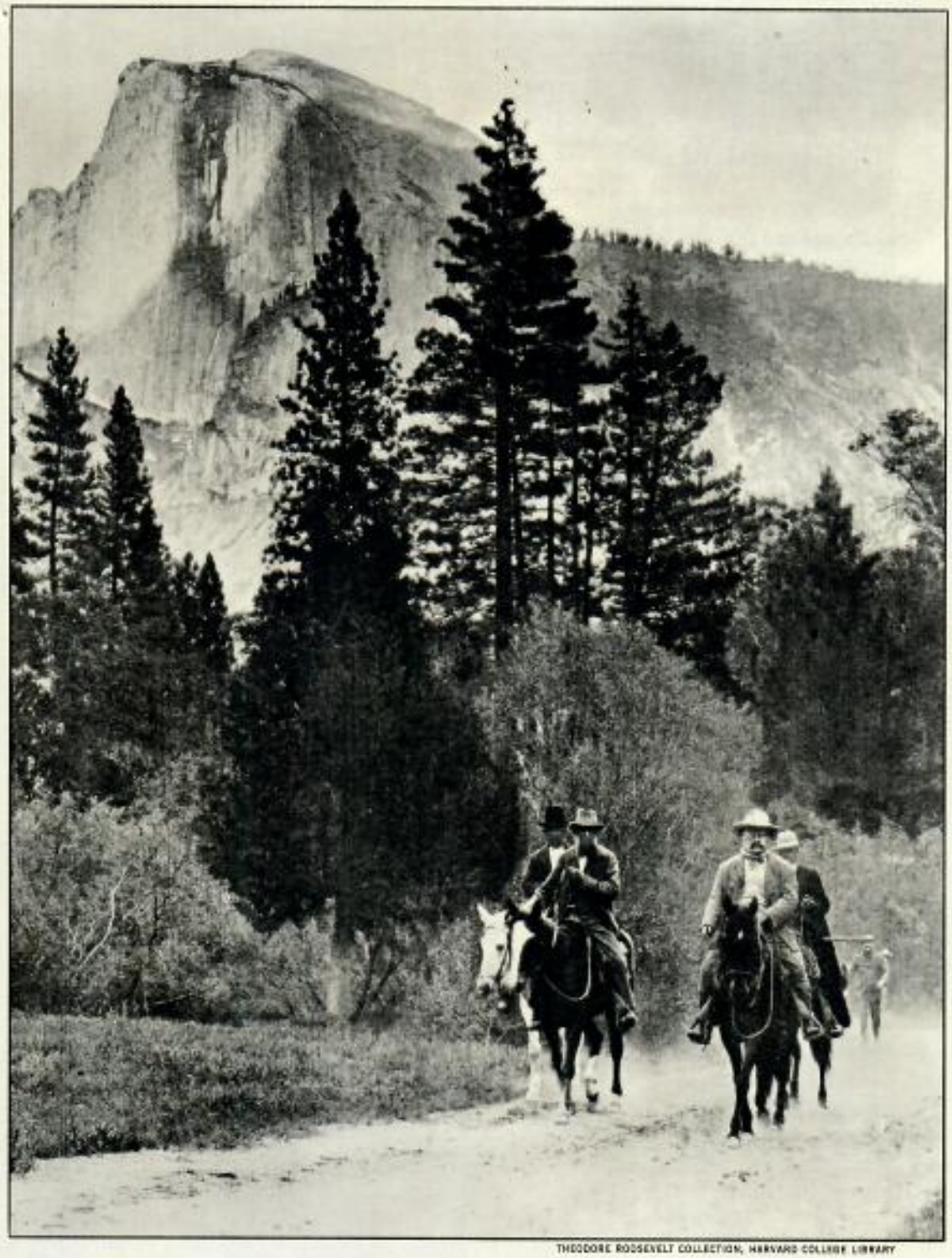
The rigors of life in the saddle rapidly knocked off the square corners of the dude from New York. "We knew toil and hardship and hunger and thirst . . . ," he wrote, "but we felt the beat of hardy life in our veins, and ours was the glory of work and the joy of living."

But the primeval richness of the plains was disappearing before his eyes, felled by the guns of the market hunters, trapped unchecked by fur traders, shorn by too many cattle. During the 1886 drought, Roosevelt told a reporter that "the cattlemen this season have paid the penalty. . . . there is not a green thing in all the region. . . . A stranger would think a donkey could not live there."

He learned many a hard lesson in the badlands and beyond on protracted hunting trips. "I owe more than I can ever express to the West," he wrote. With George Bird Grinnell, editor of *Forest and Stream* magazine, he organized the Boone and Crockett Club in 1888 to promote not only "manly sport with the rifle" but also the preservation of forest and game. The club threw its weight behind such causes as one that helped thwart destruction in Yellowstone National Park, at first only a paper preserve lacking the means for protection.

When an anarchist's bullets cut down William McKinley on September 6, 1901, and catapulted Vice President Roosevelt into the White House, Republican leader Mark Hanna growled, "Now look, that damned cowboy is President of the United States." The "cowboy" was still thinking about the buffalo. The vast herds that once numbered 60 million were gone forever, but there were still remnants. Could they be restored where others had been wiped out?

"Islands of rock in a prairie sea," the Wichita Mountains National Wildlife Refuge tumbles in heaps of boulders over the Oklahoma *(Continued on page 350)*



THEODORE ROOSEVELT COLLECTION, HARVARD COLLEGE LIBRARY

***"How happy were the days** in the Yosemite I owed to you," Roosevelt wrote John Muir, riding to his right beneath Half Dome. In 1903 the President and the great naturalist headed for Yosemite's tall timber to talk forests, birds, and conservation around the campfire. To the existing national park, Muir convinced T. R. to add Yosemite Valley and the Mariposa Grove of giant sequoias, then under California's control. Afterward, the President spoke at Sacramento: "We are not building this country of ours for a day. It is to last through the ages."*

ROOSEVELT COUNTRY 1901 to 1909

*SWEEPING MOSAIC shows the greening of the nation under Roosevelt, who halted unchecked exploitation of its natural resources and wilderness treasures with a framework of federal protection—for "the people unborn as well as the people now alive." His greatest crusader was Gifford Pinchot (**facing page**), who with T. R. founded the U. S. Forest Service and swelled its reserves from 43 million to 194 million acres. Urged on by naturalists like John Burroughs (**below**), Roosevelt set aside Florida's Pelican Island as the first federal wildlife refuge, then added 50 more. For scientific and historic preservation, he began the system of national monuments—an early designation for the Grand Canyon—and approved five new national parks. And he saw his pioneer reclamation projects as conservation because they irrigated the West for small homesteaders, rather than to benefit transient sheep and cattle barons.*

Roosevelt's unprecedented National Conservation Commission took the first inventory of the country's remaining riches. He later convened a North American Conservation Conference, and proposed another for the whole world. David Fairchild, an esteemed botanist, summed up Theodore Roosevelt as "the first and last President . . . to have a biological sense of proportions."

Tiny, far-flung islets set aside by Roosevelt today make up the Hawaiian Islands National Wildlife Refuge.

BASED ON NATIONAL PARK SERVICE PHOTOGRAPH

Camping with John Burroughs and guides in Yellowstone National Park, 1903.

T. R. established a foothold for conservation in Alaska with two huge national forests and seven wildlife refuges.


Roosevelt roamed the Adirondacks as a boy. As Vice President in 1901, he was hiking there when informed that President McKinley was dying from an assassin's bullets.
Medora
The lonesome badlands of North Dakota – later site of Theodore Roosevelt National Park – molded Roosevelt's love for the land after he bought two ranches there and punched cattle.
Mount Marcy
Sagamore Hill was T. R.'s rambling home and summer White House.
Oyster Bay
Mount Rushmore
Niobrara Bird Reservation
Niobrara Forest Reserve
From British Columbia south through the Rockies, from Arizona canyons to Louisiana bayous, T. R. tramped, camped, and hunted. His treks taught him the need to preserve the forests and their wildlife.
Washington
Pine Knot, a rustic cottage near Charlottesville, Virginia, served as President Roosevelt's retreat for fresh air, solitude, and bird-watching.
Charlottesville
Wichita National Forest and Game Preserve
Mosquito Inlet Bird Reservation
Pelican Island Bird Reservation
T. R. established a tropical forest reserve that became Caribbean National Forest and around Culebra Island a bird sanctuary, now part of Caribbean Islands National Wildlife Refuges.
Culebra Bird Reservation
PUERTO RICO
18°
66°
67°

COMING OF BUFFALO HERD INSURES A GAME PRESERVE

SO SAYS FORESTER MATTOON IN CHARGE OF WICHITA FOREST

...ther and Various Kinds of Gam... Are to be Sent Here.

PREPARING TO RECEIVE THEM

Destructive Animals Will be Killed Off—Buffalo to Arrive This Evening or Tomorrow Morning—Sent By Express in Crates.

THE DAILY NEWS-REPUBLICAN OF LAWTON, OKLAHOMA OCTOBER 12, 1907

Gifford Pinchot
Chief Forester

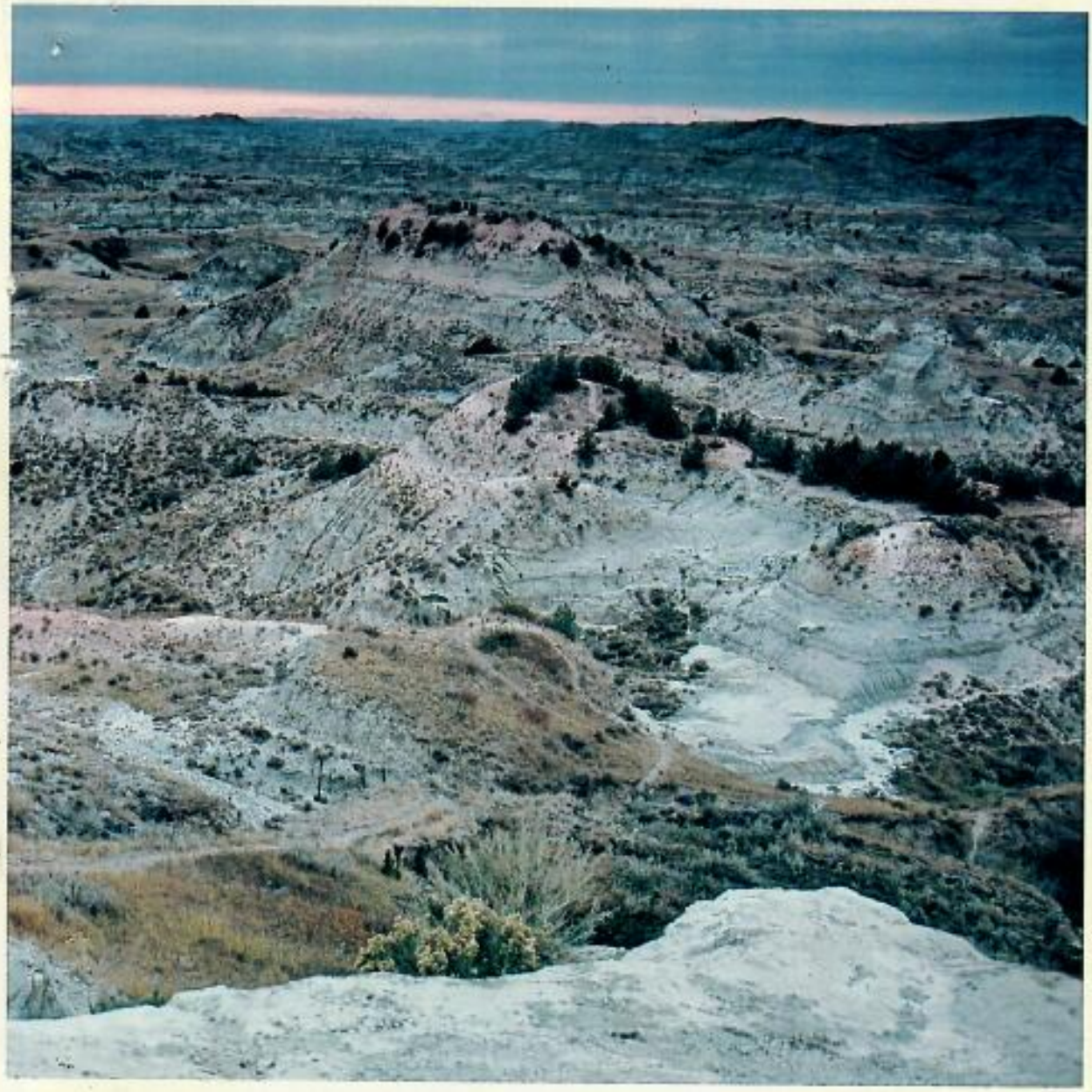
ORIGINAL SOURCE UNKNOWN

PAINTED BY WILLIAM H. BOND
RESEARCHED BY VICTORIA DUCHENEAUX
COMPILED BY ROBERT DULLI AND DAVID MILLER
NATIONAL GEOGRAPHIC ART DIVISION

Soothing emptiness *of the North Dakota badlands* ***(right)*** *drew Roosevelt in 1883 to "a land of vast silent spaces . . . where the wild game stared at the passing horseman." There the young New York assemblyman invested in two ranches. One ranch house, known as Maltese Cross or Chimney Butte* ***(below)****, was later relocated in the badlands' Theodore Roosevelt National Park.*

Short, bespectacled, and a dandy, Roosevelt needed some time to earn respect. On a roundup, cowhands guffawed when he sang out, "Hasten forward quickly there!" But the dude proved able to ride for days through blizzards, shoot deer at an impossible range, and flatten a bully who taunted him in a bar. In furs and buckskins ***(far right)*** *T. R., center, stands with two of his partners, Wilmot Dow, left, and Bill Sewall. The trio traveled 100 miles to capture outlaws who had stolen their boat.*

For about ten years Roosevelt shuttled regularly between the East and the badlands, where his neighbors watched him evolve from ranchman to statesman. No one was surprised. One rancher had called him "the most remarkable man I ever met. Unless I am badly mistaken, the world is due to hear from him one of these days."



THEODORE ROOSEVELT COLLECTION, HARVARD COLLEGE LIBRARY

(Continued from page 344) flatlands near Lawton. The buffalo hunted by the Kiowas, Comanches, and other tribes had vanished when the area, championed early by the Boone and Crockett Club, was proclaimed a game preserve by Roosevelt in June 1905.

T. R. was intensely interested in bringing back the buffalo to the Wichita. So was Quanah Parker, the old chief of the Comanches, who said wistfully, "Tell the President that the buffalo is my old friend, and it would make my heart glad to see a herd once more roaming about Mount Scott."

In October 1907, 15 prime specimens chosen from the New York Zoo were specially crated and loaded on railroad cars at Fordham Station. As the train rolled 1,858 miles toward Cache, Oklahoma, newspapers touted the event and festive crowds lined the tracks.

At Cache, a group of Indians camped out for days near holding pens, awaiting the return of the "Great Spirit's cattle." Emotions ran high when the animals arrived. Onetime warriors pressed against a wire fence to view a few of the shaggy giants that once had blackened their plains.

Elk and wild turkey, by then exterminated from the region, were also successfully reintroduced, along with a herd of Texas longhorn cattle, carefully selected to preserve the best representatives of a dying breed. Today, within the fenced refuge's 59,000 acres, the U. S. Fish and Wildlife Service maintains about 300 longhorns and 600 buffalo, auctioning roughly 100 head from each group yearly to breeders.

Elmer Parker knows each animal by number, if not by name (one fetching cow became Belle Starr). Elmer is called a biological technician, which is like labeling corn whiskey as undenatured ethyl alcohol.

The fall buffalo roundups have branded him with more than a few scars. "I'm gettin' older and slower, I guess," he sighed, as three young bulls nosed around his truck one morning. "Few years ago a buffalo got me down on the ground. I just had to play dead while he worked me over. At least he never got a horn in me. He did bust up my kneecaps and tore up my clothes pretty bad."

While Elmer and others ride herd on the wildlife, refuge manager Bob Karges has fought a running feud with the Air Force and Fort Sill Military Reservation next door. The issue: noise. Since 1972 jet fighters circling practice targets at Fort Sill have also overflown parts of the refuge.

"To have wilderness, you have to have solitude," said Karges.

For Fort Sill, Lt. Col. A. T. Brainerd responded. "These are Air Force Reserve and Air National Guard pilots, and they try not to fly over densely populated areas. It's a trade-off."

Each year 12,000 people hike through Charon's Garden, a wilderness with a splendid little amphitheater of fractured rock where buffalo, elk, and deer wander amid blackjack and post oak. Bobwhites were calling around my camp one morning when an F-105 came screaming out of the sun, followed by three more a few seconds apart.

Well into the afternoon the roar of the jets filled Charon's Garden. Surely, on days like this, when grisly old Charon was ferrying the souls of the dead across the river Styx, the passengers awakened and bade him hasten the departure, as I did mine.

ON A THREE-ACRE ISLET of mangroves in the Indian River on Florida's east coast, the first seed of the National Wildlife Refuge System was planted on March 14, 1903. "Is there any law that will prevent me from declaring Pelican Island a Federal Bird Reservation?" Roosevelt queried. Told the island was federal property, he delivered a fiat: "Very well, then I so declare it."

It was to the bird-loving President that Frank M. Chapman of the Audubon Society and others had brought the island's case. To adorn fashionable ladies' hats, plume hunters were slaughtering the area's birdlife, chiefly the egrets. A one-man crusade on behalf of the birds had long been carried on by Paul Kroegel, a German boatbuilder who had settled nearby.

Paul Kroegel's modern counterpart, Lawrence Wineland, kept an eye on the birds for 17 years until his recent retirement. "Why would a pelican want to nest here? Only the pelican knows," he ruminated in an Arkansas drawl as his boat nudged the island, its mangroves bedraggled by decades of flapping wings and guano deposits.

Brown pelicans merit the endangered

species list at present because a buildup of DDT caused them to lay thin-shelled eggs elsewhere in their range. At Pelican Island that threat has not materialized, but another one has.

Here and there, adult pelicans flapped helplessly, ensnared in rats' nests of monofilament fishing line. "There's one that's got something stuck in his neck," Lawrence pointed out. "He probably got hold of a fish that still had a lure in it."

He set about cutting birds loose, chasing down one victim hamstrung by treble hooks snagged through its wing, shoulder, and bill pouch. With Lawrence holding, I performed crude pocketknife surgery. "One more pelican mended, I guess. He'll make it all right," he judged, as the patient waddled into the water.

ACROSS THE CONTINENT, on the California-Oregon border, another haven serves both bird and man. In the Klamath basin Roosevelt established first a reclamation project, and then, in 1908, the nation's first waterfowl refuge—the Klamath Lake Reservation.

McKinley was barely cold in the ground when Gifford Pinchot and Frederick H. Newell, champions respectively of forestry and reclamation, hastened to the Roosevelt White House. "We left, two very happy men . . . ," Pinchot later recalled. "It was a Heaven-sent chance."

Roosevelt used the Reclamation Service, established in 1902, as a tool for conservation—to benefit the common man, the actual settler, with the object of irrigation "not to make money, but to make homes." Today about 6.6 million acres are controlled by the Bureau of Reclamation, an agency that, ironically, often arouses the wrath of environmentalists, to whom "reclamation" has become synonymous with "dams."

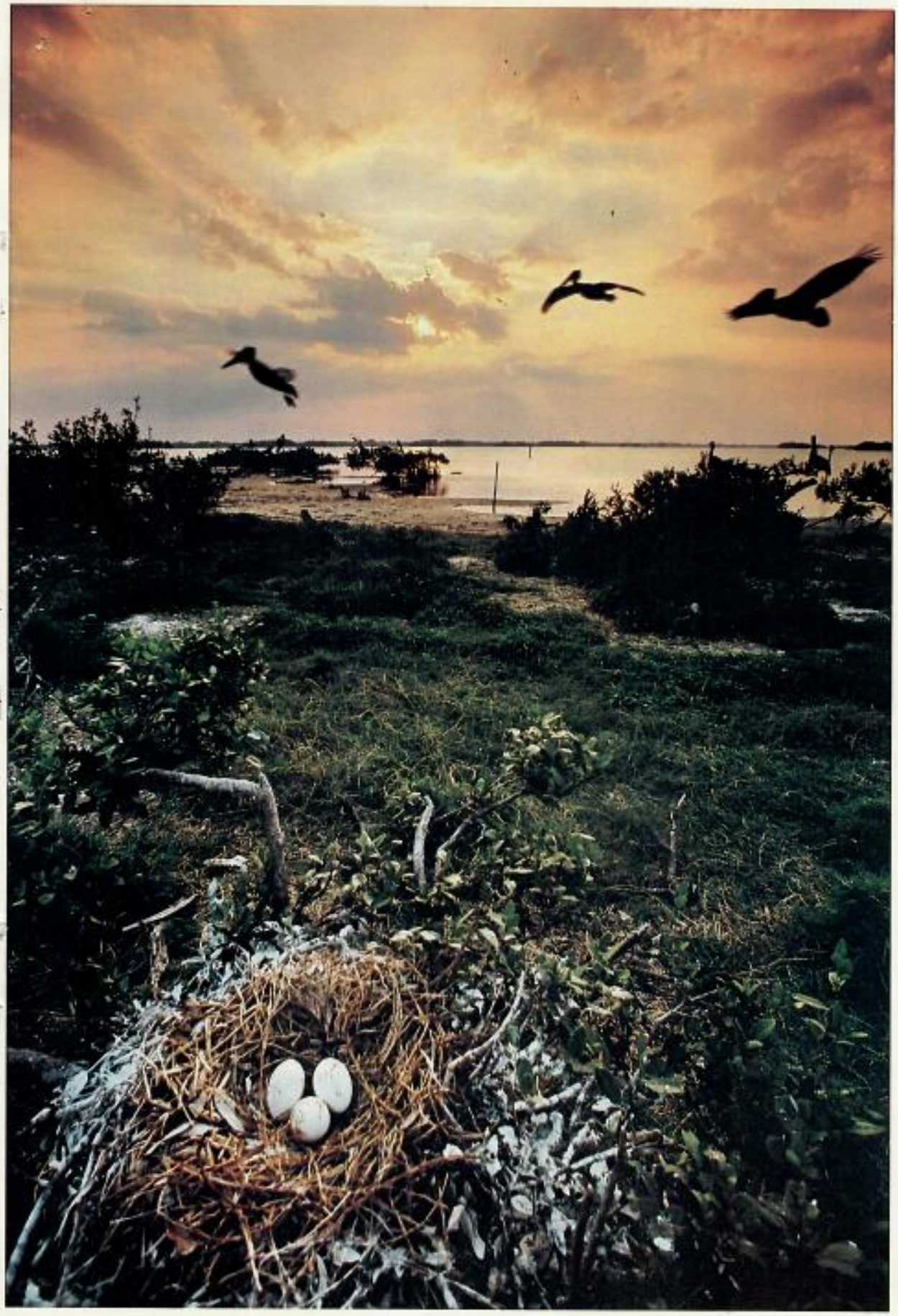
In the fertile tule marshes of the Klamath region, reclamation balances the demands of agriculture against those of a sky full of migratory ducks and geese. Three-quarters of the Pacific flyway population rests and feeds here during the spring and fall, sheltered now by five refuges.

The reclamation project grew into a complex system of dams, pumps, canals, and tunnels that now maintains the water level

THEODORE ROOSEVELT COLLECTION, HARVARD COLLEGE LIBRARY

***An indefatigable advocate** of "the strenuous life," T. R. clears the woods at his Long Island home. Years of hiking balanced his pursuit of big game with another passion—birds. He waxed rhapsodic at "the serene, ethereal beauty" of the song of the hermit thrush, "rising and falling through the still evening, under the archways of hoary mountain forests. . . ." At his Virginia retreat in 1907 he may have been the last person to observe wild passenger pigeons before their extinction, although his sighting was unconfirmed.*

***To halt a bird slaughter** by plume hunters, Roosevelt in 1903 made Florida's Pelican Island (**right**) the first federal wildlife refuge. Brown pelicans, recently endangered by a buildup of DDT in their eggs, are staging a comeback. But Florida manatees (**above**) are still threatened by motorboats and possibly by red tides. T. R. protected the manatee in his Mosquito Inlet Bird Reservation, later abolished, though the system he started now numbers 410 refuges.*



on four of the five refuges. At Lower Klamath, farmers sharecrop 4,000 acres to grow barley, and must agree to leave a third of the crop unharvested for hungry birds in the fall and winter.

Many species live here through the summer, to test a birder's eye. Mount Shasta towered in the distance as black-necked stilts and American avocets sprang up in my path by Lower Klamath Lake. Eared grebes sailed along with their young nestled on their backs. Rarely, a wary western grebe poked out its long neck.*

THEODORE ROOSEVELT COLLECTION, HARVARD COLLEGE LIBRARY

***Trailside hoarfrost** adorns Mount Marcy in the Adirondacks **(facing page)**, where Vice President Roosevelt had taken a hike on Friday the thirteenth of September, 1901. A telegram reached him: President McKinley, wounded by an assassin, was sinking fast. He died as a buckboard relay sped T. R. from the mountains. The nation soon learned that its new Chief Executive **(above)** lived up to the Rough Riders' favorite tune, "A Hot Time in the Old Town Tonight."*

Shyness did not save the western grebe from decimation by plume hunters here in the late 1800s. Each season, market hunters also shipped more than 120 tons of the region's ducks and geese to San Francisco.

Roosevelt heard of the carnage through William L. Finley and Herman T. Bohlman, a naturalist-photographer team who studied the area in 1905. Finley contributed their work on Klamath and Oregon's Malheur Lake—another Roosevelt refuge—to T. R.'s unprecedented National Conservation Commission of 1908, whose report was called "the most exhaustive inventory of our natural resources that has ever been made."

Finley and Roosevelt became old friends, and later reminisced about the wilderness of the West they had helped to save. "It will be one of the greatest memorials to your farsightedness when both you and I are gone," Finley told him.

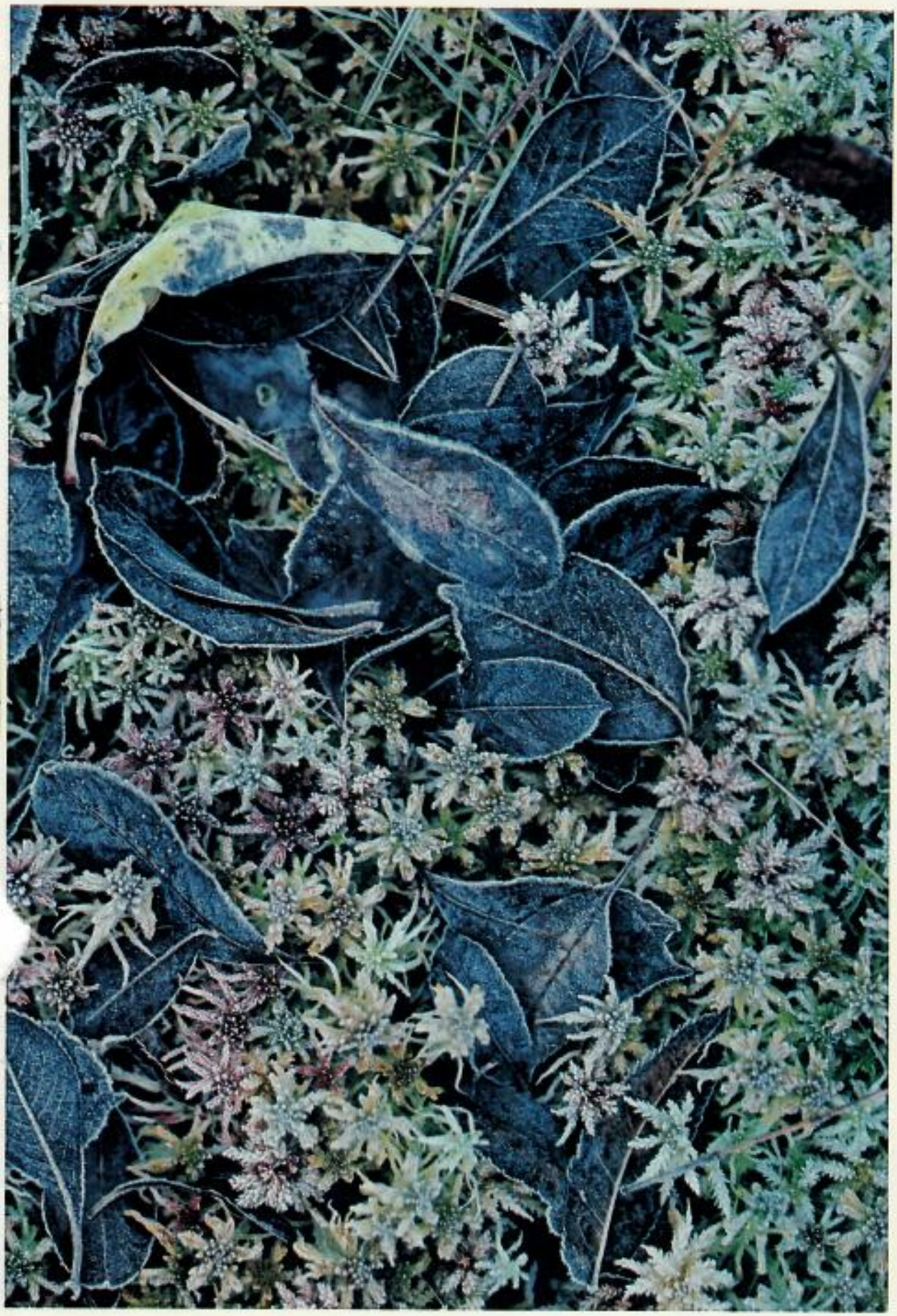
"Bully," said T. R. "I had rather have it than a hundred stone monuments."

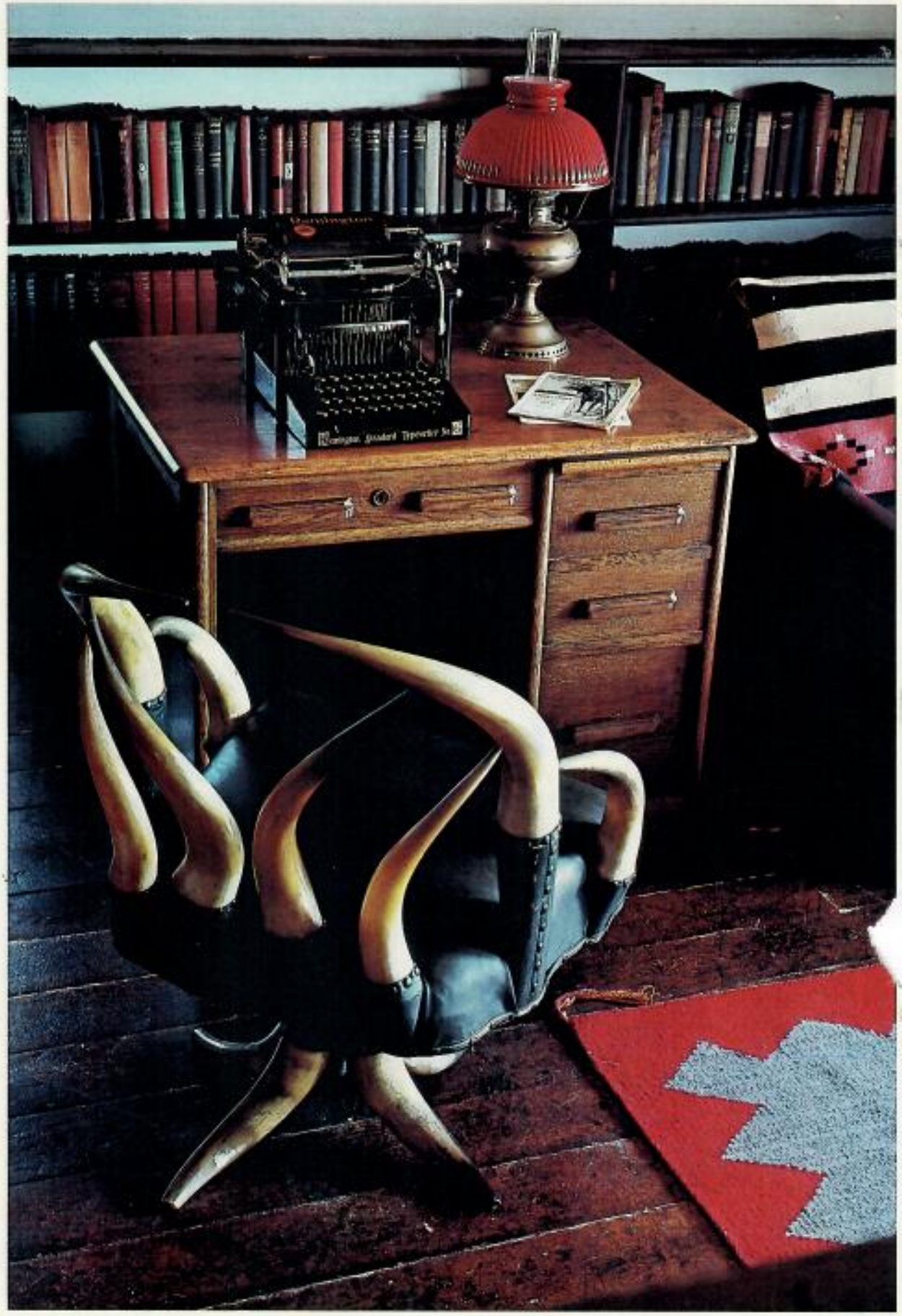
CONGRESS APPROVED five national parks during Roosevelt's tenure, including Oregon's Crater Lake and Mesa Verde in Colorado, but the park to which he drew the most attention was Yosemite. Two of its finest jewels, Yosemite Valley itself and the Mariposa Grove of giant sequoias, had been left under California's control when the national park was created in 1890. Those jewels, said critics, were being neglected by the state.

For six weeks during the spring of 1903 the President had been pressing the flesh campaigning in the West. A holiday was in order. "I want to drop politics absolutely for four days and just be out in the open with you," he had written to John Muir. On May 15 they arrived at Yosemite and headed for the trees, leaving the Secret Service behind and a bevy of officials with plans for banquets and fireworks holding the bag.

They were not entirely alone. It took three men and four mules to haul some 40 blankets that Roosevelt snuggled into at their first camp in Mariposa Grove. The next night

*See "The Birds That Walk on Water," by Gary L. Nuechterlein, NATIONAL GEOGRAPHIC, May 1982.





Peace and quiet were rare guests *at Sagamore Hill* ***(below)****, where six Roosevelt children and ten cousins "were encouraged to have all the fun possible." Completed in 1885 at Oyster Bay on Long Island, the home served as the summer White House and is now a national historic site. Mementos such as a cattle-horn desk chair* ***(left)*** *recall T. R.'s authorship of some 35 books and a staggering 150,000 letters. Other keepsakes echo his years as civil service commissioner, assistant secretary of the Navy, Rough Rider, and New York governor.*

they slept near Sentinel Dome and woke up covered with four inches of snow. "This is bullier yet!" crowed T. R.

The sage of the mountains wrote of Roosevelt, "I fairly fell in love with him." Around the campfire he seized the chance to proselytize the President: "I stuffed him pretty well regarding the timber thieves . . . and other spoilers of the forest," Muir recalled. Three years after their trip Roosevelt's pen incorporated the valley and Mariposa Grove into the national park.

What would he think of the valley now, where as many as 18,000 people and 6,000 cars have crammed the one-by-seven-mile area in a single day? For more than ten years the National Park Service has struggled to devise a plan to make Yosemite Valley something more than a drive-in rat race and remove some of the bureaucratic scenery.

"I love it, but I don't have to be here just so I can look at Half Dome out the window while I shuffle these papers," said assistant superintendent John Byrne at park headquarters. Under a plan that may take at least a decade to complete, most of the Park Service's 1,500 employees and their buildings will be relocated outside the valley. The plan will also remove some concession facilities, such as the tennis courts, and will reduce—but not ban—automobile traffic.

"But don't forget," said Byrne, "this is only three square miles of development. There are 1,186 more square miles out there, and most of that is virgin wilderness."

Outside the valley the crowds trickle away into the vast Sierra forests. Not far from Mariposa Grove, the sun flamed over my tent as it dropped behind the Chowchilla Mountains. I didn't at all mind sharing the sunset with a couple who happened by, especially since they had driven straight through from Kansas to see it. Anyway, they left before they could smell my steak frying.

In Mariposa Grove the next morning, shafts of sunlight played over the Grizzly Giant, the Telescope Tree, the Faithful Couple, names that bespeak the awe felt by millions at the sight of the famous sequoias. Roosevelt and Muir had camped near the Sunset Tree, a battered veteran 17 feet across. When he first entered the grove, T. R. lay on his back for half an hour, staring up at the behemoths that had stood,

some of them, for well beyond a millennium.

"The majestic trunks, beautiful in color and in symmetry, rose round us like the pillars of a mightier cathedral than ever was conceived even by the fervor of the Middle Ages," he wrote. To the residents of Sacramento, he said, "It would be a shame to our civilization to let them disappear."

A SPECIES OF ELK was disappearing from the Olympic Peninsula of northwestern Washington in the early 1900s. Roosevelt's personal interest in it stemmed from a friendly debate he had carried on with Hart Merriam of the Biological Survey.

Merriam, a scientific "splitter," used subtle differences among similar animals to describe many new species and subspecies. T. R., a "lumper," rebelled "when an old familiar friend is suddenly cut up into eleven brand new acquaintances."

If T. R. therefore sensed praise with a faint damn when Merriam named the Olympic elk *Cervus roosevelti* in 1897, he smothered it. "I am more pleased than I can say . . . ," he wrote Merriam. "I am only sorry that it will never be in my power to do anything except to just merely appreciate it."

He later amended such modesty by proclaiming Mount Olympus National Monument, another of his administration's innovations created by the Antiquities Act of 1906, which authorized the President to set aside "objects of historic and scientific interest." T. R.'s other national monuments included the Grand Canyon (11 years before it became a national park), the Indian ruins of New Mexico's Chaco Canyon, and Muir Woods near San Francisco.

Around Mount Olympus, hunters were gunning down the elk for their meat and canine teeth, which brought a handsome price as watch-fob ornaments. Today Olympic National Park protects about 5,000 of the majestic animals named for T. R., but a future generation of even finer splitters had the last word, classifying *Cervus elaphus roosevelti* as but another subspecies.

Roosevelt elk also bugle through part of Alaska's Chugach National Forest, among the 150 million acres of forest reserves that T. R. and Gifford Pinchot carved out. When Roosevelt took office, more than half the nation's forests had been leveled. The pioneer spirit—when, as T. R. said, "The American had but one thought about a tree, and that was to cut it down"—was still very much alive.

T. R. and Pinchot, his fiery chief forester who had been labeled "tree mad" at Yale, promoted a utilitarian philosophy. Far from locking up the forests, as many western legislators loudly alleged, they aimed at perpetuation through intelligent use. (A report on the national forests begins on page 306.) But in 1907, Congress forced a showdown.

It came on February 24, when an amendment was tacked onto the agricultural appropriations bill that would thenceforth permit only Congress to create or expand forest reserves in Oregon, Washington, Idaho, Montana, Colorado, and Wyoming. Roosevelt had eight days to sign the bill.

Little did Congress know what it had unleashed. In those six states Pinchot recalled, "We knew precisely what we wanted." He and his men worked around the clock. "At one point when they ran out of paper, Roosevelt and Pinchot were on their hands and knees in the White House drawing forest-reserve maps on the floor," said Horace M. Albright, who later became director of the National Park Service.

When T. R.'s "midnight" proclamations rang down on March 4, they created 21 new reserves totaling some 16 million acres. "The opponents of the Forest Service turned handsprings in their wrath, and dire were the threats against the Executive . . . ," he gleefully recalled.

Roosevelt took in more than 700 miles of Alaska's southern coasts with the vast Tongass and Chugach forest reserves. To Chugach, he added 700-square-mile Afognak Island, set aside in 1892 by President Benjamin Harrison as a "Forest and Fish Culture Reserve" at the urging of the Boone and Crockett Club. On Afognak, eight Roosevelt elk introduced in 1929 have multiplied to about 1,500 today.

WEST BY NORTH of Afognak, on the sweeping treeless tundra where the Yukon and Kuskokwim Rivers carry their silt toward the Bering Sea, Roosevelt created a remote bird reservation in 1909. It was so remote that in 1922 it was

abolished amid the smoke-filled rooms of Warren G. Harding's administration.

In 1980 it was reborn as part of the 20-million-acre Yukon Delta National Wildlife Refuge. In the fall more than a hundred million waterfowl and other birds stage a great migration from the delta that darkens skies in the Americas and across the Pacific.

Down the Pacific flyway streams a honking, quacking multitude, past a gantlet of hunters' shotguns that harvest a certain regulated number of ducks and geese. When the rest return to the delta for spring nesting, native hunters await them, posing a delicate balancing act for the U. S. Fish and Wildlife Service. To explain the situation, service biologists led me on a wild-goose chase.

The compact-size geese, called black brant, were in their summer flightless stage as a floatplane slowly drove 400 of them squawking along a slough. Upstream eight of us lay strung out along the mud flats. One by one we stood up on signal as the birds swam past our positions and fled in alarm—neatly into a funnel of nets ending in a pen.

In no time at all we were sitting on the tundra playing brant poker, dealing the birds back and forth to record their sex and age. Each brant got a leg band for hunters to return. Some were given large yellow collars with coded letters and numbers.

"Spring hunting by the natives is a red-hot issue up here," said refuge manager Chuck Strickland as he worked. "There are 12,000 to 15,000 Yupik Eskimos living on the delta. After sitting at home all winter eating dried salmon, some of them have a real need to go out and get fresh meat. If we're going to let that continue, we've got to know how many birds are killed in the spring."

He hopes the banding program will show how the brant and other game species are divided between lower forty-eight hunters and delta Eskimos. The latter resent being branded by the Migratory Bird Treaty Act as outlaws for their out-of-season subsistence hunting.

Earlier, at a camp called Old Chevak, biologist Vernon Byrd was mulling over the question when a young Eskimo named Peter Boyscout dropped by in search of milk for his young child. Peter, a Vietnam veteran and mechanic, told us that he was teaching a nine-year-old friend to repair outboard

Once upon a time, *this stuffed bear in the Sagamore Hill nursery adopted a Roosevelt nickname—and subsequently became a nighttime pacifier for millions of children.*

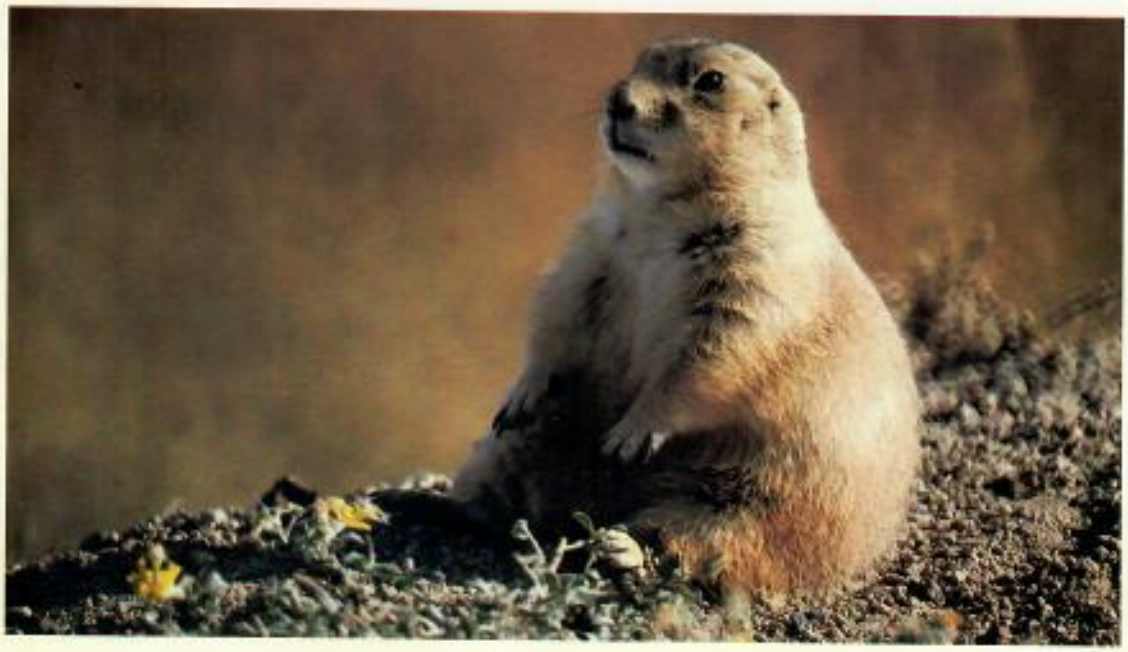
In 1902 Roosevelt made a political swing through Mississippi that included a bear hunt. A guide tracked down an old, lame, half-blind bear, tied it to a tree, and invited the President to shoot it. In disgust, T. R. refused. The incident was celebrated in a "Washington Post" cartoon, but artist Clifford K. Berryman chose to depict a bear cub as the victim. The cartoon inspired toy maker Morris Michtom to design a bear and secure permission from T. R. to use his name.

Thus, the "teddy bear" was born, despite the fact that Roosevelt hated the nickname "Teddy." The bear's success enabled Michtom to form an industry giant—the Ideal Toy Corporation.

*"**The gradual extermination** of this, the most stately and beautiful animal . . . can be looked upon only with unmixed regret . . . ," wrote Roosevelt of the elk, here grazing on Fort Niobrara National Wildlife Refuge in Nebraska (**above**). T. R. and Pinchot set aside the Niobrara Forest Reserve for a successful tree-planting experiment that served as a forerunner for the great "shelter belt" later begun by T. R.'s fifth cousin, Franklin Delano Roosevelt.*

T. R. wrote authoritative life histories of many animals, including waterfowl, buffalo, bear, mountain sheep, and cougar. He was the first President to have a book published while in office—entitled, appropriately, "The Deer Family." C. Hart Merriam, a renowned biologist, rewarded T. R.'s devotion to natural history by naming what he believed to be a new species the "Roosevelt elk."

*In Theodore Roosevelt National Park, a black-tailed prairie dog scouts his surroundings for danger (**right**). Of Roosevelt, John Burroughs wrote, "Nothing escaped him, from bears to mice, from wild geese to chickadees, from elk to red squirrels."*



motors. He mentioned that the wife of an older villager was making her husband a traditional raincoat from seal gut.

"By the way, Vernon, I've got two of those brant collars and leg bands for you. Got 'em a while ago," he said.

After he left, Vernon didn't bat an eye. "Yeah, it's illegal. What am I going to do about it? Nothing. In Alaska, the bird act is one thing. Our policy is another."

SOME PIONEER BIOLOGIST must somehow have passed word to Roosevelt of those fabulous bird cities, so unthinkably distant from the Washington of 1909. The same year, about 5,400 miles southeast of Yukon Delta, another unknown lover of birds was rewarded when T. R. created the Culebra reservation of about 22 islets east of Puerto Rico.

There the sky is filled with terns, brown pelicans, brown boobies, and other seabirds that are today part of the Caribbean Islands National Wildlife Refuges. One of the keys also supports four endangered or threatened marine turtles—hawksbills, leatherbacks, loggerheads, and green turtles.

Roosevelt had a penchant for these outposts of life, echoed by other island refuges he created in Hawaii, California, and Louisiana. In his travels he had known those rare moments when only the sounds of wings and waves break the silence.

"To lose the chance to see frigate-birds soaring in circles above the storm," he wrote, "or a file of pelicans winging their way homeward across the crimson afterglow of the sunset, or myriad terns flashing in the bright light of midday as they hover in a shifting maze above the beach—why, the loss is like the loss of a gallery of the masterpieces of the artists of old time."

Even in Washington the White House itself became something of a wildlife refuge, stocked by six rambunctious offspring. Algonquin the pony rode the elevator. Dignitaries were introduced to Josiah the badger and Jonathan Edwards the bear. A congressman once helped number four son Quentin off with his coat to carefully evict a king snake that had slithered up a sleeve.

In a sense, there were seven Roosevelt children. "You must always remember," said an English friend, "that the President is about six." In Washington's Rock Creek Park—a splendid obstacle course for puffing members of the "Tennis Cabinet"—Senator Henry Cabot Lodge was once heard to shout, "Theodore! Theodore! If you knew how ridiculous you look on the top of that tree, you would come down at once."

WASHINGTON must have suffered mortal tedium after T. R. left office. He promptly embarked on his celebrated African hunting trip, which was sponsored by the Smithsonian Institution. Biologists brought back more than 14,000 specimens, from rhinos to rodents, many new to science.

In 1914, on his "last chance to be a boy," he joined another expedition that broke new naturalistic ground exploring Brazil's River of Doubt. Its dangers proved fatal to more than one member of the party. An accident aggravated an old leg injury, causing chronic abscesses that may well have triggered the pulmonary embolism that killed Theodore Roosevelt on January 6, 1919.

Today, around his grave overlooking Oyster Bay on Long Island, the nation's oldest Audubon sanctuary cares for injured wildlife. Down the road and around the bay, National Park Service guides show visitors through a rambling, 23-room Queen Anne-style home that saw a lot of living in the days of the Roosevelt clan.

"At Sagamore Hill," T. R. wrote, "we love a great many things—birds and trees and books, and all things beautiful, and horses and rifles and children and hard work and the joy of life."

At the main entrance a comfortable porch looks to the west. Carved over one door is the family motto, *Qui Plantavit Curabit*—"He who has planted will preserve." □

Winter sun spangles *a hot spring pool in Yellowstone. Roosevelt emphasized the "essential democracy" of such sanctuaries and issued a farsighted warning: "It is clear beyond peradventure that our natural resources . . . are still being abused . . . and that we have at last reached the forks of the road."*

April 16, 1980

HL

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Pacific Marine Center
1801 Fairview Avenue East
Seattle, Washington 98102

See p 3, 6, 8

Commanding Officer
NOAA ship TOWNSEND CROMWELL

CRUISE INSTRUCTIONS: TC-80-03 (TC-89), Part I: 28 May-27 June 1980, Survey, study, and assess monk seals, seabirds, and marine resources in the Northwestern Hawaiian Islands (NWHI). Part II: 1 July-1 August 1980, Survey, study, and assess monk seals and marine resources from the nearshore to the shoreline in waters of the NWHI.

1. SCHEDULE

The NOAA ship TOWNSEND CROMWELL will be engaged in the NWHI Tripartite Cooperative projects as follows:

Part I.--Survey and study of monk seals and seabirds at Nihoa Island, Necker Island, French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Islands, and Kure Island [University of Hawaii (UH) and U.S. Fish and Wildlife Service (USFWS)]. Survey and assess pelagic and demersal marine resources in waters of the NWHI [National Marine Fisheries Service (NMFS)].

Part II.--Survey of monk seals at Pearl and Hermes Reef [NMFS]. Survey and assess the marine resources from the nearshore to the shoreline at Midway Islands, Pearl and Hermes Reef, Kure Island, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island [Hawaii Division of Fish and Game (HDFG)]. Survey and assess shrimp, bottom fish, and benthopelagic fish resources in waters of the NWHI [NMFS].

Part I

28 May - Begin cruise, Part I. Embark Hida, Moffitt, Harrison, Seki, Conant, Ludwig, Bruner, and Saito. Depart Snug Harbor, Honolulu. Proceed to Nihoa.

29 May - Arrive Nihoa. Disembark Conant and Bruner. Depart Nihoa and proceed to Necker, French Frigate Shoals, Laysan, and Lisianski.

10 June - Arrive Lisianski Island. Complete field work.

13 June - Embark Gilmartin, DeLong, Kooyman, Knudtson, and Loughlin. Depart Lisianski and proceed to Midway.

14 June - Arrive Midway. Disembark Saito, Gilmartin, DeLong, Kooyman, Knudtson, and Loughlin. Embark Burr. Depart Midway and proceed to Salmon Bank, Gambia Shoals, Pearl and Hermes Reef, Ladd Bank, and Kure.

27 June - Arrive Midway. End of Part I.

Part II

1 July - Begin cruise, Part II. Embark Ito, Tagami, Kanenaka, Koenig, Masuda, Okamoto, Sanderson, Atwood, Burr, and Herbst. Depart Midway. Proceed to survey Kure, Pearl and Hermes Reef, Lisianski, Laysan, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker, and Nihoa.

1 August - Arrive Snug Harbor, Honolulu. End of cruise.

2. SCIENTIFIC OBJECTIVES

The objectives of the cruise are as follows: The vessel will provide transportation and accommodations from Lisianski to Midway for all personnel involved in the field work on the monk seals. The purpose of this transfer, which has been scheduled to coincide with the most opportune time to study the animals at Lisianski, is to conduct pilot studies to assess the feasibility of using radio transmitter tags on Hawaiian monk seals to obtain information on hauling patterns and depth of dive recorders to assess marine feeding habitat utilization.

Part I.--The USFWS objectives during the cruise are to conduct various surveys and studies of seabirds at selected sites in the NWHI. Specifically, these will include the following:

a. Conduct radial transects (CROMWELL) around selected islands to determine feeding areas.

b. Collect stomach samples from selected bird species and areas.

c. Conduct intensive population work on selected species (banding and color marking).

d. Study the activity patterns of selected species.

e. Collect some birds for ciguatera analysis.

f. Make population estimates of terrestrial birds, monk seals, and turtles as necessary.

g. Collect birds in feeding flocks (optional).

Parts I and II.--The NMFS objectives on Parts I and II of the cruise are as follows:

a. Conduct offshore trolling surveys for tunas and other pelagic species.

b. Conduct fishing operations using shrimp pots and handlines for shrimp and bottom fish to determine their availability, catchability, distribution, and relative abundance.

c. Conduct experimental fishing with deepwater fish traps fitted with modified entrances.

d. Collect stomachs, ovaries, and otoliths from commercially valuable species and liver and blood samples from wahoo.

e. Collect fish flesh, kahala stomachs and gonads, and whole moray eels for ciguatoxin studies.

f. Assist Marine Mammal Laboratory (MML) personnel and William Gilmartin, Wildlife Biologist, in transporting supplies and equipment between the vessel and campsites at selected islands.

g. Conduct night-light fishing stations with dip nets, handline, and spin-fishing gear to determine availability, catchability, distribution, and relative abundance of squids, mackerels, and baitfish.

Part II.--The HDFG will survey and assess the marine resources from the nearshore zone to the shoreline at selected islands and atolls, including Kure, Midway, Pearl and Hermes Reef, Lisianski, Laysan, Maro Reef, French Frigate Shoals, Necker, and Nihoa. The objectives are as follows:

a. Categorize study areas according to geographical zones and bottom types to establish resource assessment stations in nearshore waters (splash zone to 20-m depth).

b. Conduct underwater fish counting transects to determine fish species composition, densities, and habitat type.

c. Conduct hook and line, cast or dip netting, spearing, trapping or hand gathering sampling methods to collect biological specimens of fish, algae, coral, crustacean, mollusc, and other marine organisms to obtain data including the following: identification, morphometric measurements, diet analysis, gonad analysis, ciguatoxin analysis, age determination of selected species, and to supplement determination of relative abundance.

d. Conduct tagging of the ulua, Caranx ignobilis, to determine their movement and growth rate.

e. Conduct observations to supplement data obtained from underwater transects or sampling methods.

Botanical and ornithological studies.--In general, the mission of the botanist is to make an analysis of the status and distribution of plants on the islands visited. This work should identify changes in vegetative types for some of the islands that are already mapped. It will also show whether additional exotic plants have become established on those islands. This information is valuable in that it permits some assessment of the potential for displacement of some colonies of nesting seabirds due to loss of, or significant adverse changes to their nesting habitat. A major objective on Laysan Island is to investigate the die-back of naupaka and determine the necessity or feasibility of reestablishing this plant in some areas.

A thorough vegetative analysis of species composition and abundance on Necker and Nihoa is necessary for evaluating the proposed transplant of the Nihoa millerbird to Necker. This action has been identified in the USFWS Annual Work Plan Advice and is intended to enhance the survival prospects of this species. The Nihoa millerbird is one of the rarest endangered species found in the Hawaiian Islands National Wildlife Refuge (HINWR).

In general, the mission of the ornithologist is to provide backup support for the botanist, particularly on Necker and Nihoa in the event of an accident, and also afford the person, who is the State's non-game biologist, an opportunity to become familiar with the seabirds of the HINWR. Since he will be a key person involved in the conservation of these avian resources, it is imperative that he be aware of the species and potential problems related to their continued utilization of these islands.

3. SCIENTIFIC PERSONNEL

Part I

*Thomas S. Hida, Chief Scientist, Fishery Biologist, NMFS, SWFC, HL
*Robert B. Moffitt, Research Assistant, NMFS, SWFC, HL
*William Gilmartin, Wildlife Biologist, NMFS, SWFC, HL (13-14 June)

Craig S. Harrison, Cooperating Scientist, USFWS
Eric Knudtson, Cooperating Scientist, USFWS (13-14 June)
Jerry Ludwig, Cooperating Scientist, USFWS
Michael T. Seki, Cooperating Scientist, USFWS

Philip Bruner, Cooperating Scientist, UH (28-29 May)
Sheila Conant, Cooperating Scientist, UH (28-29 May)

Tim Burr, Cooperating Scientist, Division of Forestry and Wildlife, Department of Land and Natural Resources (DLNR), Hawaii (14-27 June)
Ralph Saito, Cooperating Scientist, HDFG (28 May-14 June)

Robert DeLong, Cooperating Scientist, NMFS, Northwest and Alaska Fisheries Center, MML (13-14 June)
Gerald Kooyman, Cooperating Scientist, Scripps Institution of Oceanography (13-14 June)
Thomas R. Loughlin, Cooperating Scientist, NMFS, Washington, D.C. (13-14 June)

Part II

*Bernard M. Ito, Chief Scientist, Research Assistant, NMFS, SWFC, HL
*Darryl T. Tagami, Research Assistant, NMFS, SWFC, HL

Derral Herbst, Cooperating Scientist, USFWS

Julia Atwood, Cooperating Scientist, Marine Options Program, UH
Laurie Sanderson, Cooperating Scientist, Marine Options Program, UH

Tim Burr, Cooperating Scientist, Division of Forestry and Wildlife, DLNR, Hawaii
Brian Kanenaka, Cooperating Scientist, HDFG
Jim Koenig, Cooperating Scientist, HDFG
Shugo Masuda, Cooperating Scientist, HDFG
Henry Okamoto, Cooperating Scientist, HDFG

Alternates:

Fred Ball, Cooperating Scientist, HDFG
Eric Onizuka, Cooperating Scientist, HDFG
Dennis Shinno, Cooperating Scientist, HDFG
Mike Yamamoto, Cooperating Scientist, HDFG
Leslie Jensen, Cooperating Scientist, Marine Options Program, UH

*Authorized per diem at the rate of $1.50/day to be paid via the Imprest Fund on a Travel Roll Voucher at the termination of the cruise. Organization Code, Task Numbers, and Object Class for the scientific personnel are as follows: FT2000, 88A2J100 (Hida, Moffitt, Ito, and Tagami), 88C5H100 (Gilmartin), and 2100.

4. OPERATIONAL PLANS

The operational plans for NMFS during Part I and Part II of the cruise are as follows:

Part I [NMFS]

a. Prior to sailing, NMFS personnel will inspect the XBT launcher and recorder, and the thermosalinograph. Any malfunction will be reported to the vessel's command, who will be responsible for taking corrective action.

b. MMD personnel will be transported from Lisianski to Midway on dates suited for their purpose. The NMFS survey will begin at Nihoa and terminate at Midway. NMFS and USFWS will coordinate their work on a schedule compatible with the monk seal work.

Parts I and II (NMFS)

a. Direct trolling will be conducted around as many of the islands and banks as practicable.

b. Samples of flesh from commercially important fish species, gonads and stomachs of kahala, and whole moray eels will be collected, labeled, and frozen for ciguatoxin studies.

c. Collect stomachs, ovaries, and otoliths of commercially valuable fishes. Preserve stomachs and ovaries in Formalin; all otoliths should be kept frozen.

d. Collect blood and liver samples from wahoo keeping the liver samples frozen at or below -20°C and blood samples frozen in the chest freezer.

e. Conduct shrimp trapping in depths ranging from 200 to 600 fathoms using four strings of shrimp pots with each string consisting of four pots. Spacing of pots will be set at 5, 10, 15, and 20 fathoms. Set pots at night at locations where bottom life signs (clouds) are visible on the fathometer.

f. Obtain bottom sample over shrimp grounds with a bottom grab.

g. Examine stomachs of sharks for remains of young turtles, birds, and seals.

h. Conduct experimental fishing with four deepwater fish traps fitted with modified entrances in depths between 70 and 200 fathoms. Each trap will be fished individually on one float line. Soaking time should vary from 1 to 3 nights.

i. Conduct handline fishing operations in depths between 70 and 200 fathoms for snappers, groupers, and carangids to determine their availability, catchability, distribution, and relative abundance during daylight hours and at night.

j. Conduct night-light fishing stations with a 1,500-W bulb while either anchored or adrift at night, to attract juvenile fishes, bigeye scad, mackerel scad, baitfishes, and squid. Collect organisms congregated around and below the light with dip net, mackerel handline, or spin-fishing gear. Estimate abundance, if possible.

Part II

The operational plans of the HDFC are as follows:

a. Conduct underwater transects in varying depth zones and bottom types using scuba and snorkel gear.

b. Employ sampling methods such as cast or dip netting, hand collecting, spearing, trapping, and hook and line to collect biological specimens and to supplement data on relative abundance.

c. Collect and preserve biological samples for subsequent shoreside examination. Storage for the preserved and frozen specimens will be required on the vessel.

d. Conduct visual observations to supplement data obtained from underwater transects or other sampling methods.

e. Conduct trapping and hand collecting of lobsters at night at preselected sites or grids at Pearl and Hermes Reef and Maro Reef to obtain catch and effort data for stock assessment, and stomach samples for subsequent examination.

f. Samples of flesh from important nearshore fish species will be collected, labeled, and frozen for ciguatoxin studies.

g. Collect length-weight data, stomach, gonads, and otoliths from selected nearshore fish species.

5. FOREIGN FISHING VESSEL SIGHTINGS

Sightings of foreign fishing vessels will be reported per PMC OPORDER 1-01.9.

6. BATHYTHERMOGRAPH LOG

A bathythermograph log, NOAA Form 77-22, will be maintained by the Chief Scientist. The scientist on watch will fill out the bathythermograph trace readings from the CTD or XBT recorded for each station. The bridge will supply the environmental information for each station. The data will be transmitted via Coast Guard radio. The logs and original data will be retained by the Chief Scientist at the end of the cruise and forwarded to NODC.

7. MARINE POLLUTION MONITORING PROJECT

The ship's officers will maintain a watch and log per Project Instruction entitled "Integrated Global Ocean Station System (IGOSS) Marine Pollution Monitoring Pilot Project," dated June 2, 1975.

8. WEATHER OBSERVATIONS

A ship's weather observation form, NOAA Form 72-1, will be maintained during the cruise by the bridge watch. The data will be relayed to the National Weather Service via radio, and the original data will be sent by the command to the National Weather Service at the end of the cruise per PMC OPORDER 2-07.

9. NAVIGATIONAL CONTROL

Primary control during the project will be SATNAV, loran A/C supplemented by radar, visual, etc.

10. MARINE OPERATIONS LOG

A Marine Operations Log, NOAA Form 77-2, will be maintained by the bridge watch during the project per PMC OPORDER 2-08. The Chief Scientist and the Commanding Officer will work out the details regarding forms required by the project for each of the operations, such as trawling, fish trapping, handlining, trolling, XBT, etc., so as to integrate them into the Marine Operations Log.

Turtles

11. BIRDS, AQUATIC MAMMALS, AND FISH SCHOOL LOG

During the cruise the bridge watch will log occurrence of birds, aquatic mammals, and fish schools on forms provided by the Honolulu Laboratory.

12. RECORDS ANNOTATION

Chartlets - The command will supply the Chief Scientist with chartlets of all stations that he requests.

13. COMMUNICATIONS

Activity reports and position reports will be sent to the Director, Honolulu Laboratory daily. The Chief Scientist will establish a regular radio schedule with the Honolulu Laboratory through Snug Harbor, Honolulu.

14. EQUIPMENT LIST

a. Furnished by vessel:

Portable VHF radio (2)
XBT launcher and recorder
Thermosalinograph
15-ft Zodiac and 20-hp outboard motor
Winch with minimum of 500 fathoms of 3/16-in. wire
Handline gurdies
Trawl winches
Baitwells
Outriggers and trolling lines (6 each)

Bottom grab
17-ft Boston whaler and outboard motor
Hauler for traps

b. Furnished by NMFS:
Fish traps (modified; 4 plus spares)
Chest freezers (3)
Frozen squid (100 lb)
XBT probes (120)
Salinity bottles (2 boxes)
Trolling lines and lures
Frozen mullet or mackerel (200 lb)
Dip net, long handle
Night light, 1,500-W bulb, spare bulb
Measuring devices: 1-m caliper, 2-m caliper, dial calipers, measuring board, spring scales, beam scales, macro scale, etc.
Shrimp pots (12 plus spares)
Miscellaneous including floats, flags, lead weights for flagpoles, handline weights, mainline for traps, float lines, spool of polypropylene rope, and other items necessary to accomplish cruise mission.

c. Furnished or required by USFWS:

Adequate storage space for camping gear such as tents, Coleman stoves, and lanterns
Adequate storage space for collecting bottles.
Adequate outboard motor fuel and oil for getting on and off all islands and, additionally, surveying French Frigate Shoals and Pearl and Hermes Reef.
Adequate food for shore parties when camping. Preference is for prepared food which could be reheated, in addition to canned food.
Space to store USFWS Zodiac and outboard motor.
Permission to collect birds from either Zodiac or bow of CROMWELL using USFWS shotgun(s).
Small amount of freezer space for ciguatera samples.
Storage space for resupply of food to Laysan field camp including canned goods and limited refrigerated items.
Space to store three 55-gal drums of fuel for Tern Island.

d. Furnished by HDFG:

21-ft Boston whaler with two 55-hp motors, fuel tanks, etc.
17-ft Boston whaler with 25-hp motor, fuel tanks, etc.
Spare 55-hp outboard motor
Six 55-gal drums of gasoline
scuba and snorkel gear (seven sets) plus 12 air tanks
Air compressor
Materials for recording data

Sampling gear: cast nets (2); dip nets (2); hook-and-line gear (12 sets); fish traps (4); and spears (20)
Measuring and weighing instruments: calipers (2) and scales (2)
VHF radios (2)
Ice, about 900 lb for preserving specimens while in the field
Bait (50 lb cuttlefish)
Other equipment, parts, supplies, and materials needed to accomplish cruise mission.

15. The Chief Scientist and Commanding Officer are required by Section IX of NOAA Directive 17-17 to submit a joint cruise report to the Director, PMC. The report will be submitted by the Commanding Officer and addressed to Director, PMC. It shall include the following information:

a. Cruise title

b. Cruise period

c. Area of operation

d. Cruise objectives

e. Actual itinerary

f. Deviations from Cruise Instructions

g. Breakdowns and incidents

h. Personnel list (actual)

i. Disposition of data

j. Statement that Chief Scientist will supply a separate report entitled "Cruise Results" which will become a part of the cruise report.

16. CRUISE RESULTS

The Chief Scientist will submit the cruise results, according to SWFC procedures and distribute through normal mailing list, including Director, PMC (3 copies) and Commanding Officer, TOWNSEND CROMWELL (2 copies), within 30 days of the completion of the cruise.

17. MONTHLY SHIP ACCOMPLISHMENT REPORT - BIO

The report while at sea will be transmitted via radioteletype during this cruise. The original will be forwarded to OA/C7, a copy to OA/CPM, and a copy for the ship's file.

18. TIME AND ATTENDANCE REPORTS

The time and attendance reports will be filled out by the port secretary and mailed while the ship is at sea. The overtime and penalty pay information will be relayed to the port secretary.

19. DATA DISPOSITION

a. All data gathered by the ship's personnel that is desired by the Chief Scientist will be released to him.

b. A complete ROSCOP II, NOAA Form 23-24, will be completed within the 30-day time frame by the Chief Scientist and distributed as required through the Honolulu Laboratory.

c. All completed XBT logs, NOAA Form 77-22, shall be submitted to NODC for transmittal to IGOSS by the Chief Scientist.

Eugene A. Taylor, RADM, NOAA
Director, Pacific Marine Center

Richard S. Shomura
Director, Honolulu Laboratory

Joint resolution of the Survival Service Commission and the Commission on National Parks and Protected Areas passed at their meeting in San Jose, Costa Rica, 12-17 March 1979. Both Commissions are part of the International Union for the Conservation of Nature (IUCN).

3. HAWAIIAN ISLANDS

RECOGNIZING that the small oceanic islands and atolls which comprise the Northwestern Hawaiian Islands constitute critical breeding and feeding areas for the endemic monk seal, numerous species of sea-birds, three endemic land birds, and a population of green turtles;

RECALLING that most of these areas were declared a bird sanctuary in 1909 by the President of the United States, with the areas later being designated as the Hawaiian Islands National Wildlife Refuge;

REALIZING that the ecosystems of such oceanic island areas are particularly vulnerable to degradation and species extinction as a result of human intrusion;

BEING AWARE that consideration is presently being given to the development of various commercial fisheries in waters close to the Hawaiian Islands;

THEREFORE, BE IT RESOLVED that the joint meeting of the CNPPA/SSC request the Director General of IUCN to transmit to the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the State of Hawaii an expression of support that the breeding and feeding areas of the wildlife species of the Northwestern Hawaiian Islands continue to be maintained in an undisturbed and protected state.

4. OTTER PELTS (for importing countries and CITES)

RECOGNIZING the continuing commercial demand for otter pelts which directly threatens remaining populations, including the more isolated areas in which law enforcement is difficult, the IUCN/SSC Otter Specialist Group recommends that the Commission urge major consumer countries which are currently Germany, France, Italy, Great Britain and Japan, to curtail the importation of pelts and finished products.

RECOGNIZING that the skins of many otter species can not be identified with certainty unless they are examined in their entirety, we recommend that all the South American Species, namely Ptetronura brasiliensis, Lutra felina, L. provocax, L. enudris, L. annecteus, L. platensis, should remain on Appendix I of the CITES and the North American species L. canadensis be maintained on Appendix II.

5. MONARCH BUTTERFLY

WHEREAS the wintering colonies of Monarch butterflies in Mexico have been uniformly recognized as the largest regular aggregation of migratory butterflies known;

AND WHEREAS potential threats to these Monarchs exist in the form of logging the roost trees, accidental fire, eventual tourist development if unplanned, and possible commercial exploitation for their wings;

COPY

University of Hawaii at Manoa

Hawaii Institute of Marine Biology
P.O.Box 1346 • Coconut Island • Kaneohe, Hawaii 96744
Cable Address: UNIHAW

July 5, 1979

Mr. Brent Giezentanner
Refuge Manager
U. S. Fish and Wildlife Service
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Brent:

As I indicated during our return flight from Tern Island on June 30th, I would like to offer some ideas and thoughts relating to the immediate FWS Refuge caretaker role for French Frigate Shoals.

1. Glass balls - I recommend that your office issue rules prohibiting the collection and removal of all glass balls from French Frigate Shoals, except for those found on Tern Island that can be retrieved without disturbance to wildlife. With six years of field experience at French Frigate Shoals and other areas in the Leeward Hawaiian Islands, I can attest to the fact that the quest for glass balls by most civilian and military personnel quickly turns into a mania that is both excessive and unreasonable. Karl Kenyon has written extensively about the deleterious effects on the monk seal resulting from this hunt and find "sport." The same case can be made for basking turtles, particularly at French Frigate Shoals. On both Trig and Whale-Skate Islands, the highest incidence of turtle basking occurs along the same shorelines where glass balls come ashore. I have documented on numerous occasions the easily disturbed state of turtles basking at these locations, in contrast with baskers on East Island where far fewer glass balls come ashore. My conclusion is that repeated disturbances by personnel gathering glass balls over the years on Trig and Whale-Skate have been responsible for this increased sensitivity to man. Furthermore, another important consideration is the fact that most of the glass balls coming ashore on the various islands at French Frigate Shoals are highly transitory; that is, they wash ashore for several days and then are carried by tides and currents along the shorelines back into the ocean. This requires resident glass ball hunters to frequently visit each island in order to gather the standing crop.

   With the recent change in authority at Tern Island, the time is indeed right for a glass ball prohibition. If action is not taken now, it will probably be difficult to initiate such a rule once your permanent caretakers are on duty.

2. Lights on Tern Island - As you will have noted in the draft Tern Island Study Report, lights at Tern have been adversely impacting turtles for many years. I therefore urge you to totally ban the use of the high intensity tennis court and boat hoist lights, except under emergency conditions. Furthermore, as many of the smaller (but nevertheless bright) outside building and sidewalk lights as possible should be turned off.

3. VHF Radio - A standard VHF base station radio should be installed at a central location in the facility for full-time monitoring of emergency channel 16. This will provide a measure of safety for vessels passing the area, as well as a means of communicating with observed or suspected violators of the refuge boundary.

4. Surveillance for Trespassers - A lookout should be conducted daily using binoculars from the rooftop of the generator plant building. From this vantage point a reasonable view of Trig, Whale-Skate and Shark can be obtained. On calm weather days, East and the waters adjacent to La Perouse Pinnacle are observable. An evening check, perhaps just before turning in for the night, would also be worthwhile. I mention this point about regular surveillance from Tern Island because, on a number of occasions over the years, vessels have been well within the northern half of French Frigate Shoals without being noticed by resident personnel.

Many thanks for giving me the opportunity to offer these suggestions, some of which you may already have under consideration. With your departure in several weeks time, I want to express my appreciation for your dedication to wildlife conservation during your tenure here in Hawaii. Although we have not always been in total agreement on every issue, I feel that we have maintained a quality relationship that will insure friendship and mutual professional respect for many years to come. I wish you all the best and happiness in your new job.

Sincerely,

GEORGE H. BALAZS
Assistant Marine Biologist
and Deputy Chairman
IUCN Marine Turtle Group

GHB:ec

cc: Dale Coggeshall
G. Causey Whittow

United States Department of the Interior

FISH AND WILDLIFE SERVICE
WASHINGTON, D.C. 20240

ADDRESS ONLY THE DIRECTOR,
FISH AND WILDLIFE SERVICE

SE Log # 79-333

In Reply Refer To:
FWS/OES/CKD
SP

MAY 0 4 1979

Department of Planning & Economic
Development
P.O. Box 2359
Honolulu, Hawaii 96804

Dear Sir or Madam:

The Service is considering proposing that an area in Honolulu County, Hawaii be designated as "critical habitat" for the green sea turtle (Chelonia mydas) which is listed as a Threatened species under the Endangered Species Act of 1973. A Critical Habitat is an area which is considered to be essential to the conservation of an Endangered or Threatened species and which may require special management or protection. It may include areas not presently occupied by the species, but considered essential for population increase or protection of resources upon which the species depends. Such a designation has the effect of prohibiting Federal agencies from authorizing, funding, or carrying out any action which would result in the destruction or adverse modificiation of those elements in the specified area necessary to the species' normal needs.

In proposing an area for Critical Habitat designation, the probable economic and other impacts of such a designation must be taken into account. We would appreciate your supplying us with any information you might have regarding such impacts likely to result from a Critical Habitat designation in the area delineated on the attached map. Should a proposal result from the present investigation, additional opportunity will be provided for public involvement through a public meeting or hearing and the normal regulatory comment period. At this time we are only gathering data; for example, the increased (or decreased) costs or loss of revenue if Federal actions in the area were modified to avoid impacting green sea turtle.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Please bear in mind that designation of an area as Critical Habitat has an effect only upon actions undertaken, authorized, or funded by Federal agencies. It does not constrain other human activities in the area so designated, and in most cases should cause little or no change in current patterns of land use.

Thank you for your assistance in this matter. Please refer any questions you may have to Dr. C. Kenneth Dodd, Jr., Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240, Telephone 703/235-1975.

Sincerely yours,

/s/ Robert S. Cook

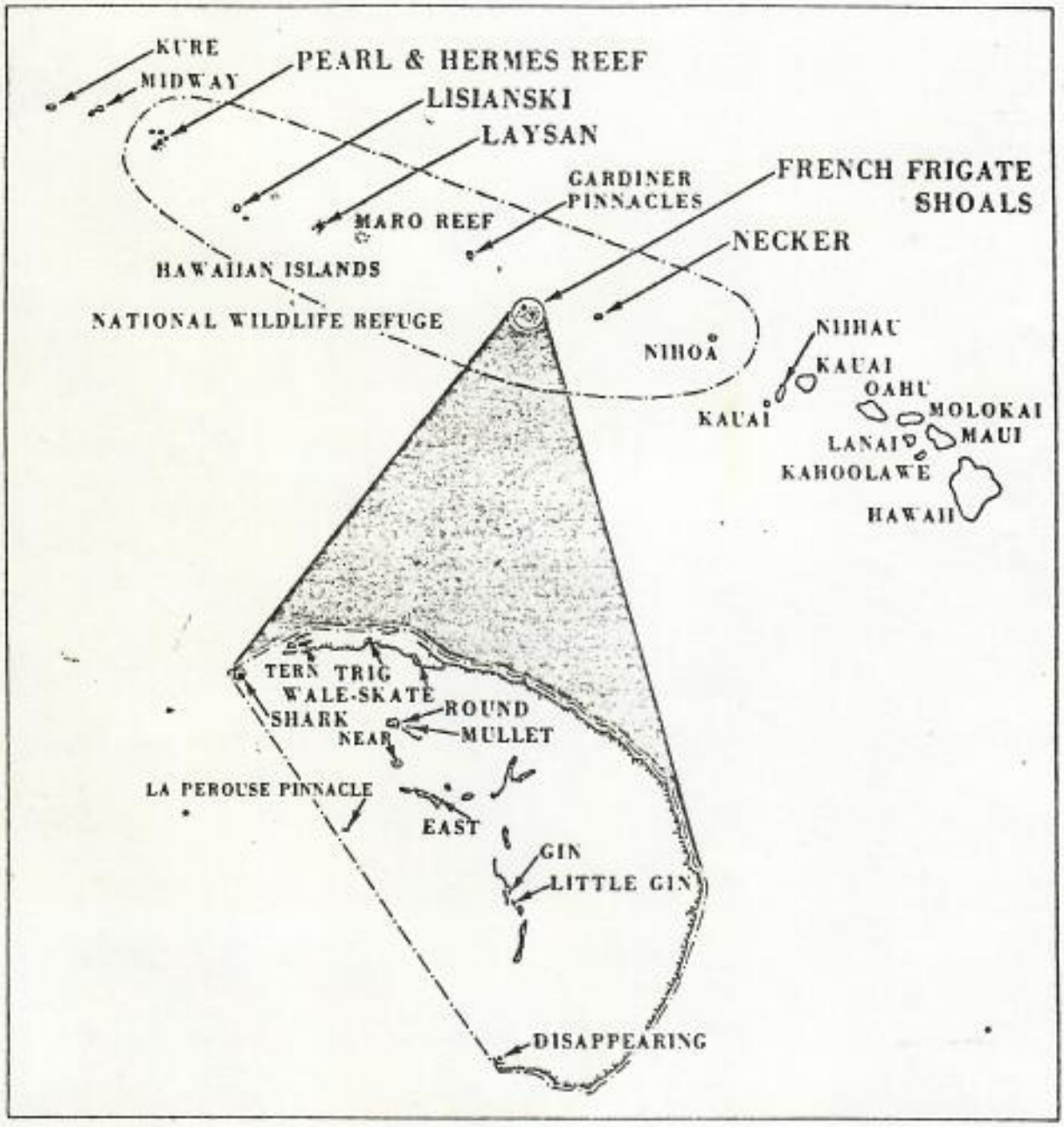
Acting Director

Enclosure

GREEN SEA TURTLE

Hawaiian Islands National Wildlife Refuge

HAWAII



CAN'T SPELL BUT YOU CAN CATCH THE DRIFT!

U.S. FISH AND WILDLIFE SERVICE
OFFICE OF ENDANGERED SPECIES
WASHINGTON, D.C. 20240

June 18,1979

Dear George:

With regard to Tern Island, this was not included with the draft Critical Habitat that I prepared long ago; as I recall, I primarily used your recommendations which did not include Tern. However, if you believe that it should be included if and when critical habitat is proposed, then drop me a rough map with the area outlined (and a word description if necessary), and I will include it. This will not occur for some time however because of the crass inepitude of those now trying to control endangered species (they still do not know the meaning of economic impacts and seem to be dragging their feet in every way possible- a pox on all lawyers).

I can't give you a complete draft of the Fed. Reg. proposal since that would violate the Administrative Procedures Act (so I am told). However, the enclosed will give you the areas unofficially.

Also enclosed is something I received recently concerning Tern which you might be interested in.

If you need anything else, let me know. Thanks for your help.

Ken

DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

GEORGE R. ARIYOSHI
Governor

HIDETO KONO
Director

FRANK SKRIVANEK
Deputy Director

Kamamalu Building, 250 South King St., Honolulu, Hawaii • Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

June 5, 1979

Dr. C. Kenneth Dodd, Jr.
Office of Endangered Species
U.S. Fish and Wildlife Service
Washington, D.C. 20240

Dear Dr. Dodd:

I am in receipt of a letter, dated May 4, 1979, which requests information regarding impacts to the State of Hawaii which would result should the French Frigate Shoals be designated as a critical habitat.

In order to broaden Hawaii's economic base, now based largely on tourism and defense, the creation and expansion of alternative industries become important. One industry that has been identified is the commercial fishing industry.

In this regard, I recently had a meeting with Edward Shallenberger, President of Manta Corporation. The Corporation has been contracted to examine future management alternatives of Tern Island (an island which falls in the French Frigate Shoals area). At that time, I expressed the State's desire to use Tern Island as a joint research and commercial fisheries support station. (Enclosed for your information is a draft summary of the meeting.)

Further investigation into the matter produced the enclosed chart which gives data on the annual skipjack catches around the French Frigate Shoals area for 1978 by the Japanese. Between 8,200 to 10,000 metric tons are estimated to have been caught in that area. Ten thousand metric tons of shipjack is worth $7.5 million at present cannery prices. Conceivably, Tern Island could be used as a base for Hawaii's local commercial fishing fleet in order to expand the local catch.

The State of Hawaii has as much concern for impact on the environment as does the federal government, so the State will not allow any action which will be damaging. Controls are necessary but should be jointly administered and not overly stringent.

If you have any questions, feel free to contact me.

Sincerely,

Hideto Kono

HK:apk
Enc.

* * * * *

GREEN SEA TURTLE
(Chelonia mydas)

Florida. St. Lucie and Martin Counties. All areas of eastern facing beachfront on Hutchinson Island, from mean high tide inland to a point .2 mile from shore or to the primary dune system, whichever comes first, for a

distance of 4 nautical miles north of and 5 nautical miles south of the St. Lucie-Martin County line.

Florida. Martin County. All areas of eastern facing beachfront on Jupiter Island from mean high tide inland to a point .2 mile from shore or to the primary dune system, whichever comes first, beginning from the Hobe Sound National Wildlife Refuge--St. Lucie Inlet State Park boundary in the north and running 3.5 miles to the south. Most of this land is within the Hobe Sound National Wildlife Refuge.

Florida. Brevard County. All areas of eastern facing beachfront on the Canaveral Peninsula and barrier island east of Mosquito Lagoon, from mean high tide inland to a point .2 mile from shore or to the primary dune system, whichever comes first, for a distance of 28 miles from the Brevard-Volusia County line in the north to the beach opposite Camera Pad A on the Cape Canaveral Air Force Station.

American Samoa. Rose Atoll (14°33'S, 168°09'W). Rose and Sand islets--entire land area of both islet.

The following areas in the Trust Territory of the Pacific:

1) Palau District. Helen's Island (2°59'N, 131°49'E)--entire island,
2) Palau District. Merir Island (4°19'N, 132°19'E)--entire island,
3) Yap District. Ulithi atoll (10°00'N, 139°48'E). The islands of Pig, Iar, and Gielap--entire islands,
4) Yap District. Ngulu atoll (8°30'N, 137°30'E). The islands of North and Meseran--entire islands,

5) Yap District. Pikelot Island (8°05'N, 147°38'E)--entire island,

6) Truk District. East Fayu Island (8°34'N, 151°21'E)--entire island,

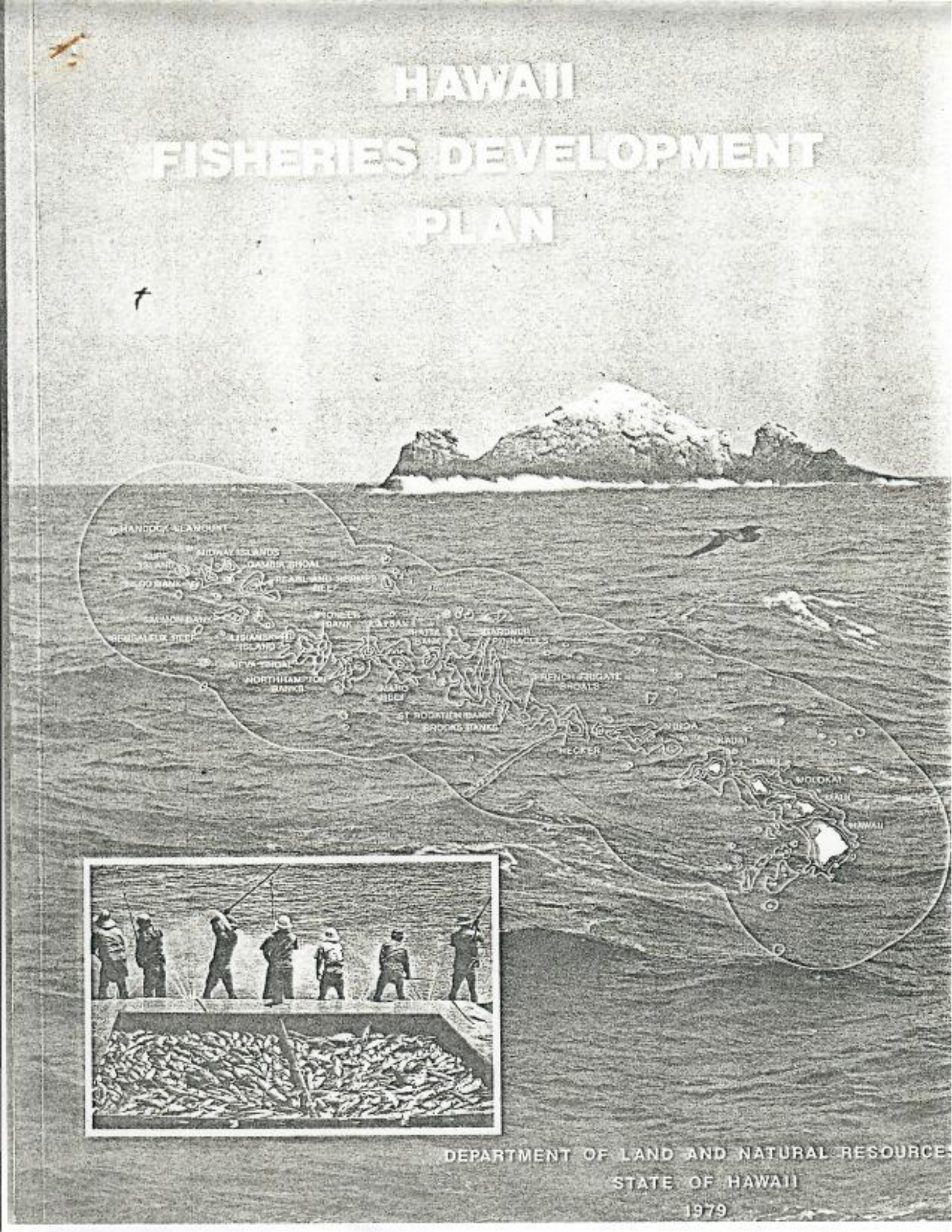
7) Ponape District. Oroluk atoll (7°38'N, 155°10'E). Oroluk Island--entire island,

8) Marshall Islands District. Bikar atoll (12°13'N, 170°05'E). All land areas within the atoll,

9) Marshall Islands District. Jemo Island (10°8'N, 169°32'E)--entire island.

The following islands in the Hawaiian Islands National Wildlife Refuge, Honolulu County, Hawaii: Necker Island, French Frigate Shoals (including East, Whale—Skate, Trig, Round, Mullet, Disappearing, Gin, Little Gin, and Shark islands), Laysan Island, Lisianski Island, Pearl and Hermes Reef--all land areas.

HAWAII
FISHERIES DEVELOPMENT
PLAN



DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE OF HAWAII
1979

Palmyra Island. Located in islands 1,100 miles southwest of Honolulu, Palmyra is a privately-owned possession of the U.S. Following a massive infrastructure build-up in World War II, the island was virtually abandoned until 1978. A private corporation now holds the development rights to Palmyra, and has initiated copra production.

The channel and lagoon anchorage are excellent, and the docks are reputed to be satisfactory. The airstrip is being improved to accomodate jet traffic, but fuel and water tanks, and buildings, are in need of renovation.

The strategic importance of Palmyra cannot be underestimated, as it is the only significant American Central Pacific possession between 19° N and 13° S latitudes. This area is rich in tuna resource, but most of the islands and their 200-mile fisheries zones are part of the new Republic of Kiribati. Palmyra could serve as a major support base for the Hawaiian tuna fleet during northern winter operations.

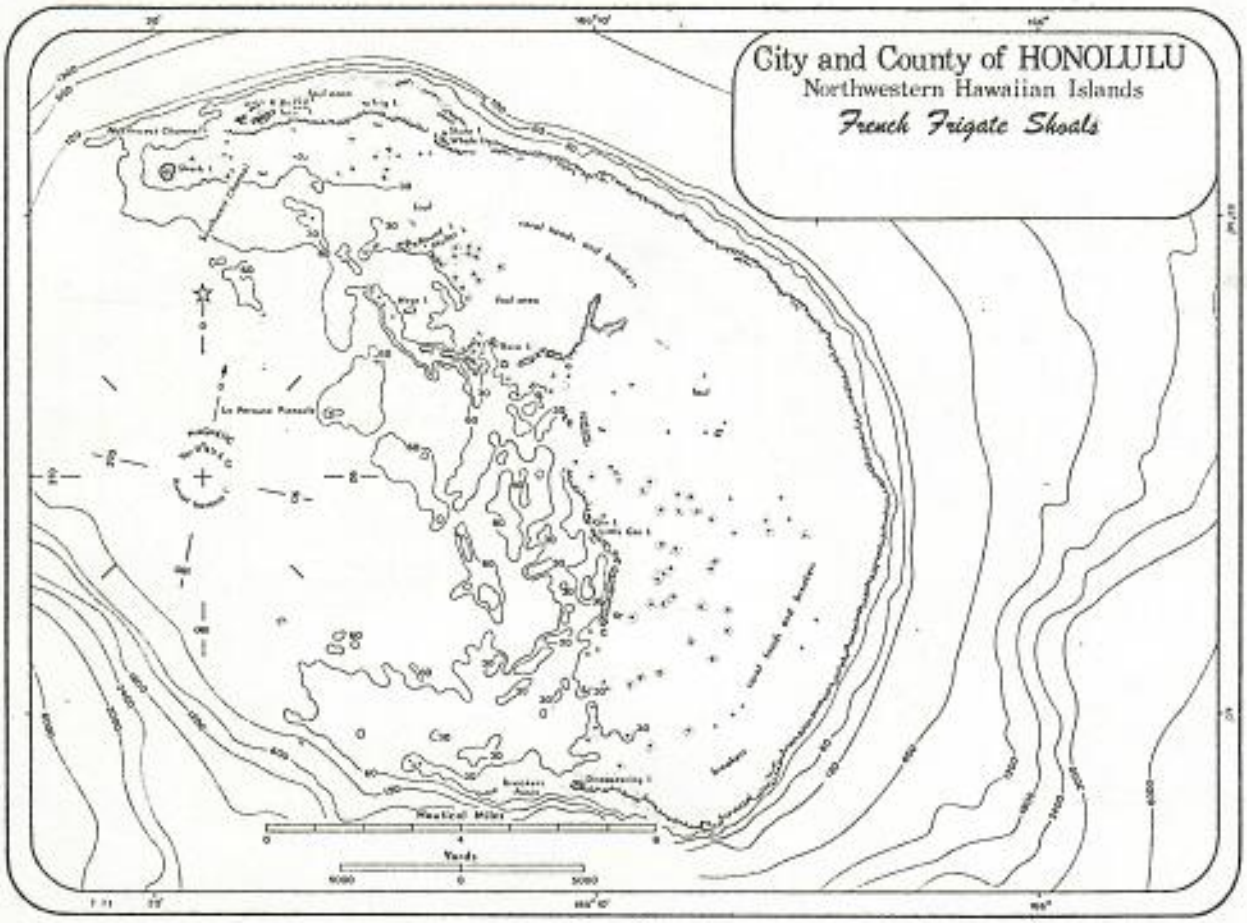
Although not a political or geographic part of Hawaii, Palmyra could play an important economic role. *The State should assist Palmyra's proprietors with infrastructure planning, and facilitate cooperative ventures between prioprietors and Hawaii's fishing industry*.

French Frigate Shoals. This atoll, 556 miles northwest Honolulu, is centrally located in the Northwestern (or Leeward) Hawaiian Islands. During World War II, the Navy untilized French Frigate Shoals as an emergency base for Midway-Honolulu air operations. Following WWII, a Coast Guard LORAN station was established on Tern Island. An airstrip, channel, anchorages, living quarters, fuel and water storage, and power plant were available to service the LORAN station. In July 1979 the Coast Guard shut down the station, and its future is now the subject of controversy.

French Frigate Shoals is historically a part of the Northwestern Hawaiian Islands National Wildlife Refuge, but the State and Department of Interior have a long-standing dispute regarding jurisdictional boundaries of the Refuge. The various intricacies of the dispute will not be addressed in this report; suffice it to say that the utilization of Tern Islands as a fisheries base is tied to the dispute.

The importance of French Frigate Shoals lies in its location amidst the rich banks of the Leeward chain. Virtually all of the State's potential bottomfish and shellfish resources are found between Nihoa and Midway islands, with French Frigate Shoals as a focal point. The facilities at Tern Island present a unique opportunity for a safer, more economical fishery in that region.

Regardless of jurisdictional disputes, a central question is the relationship of fisheries development to wildlife conservation. French Frigate Shoals has historically harbored large breeding populations of the endangered Monk Seal and the threatened Green Sea Turtle. Staunch



Source: Grace, Jean McKean, "Marine Atlas of Hawaii: Bays and Harbors", University of Hawaii, 1974.

conservationists maintain that fisheries activities pose a threat to these endangered species and seabirds, while fishermen contend that with a modicum of care their activities will not impact on the seals, turtles, or birds. Rather than argue the point on a theoretical basis, it would seem logical to devise a carefully-monitored fisheries support pilot project at Tern Island. The State, University, and Federal Government are currently conducting a cooperative survey of Leeward Island resources, but these studies cannot hope to address the impact of fishing activities on the ecosystem. At the same time, the U.S. Fish and Wildlife Service is utilizing the Tern Island Facilities as a wildlife research base.

With close to $500,000 per year being spent on research projects in the Leeward Islands at least through FY 1981, it would be illogical and extremely inefficient not to directly monitor the impact of fisheries activities, particularly those related to a fisheries base at Tern Island. It should be noted that until the cooperative survey is completed in 1981, non-research fishing activities *within the lagoons* should not be encouraged.

(COURTESY OF U.S. FISH & WILDLIFE SERVICE)

Tern Island

The State has requested Fish and Wildlife Service concurrence in a Tern Island Fisheries Base Pilot Project. The pilot project would utilize an anchored freezer barge or mothership, shoreside fuel and water tanks, periodic air flights, and limited living quarters. *It is recommended that the State vigorously pursue the Tern Island project with the Department of Interior and, following concurrence, assist industry in the initiation, coordination, and monitoring of pilot operations.*

The full utilization of Tern Island as a fisheries base must await the results of this pilot project. However, for planning purposes, a preliminary scenario can be laid out. To fully utilize Tern Island, the turning basin would have to be expanded, bulkheads repaired, docks replaced, and a cold storage plant erected. In all probability the costs would be prohibitive. Another alternative, almost as convenient and more cost-effective, is essentially an expansion of the proposed pilot project. Refrigerated barges of various sizes can be deployed either adjacent to the basin bulkhead or at moorings. The catcher vessels would off-load to the barges, then take on fuel and supplies from shoreside. Mooring buoys in the main channel would be provided for inclement weather or for rest breaks. Vessel repairs could be accomodated at a floating dock in the basin. Shop facilities are already

available ashore, as well as quarters and galley for a small repair crew. Emergency part supplies and medical evacuation can be accomplished via small aircraft.

Although year-round bottomfish and shellfish operations are anticipated, the heaviest volume of landings could conceivably come during the summer aku season. It is possible that live bait could be barged to French Frigate Shoals for use by relatively small pole-and-line vessels. If so, a seasonal catch of several thousand tons of aku and small ahi is not unreasonable. Large barges (ca. 500 ton capacity) could carry the bait and store the catch. Tug service in conjunction with the Midway albacore fishery would be ideal. During the fall, winter, and spring smaller barges could be used to service the multi-purpose fleet.

Using this scenario, improvement costs would be minimal, and operational costs would be borne by industry. However, to determine the feasibility of this scenario, the pilot program must first be undertaken. It is anticipated that industry will be reluctant to finance the entire project because of its novel approach and the fragmentation of producers and handlers. *It is recommended that the State bear one-half of the cost of tug, barge, and container rental for a six month pilot project in FY 1982. The total project cost is estimated at $100,000; thus industry's and the State's share would each be approximately $50,000.* By 1982, it is anticipated that about ten vessels will be operating in the Leewards--at least on a seasonal basis. The estimated fuel savings alone for these vessels, if a barge/support station were operated at Tern Island, would be around $75,000. The additional fishing days would produce, roughly, another $150,000. Thus, the pilot project should be appealing to the vessel operators.

Summary of Infrastucture Recommendations

1. If at all possible, the infrastructure necessary to service the expanded Honolulu fleet should be consolidated in proximity to a new, major fishing port. The required infrastructure will include a fuel dock, fish distribution and cold storage, ice plant, engine and electronics repair, and possibly, haul-out facilities.

2. Hilo requires dockside fuel, ice, and haul-out facilities.

3. Kona requires haul-out and dockside ice facilities.

4. Maalaea requires dockside fuel and haul-out facilities.

5. Nawiliwili and Port Allen require dockside fuel facilities. Nawiliwili needs dockside ice, and a haul-out facility should be located at either of these ports.

Western Pacific Regional Fisheries Management Council (WPRFMC) and NMFS should share the costs with the State.

Develop management data. The vessel charters discussed above will produce catch effort and biological data which should be used to estimate optimal bottomfish yields. It is recommended that the WPRFMC and NMFS supply the necessary manpower to analyze these data and development management plans.

Promote utilization of high quality frozen bottomfish. The development of the Leeward Island bottomfishery will definitely impact on the present bottomfish marketing structure. The nearshore fishermen, catching small volumes, must produce a high quality fresh product to receive the required high prices. The long-range Leeward Island vessels will not be able to land large quantitites of fresh fish, but will have to freeze most of their catch. If conventional freezing is used, their product will be less acceptable and assume prices close to imported snappers. Relatively low temperature flash freezing will produce an intermediate-quality product that must find a suitable level on the local and export market. Care must be taken not to over-compete with the nearshore fresh fish producers, but at the same time produce adequate income for the long-range vessels. This will require a careful marketing strategy and skillful product promotion. *It is proposed that promotional activities be undertaken by the Seafood Promotion Committee discussed in an earlier section.* Promotion costs could be covered by industry assessments after the program is firmly established.

Survey of deep resources. There is some evidence that alfonsin and other resources may occur in waters deeper than 200 fathoms, but virtually no information is available. It is proposed that NMFS incorporate deep bottomfish surveys in its Leeward Island activities, and that a bottomfish vessel be chartered to survey deep main island waters. The program should commence in FY 1982, with local survey costs of approximately $50,000. The Leeward Island surveys should be absorbed within the NMFS research ship budget, while PTDF, NMFS, WPRFMC, and the State are potential financiers of the main island survey.

Develop Tern Island fisheries base. The Leeward Island bottomfish, shrimp, lobster, and tuna vessels can save a large percentage of operating costs by utilizing a central out-base. Tern Island, French Frigate Shoals offers the only possibility of a fisheries base in the central Leewards. This topic has been thoroughly discussed in a previous section, *but the recommendation to initiate a Tern Island fisheries base pilot project is here again presented.*

Seamount Groundfish Fisheries

The seamount fisheries for armorheads and alfonsins, described in Chapter III, are both enticing and provacative. Information on these fisheries is generally sketchy, but it is known that when the fishery began in 1969-70, trawl catches exceeded 60 tons per hour, primarily armorheads. By 1979, the catch rates had plummeted to about one ton per hour. During this ten-year span, there is considerable evidence of overfishing--yet the total catch in the North Pacific seamount area has remained above 20,000 metric tons/year.

University of Hawaii at Manoa

Hawaii Institute of Marine Biology
P.O.Box 1346 • Coconut Island • Kaneohe, Hawaii 96744
Cable Address: UNIHAW

December 27, 1977

MEMORANDUM

TO: Personnel and Cooperating Researchers
Aboard the NOAA Vessel TOWNSEND CROMWELL

FROM: George H. Balazs
Assistant Marine Biologist

SUBJECT: Recovery of Sea Turtle Parts from the Stomachs of Carnivorous Fishes.

Virtually nothing is known about the natural history of sea turtles from the time they leave their natal beaches as hatchlings until they first appear as juveniles (approx. 10 lbs or larger) in nearshore feeding areas. This scarcity of information is due mostly to the fact that turtles under 10 lbs. are seldom ever seen, thereby making them unavailable for scientific study. It has been reasonably assumed that smaller size turtles live for a time in the open ocean, or on banks distant from land, where they feed at the surface on small invertebrates.

One method which I believe has considerable potential for gaining biological and ecological information on this little-known size category involves the indirect sampling of the turtles from the stomachs of carnivorous fishes. Certain bony fishes and sharks could be expected to periodically prey on small turtles in the open ocean. The recovery of turtle parts from the stomachs of such predators is therefore possible, provided that individuals conducting the examinations are alerted to the immense importance of such findings and are able to recognize the derived parts. The purpose of this memorandum is to provide information on these two points, and to request assistance in the recovery of such turtle parts.

In the Hawaiian chain, the green turtle (*Chelonia mydas*) is by far the most common species of sea turtle. The major breeding site for this native reptile is French Frigate Shoals, where from July through October of each year an estimated 25 to 50 thousand hatchlings emerge from nests and enter the ocean. Vigorous swimming and ocean currents disperse these young animals over a wide area of the Hawaiian chain, but greater concentrations probably occur in the ocean areas between French Frigate Shoals and Kure Atoll. Chances for the recovery of parts from the stomachs of predators in this northwestern segment of the Hawaiian chain are therefore undoubtedly greater.

The recognition and recovery of turtle parts should be enhanced by the following appended material:

1) Photograph of a live hatchling green turtle (weight-one ounce, upper shell length-two inches);

2) Plastic bag containing a dried and intact hatchling green turtle;

3) Plastic bag containing the dried fragments of a hatchling green turtle, representative of how partially digested pieces may appear in the stomachs of predators;

4) Plastic bag containing the dried fragments of a juvenile green turtle, representative of how partially digested pieces may appear in the stomachs of predators.

When parts are recovered, it will be important to record the species and size of the predator, and the location of capture. The entire stomach and intestinal contents of the predator should be preserved in formalin for my subsequent examination.

Any assistance that can be provided in this work will be greatly appreciated. If there are any questions, please feel free to telephone me at 247-6631.

GHB:ec

Dr. George Balazs

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812

Date: April 9, 1979 **Reply to Attn. of:** F142:RAS

To: Northwestern Hawaiian Islands Participants

From: Robert A. Skillman, Coordinator, Northwestern Hawaiian Islands Study

Subject: Report on reef fish communities

Attached is a report by Edmund (Ted) Hobson on his latest survey of the reef fish communities in the Hawaiian Archipelago. Dr. Hobson conducted his field program jointly with Dr. Grigg from whom we heard a seminar at our last meeting.

Attachment

Fish Communities in the Hawaiian Archipelago

A Report on Participation in the Northwest Hawaiian Islands Project

October 31 to November 19, 1978

Edmund S. Hobson

Tiburon Laboratory

I monitored the fish communities at the Kona study sites, October 31 to November 3, making counts along the established transect lines, as well as general observations in the nearshore habitats following procedures defined earlier. On November 4, I joined Dr. R. Grigg and others from the University of Hawaii, aboard R. V. Easy Rider for study of coral reef communities at Niihau, Nehoa, Necker, and French Frigate Shoals. Major findings of this work are outlined below.

New Perspective Gained on Hawaiian Coral Reefs

Hawaiian reefs have long been recognized as differing from most Indo-Pacific coral reefs in the absence in Hawaii of corals of the genus Acropora. Acropora spp. are the major scleractinian corals on coral reefs, and their absence in Hawaii generally has been assumed to stem from low water temperatures there. It is now clear, however, that there must be some other reason why these corals are absent from

the major Hawaiian Islands. During the cruise aboard Easy Rider we found Acropora to be a major component of reefs at French Frigate Shoals in the Northwest Hawaiian Islands where water temperatures are, in fact, considerably lower than on the major Hawaiian Islands. During recent years a few small isolated heads of Acropora had been seen at French Frigate Shoals, and one small colony was collected at the high Island of Kauai, but there was no evidence that these were significant elements of the fauna. This joint NMFS-HIMB investigation, however, found Acropora to be dominant coral on some reefs, and individual heads up to 5 meters in diameter. We also found the coral-feeding butterfly fish, Chaetodon trifacialis, a widespread Indo-Pacific form unrecognized as a member of the Hawaiian fauna, to be numerous in close association with these corals.

Blue-Lined Snapper May be Displacing Goatfishes in Hawaii

The blue-lined snapper, Lutjanus kasmiri, was introduced into the Hawaiian Islands about 20 years ago to enhance the nearshore fishery, and currently is experiencing a population explosion. During my monitoring of the fish communities at Kona since 1969 I've noted possible effects of the sharp increase in this snapper there. I observed this species only rarely during 15 months of intensive study in 1969 and 1970, but noted a small school residing in Honaunau Bay

in 1974. Apparently, like many other snappers, this fish forms schools in established locations by day from which it disperses to feed at night. In 1974, it co-occurred by day with an aggregation of goatfish, Mulloidichthys vanicoelensis, which has a similar day-night activity pattern, and which alone had occupied this location in 1969-1970. In 1977, and again on this visit, an immense school of blue-lined snappers occurred here, and only a few M. vanicoelensis were present. Similarly, a large school of the closely related goatfish, Mulloidichthys flavolineatus, and an aggregation of still another, Parupeneus porphyreus, both of which were consistently present at a nearby spot in 1969-1970, and in 1974, were absent in 1977 and also this year. At the same time, there has been a general decrease in goatfishes along a transect line on a neighboring reef, where the fishes have been monitored since 1969 (Table 1).

Table 1. Relative Abundance (Percent of Individuals of all Species) of Goatfishes on a Transect Line at Honaunau, Hawaii, 1969-1978

	1969	1974	1977	1978
Mulloidichthys flavolineatus	00.12	04.81	00.40	____
Parupeneus multifasciatus	00.58	01.60	____	00.32
P. bifasciatus	00.12	____	____	____
P. porphyreus	00.08	00.64	____	____
P. pleurostigma	00.04	____	____	____

Although the numbers involved in these counts are too small to carry much significance, they are consistent with the other observations, and warrant attention because the goatfishes have been an important component of Hawaiian reefs since ancient times. If nothing else, these data offer clues for direction of needed research. Significantly, many snappers and goatfishes world-wide have highly similar diets, even though the way they feed is different. I intend to pursue this point in future work.

L. Balazs

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812

CRUISE REPORT

VESSEL: Townsend Cromwell, cruise 79-02 (TC-83)

CRUISE PERIOD: Part I: March 31-May 1, 1979
Part II: May 1-June 6, 1979

AREA OF OPERATION: Hawaiian Archipelago and Hancock Seamounts

TYPE OF OPERATION: Part I. Personnel from the National Marine Fisheries Service (NMFS) and Sea Grant Program, University of Hawaii (SGUH) participated in the assessment of the primary and secondary productivity of the waters of the Hawaiian Archipelago and anchored fish aggregation buoys off Barbers Point, Oahu and Kailua-Kona, Hawaii.

Part II. Personnel from NMFS, the Hawaii Division of Fish and Game (HDFG), and the U.S. Fish and Wildlife Service (FWS) participated in the third joint cruise under the terms of the Tripartite Cooperative Agreement for the survey and assessment of the living resources of the Northwestern Hawaiian Islands (NWHI). The NMFS portion of the cruise included a survey of pelagic tuna and demersal resources in the NWHI and Hancock Seamounts, and conducted specific experiments as requested for the spiny lobster management plan. The FWS and HDFG personnel surveyed the seabirds, land birds, monk seals, and sea turtles on land and at sea.

ITINERARY: March 31 - Departed Honolulu to anchor fish aggregation buoys off Barbers Point and Kailua-Kona and began measurements of productivity at selected environmental stations off the main Hawaiian Islands.

April 8 - Arrived Honolulu to embark and disembark scientific personnel.

9 - Departed Honolulu to continue productivity studies in the NWHI.

April 30 - Arrived at Midway.

May 1 - SGUH personnel disembarked. End of Part I. NMFS personnel embarked. Begin Part II.

3 - Departed for Hancock Seamounts to survey armorhead and alfonsin resources.

8 - Arrived at Midway. Embarked FWS and HDFG personnel. Departed Midway for Kure to begin assessment of living resources in the NWHI.

25 - Arrived at Honolulu. Disembarked FWS and HDFG personnel. Embarked additional NMFS personnel.

27 - Departed for Necker to observe predation on surface-released spiny lobsters.

June 6 - Arrived at Honolulu. End of cruise.

MISSIONS AND RESULTS:

Part I

A. Conduct environmental stations to study plankton and productivity of the Hawaiian Archipelago, with an extensive field sampling program to evaluate differences in the distribution of hydrographic conditions, nutrient levels, particulate matter, plankton stocks, and productivity rates at stations along each of four transects across the archipelago.

Twenty-three environmental stations were completed at preselected positions and four additional stations were conducted between transects.

1. Forty-six CTD casts were conducted to obtain day and night profiles on temperature, salinity, and depth.

2. Thirty-five XBT casts were made to obtain temperature-depth profiles.

3. Twenty-seven hydrocasts using 10 hydrobottles per cast were completed to obtain water samples for analysis of nitrite, nitrate, phosphate, particle size of suspended matter, fluorescence, chlorophyll a, and phaeopigments.

4. Twenty-three productivity buoy operations were completed for C^{14} assimilation determinations.

5. Twenty-three photometer readings and 24 Secchi disc casts were made.

6. Macrozooplankton samples were collected with 39 bongo tows, 39 neuston tows, 16 vertical plankton hauls, 6 Cobb trawl hauls, 6 Isaac-Kidd trawls, 8 four-meter square plankton tows, and 11 one-meter plankton tows.

7. Eighteen acoustic assessments of sound scattering by organisms were conducted.

B. Miscellaneous observations and activities.

1. Eight direct trolling operations were conducted.

2. One handline station was conducted at French Frigate Shoals.

3. One lobster trapping station was conducted at Midway.

4. Attempted trolling operations at Buoy A to bring back some live mahimahi, Coryphaena hippurus, but none were caught.

5. Anchored a fish aggregation buoy (Buoy A) 16 miles southwest of Barbers Point and Buoy F off Kailua-Kona.

Part II- A. Survey of the seabirds, land birds, monk seals, and sea turtles on land and at sea (FWS and HDFG).

Population estimates and breeding chronology of all seabirds were made on each of the NWHI. Population estimates of endangered terrestrial birds were made on Laysan and Nihoa. Counts were made of monk seals and green sea turtles on each island. Three hundred eighty-one forage samples were collected from seabirds.

B. Assessment of demersal and pelagic resources over banks and offshore grounds of the NWHI from Nihoa to Kure.

Sampling methods included lobster and fish trapping, handline fishing for snappers and groupers, and trolling for pelagic tuna and tunalike fishes (NMFS).

During the cruise, escape vents were placed in the inner chamber of the fish traps and their effectiveness observed.

2. Handlining

Eleven handline fishing stations were occupied during Part II. Fishing occurred during the day or early evening. Usually, four lines (two hydraulic powered and two electric powered gurdies) were employed; each line usually had four hooks (size 26) and a 5-lb weight. A total of 135 fishes were caught during the cruise: 22 Pristipomoides filamentosus, 9 P. sieboldii, 9 Rooseveltia brighami, 2 Etelis carbunculus, 41 E. marshi, 32 Epinephelus quernus, 8 Caranx chelio, 5 Seriola dumerilii, and 5 other miscellaneous species. Fishing conditions were usually bad as sharks were encountered at every fishing station; loss of gear and fish was always encountered.

3. Trolling

There were eight trolling operations where 31.5 h were spent trolling on Part I; six lines were used. A total of 99 fishes were caught: 74 Euthynnus affinis, 17 Thunnus albacares, 5 Acanthocybium solandri, 1 Katsuwonus pelamis, and 2 Coryphaena hippurus. On Part II 35.9 h of direct trolling with nine lines produced 167 fishes: 109 E. affinis, 48 T. albacares, 3 K. pelamis, 1 A. solandri, 1 C. hippurus, 1 Caranx ignobilis, 1 Caranx melamphygus, 1 S. dumerilii, and 2 Elagatis bipinnulata. Fishing was good at Nihoa, Northampton Seamounts, Pearl and Hermes Reef, and Necker. Catch rates in these areas were better than 0.5 fish per line-hour.

4. Biological samples

Various biological samples were collected for the Honolulu Laboratory's Insular Resource projects. All ovaries (ca. 114) were collected from snappers, groupers, carangids, kawakawa, and ono for fecundity and spawning season determinations. All stomach contents and spewings (ca. 200) were collected from demersal and pelagic fishes for the feeding habit study. About 24 pairs of

otoliths were collected from selected size ranges of certain snappers and groupers lacking in the overall collection of the age and growth studies. All fishes caught at handline stations were measured and weighed for determination of length-weight relationships and for length-frequency analyses.

5. Ciguatoxin study

Sets of tissue samples were collected for ciguatoxin analysis from 68 fishes caught on Part II of this cruise. A set of tissue samples consisted of material from (a) dorsal anterior musculature, (b) ventral anterior musculature, (c) gonad, (d) liver, (e) postventral musculature, and (f) brain tissue. Ovaries were not collected from female fishes; these were preserved for fecundity studies. Brain tissue was collected only when the otoliths were extracted. Six large spiny lobsters, P. marginatus, and three slipper lobsters, S. squammosus, were also saved for ciguatoxin studies.

C. Assessment of seamount resources (NMFS).

1. Trawl

Six successful tows were made with the Noreastern trawl at various times of the day. The largest single catch was about 550 kg of armorhead, Pentaceros richardsoni, at the southeast Hancock Seamount.

2. Handlining

Three handline fishing stations were occupied on the northwest Hancock Seamount at sunset and sunrise. Two lines (hydraulic powered gurdies) were employed; each line had 20 hooks (size 16) that were spaced a meter apart. Each hook was secured to the mainline with a 13.6-kg (30-lb) test leader about 46 cm long. Squid was the only bait used. Catch was fairly good as 108 armorheads and 10 alfonsins, Beryx splendens, were caught. One handline station on southeast Hancock Seamount was not as successful as dogfish, Squalus blainvillei, was thought to have bitten off the hooks with the bait.

3. Biological sampling

Six specimens each of small Beryx splendens and Zenopsis nebulosa were saved for morphometric and meristic measurements. Unidentified specimens were also saved for later identification. A second species of Beryx, B. decadacthylus also occurred in the catches. Otolith samples and stomach samples were also collected.

D. Predator-prey observations

The alleged predation of spiny lobsters thrown overboard from a ship was observed and documented with a 16-mm movie camera. Divers observed and photographed the behavior of suspected predators, the white ulua, C. ignobilis, omilu, C. melampygus, gray reef shark, Carcharhinus menisorrah, galapagos shark, C. galapagensis, and the whitetip shark, Triaenodon obesus, as sublegal lobsters were thrown overboard. These predators showed interest by swimming up to the spiny lobsters as they sank to the bottom, but were not observed to consume any of them. Separate observations were made on berried spiny lobsters and sublegal slipper lobsters. Observations were also made on the Cromwell's method of releasing lobsters at the bottom using a large folded canvas.

E. Miscellaneous observations and activities

1. Over 300 live spiny lobsters were brought back for experiments on determining catchability and observations on molting, spawning frequency, growth, and tag retention.

2. Fifty lobster heads were brought back from Pearl and Hermes for genetic studies by Dr. James Shaklee, Department of Zoology, University of Hawaii.

3. About 200 lb of moray eels were brought back for Robert DeLong, Marine Mammal Division, Northwest and Alaska Fisheries Center, NMFS, Seattle.

4. Fifty kawakawa blood samples and 49 liver samples were brought back for Anthony Lewis, Australian National University, Canberra A.C.T., Australia.

5. Collected about six Chaetodon miliaris and also about six postjuvenile C. miliaris for Stephen Ralston, Department of Fisheries, University of Washington, Seattle.

6. Nine live kawakawa were brought back for the Laboratory's Experimental Ecology of Tunas task.

7. Seventeen XBT casts were made while traveling between banks and seamounts and on transects on the seamounts.

8. The thermosalinograph was operated throughout the cruise.

9. The Occurrence of Birds, Aquatic Mammals and Fish School Log was maintained throughout the cruise during daylight from 0600 to 2000.

10. Seventeen neuston tows were made on Part II; 14 were made in the open sea. Three juvenile mahimahi and a billfish were obtained for age and growth studies. Other neustons collected will be very useful in the identification of forage items from birds and fishes.

11. On two occasions, May 25 and June 6, the Cromwell trolled around Buoy A at sunrise to attempt to capture mahimahi, but none were caught.

12. Seven night-light stations were conducted when the ship was anchored. Specimens to assist in the identification of forage material and a few juvenile fishes for age and growth studies were collected.

13. The Witham collector (for juvenile spiny lobsters) was set once at Necker just before the new moon. No puerulus was collected.

14. Nine fish specimens were saved for photographing.

15. Surveys were made of both northwest and southeast Hancock Seamounts and of the unnamed bank northwest of Lisianski by the ship's officers.

SCIENTIFIC PERSONNEL:

Part I

Robert L. Humphreys, Jr., Chief Scientist, Research Assistant, NMFS, SWFC, HL (31 March-1 May)
Walter M. Matsumoto, Fishery Biologist, NMFS, SWFC, HL (31 March-1 April)

Jed Hirota, Cooperating Scientist, SGUH (31 March-8 April)
Vernon J. H. Hu, Cooperating Scientist, SGUH (8 April-1 May)
Andy E. Jahn, Cooperating Scientist, SGUH (31 March-1 May)
Robert Nicholson, Cooperating Scientist, SGUH (31 March-1 May)
F. Randy Shuman, Cooperating Scientist, SGUH (31 March-1 May)
James P. Szyper, Cooperating Scientist, SGUH (31 March-1 May)
Satoru Taguchi, Cooperating Scientist, SGUH (31 March-1 May)
Marc Weinstein, Cooperating Scientist, SGUH (8 April-1 May)

Part II

James H. Uchiyama, Chief Scientist, Fishery Biologist, NMFS, SWFC, HL (1 May-6 June)
Alan R. Everson, Research Assistant, NMFS, SWFC, HL (27 May-6 June)
Reginald M. Gooding, Fishery Biologist, NMFS, SWFC, HL (1-8 May, 27 May-6 June)
Robert L. Humphreys, Jr., Research Assistant, NMFS, SWFC, HL (1 May-6 June)
Robert B. Moffitt, Research Assistant, NMFS, SWFC, HL (1 May-6 June)
John J. Naughton, Fishery Biologist, NMFS, SWR, WPPO (27 May-6 June)
Linda M. Paul, Research Assistant, NMFS, SWFC, HL (8 May-6 June)
Jeffrey J. Polovina, Statistician, NMFS, SWFC, HL (8-25 May)
Elisabeth Cummings, Cooperating Scientist, Wildlife Biologist, FWS (8-25 May)
Craig F. Harrison, Cooperating Scientist, Wildlife Biologist, FWS (8-25 May)
Mark Rauzon, Cooperating Scientist, Biological Technician, FWS (8-25 May)
Nelson Santos, Cooperating Scientist, Wildlife Biologist, HDFG (8-25 May)

Submitted by: Robert L. Humphreys, Jr.
Robert L. Humphreys, Jr.
Chief Scientist, Part I

James H Uchiyama
James H. Uchiyama
Chief Scientist, Part II

Approved by:
Tamio Otsu
Acting Director, Honolulu Laboratory

June 20, 1979

George Balazs

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812

June 8, 1979 F142:HSHY

TO: Distribution

FROM: Heeny S. H. Yuen, Vessel Coordinator, Honolulu Laboratory

SUBJECT: Townsend Cromwell cruise schedules

Enclosed are Townsend Cromwell cruise schedules for fiscal years 1979, 1980, and 1981.

Revised June 8, 1979

TOWNSEND CROMWELL CRUISE SCHEDULE

Fiscal Year 1979

Cruise No.	Date Start	Date End	Days at sea	Shore days[1]	Days between cruises[2]	Area and type of operation
	10/01/78	10/15/78			15[3]	In port, Honolulu
TC-78/04 (TC #81)	10/16/78	12/17/78 (Cruise aborted)	22	0		NWHI - Insular resource surveys; environmental and productivity studies
					56	In port, Honolulu
TC-79-01 (TC #82)	01/03/79	03/17/79	67	7		Eastern tropical Pacific - porpoise surveys
	03/18/79	03/30/79			13	In port, Honolulu
TC-79-02 (TC #83)	03/31/79	06/06/79	66	3		NWHI - Part I, Productivity studies - Part II, Seabird surveys - Insular resource surveys
	06/07/79	06/17/79			11	In port, Honolulu
TC-79-03 (TC #84)	6/18/79	08/05/79	47	3		NWHI - Part I, Productivity studies - Part II, Nearshore resource surveys - Insular resource surveys
	08/07/79	08/17/79			11	In port, Honolulu
TC-79-04 (TC #85)	08/18/79	(09/30/79)	40	4		The Samoas - aggregation objects; Insular resources (continues into FY-80)
	Totals		242	17	106	365

[1]Mandatory shore days, 2 for every 19 sea days; usually taken away from home port, e.g., Midway Islands, Pago Pago.

[2]Days taken between cruises for post- and pre-cruise activities, minor maintenance usually taken in home port, Honolulu.

[3]Plus 3 days in FY 1978.

Revised June 8, 1979

TOWNSEND CROMWELL CRUISE SCHEDULE

Fiscal Year 1980

Cruise No.	Days Start	Days End	Days at sea	Shore days	Days between cruises	Area and type of operation
TC-79-04 (TC #85)	continued	10/25/79	23	2		The Samoas - aggregation objects; insular resources
	10/26/79	12/02/79			38	Shipyard, Honolulu
TC-79-05 (TC #86)	12/03/79	12/14/79	12			Hawaiian Islands
	12/15/79	1/02/79			18	In port, Honolulu
TC-80-01 (TC #87)	01/03/80	03/09/80	60	7		Eastern tropical Pacific - porpoise survey
	03/10/80	03/20/80			11	In port, Honolulu
TC-80-02 (TC #88)	03/21/80	05/13/80	50	4		NWHI - Insular resource survey
	05/14/80	05/24/80			11	In port, Honolulu
TC-80-03 (TC #89)	05/25/80	07/30/80	61	6		NWHI - Nearshore resource survey seabird and monk seal surveys; insular resource surveys
	07/31/80	08/13/80			14	In port, Honolulu
TC-80-04 (TC #90)	08/14/80	(09/30/80)	44	4		NWHI - Insular resource survey (continues into FY-81)
	Totals		250	23	92	365

Revised June 8, 1979

TOWNSEND CROMWELL CRUISE SCHEDULE

Fiscal Year 1981

Cruise No.	Date Start	Date End	Days at sea	Shore days	Days between cruises	Area and type of operation
TC-80-04 (TC #90)	continued	10/05/80	15	0		
	10/16/80	10/26/80			11	In port, Honolulu
TC-80-05 (TC #91)	10/27/80	12/19/80	49	4		NWHI - Insular resource surveys
	12/20/80	01/04/81			16	In port, Honolulu
TC-81-01 (TC #92)	01/05/81	03/05/81	56	4		NWHI - Insular resource surveys
	03/06/81	03/16/81			11	In port, Honolulu
TC-81-02 (TC #93)	03/17/81	05/08/81	49	4		NWHI - Insular resource surveys
	05/09/81	06/22/81			45	Shipyard, Honolulu
TC-81-03 (TC #94)	06/23/81	08/07/81	43	3		NWHI - Insular resource surveys
	08/08/81	08/19/81			12	In port, Honolulu
TC-81-04 (TC #95)	08/19/81	09/28/81	38	3		NWHI - Insular resource surveys
	09/29/81	09/30/81			2	In port, Honolulu
	Totals		250	18	97	365

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812

Dr. George Balazs

May 21, 1979 F142:RAS

TO: Participants Northwestern Hawaiian Islands Meeting

FROM: Robert A. Skillman, Coordinator NWHI Study

SUBJECT: Summary of 17 May 1979 Meeting

The May meeting of the NWHI study group was held on the 17th at the Honolulu Laboratory. The agenda of the meeting is attached.

First, Richard S. Shomura, Honolulu Laboratory Director, reviewed recent developments regarding the Hawaiian monk seal. Field research on the monk seal has been conducted by the Marine Mammal Division, Northwest and Alaska Fisheries Center, primarily with Marine Mammal Commission funding. Apparently there never was an approved monk seal program and therefore no programmatic funds available. Recently, Mr. Terry Leitzell, the Head of the NMFS, has assigned the lead research role to the Southwest Fisheries Center (Honolulu Laboratory) effective in FY81 and reconfirmed the management role of the Southwest Region office. Steps are being taken now to establish a monk seal recovery team and to develop a research plan. The research by Brian and Pat Johnson on Laysan Island has been funded this year by a consortium made up of the Honolulu Laboratory, NMFS Marine Mammals and Endangered Species office in Washington, the Marine Mammal Commission, and the Marine Affairs Coordinator, State of Hawaii. An opinion was voiced that the Johnsons should spend about a year analyzing their data before any additional work be done. Later in the meeting, it was suggested that the Honolulu Laboratory should document their monk seal program by adding a new appendix to the Tripartite Cooperative Agreement. Mr. Shomura concurred with this suggestion.

Next Mr. Shomura brought the group up to date on some events relating to marine turtles. Virtually all NMFS funding for marine turtles is now being allocated to the Gulf of Mexico area for the turtle/shrimp trawler problem, but the Honolulu Laboratory is still trying to access some of this money. On July 31, August 1, and 2, 1979, there will be a technical meeting at the Honolulu Laboratory to review research needs on a Pacific-wide basis. In December 1979, the South Pacific Commission and the Honolulu Laboratory will be hosting a meeting in Noumea, New Caledonia to review ongoing research and rearing studies in the Pacific. The Marine Affairs Coordinator is still funding work performed by George Balazs and will do so in FY80 with approximately $9,000. The University of Hawaii Sea Grant Program will likewise be putting up some $26,700.

The ciguatoxin sampling programs conducted by the NMFS and HDFG were reviewed by Richard N. Uchida and Henry Okamoto. The HDFG is sampling fishes, primarily three species, from the inshore areas, and the NMFS is working primarily on commercial species from the offshore or deeper reef areas. All samples are being tested by Dr. Hokama from the University of Hawaii using his radioimmunoassay (RIA) methodology. Dr. Hokama also ran the tests on monk seal samples for Mr. Bill Gilmartin, U.S. Navy, in cooperation with the Marine Mammal Division. A common data log form is being used by both NMFS and HDFG. Some of the results from the RIA tests were presented. The HDFG presented the attached report on ciguatoxin sampling. The Honolulu Laboratory has submitted a task plan for FY81 in conjunction with a technology lab at the Southeast Fisheries Center. This plan includes research on development of a quick test for ciguatoxin, pharmacological work, and a pathway study. It was pointed out that the Food and Drug Administration has issued a request for proposals to develop a rapid test for ciguatoxin and a pathway analysis and that Drs. Banner, Hokama, et al. have responded. The consensus of the discussion was that these various projects did not seem to be coordinated and that a group planning session should be convened in Hawaii to develop a coordinated research plan.

Since George Liao could not attend the meeting, Dr. Skillman indicated that the Honolulu Laboratory is working to get the ecosystems model provided by Taivo Laevastu converted from CDC FORTRAN to the University of Hawaii's IBM FORTRAN.

Dr. Skillman proposed that the NWHI research segment of the University of Hawaii Sea Grant Program be made a formal part of the Tripartite Cooperative Agreement by developing a new appendix to the Agreement. He pointed out that it was impractical to redraft the Agreement which would then require agency review and resigning. The new appendix could be developed jointly by the Honolulu Laboratory and Sea Grant and submitted, by the NMFS, as set out in the Agreement for acceptance by the USFWS and the Hawaii Board of Land and Natural Resources. While the Sea Grant program was developed in consultation with the participants in the Agreement, it was suggested that it would be desirable to document that coordination with respect to the relationship of the NMFS and Sea Grant to their parent organization NOAA, to the relationship of the University of Hawaii Sea Grant Program to other state agencies or offices, and to the day-to-day details of field trip planning and access to the Hawaiian Islands National Wildlife Refuge. Some concern was voiced about the increased size of the study and access to the major ocean platform, the Townsend Cromwell. It was pointed out that most of the Sea Grant field work was scheduled to be done on chartered vessels. It was agreed that Dr. Skillman should draft a new appendix for consideration by the participants.

With respect to the last agenda item, Dr. Skillman announced that he will be transferred to the U.N. South China Sea Fisheries Development and Coordinating Programme in Manila, Philippines for a one-year period starting in June 1979. Mr. Shomura indicated that he is working on some kind of a

transfer of Dr. Richard Grigg from the Hawaii Institute of Marine Biology to the staff of the Honolulu Laboratory to serve as the acting coordinator for the cooperative study. The participants agreed that this would probably be a good idea.

Other business that came up included a suggestion that cruise scheduling should be placed on the agenda for discussion at the next monthly meeting. In response to concern about how the various inshore studies are coordinating their work, Mr. Uchida will hold a meeting next week to bring the various scientists involved together. A report on the meeting will be presented at the next monthly meeting.

Henry Sakuda announced that HDFG is going to initiate aerial surveys from the U.S. Coast Guard's C-130 aircraft to attempt to assess certain inshore pelagic fishes. He and other HDFG personnel will meet with Reginald Gooding, Honolulu Laboratory, to discuss work Mr. Gooding and Bernard Ito have been doing on aerial photographic surveys for monk seals and marine turtles from the same aircraft.

The next monthly meeting will be held early in June, probably before 7 June.

Attachments

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812

Date: May 11, 1979

Reply to Attn. of: F142:RAS

To: Participants, Northwestern Hawaiian Islands Study

From: Robert A. Skillman, Coordinator, Northwestern Hawaiian Islands Study

Subject: Notice of May 1979 meeting

The next monthly meeting will be held at 0800, Thursday, 17 May 1979, in the Seminar Room, Honolulu Laboratory.

It has been several months since we have met and, therefore, there is a lot to catch up on. The following topics will be discussed:

1. Honolulu Laboratory monk seal research plans - R. S. Shomura
2. Ciguatoxin sampling program - R. N. Uchida and H. Okamoto
3. Ecosystem modeling work - G. Liao
4. New appendix for Tripartite on Sea Grant - R. A. Skillman
5. Designation of Acting Coordinator - R. S. Shomura

FISH & GAME NWHI CIGUATERA TOXIN SAMPLING PLAN

1977

Prior to the 1977 NWHI nearshore fishery assessment study cruise, a meeting was held at the Hawaii State Department of Health (DOH) to discuss ciguatera toxin sampling plan with the University of Hawaii (UH), DOH, HDFG, and NMFS personnel. It was decided at the meeting that target fish species would be ulua, po'ou, and kahala. The experience gained in 1977 showed that ulua was not readily available at all locations surveyed, and we also experienced considerable difficulty to collect adequate numbers of po'ou and kahala samples.

1978

Based on the 1977 result, we decided that a random sampling of different fish species be conducted to get a feel as to what fish species should be considered for the ciguatera study. Based on the 1978 study which sampled 57 different species, plans have been formulated for the 1979 study.

1979

It should be realized that ciguatera sampling is only one part of the NWHI fishery assessment study plan. Therefore, time (10% to 15%) and money (about $3,000 for testing) are limiting factors that will dictate the extent of data collection that we can plan on.

The fish species selected as target species for examination was based on the following: 1) abundance, 2) catchability, 3) food habits--different food habits and nocturnal or diurnal feeding periods, 4) indication of species toxicity from 1978 data, and 5) economic importance.

Data will be collected on NMFS ciguatera data form. In addition to the information on the form, size of gonad (to determine spawning periods and size of sexually mature fish) and stomach contents will be collected for our assessment study.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu Laboratory
P. O. Box 3830
Honolulu, Hawaii 96812

Date: May 11, 1979

Reply to Attn. of: F142:RAS

To: Participants, Northwestern Hawaiian Islands Study

From: Robert A. Skillman, Coordinator, Northwestern Hawaiian Islands Study

Subject: Notice of May 1979 meeting

The next monthly meeting will be held at 0800, Thursday, 17 May 1979, in the Seminar Room, Honolulu Laboratory.

It has been several months since we have met and, therefore, there is a lot to catch up on. The following topics will be discussed:

1. Honolulu Laboratory monk seal research plans - R. S. Shomura
2. Ciguatoxin sampling program - R. N. Uchida and H. Okamoto
3. Ecosystem modeling work - G. Liao
4. New appendix for Tripartite on Sea Grant - R. A. Skillman
5. Designation of Acting Coordinator - R. S. Shomura

See Kim Thursday

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu and La Jolla Laboratories
P. O. Box 3830
Honolulu, Hawaii 96812

CRUISE REPORT

VESSEL: Townsend Cromwell, cruise 76-04-71.

CRUISE PERIOD: May 3-June 9, 1976

AREA OF OPERATION: Northwestern Hawaiian Islands and waters off Oahu.

ITINERARY:

May 3 and 4	- Day trips to Penguin Bank for gear shakedown and demonstrations.
May 5	- Departed Kewalo Basin, Honolulu, for Northwestern Hawaiian Islands.
May 6-18	- Made a preliminary survey of the inshore marine fauna at Nihoa, French Frigate Shoals, Laysan, and Necker.
May 19	- Arrived Kewalo Basin. Changed personnel.
May 24	- Departed Kewalo Basin for a day trip to calibrate pressure sensing/reporting transmitters for range.
May 25-June 8	- Tracked skipjack tuna.
June 9	- Arrived Kewalo Basin.

MISSIONS AND RESULTS

A. To review certain gear handling operations in order to familiarize the class on fishery science of the University of Hawaii and personnel of the Honolulu Laboratory with ocean research procedures and techniques.

Demonstrations of the shrimp trawl, Isaac-Kidd trawl, STD, XBT, and CTFM sonar were made for 30 students and 5 desk-bound observers. The ship's officers and field party explained or demonstrated other equipment and procedures connected with navigation and research.

B. To assist in the conduct of a preliminary orientation survey of the nearshore and shoreline fishery resources as well as of the sea birds, terrestrial birds, green sea turtle, and the Hawaiian monk seal of the Northwestern Hawaiian Islands by personnel of the State of Hawaii Division of Fish and Game. The information collected will be used in the designing and planning of a resource assessment study of the area.

Fishery Resources: Various sampling and survey techniques were employed to inspect a total of 15 areas at: Nihoa Island (2); French Frigate Shoals (9); Laysan Island (2); and Necker Island (2). Six night surveys were conducted over areas surveyed during the day.

Data on the composition, distribution and densities of fishes, macroinvertebrates and algae, as well as bottom topography, were collected through shoreline, surface and underwater transects, and observations. Specimens and samples were also collected using nets, hooks-and-lines, and traps. General quantitative information on fish compositions and densities were also collected at selected sites.

Various species of fishes were collected and examined and/or preserved for further analysis throughout the cruise. These included representatives of the following families of fishes:

Carangidae	Carcharhinidae	Scombridae
Polynemidae	Kyphosidae	Belonidae
Kuhliidae	Mullidae	Lutjanidae
Acanthuridae	Priacanthidae	Sphyraenidae
Mugilidae	Balistidae	
Labridae	Scaridae	

Samples of macroinvertebrates, algae, and bottom substrates were also collected, examined, and/or preserved for further analysis.

Four fish counting transects were conducted at selected sites. The significant data are summarized in Table 1.

The preliminary survey indicated that the ulua (Carangidae) and sharks (Carcharhinidae) are large in size and abundant in certain areas, while others of such families as Holocentridae, Apogonidae, Pomacentridae, Chaetodontidae, Acanthuridae, and Muraenidae, commonly associated with similar habitats in the major Hawaiian Islands appeared

to be noticeably absent. The low diversity of fish species present over the nearshore reef areas surveyed may be caused by the abundance of the larger sized predators.

Macroinvertebrates were also limited to a few species of gastropods, bivalves, and corals, most of which were generally sparse in most areas.

Wildlife Resources: A total of seven areas, including sites at Nihoa Island, French Frigate Shoals (Tern, Whale-Skate, Little Gin, and Disappearing Islands), Laysan Island and Necker Island were surveyed to gather information on the wildlife inhabitants. The numbers of Hawaiian monk seals and green sea turtles and the number of sea bird and terrestrial bird species observed are listed in Tables 2 and 3.

A Hawaiian monk seal was found dead on Little Gin Island at French Frigate Shoals on May 16. Due to its advanced stage of decomposition, only the head was recovered and retained for further examination.

C. To continuously monitor the swimming of several large skipjack tuna, 7 kg or larger, for data on swimming depth and activity. These data are pertinent to a hypothesis resulting from studies of the energy budget and physiology of skipjack tuna which states that the duration that skipjack tuna can survive in temperatures of the upper mixed layer is dependent on their size and activity.

Large skipjack tuna were tagged by James Uchiyama who boarded the commercial fishing ship Anela for that purpose. The tags were cylindrical transmitters, 16 mm diameter and 92 mm length, which transmitted pulses at a frequency of 48 kHz. Pulse rates which were regulated by ambient pressure ranged from 60/min to 150/min. The CTFM sonar was used to detect and locate the transmitted signals. The system had an approximate range of 2 km.

Five skipjack tuna greater than 70 cm fork length were tagged on separate occasions. The tag was placed in the stomach through the mouth. Two of the fish regurgitated their tags, one immediately after release and the other 2 h after release. The other three fish were tracked for 11, 25, and 9 h, respectively. There were visual confirmations that at least two of the fish rejoined their schools after release, i.e., schools of large skipjack tuna were sighted where the sonar indicated the tagged fish to be.

The large skipjack tuna demonstrated a facility for rapid depth changes by swimming 100 m vertically within 2 min. They occasionally reached a depth of 270 m. One fish went as deep as 275 m once.

A movement pattern that was exhibited by all three fish was an ascent to a zone within 75 m of the surface at about 7:45 p.m. The one fish that was tracked throughout the night remained in that zone until 5:50 a.m. The other two fish were in that zone for approximately 2 h at which point one fish was lost and one fish started going deeper, possibly in the first throes of death. The latter fish eventually sank out of range at 35 min after midnight.

The average horizontal speed of the tagged fish ranged from 1.7 to 2.2 body lengths/sec (1.2 to 1.6 m/sec). The last 5 h of the fish that died is not included. The speed values are minimum estimates because they are based on straight line calculations of the ship's position at 30-min intervals. The highest average speed attained for a half hour period was 6.1 body lengths/sec (4.3 m/sec).

The fish were in temperatures of 20°C or higher roughly 90%, 50%, and 75% of the time for the 25, 11, and 9 h tracks, respectively. The lowest temperature entered was 12.5°C.

Records of swimming depth were obtained by timing the pulse rate with a stopwatch. A recorder to record the pulses continuously should be installed for more refined depth data.

Relative to the small skipjack tuna which have been tracked previously, the large skipjack tuna are more difficult to track. On several occasions they moved out of tracking range with bursts of speed.

XBT records were made at approximately 6-h intervals during tracking.

Miscellaneous Activities: Heads and length measurements from 28 jacks (Carangidae) were collected for a study on age determination from otolith markings.

Two specimens and one head of gray reef sharks were frozen and brought back for Dr. Wolf Reif, visiting professor from the University of Tubingen, West Germany.

The putrefied head of a Hawaiian monk seal bull was frozen and brought back for Dr. G. Causey Whittow, professor of physiology, Pacific Biomedical Research Center, University of Hawaii.

SCIENTIFIC PERSONNEL:

Heeny S. H. Yuen	- Chief Scientist
Randolph K. C. Chang	- Research Assistant (5/24-6/9/76)
Andrew E. Dizon	- Fishery Biologist (5/24-6/9/76)
Bernard M. Ito	- Research Assistant (5/3-4/76)
James H. Uchiyama	- Research Assistant on Anela (5/25-6/8/76)
Howard O. Yoshida	- Fishery Biologist (5/3-4/76)
Kenji Ego	- Chief, Fisheries Branch, State of Hawaii Division of Fish and Game (F&G) (5/5-19/76)
John Giffin	- Wildlife Biologist, F&G (5/5-19/76)
Stanley Hara	- Senator, Hawaii Legislature (5/5-19/76)
Donald J. S. Merten	- President, Communications Associates, Inc. (5/24/76)
Dean Ohtani	- Fisheries Technician, F&G (5/5-19/76)
Henry Okamoto	- Aquatic Biologist, F&G (5/5-19/76)
Eric W. Onizuka	- Aquatic Biologist, F&G (5/5-19/76)
Palmer C. Sekora	- Refuge Manager, U.S. Fish and Wildlife Service (5/10-15/76)
T. C. Yim	- Senator, Hawaii Legislature (5/5-19/76)

Submitted by Kenji Ego

Kenji Ego
Chief, Fisheries Branch,
State of Hawaii Division
of Fish and Game

Heeny S. H. Yuen

Heeny S. H. Yuen
Chief Scientist

Approved by:

Tamio Otsu
Acting Director, Honolulu
Laboratory

Attachments

July 6, 1976

Table 1.--Results of fish counting transects.

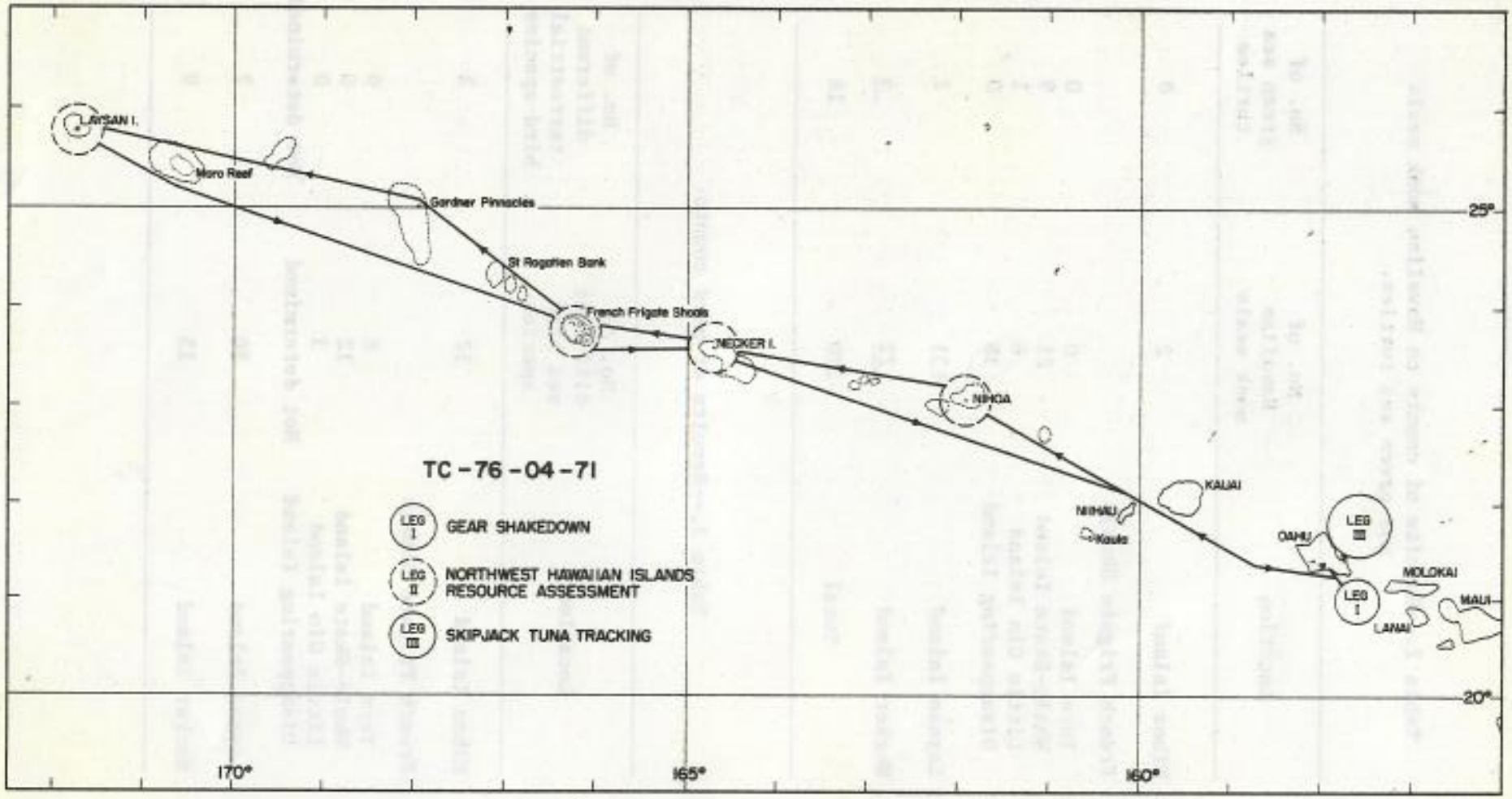
Location	No. of fish species	Estimated densities (lb/acre)	Major fish species ranked in terms of greatest densities
Nihoa Island	26	147.61	1. Chromas ovalis 2. Ctenochaetus strigosus 3. Naso lituratus
French Frigate Shoals			
East Island	29	1,979.89	1. Scarus perspicillatus 2. Kyphosus cinerascens 3. Mulloidichthys samoensis
Whale-Skate Island	32	4,232.31	1. Mulloidichthys samoensis 2. Carangoides ajax 3. Scarus perspicillatus
Laysan Island	34	756.95	1. Scarus perspicillatus 2. Acanthurus triostegus (= A. sandvicensis) 3. Thalassoma purpureum (= T. umbrostigma and T. fuscum)

Table 2.--Results of counts on Hawaiian monk seals and green sea turtles.

Location	No. of Hawaiian monk seals	No. of green sea turtles
Nihoa Island	2	0
French Frigate Shoals		
Tern Island	0	0
Whale-Skate Island	21	9
Little Gin Island	6	1
Disappearing Island	38	0
Laysan Island	131	2
Necker Island	22	6
Total	220	18

Table 3.--Results of bird counts.

Location	No. of different sea bird species	No. of different terrestrial bird species
Nihoa Island	12	2
French Frigate Shoals		
Tern Island	8	0
Whale-Skate Island	12	0
Little Gin Island	3	0
Disappearing Island	Not determined	Not determined
Laysan Island	20	2
Necker Island	15	0


LAYSAN I.
Moro Reef
Gardner Pinnacles
St Rogatien Bank
French Frigate Shoals
NECKER I.
NIHOA
KAUAI
NIIHAU
Kauia
OAHU
LEG III
LEG I
MOLOKAI
MAUI
LANAI
25°
20°
170°
165°
160°
TC-76-04-71
LEG I
GEAR SHAKEDOWN
LEG II
NORTHWEST HAWAIIAN ISLANDS RESOURCE ASSESSMENT
LEG III
SKIPJACK TUNA TRACKING

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu and La Jolla Laboratories
P. O. Box 3830
Honolulu, Hawaii 96812

NARRATIVE REPORT

TOWNSEND CROMWELL, CRUISE 76-04-71

I. CRUISE PERIOD: May 3-June 9, 1976

II. AREA OF OPERATION: Northwestern Hawaiian Islands and waters off Oahu.

III. MISSIONS AND RESULTS:

A. To review certain gear handling operations in order to familiarize the class of fishery science of the University of Hawaii and personnel of the Honolulu Laboratory with ocean research procedures and techniques.

Demonstrations of the shrimp trawl, Isaac-Kidd trawl, STD, XBT, and CTFM sonar were made for 30 students and 5 non-seagoing HL staff members. The ship's officers and field party explained or demonstrated other equipment and procedures connected with navigation and research.

B. To assist in the conduct of a preliminary orientation survey of the nearshore and shoreline fishery resources as well as of the sea birds, terrestrial birds, green sea turtle, and the Hawaiian monk seal of the Northwestern Hawaiian Islands by personnel of the State of Hawaii Division of Fish and Game. The information collected will be used in the designing and planning of a resource assessment study of the area.

Fishery Resources

A total of 15 areas at Nihoa Island (2 areas), French Frigate Shoals (9 areas), Laysan Island (2 areas), and Necker Island (2 areas) was surveyed during the cruise. This included six night surveys conducted over areas that were inspected during the day. A large number of promising sites which were judged excellent for inspection by Division of Fish and Game personnel were not inspected or surveyed due to Federal restrictions imposed on access to these areas. Future cruises should strive to obtain prior approval for access to these restricted areas to undertake the needed studies.

Various sampling and survey techniques were tested during the preliminary orientation survey to determine their effectiveness. Data on the composition, distribution, and density of fishes, macroinvertebrates and algae, as well as bottom topography, were collected through shoreline, surface and underwater transects, and observations. Specimens and samples were collected using nets, hooks-and-lines, traps, and by hand. General quantitative information on fish compositions and densities were also collected at selected sites.

Nearly all survey and sampling techniques employed proved satisfactory under the conditions encountered; however, it appeared desirable that improved methods of conducting underwater surveys to maximize data collection and to cover wider areas be investigated. Alternatives such as use of a wet submersible capable of being towed by a small skiff, spaced underwater "spot" transects and underwater television photography methods are being considered for future survey use. Larger "working" boats (greater than 17-footers) will also be needed to transport gear and personnel and sustain inclement sea conditions.

Various species of fishes, macroinvertebrates, algae and bottom substrates that were found during the survey are summarized in Table 1.

Underwater fish counting transects conducted at selected sites at Nihoa Island, French Frigate Shoals (East and Whale-Skate Islands) and Laysan Island revealed the presence of 59 different species of fishes. Eight of these species were present at every site. An average of 30 species of fishes, ranging between 26 (Nihoa Island) and 34 (Laysan Island), were counted at each of the four sites with resultant estimated average standing fish crop density of nearly 1,779 pounds per acre (ranging between 148 and 4,232 pounds per acre at Nihoa and Whale-Skate Islands of French Frigate Shoals, respectively).

The weke-'a'a, Mulloidichthys samoensis, contributed the greatest density by weight while the piha, Spratelloides delicatulus, was the most numerous (in terms of numbers of individuals of a single species) observed at the fish counting stations. Table 2 lists the top 10 species of fishes in terms of largest estimated densities and most numerous individuals encountered during the fish counts.

The preliminary survey which included considerable surface observations, indicated that the uluas (Carangidae) and sharks (Carcarhinidae) were abundant in certain areas, while other fishes, including the squirrelfishes (Holocentridae), cardinalfishes (Apogonidae), damselfishes (Pomacentridae), butterflyfishes (Chaetodontidae), surgeonfishes (Acanthuridae), and

eels (Muraenidae) that are commonly associated with similar habitat types in the major Hawaiian Islands appeared to be noticeably absent or scarce. The low diversity of fish species observed over the nearshore reef areas is believed to be due to the abundance of large sized predators such as the uluas and sharks coupled with the limited area surveyed. Fishes observed were predominantly in the maximum or near maximum size classes and the relative absence of juvenile fishes was particularly striking. Macroinvertebrates were also limited to a few species of gastropods, bivalves, and corals which were generally sparse in most areas.

Wildlife Resources

A total of seven areas which included sites at Nihoa Island, French Frigate Shoals (Tern, Whale-Skate, Little Gin, and Disappearing Islands), Laysan Island, and Necker Island was surveyed to gather information on the major wildlife fauna. Table 3 summarizes the observations made of the sea birds, terrestrial birds, green sea turtles, and Hawaiian monk seals at each island.

C. To continuously monitor the swimming of several large skipjack tuna, 7 kg or larger, for data on swimming depth and activity. These data are pertinent to a hypothesis resulting from studies of the energy budget and physiology of skipjack tuna which states that the duration that skipjack tuna can survive in temperatures of the upper mixed layer is dependent on their size and activity.

Large skipjack tuna were tagged by James Uchiyama who boarded the commercial fishing ship Anela for that purpose. The tags were cylindrical transmitters, 16 mm diameter and 92 mm length, which transmitted pulses at a frequency of 48 kHz. Pulse rates which were regulated by ambient pressure ranged from 60/min to 150/min. The CTFM sonar was used to detect and locate the transmitted signals. The system had an approximate range of 2 km.

Five skipjack tuna greater than 70 cm fork length were tagged on separate occasions. The tag was placed in the stomach through the mouth. Two of the fish regurgitated their tags, one immediately after release and the other 2 h after release. The other three fish were tracked for 11, 25, and 9 h, respectively. There were visual confirmations that at least two of the fish rejoined their schools after release, i.e., schools of large skipjack tuna were sighted where the sonar indicated the tagged fish to be.

The large skipjack tuna demonstrated a facility for rapid depth changes by swimming 100 m vertically within 2 min. They occasionally reached a depth of 270 m. One fish went as deep as 275 m once.

A movement pattern that was exhibited by all three fish was an ascent to a zone within 75 m of the surface at about 7:45 p.m. The one fish that was tracked throughout the night remained in that zone until 5:50 a.m. The other two fish were in that zone for approximately 2 h at which point one fish was lost and one fish started going deeper, possibly in the first throes of death. The latter fish eventually sank out of range at 35 min after midnight.

The average horizontal speed of the tagged fish ranged from 1.7 to 2.2 body lengths/sec (1.2 to 1.6 m/sec). The last 5 h of the fish that died are not included. The speed values are minimum estimates because they are based on straight line calculations of the ship's position at 30-min intervals. The highest average speed attained for a half hour period was 6.1 body lengths/sec (4.3 m/sec).

The fish were in temperatures of 20°C or higher roughly 90%, 50%, and 75% of the time for the 25, 11, and 9 h tracks, respectively. The lowest temperature entered was 12.5°C.

Relative to the small skipjack tuna which have been tracked previously, the large skipjack tuna are more difficult to track. On several occasions they moved out of tracking range with bursts of speed.

XBT records were made at approximately 6-h intervals during tracking.

According to Mr. Uchiyama and the captain of the Anela the large skipjack tuna were very difficult to tag. After the fisherman had the skipjack tuna cradled in his arm he had to keep tension on the line while the tag was being inserted. The hook was removed after the tag was in. If this procedure was not followed the skipjack tuna would be moving too much for the tag to be inserted.

Operations with the Anela went smoothly most of the time. Communications were by walkie-talkie when the Cromwell trailed the Anela during fishing operations. This mode of communication was faster than normal radio channels and had the advantage of not broadcasting the whereabouts of the Anela to the rest of the fishing fleet. We did have problems reestablishing contact with the Anela after we were through with tracking one fish and wanted another fish tagged. The difficulty was

due to a malfunctioning radio on the Anela. The lack of immediate recontact caused us to lose a few days of tracking.

Tracking days were also lost when we had to stand by while the Anela spent the day baiting. On future tracking cruises the Cromwell should be equipped to fish when circumstances are such that time can be saved in getting a fish tagged. Tagging from the Cromwell would also offer opportunity to experiment with gentler ways of getting the transmitter into the fish.

The transmitter tags were purchased from Communication Associates, Inc. This is a first-time purchase from that supplier. The transmitters performed consistently well. A common difficulty with transmitter tags in the past was the unpredictable waxing and waning of signal strength. The signal strength of the present tags was steady. Tracking is facilitated greatly when the signal strength is at a consistent level.

Records of swimming depth were obtained by timing the pulse rate with a stopwatch. This method provides information on depth almost immediately with a minimum of processing. There are two major disadvantages of this method, however. Variability in the reaction time of the observer in operating the stopwatch and in the reading of the stopwatch are sources of error. Because a discrete block of time of 12-25 sec is needed to make an observation, a depth reading represents the average depth of the fish for that block of time. When a fish is making rapid vertical changes, a true representation is impossible to obtain. I recommend the installation of equipment to continuously record the signal pulses at the least. Electronic data processing equipment with a printer or a plotter would be desirable.

D. Miscellaneous

Collections of specimens and samples for other researchers.

1. Head samples and length measurements of 28 ulua (Carangidae) specimens were collected for age determination studies (utilizing otolith).

2. Opihi (Patellidae) from Nihoa and Necker Island and sand samples from the lagoon at Laysan Island were collected for Dr. E. Allison Kay, professor of General Science at the University of Hawaii.

3. Two whole gray reef sharks and a head of another were collected for Dr. Wolf Reif, a visiting professor from the University of Tubingen in West Germany.

4. The head of a partially decomposed Hawaiian monk seal recovered from Little Gin Island (French Frigate Shoals) on May 16, 1976 was provided to Dr. G. Causey Wittow, professor of Physiology at the Pacific Biomedical Research Center of the University of Hawaii for further examination.

IV. ITINERARY:

May 3 and 4	- Day trips to Penguin Bank for gear shakedown and demonstrations.
May 5	- Departed from Kewalo Basin, Honolulu, for Nihoa Island.
May 6	- Arrived at Nihoa Island. Began survey.
May 7	- Continued survey at Nihoa Island. Departed from Nihoa Island for French Frigate Shoals.
May 8	- Arrived at French Frigate Shoals; began survey.
May 9	- Continued survey at French Frigate Shoals.
May 10	- Continued survey of French Frigate Shoals; departed French Frigate Shoals for Laysan Island.
May 11	- Circled Gardner Pinnacles for familiarization while en route to Lay an Island.
May 12	- Arrived at Laysan Island; began survey.
May 13	- Continued survey at Laysan Island.
May 14	- Departed from Laysan Island for French Frigate Shoals.
May 15	- Arrived at French Frigate Shoals.
May 16	- Conducted additional survey at French Frigate Shoals; departed from French Frigate Shoals for Necker Island.
May 17	- Arrived at Necker Island; conducted survey. Departed Necker Island for Kewalo Basin.
May 18	- En route to Kewalo Basin.
May 19	- Arrived at Kewalo Basin.
May 25-June 8	- Tracked skipjack tuna off windward Oahu.
June 9	- Arrived Kewalo Basin. End of cruise.

V. RECORDS

BT and environment logs (HL)
BT log, NODC (Fleet Numerical Weather Central, Monterey, CA)
Daily activity messages (HL)
Dead reckoning abstract (HL)
Deck log (HL)
Deck log weather observations (HL)
Marine operations log (HL)
Occurrence of bird, aquatic mammals, and fish school (HL)
Progress sketch (HL)
Scientists' log (HL)
Standard surface trolling data sheets (HL)
Surface thermosalinograph graph (HL)
Track chart (rough) for tracking skipjack tuna (HL)
Ultrasonic tag tracking log (HL)
XBT traces (HL)

State of Hawaii, Division of Fish and Game files:

Field logbooks, sample, number, and length data
Fish transect data log

VI. SCIENTIFIC PERSONNEL:

Heeny S. H. Yuen	- Chief Scientist
Randolph K. C. Chang	- Research Assistant (5/24-6/9/76)
Andrew E. Dizon	- Fishery Biologist (5/24-6/9/76)
Bernard M. Ito	- Research Assistant (5/3-4/76)
James H. Uchiyama	- Research Assistant on Anela (5/25-6/8/76)
Howard O. Yoshida	- Fishery Biologist (5/3-4/76)
Kenji Ego	- Chief, Fisheries Branch, State of Hawaii Division of Fish and Game (F&G) (5/5-19/76)
John Giffin	- Wildlife Biologist, F&G (5/5-19/76)
Stanley Hara	- Senator, Hawaii Legislature (5/5-19/76)
Donald J. S. Merten	- President, Communication Associates, Inc. (5/24/76)
Dean Ohtani	- Fisheries Technician, F&G (5/5-19/76)
Henry Okamoto	- Aquatic Biologist, F&G (5/5-19/76)
Eric W. Onizuka	- Aquatic Biologist, F&G (5/5-19/76)
Palmer C. Sekora	- Refuge Manager, U.S. Fish and Wildlife Service (5/10-15/76)
T. C. Yim	- Senator, Hawaii Legislature (5/5-19/76)

Submitted by Henry K. Sakuda for
Kenji Ego
Chief, Fisheries Branch
State of Hawaii Division
of Fish and Game

Heeny S. H. Yuen
Chief Scientist

Approved by Richard S. Shomura
Director, Honolulu Laboratory

Attachments

November 28, 1976

TABLE 1. Fishes, macro-invertebrates, algae and bottom substrates sampled (S) and/or observed (O) at the survey areas at Nihoa Island, French Frigate Shoals, Laysan Island and Necker Island during the Townsend Cromwell Cruise 71.

FISHES:

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
SHARKS	CARCARHINIDAE				
Shark	(Unidentified species)	S	O	S,O	O
Tiger shark	Galeocerdo cuvieri	-	O	S	-
RAYS	MYLIOBATIDAE				
Hihimanu	Aetobatus narinari	-	O	O	-
RAYS	MOBULIDAE				
Halalua	(Unidentified species)	O	-	-	-
LIZARDFISHES	SYNODONTIDAE				
'Ulae	Synodus variegatus	-	-	O	-
BAITFISHES	DUSSUMIERIIDAE				
Piha	Spratelloides delicatulus	-	O	O	-
SQUIRRELFISHES	HOLOCENTRIDAE				
'Ala'ihi	Adioryx spinifer (=Holocentrus spinifer)	-	O	-	-
'Ala'ihi	A. xantherythrus (=H. xantherythrus)	S	-	O	-
'Ala'ihi	Flammeo sammara (=H. sammara)	-	O	-	-
'U'u	Myripristis amaenus (=M. argyromus)	-	-	O	-
BARRACUDAS	SPHYRAENIDAE				
Kawalea	Sphyraena helleri	S	-	-	-
NEEDLEFISHES	BELONIDAE				
'Aha'aha	Strongylura gigantea	S, O	S, O	-	O
HALFBEAKS	HEMIRAMPHIDAE				
Iheihe	(Unidentified species)	-	O	-	-
THREADFINS	POLYNEMIDAE				
Moi	Polydactylus sexfilis	-	S, O	-	-

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
RED BIG EYE	PRIACANTHIDAE				
'Aweoweo	Priacenthus cruentatus	-	S, O	-	-
KUHLIIDS	KUHLIIDAE				
Aholehole	Kuhlia sandvicensis	O	S	S, O	O
MULLETS	MUGILIDAE				
Uouoa	Neomyxus chaptalii	-	S	S	-
'Ama'ama	Mugil cephalus	-	S	-	-
JACKS	CARANGIDAE				
'Opelu	Decapterus pinnulatus	-	S	-	-
Akule	Trachurops crumenophthalmus	-	S	-	-
White ulua	Carangoides ajax	-	S, O	S	-
Papa ulua	C. ferdau	S, O	S, O	O	-
'Omilu	Caranx melampygus	-	S, O	S, O	S
SNAPPERS	LUTJANIDAE				
Gurutsu	Aphareus furcatus	S	-	-	-
GOATFISHES	MULLIDAE				
Weke'a'a	Mulloidichthys samoensis	-	S, O	O	-
Malu	Parupeneus pleurostigma	-	O	O	-
Moano kea	P. chryserydros	-	-	O	-
Kumu	P. porphyreus	-	O	-	-
Moano	P. multifasciatus	O	S, O	O	-
RUDDERFISHES	KYPHOSIDAE				
Nenue	Kyphosus cinerascens	S, O	S, O	S, O	S, O
BUTTERFLYFISHES	CHAETODONTIDAE				
Blue striped butterflyfish	Chaetodon fremblii	-	O	O	-
Cross striped butterflyfish	C. auriga	-	O	-	-
Tear drop butterflyfish	C. unimaculatus	-	-	O	-
Orange striped butterflyfish	C. ornatissimus	O	-	-	-
Butterflyfish	C. miliaris	-	O	O	-

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
ANGEL FISHES	POMACANTHIDAE				
Black banded angelfish	Holacanthus arcuatus	O	-	-	-
DAMSELFISHES	POMACENTRIDAE				
Kupipi	Abudefduf sordidus	O	-	O	O
Maomao	A. abdomilais	-	O	S, O	-
Damselfish	A. imparipennis	O	-	-	-
Damselfish	Pomacentrus jenkinsi	O	O	O	-
Blue damselfish	Chromis ovalis	O	-	-	-
HAWKFISHES	CIRRHITIDAE				
Po'o-pa'a	Cirrhitus pinnulatus (=C. alternatus)	-	O	-	-
WRASSES	LABRIDAE				
'A'awa	Bodianus bilunulatus	S, O	S, O	S	-
Cleaner wrasse	Labroides phthirophagus	-	O	O	-
Po'ou	Cheilinus rhodochrous	S	S	-	-
Wrasse	Hemipteronotus taeniourus (=Novaculichthys taeniourus)	-	-	O	-
Lae-nihi	H. umbrilatus	-	-	O	-
Hinalea lau-wili	Thalassoma duperreyi	-	O	O	-
Hinalea luahine	T. ballieui	S, O	S, O	S, O	S, O
Wrasse	T. purpureum (=T. umbrostigma and T. fuscum)	S	O	S, O	O
Hinalea i'iwi	Gomphosus varius	-	O	O	-
Hilu	Coris flavovittata	O	O	O	-
'Omaka	Stethojulis balteata (=S. axillaris and S. albovittata)	-	O	O	-
Hinalea 'aki-lolo	Macropharyngodon goeffroyi	-	O	-	-
'Opule	Anampses cuvieri (=A. godefforyi)	-	-	O	-
PARROTFISHES	SCARIDAE				
Uhu	Calotomus spinidens (=C. sandvicensis)	-	O	-	-
Uhu	Scarus dubius	O	O	-	-
Uhu uliuli	S. perspicillatus	-	O	S, O	-
Uhu	S. sordidus	-	-	O	-

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
MOORISH IDOLS	ZANCLIDAE				
Kihikihi	Zanclus canescens	O	O	O	O
SURGEONFISHES	ACANTHURIDAE				
Manini	Acanthurus triostegus (=A. sandvicensis)	O	O	S, O	O
Surf maiko	A. guttatus	O	-	-	-
Maikoiko	A. leucopareius	O	O	O	-
Maiko	A. nigroris	O	O	S, O	-
Palani	A. dussumieri	O	-	-	-
Pualu	A. xanthopterus	O	-	-	-
Pualu	A. mata	O	O	-	-
Kole	Ctenochaetus strigosus	O	O	O	-
Lau'i-pala	Zebrasoma flavescens	O	-	O	-
Kala	Naso lituratus	O	-	O	-
Kala	N. unicornis	O	O	O	-
TRIGGERFISHES	BALISTIDAE				
Humuhumu-'ele'ele	Melichthys niger (=M. buniva)	S, O	O	-	-
Humuhumu-uli	M. vidua (=M. nycteris)	S, O	-	-	-
Humuhumu-umauma-lei	Sufflamen bursa (=Balistes bursa)	O	-	-	-
Humuhumu-mimi	S. frenatus (=Balistes capistratus)	S	-	-	-
SHARPBACKED PUFFERS	CANTHIGASTERIDAE				
Spotted puffer	Canthigaster jactator	-	O	O	-
BLENNIES	BLENNIDAE				
Pao'o	Istiblennis zebra	O	-	O	O
ELEOTRIDS	ELEOTRIDAE				
Eleotrid	(Unidentified species)	-	-	-	O
TUNA	SCOMBRIDAE				
Kawakawa	Euthynnus yaito	S	-	S	-

MACRO-INVERTEBRATES:

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
SPINY LOBSTER Ula	PANULIURIDAE Panalirus marginatus (=P. Japonicus)	-	O	-	-
ROCK CRAB 'A'ama	GRAPSIDAE Grapsus grapsus	O	-	O	S, O
GHOST CRAB 'O-hi-ki	OCYPODIDAE Ocypode ceratophthalma	-	O	O	-
SQUILLA 'Alo'alo	SQUILIIDAE Squilla oratoria	O	O	-	-
BRINE SHRIMP Brine shrimp	--- Artemia sp.	-	-	O	-
BARNACLES Barnicle	BALANIDAE Balanus sp.	-	-	O	-
GOOSE NECK BARNACLES Goose neck barnicle	LEPADIDAE Lepas sp.	-	O	O	-
COWRY Cowry	CYPRAEIDAE Cypraea spp.	-	-	-	S
SEA SNAILS Pipihi	NERITIDAE Nerita spp.	S, O	-	O	S, O
LIMPETS Opihi	PATELLIDAE Patella spp.	S, O	-	-	S, O
ROCK SHELLS Rock shell	MURICIDAE Purpura spp.	S, O	-	-	S, O
PERIWINKLES Periwinkle	LITTORINIDAE Littorina spp.	O	-	O	O
TURBINE SHELL Cat-eye shell	TURBINIDAE Turbo intercostalis	-	-	O	O

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
ROCK OYSTER Rock oyster	SPONDYLIDAE Spondulus hawaiiensis	-	O	O	-
SEA ANEMONIES	ANEMONIDAE (unidentified species)	O	-	O	O
SEA ANEMONIES	SAGARTIDAE (unidentified species)	O	-	O	O
CORAL Coral	POCILLOPORIDAE Pocillopora spp.	O	O	O	O
CORAL Coral	PORITIDAE Porites spp.	O	O	O	O
SEA URCHINS Wana Slate pencil urchin Ha'uke'uke	ECHINOMETRIDAE Echinometra sp. Heterocentrotus sp. Colobocentrotus sp.	O O S, O	O - -	O - -	O - S, O
SEA CUCUMBERS	HOLOTHURIDAE (unidentified species)	O	O	O	O

ALGAE AND BOTTOM SUBSTRATE:

Common Name	FAMILY NAME Scientific Name	Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
ALGAE	(Various families) (including following genera) Ulva sp. Laurencia sp. Caulerpa sp. Cnoospora sp. Sargassum sp. Asparagopsis sp. Enteromorpha sp.				
Sand	---				

TABLE 2. Top ten species of fishes observed during the underwater fish counting transects ranked in terms of largest estimated densities and number of individuals counted. The number of stations at which they occurred is also given.

Estimated Densities:

Rank	Common Name	Scientific Name	Density Pounds/ Acre	Occurrence (No. Stations)
1	Weke-'a'a	Mulloidichthys samoensis	1,969	3
2	Uhu uliuli	Scarus perspicillatus	1,948	3
3	White ulua	Carangoides ajax	1,022	1
4	Nenue	Kyphosus cinerascens	559	4
5	Kala	Naso unicornis	384	4
6	Manini	Acanthurus triostegus (=A. sandvicensis)	375	4
7	Hinalea	Thalassoma purpureum (=T. fuscum and T. umbrostigma)	152	3
8	'Omilu	Caranx melampygus	128	3
9	Hinalea luahine	Thalassoma ballieui	85	4
10	White banded maiko	Acanthurus leucopareius	81	4

Number of Individuals:

Rank	Common Name	Scientific Name	Density Number/ Acre	Occurrence (No. Stations)
1	Piha	Spratelloides delicatulus	50,000	2
2	Weke-'a'a	Mulloidichthys samoensis	1,006	3
3	Manini	Acanthurus triostegus (=A. sandvicensis)	239	4
4	Nenue	Kyphosus cinerascens	222	4
5	Uhu uliuli	Scarus perspicillatus	180	3
6	Kole	Ctenochaetus strigosus	108	4
7	Hinalea lau-wili	Thalassoma duperreyi	105	3
8	Blue damselfish	Chromis ovalis	100	1
9	Kala	Naso unicornis	98	4
10	'Omaka	Stethojulis balteata (=S. axillaris and S. albovittata)	75	2

TABLE 3. Wildlife (sea birds, terrestrial birds, mammals and reptiles) resources observed at Nihoa Island, French Frigate Shoals, Laysan Island and Necker Island during the Townsend Cromwell Cruise 71. Number of individuals per species are indicated as: "A" (abundant), "C" (common), "S" (scarce) and "N" (none).

SEA BIRDS:

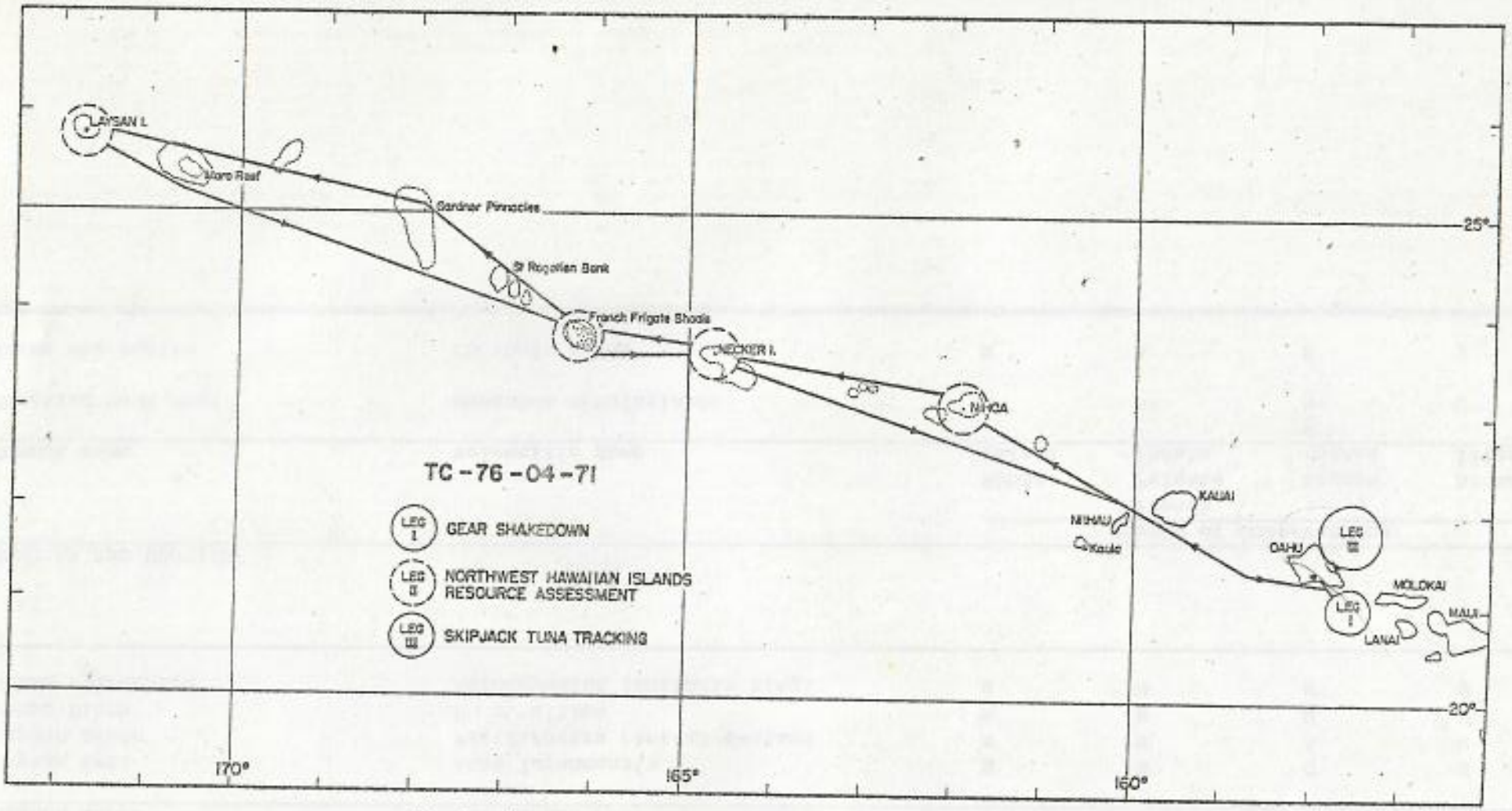
Common Name	Scientific Name	Status of Observations			
		Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
Laysan albatross	Diomedea immutabilis	N	A	A	C
Black-footed albatross	D. nigripes	N	A	C	C
Wedge-tailed shearwater	Puffinus pacificus chlororhynchus	A	A	A	C
Christmas Island shearwater	P. nativitatis	N	S	C	N
Bonin Island petrel	Pterodroma phaeopygia sandwichensis	N	N	S	N
Bulwer's petrel	Bulweria bulwerii	S	N	S	N
Sooty storm petrel	Oceanodroma tristrami	S	N	N	N
Red-tailed tropicbird	Phaethon rubricauda rothschildi	C	A	C	C
Masked booby	Sula dactylatra personata	S	A	C	C
Brown booby	S. leucogaster plotus	C	N	S	S
Red-footed booby	S. sula rubripres	A	A	C	C
Great frigate bird	Fregata minor palmerstoni	A	A	A	A
Golden plover	Pluvialis dominica fulva	N	N	S	N
Ruddy turnstone	Arenaria interpres	N	C	A	C
Wandering tattler	Heteroscelus incanum	N	N	S	S
Bristle-tighed curlew	Numenius tahitiensis	N	N	C	N
Sooty tern	Sterna fuscata oahuensis	C	A	A	A
Gray-backed tern	S. lunata	C	A	A	A
Common noddy tern	Anous stolidus pileatus	C	A	A	A
Hawaiian noddy tern	A. tenuirostris melanogenys	N	A	C	C
Blue-gray noddy tern	Procelsterna cerulea saxatilis	C	N	N	N
Fairy tern	Gygis alba	C	C	C	A

TERRESTRIAL BIRDS:

Common Name	Scientific Name	Status of Observations			
		Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
Laysan teal	Anas laysanensis	N	N	C	N
Laysan finch	Psittirostra cantans cantans	N	N	A	N
Nihoa finch	P. c. ultima	A	N	N	N
Nihoa millerbird	Acrocephalus familaris kingi	S	N	N	N

MAMMALS AND REPTILES:

Common Name	Scientific Name	Status of Observations			
		Nihoa Island	French Frigate Shoals	Laysan Island	Necker Island
Hawaiian monk seal	Monachus schuinslandi	S	A	A	C
Green sea turtle	Chelonia mydas	N	A	S	S



Track chart for Townsend Cromwell, Cruise 76-04-71

Tables for this cruise are available at the Honolulu Laboratory.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
Honolulu and La Jolla Laboratories
P. O. Box 3830
Honolulu, Hawaii 96812

CRUISE REPORT

VESSEL: Townsend Cromwell, cruise 77-02-75 (Part III)

CRUISE PERIOD: May 12-June 27, 1977

AREA OF OPERATION: Northwestern Hawaiian Islands and Hancock Seamount

ITINERARY:

May 12 - Loaded vessel, departed Kewalo Basin. Swung the magnetic compasses and returned to Kewalo Basin to disembark the compass technicians. Departed immediately for Waianae.

May 13 - Made shakedown and diver check of the new Noreastern bottom trawl, in about 20 fathoms, off the Dillingham Field area. Returned to Kewalo Basin.

May 14-15 - Departed Kewalo Basin and headed for Necker Island. Ran environmental stations en route.

May 16-17 - Trapped, handlined, and ran environmental stations around Necker Island.

May 18-19 - Trapped and trawled on Raita Bank.

May 19-22 - Trapped and trawled around Maro Reef.

May 22-23 - Trapped at Laysan Island. Dan and Patty Johnson (Marine Mammal Commission researchers) came aboard for a visit.

May 23-25 - En route to Hancock Seamount.

May 25-26 - Trawled and handlined at SE Hancock Seamount.

May 26-30 - Trapped, trawled, and ran environmental stations around Kure Island.

May 30-31 - Ran environmental stations en route to Midway Islands.

May 31 - Arrived Midway Islands; Robert Moffitt and two University of Hawaii MOP (Marine Options Program) students, Douglas Davis and Jayne Fitzgerald, joined the scientific field party.

June 2 - Departed Midway Islands.

June 2-6 - Trapped, trawled, handlined and ran environmental stations around Midway Islands.

June 7-9 - Trapped, trawled, handlined, and ran environmental stations around Pearl and Hermes Reef.

June 10-11 - Trapped, trawled, and handlined on Salmon Bank.

June 12-14 - Trapped, trawled, handlined, and ran environmental stations around Lisianski Island.

June 14 - Handlined on Pioneer Bank.

June 15-18 - Trapped, trawled, handlined, and ran environmental stations around Laysan Island. Dan and Patty Johnson visited ship.

June 19-23 - Trapped (including trap competition experiment and ghost fishing experiments), trawled, and handlined around Maro Reef.

June 23-27 - En route to Honolulu; ran environmental stations off Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa.

June 27 - Arrived Kewalo Basin (end of Part III).

MISSIONS AND RESULTS: The objectives of this part of the cruise were to:

A. Conduct bottom trawling, lobster trapping, and handline fishing to determine availability and relative abundance of demersal fish and crustaceans at islands and banks of the Northwestern Hawaiian Islands from Raita Bank to Kure Island and over Hancock Seamount.

Surveys and some fishing were conducted at all the planned target areas with the exception of Northampton Banks. In addition, a trap competition experiment was conducted at Necker Island.

1. Bottom trawling

A total of 31 trawl stations of 30 min fishing time on the bottom were conducted. Of these, eight successful trawls were made with the Noreastern net before it hooked up on the bottom and was lost at Kure Island. The remainder of the trawls were made with the Norwegian net. Nine hauls were made at Maro Reef, eight at Laysan Island, five at Pearl and Hermes Reef, three at Lisianski Island, two each at Hancock Seamount and Kure Island, and one each at Raita and Salmon Banks.

A good deal of time was spent searching for suitable trawling grounds. Generally speaking, in depths beyond the upper bank, the bottom, in most of the areas surveyed, was found to be too rough and precipitous for trawling. In fact, during this cruise the lack of suitable trawling grounds was the limiting factor on the number of trawl stations, not lack of time.

Catches of particular interest were: 144.5 kg (318 lb) of ulua, Caranx cheilio, taken in 64 m (35 fathoms) off Pearl and Hermes Reef and 91.4 kg (201 lb) of "red tail" opelu, Decapterus russelli, taken in 340.4 m (186 fathoms) off Laysan Island.

At Hancock Seamount, 20 kg (44 lb) of pelagic armorhead, Pentaceros richardsoni, were taken in 264-311 m (144-170 fathoms). In the same trawl, 134 individuals weighing 29 kg (64 lb) of an unidentified nomeid were also taken.

The catches usually consisted of a relatively narrow range of the more common shallow- and medium-depth reef fishes. Usually no single species was particularly numerous in a catch. Exceptions to this generalization were: 1,073 puffers, Lagocephalus hypselogeneion, weighing 117 kg (257 lb) and caught in 110 m (60 fathoms) at Maro

Reef, 93 kg (204 lb) of the same species caught in 110 m off Kure Island, and a total of 562 filefish, Pseudomonocanthus gerretti weighing 33 kg (72 lb) caught on three trawl stations at Maro Reef in 110-181 m (60-90 fathoms). Squat lobster, Scyllarides squammosus, and spiny lobster, Panulirus marginatus, were frequently caught in small quantities; the latter only on night trawls.

2. Trapping

Varying amounts of trapping effort were expended along the chain, including sets at Necker Island, Rafta Bank, Maro Reef, Laysan Island, Lisianski Island, Salmon Bank, Pearl and Hermes Reef, Midway and Kure Islands. A total of 49 trap sets were made. A set consisted of either 4, 6, 12, or 15 strings of traps. Most of the sets during the cruise were made up of six strings (stations) and most strings consisted of either four modified Hawaiian type fish traps or eight California lobster pots. All sets consisted of a string of eight lobster pots alternated with a string of four fish traps. The only exceptions were the trap competition sets made at Necker Island and Maro Reef. A total of 1,112 trap-nights with lobster pots and 548 trap-nights with fish traps were expended during the cruise. Traps were baited with mackerel, Scomberomorus maculatus, and set between 1800 and 1930. They were picked up the following morning between 0800 and 1200. A total of 2,851 spiny lobsters weighing 2,418 kg (5,320 lb), and 657 squat lobsters, Scyllarides squammosus and Scyllarides sp. weighing 353 kg (777 lb) were taken. Of these, 1,327 spiny lobsters and 397 squat lobsters were caught in the fish traps and 1,524 spiny lobsters and 260 squat lobsters in the lobster pots.

Catches in most of the areas fished were small. Sets made at Maro Reef, Laysan and Midway Islands produced the best catches. The largest catch was 428 lobsters caught at Maro Reef in 30-35 m (16-19 fathoms). The set consisted of 48 lobster pots and 24 fish traps. The smallest catch (one lobster) was in a set of 24 lobster pots and 12 fish traps

in 15-26 m (8-14 fathoms) at Lisianski Island. Most of the spiny lobsters taken during this cruise were well over the minimum legal weight of 0.45 kg (1 lb). The average weight of spiny lobsters caught in the lobster pots was 0.88 kg (1.9 lb) and for the fish traps, 0.81 kg (1.8 lb). Individuals frequently weighed over 1.4 kg (3 lb). All lobsters taken were measured and sexed, and a total of 1,470 spiny lobsters were tagged and released.

Other species commonly trapped included moray eels of several species, conger eel, sea bass, Epinephelus quernus, wrasse, Bodianus bilunulatus, and goatfish, Parupeneus sp. However, with the exception of moray eels, the fish catch was remarkably small.

3. Handlining

Seventeen handline stations (two lines fishing with four hooks each) were made along the island chain, hooking mostly hapuupuu, E. quernus, kahala, Seriola dumerilii, ulua, Carangidae, and ehu, Etelis marshi.

The three largest single station catches were made at: Pioneer Bank where the catch consisting primarily of hapuupuu, ehu, kahala, and ulua was taken in 183-220 m (100-120 fathoms) and weighed 129 kg (283 lb); Pearl and Hermes Reef, hapuupuu and ehu taken in 165-320 m (90-175 fathoms) weighed 62 kg (136 lb), and Midway Islands, 13 hapuupuu and 1 ehu in 156 m (85 fathoms) weighed 63 kg (143 lb).

On SE Hancock Seamount, six pelagic armorhead, one alfonsin, Beryx splendens, two unidentified rudderfish, and three dogfish, Squalus fernandinus, were caught in 256-659 m (140-360 fathoms).

B. Collect plankton and forage organisms with plankton nets and midwater trawls.

A total of 47 (24 day and 23 night) oblique plankton hauls to an estimated depth of either 100 or 200 m

were made at prescribed environmental monitoring stations located off Nihoa, Necker Island, French Frigate Shoals, Garnder Pinnacles, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway and Kure Islands.

Because it was impractical to handle both bottom and midwater trawl gear, a pre-cruise decision was made to eliminate midwater trawling from this part of the cruise.

C. Collect date on oceanographic conditions with CTD and XBT casts.

A CTD cast to 1,000 m was made at 20 of the 21 offshore (200 m) oblique plankton stations. At Station No. 382, 25 miles east of French Frigate Shoals, the CTD probe became inoperative so the cast was aborted.

Ninety-three XBT casts were made, including 1 at every trawl and plankton station.

D. Conduct trolling to determine availability and relative abundance of pelagic fishes.

A total of 7.3 h of trolling at troll speeds were conducted on 7 days. The catch included 15 skipjack tuna, Katsuwonus pelamis, weighing 31 kg (68 lb), 27 yellowfin tuna, Thunnus albacares, 131 kg (269 lb), 18 kawakawa, Euthynnus affinis, 75 kg (165 lb), and 1 rainbow runner, Elagatis bipinnulatus, 2.5 kg (5.5 lb). No incidental trolling at cruise speed was conducted.

E. Conduct experiments to determine retention of lobster in unbaited traps.

At Maro Reef two so-called "ghost fishing" experiments were conducted.

F. Conduct experimental fishing with bottom longline and octopus pots as schedule permits.

Schedule not permitting, neither of the above experimental fishing techniques were tried.

G. Conduct gear competition experiments.

A single experiment was conducted at Necker Island. Four strings each of eight lobster pots were set in about 55 m (30 fathoms). In each of the four strings, the pots were attached at a different distance from one another. The intervals used were: 9.1 m (5 fathoms), 18.3 m (10 fathoms), 27.5 m (15 fathoms), and 36.6 m (20 fathoms).

At Maro Reef two experiments were conducted to compare the fishing efficiency of four-pot strings of lobster pots with eight-pot strings (all pots at 9.1 m intervals).

H. Miscellaneous observations and activities.

1. A total of 50 bird flocks was sighted. Six flocks were associated with skipjack tuna schools, one with a yellowfin tuna school, and nine were with unidentified schools.

   Nine herds of porpoise were seen, two of these were identified as bottlenose, Tursiops truncatus. Off Laysan Island single monk seals, Monachus schaunislandi, were seen swimming near the ship twice, and monk seals were also observed on the beaches at Laysan Island and Pearl and Hermes Reef. No counts were made of animals on shore.

2. Fish and invertebrate samples were either preserved in Formalin or frozen for identification, stomach analysis, or otolith studies.

3. Salinity samples and surface temperature readings were taken with each XBT cast.

4. The surface thermosalinograph was run continuously.

5. Fathometer traces of the bottom were kept for the bottom trawl stations.

6. Standard weather observations were made at 0000, 0600, 1200, and 1800 G.m.t. by the ship's officers.

7. The Marine Operations Log, Deck Log, and Dead Reckoning Abstracts were kept and chart overlays of all stations were made by the ship's officers.

SCIENTIFIC PERSONNEL: Reginald M. Gooding, Chief Scientist
Glenn R. Higashi, Research Assistant
Robert B. Moffitt, Research Assistant (May 31-June 27)
John J. Naughton, Fishery Biologist (May 12-13)
Martina K. K. Queenth, Research Assistant
Paul M. Shiota, Research Assistant
Darryl T. Tagami, Research Assistant

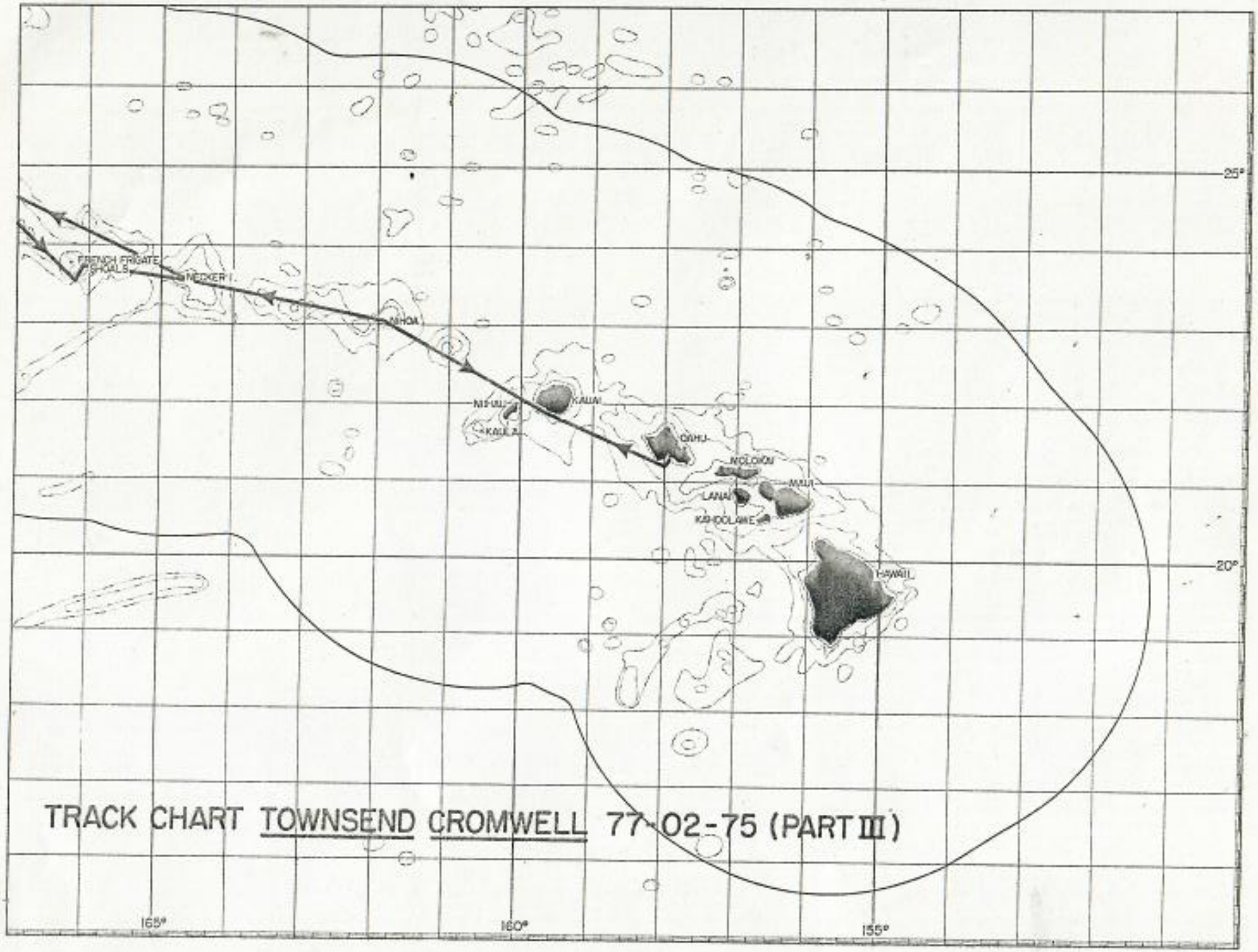
Douglas T. Davis, Cooperating Scientist, MOP, University of Hawaii
Jayne L. Fitzgerald, Cooperating Scientist, MOP, University of Hawaii

Submitted by
Reginald M. Gooding
Chief Scientist, Part III

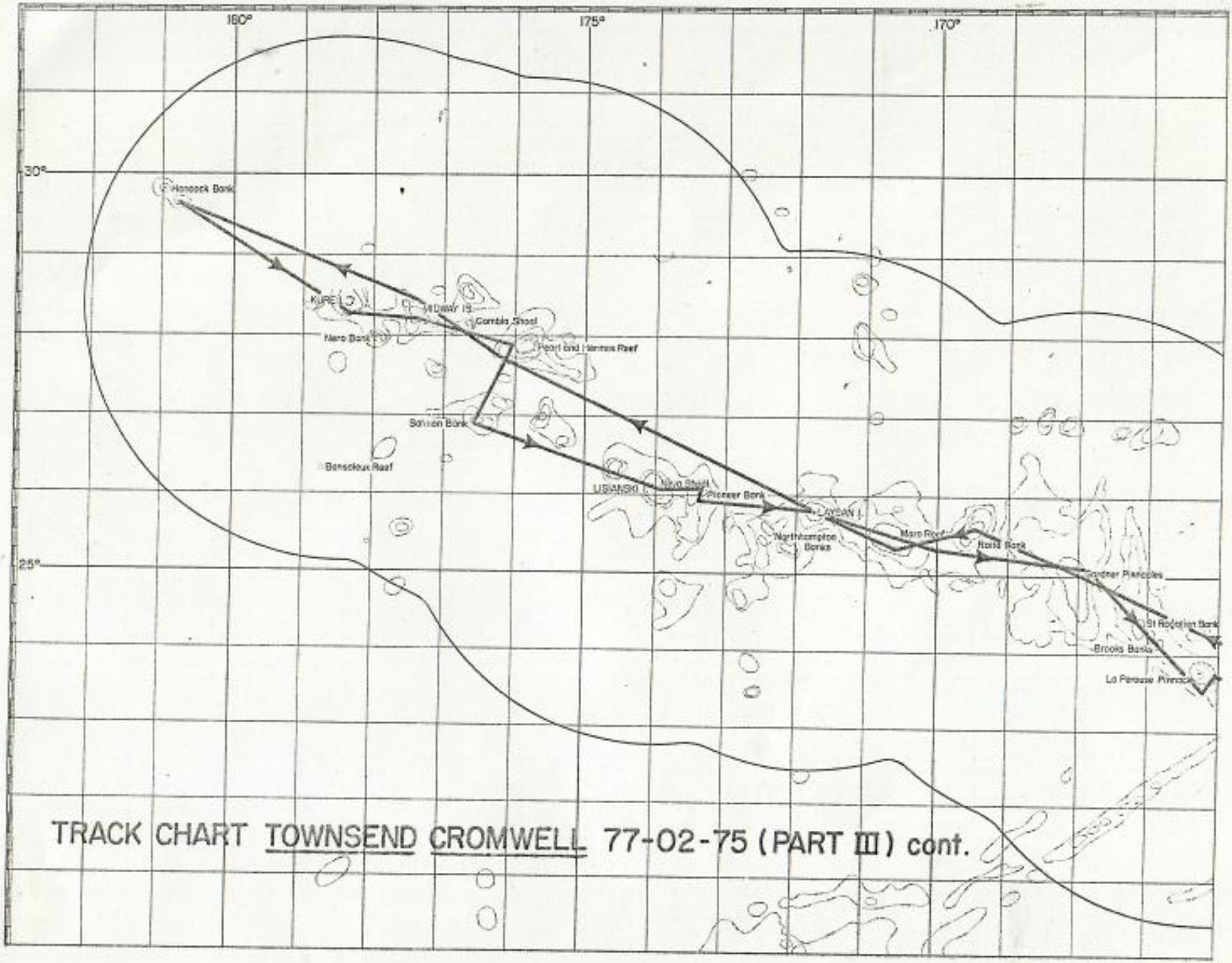
Approved by
Richard S. Shomura
Director
Honolulu Laboratory

Attachment: Track chart

July 28, 1977



TRACK CHART TOWNSEND CROMWELL 77-02-75 (PART III)



TRACK CHART TOWNSEND CROMWELL 77-02-75 (PART III) cont.