

COOPERATIVE NORTHWESTERN HAWAIIAN ISLANDS
RESOURCE ASSESSMENT PROGRAM

November 1, 1976

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INTRODUCTION

The Northwestern Hawaiian Islands (NWHI), often referred to as the "Leeward Islands," stretch for over a thousand miles north-westward beyond the island of Kauai in the major Hawaiian group. The tiny islands and atolls composing this chain have been worn down to vestiges of their former estate and support only a limited assortment of land animals and plants. The flora is similar to that of a tropical beach with virtually all the plants near the shore with but a few exceptions. Crowding these islands are a rich assortment of marine and shore birds.

There is a great urgency to know a great deal more about the marine resources of these NWHI. The State of Hawaii, pressed with growing demands for assessment and rational utilization of its marine resources, recognizes the vital importance of the sea to its economic growth and has fostered a program of harvesting the marine resources of the waters surrounding the entire Hawaiian chain (Hawaii and the Sea, published by the State of Hawaii, Department of Planning and Economic Development, 1969, 1974).

The NWHI, with the exception of a few islands near the southeastern end of the chain, are virtually untouched by commercial fishing. It would be highly desirable, from the point of view of population dynamics, to investigate an area such as the NWHI where relatively virgin conditions exist. The study would allow a determination of the status of the stock before the effects of fishing mortality sets in. And Honolulu's proximity to the NWHI is advantageous to an intensive investigation at minimal costs.

Another important consideration in undertaking a study of the NWHI is the interrelationship between the marine environment in that area and their inhabitants. Designated a National Wildlife Refuge in 1909, the NWHI, except Midway, is a sanctuary for numerous species of seabirds, Hawaiian monk seals, and sea turtles. However, the boundary of the refuge is a source of attrition between the State of Hawaii, who represents potential user groups and the U.S. Department of the Interior's Fish and Wildlife Service (FWS), who administers the refuge. A study of the marine species utilized as food by the refuge inhabitants should help to obviate the conflict.

Additionally, with the advent of the Fishery Conservation and Management Act of 1976, which prescribed a 200-mile coastal jurisdiction, it becomes imperative that the character of the waters surrounding the NWHI and the extent of the marine resources be fully investigated. Not only will information be required for negotiations with foreign countries, but also for those U.S. fishers who may be looking for new fishing grounds as a result of being displaced from traditional grounds in foreign waters.

The extent of the research proposed is beyond the present capabilities of the staff and facilities of any research agency in Hawaii. Therefore, the National Marine Fisheries Service (NMFS), Southwest Fisheries Center, Honolulu Laboratory, has proposed a cooperative research effort with the State of Hawaii's Division of Fish and Game (HDFG), University of Hawaii Sea Grant, and the FWS. The study will encompass assessment of the terrestrial, nearshore, slope, seamounts, and pelagic resources of the NWHI and the interaction and interrelationship of the various resources as it relates to competition for food and habitat.

OVERVIEW OF PROPOSED PROGRAM

A broad program of research to study the terrestrial and marine resources of the NWHI could be structured into the following categories:

1. Nearshore
2. Inner and outer shelves, shelf edge, and upper slope
3. Pelagic
4. Seamounts and offshore banks
5. Hawaiian monk seals and marine turtles
6. Marine birds
7. Interaction and interrelationship of the various resources listed above

The Honolulu Laboratory proposed exploratory fishing surveys of the NWHI over a 5-year period beginning with cruise TC-76-06-73 of the NOAA ship Townsend Cromwell (FRS-43) beginning October 12, 1976. A preliminary proposal of the types of information needed to assess the marine community is as follows:

1. Bottom topography of the areas surrounding the NWHI.
2. Distribution and relative abundance of demersal fish and shellfish on the inner and outer shelves, shelf edge, and upper slope.
3. Distribution and relative abundance of fishes found on seamounts and offshore banks.
4. Species composition, distribution and density of planktonic and macroorganisms including fish, crustaceans, mollusks, corals, and algae.
5. Physical and chemical parameters of the waters surrounding the various islands and seamounts.
6. Distribution and relative abundance of the pelagic fishes with emphasis on tuna and tunalike species.
7. Food, feeding habits, distribution and abundance of marine birds, seals, and green sea turtles.

The Honolulu Laboratory will focus attention on a quantitative fishery assessment and survey of the inner and outer shelves, shelf edge, and upper slope zones, the pelagic zone with emphasis on tuna and tunalike fishes, and resources over submerged seamounts and offshore banks. A basic inventory of the physical and biological characteristics of the waters overlying these zones will also be undertaken.

Study and assessment of the land-associated resources will be the basic responsibility of the FWS. Their investigation will include determination of the magnitude of the marine bird resource in the sanctuary, the energy dynamics of marine birds, and the food and feeding habits of marine birds. The Northwest Fisheries Center in Seattle will undertake life history studies of the Hawaiian monk seal. Studies on the distribution, abundance, feeding habits, and behavior of the green sea turtles will be carried out by the Hawaii Institute of Marine Biology, University of Hawaii (HIMB).

Participation of the HDFG will be directed to the study and assessment of fishery resources of the nearshore zone, which extends from the shoreline, including the splash zone, seaward to a depth of about 20 m.

SAMPLING GEAR

The resource assessment surveys do not constitute a program in gear design; rather, the primary objective of these surveys will be the determination of distribution and relative abundance patterns and to approximate the magnitude of the exploitable stock. It is anticipated, however, that problems in gear design can be considered during subsequent stages of development of a fishery.

For demersal species, the primary gear considered will be fish trawls, traps, pots, and handlines; for pelagic species, such as tunas and tunalike fishes, pole-and-line fishing with live bait and troll gear appear to be the most appropriate sampling gears.

In addition to the gears used to accomplish our primary objectives, other sampling devices will be used to collect data for environmental studies. Acoustic gear will be used to obtain better estimates of the bottom configuration, grab samplers to determine ocean bottom types, midwater trawl, and plankton hauls for micronekton and zooplankton studies, and STD and XBT casts to determine changes within the physical parameters.

DISTRIBUTION OF SAMPLING ACTIVITIES

At present, little is known about the bottom topography of the area; therefore, it is highly desirable to determine initially, the stratum boundaries during the early surveys to select the character that would be most useful for stratifying the sampling activities. Stratification could also be done according to depth ranges, for example, inner shelf (10-20 fathoms or 18-36 m), outer shelf (20-25 fathoms or 36-45 m), shelf edge (25-50 fathoms or 45-90 m), top of the upper slope (50-100 fathoms or 90-180 m), middle of the upper slope (100-150 fathoms or 180-270 m), and bottom of the upper slope (150-200 fathoms or 270-360 m). A diagrammatic sketch is shown in Figure 1.

Fig. 1

Exploratory trawling surveys will be conducted to determine the locations of trawlable grounds. A previous exploratory cruise to the NWHI (cruise 80 of the RV David Starr Jordan) has shown that the 20-600 m depth zones hold the most promise for fishery development. Grab samplers will be used to obtain small samples from the surface layer of the ocean bottom at selected study areas. Ocean bottom types will be categorized as follows: (1) sand, (2) silt, (3) rubble, (4) boulder, (5) live coral, (6) bedrock, (7) sandstone flats, (8) dead coral flats, and (9) others.

Not only the shelf and upper slope area but also the submerged offshore banks and seamounts will be investigated. Larger banks will undoubtedly receive more sampling effort and seamounts will be subjected to briefer surveys.

As more information is gathered on the locations of trawlable grounds, the surveys will be designed so that both random and systematic sampling of known fish concentrations will be conducted day and night. For example, the stock of Naso spp. (Acanthuridae) has been found to be rather substantial during cruise 67 of the RV Townsend Cromwell in the 22-54 m (18-30 fathom) depth range near Nihoa Island. Known concentrations of Naso spp. will be sampled systematically and other areas will be trawled randomly to determine the extent of their distribution and abundance.

Other aspects of the assessment surveys would require the use of traps, pots, and handline gear. From the results of preliminary fishing with these gears, study sites for more intensive sampling will be selected and sampling stations within each study site will be established.

NMFS SAMPLING PROGRAM

DEMERSAL SPECIES

Species groups that are more likely to be encountered and which are of interest to NMFS are as follows: Serranidae (Epinephalus), 1 sp.; Carangidae (Seriola, Carangoides, Caranx), 9 spp.; Lutjanidae (Pristipomoides, Lutjanus, Aprion, Etelis), 6 spp.; and Mullidae (Mulloidichthys, Parupeneus), 6 spp. Fish families of lesser interest are the Holocentridae, Priacanthidae, Cirrhitidae, Pomacentridae, Labridae, Acanthuridae, Pentacerotidae, and Scorpaenidae--about 22 spp.

Crustaceans of interest are shrimp (Heterocarpus, Penaeus), 3 spp.; kona crab (Ranina serrata); lobster (Panulirus) 2 spp.; and white crab (Portunus sanguinolentus).

Specific objectives would be to determine the following:

1. The structure of the fish communities present on the inner and outer shelves, shelf edge, and upper slope zones.
2. Their distribution in time and space.
3. The relative abundance of the exploitable stock of each species present.
4. The yield potential of each species.
5. The feasibility of commercial exploitation of the various species stock.

Sampling for demersal fishes will be carried on in depths ranging from 20 to 400 m, with stratification of the potential fishing grounds into six strata as shown in Figure 1. Fish trawls, traps, and handlines, the principal gears to be used, will be standardized after initial tests have been completed. Preliminary surveys will be conducted with a high-opening, roller-rigged Norwegian fish trawl, with gear modification carried out as necessary. Standard fish traps and traditional handlines will also be used in the surveys.

The exploitation of two demersal fish species--the pelagic armorhead, Pentaceros richardsoni, and alfonsin, Beryx splendens--on the seamounts and offshore banks near the NWHI are now exploited by Japanese and Russian trawlers. Unconfirmed reports indicate that for the armorhead, at least, Russian trawlers harvested about 133,400 MT (metric tons) during an 8-month period in 1969-70. The bulk of the Japanese and Russian catches of armorhead, however, occur outside the U.S. fishery conservation and management zone. Inside the zone, on Hancock seamount, foreign catches of armorhead are unknown. Trawling surveys of seamounts and banks will be conducted to obtain estimates of the exploitable stock.

Occurring in quantities apparently sufficient to support a fishery, two species of shrimp, Heterocarpus spp., have been caught in exploratory deepwater shrimp trapping surveys in Hawaiian waters. In 1973, preliminary surveys showed that Heterocarpus spp. also occur in modest quantities near Necker Island and French Frigate Shoals in the NWHI. Additional shrimp trapping surveys will be necessary in selected areas to determine depth-abundance curves, optimum fishing strategy, and standing biomass.

Also found near French Frigate Shoals were small quantities of the penaeid shrimp, Penaeus marginatus. Additional exploratory surveys with the shrimp trawl will be necessary to determine the locations of commercial concentrations and estimate their distribution and standing biomass.

Other crustaceans of interest for possible exploitation are the spiny lobster, kona crab, and white crab. Trapping operations will be conducted for these species along with fish-trapping surveys. These species, however, will receive less sampling effort if preliminary results indicate that the stocks are too small for commercial exploitation.

BENTHOPELAGIC SPECIES

Benthopelagic species, those that occur both on or near the bottom and in midwater or surface layers, may be present in sizable quantities as results of a preliminary acoustic survey in the summer of 1973 indicated. Schools of unidentified fish, detected on top of the banks and estimated to be at depths of 10-30 m and extending nearly 11 km in one direction, were near the bottom during daylight hours but were observed to move off the bottom and disperse in midwater at night. The high-opening bottom fish trawl will be used in attempts to sample and identify these schools.

At night-light stations, handlines will be used to sample for the presence of the commercially important akule, Trachurops crumenophthalmus, and opelu, Decapterus pinnulatus. Also, observations will be made near islands and atolls to determine whether night light can be used effectively to attract baitfish in any appreciable quantities. Previous NMFS surveys, which date back to the early 1950's, showed that baitfish are present in small quantities near the shorelines of several islands and atolls; however, their occurrence appears to be sporadic.

PELAGIC SPECIES

In recent years, the NWHI has also received increasing attention from foreign tuna pole-and-line and longline fishing vessels. In the summer of 1974, for example, Japanese pole-and-line vessels reportedly caught 1,350 MT of skipjack and yellowfin tunas from waters near the NWHI. In addition to skipjack tuna, Katsuwonus pelamis, and yellowfin tuna, Thunnus albacares, data collected on previous NMFS research cruises to the North Pacific have shown that in the general vicinity of the NWHI, a number of other tuna and tunalike fishes are present. Among them are bigeye tuna, Thunnus obesus, albacore, T. alalunga, wahoo, Acanthocybium solandri, kawakawa, Euthynnus affinis, bonito, Sarda sp., and mackerel, Scomber sp. Some species of tuna and tunalike fishes apparently are sufficiently abundant seasonally in waters of the NWHI so that they can form the base of a troll fishery which could be conducted in conjunction with bottom fishing.

To assess the pelagic resource, survey vessels will troll during all daylight hours between stations. Furthermore, it is anticipated that commercial fishing boats will be chartered to fish the study area with pole-and-line and troll gear to assess the relative abundance of the various pelagic species in space and time.

SUPPLEMENTARY RESEARCH

It is anticipated that primary aggregation studies conducted in June-September 1976 on cruise 76-05-72 of the RV Townsend Cromwell in Trust Territory waters will be continued not only in the main group of the Hawaiian Islands but also in waters of the NWHI. Anchored floating objects will be placed over various offshore banks, as time permits, during the survey cruises in attempts to concentrate schools of pelagic fishes. Observations on species and numbers aggregated by the floating objects will be made daily while the survey vessel is nearby and examined during the time that the vessel passes through the area to and from port.

Among the most useful characteristics for age and growth determination of fish--at least for fishes of the temperate zone--are the annuli on bony parts such as scales, otoliths, spines, and opercular bones. Attempts to age tropical fishes by examining hard parts and by other conventional means such as length-frequency mode progression analyses have failed because of the absence of well-defined annuli and the presence of protracted spawning periods in some species. In recent years, however, researchers have successfully aged tropical species by examination of daily growth increments in the sagittae of otoliths. Samples of otoliths collected from fishes captured during the survey of the NWHI will be examined by a specially trained team conducting age and growth studies at the Honolulu Laboratory.

COOPERATIVE RESEARCH

Extensive observations of various environmental parameters and collection of a variety of fishes, invertebrates, fish eggs and larvae, and micronekton by plankton hauls and midwater trawls will provide physical data and biological samples which could be examined by cooperating investigators. Although critical examination of some of these biological samples and environmental data may not be done immediately, the opportunity to commence their collection in such a poorly known region should not be ignored.

The nearshore and lagoon areas will be the primary responsibility of the HDFG. The nearshore area includes (1) the splash zone or the land area exposed to spray and under the influence of waves, (2) the inner nearshore zone from the shoreline to a distance of about 6 m seaward, and (3) the outer nearshore zone extending from the outer boundary of the inner nearshore zone to a depth of about 20 m. The inventory of the marine fauna in these areas will be accomplished by conducting fish survey transects with scuba divers. Islands and atolls that would come under investigation include Nihoa, Necker, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan, Lisianski, Pearl and Hermes Reef, and Kure Island. It is anticipated that the HDFG will provide assistance in evaluating the results of each cruise.

Another research proposal is a study of the structure of nearshore reef communities. Preliminary surveys by the HDFG (cruise 76-04-71 of the RV Townsend Cromwell) have indicated that some fish species common to waters of the major Hawaiian group appear to be virtually absent from waters surrounding the NWHI. From an ecological point of view, it would be highly desirable to determine if there is an actual break in the distribution of major species or groups. Cooperating in this project will be the Southwest Fisheries Center's Tiburon Laboratory. Biologists of the Tiburon Laboratory will conduct an ecological study of the nearshore fish community and note changes of species complex throughout the entire Hawaiian chain.

Responsibilities for survey and assessment of land-associated resources lie with the FWS. Their studies will include the determination of a base line magnitude of the marine bird resource in the wildlife refuge, the energy dynamics of marine birds, an inventory of the food consumed, location of major feeding areas, and rate of food consumption. An important part of their research will center on an assessment of the potential effects of commercial and sport fishing upon marine birds. In addition to these studies, the HIMB contemplates a census of adult green sea turtles and studies on their distribution and abundance, daily activities, and types of food consumed.

The FWS Mammal Research Unit in Anchorage, Alaska, also plan to undertake studies of the Hawaiian monk seal in cooperation with personnel of the NMFS, Northwest Fisheries Center, Seattle. Surveys will be made to estimate their abundance, rate of mortality, age composition, sex ratio, food and feeding habits, female recruitment, and tolerance to human disturbance. The effects of proposed fishery harvest within waters of the NWHI will also be evaluated.

The possibility that ciguatera toxin may occur in some species found in the NWHI is most important to the successful marketing of those species. The flesh of a number of fishes is toxic to man. Some are always toxic whereas others may be consumed safely most of the time but suddenly cause grave illness or even death at other times. Poisonous fishes frequently occur among reef dwellers. More than 300 kinds of fishes have been incriminated in ciguatera-type fish poisoning, a poison which affects mostly the nervous reaction with a reversal of hot and cold sensations being common in severe cases. It is anticipated that some species, before they can be market tested, will need to be evaluated for ciguatera toxin.

APPLICATION OF POTENTIAL ACCOMPLISHMENTS

The accumulation of data, their analyses, and final dissemination of the results will greatly increase not only our knowledge of the fishery resources of the NWHI but also our understanding of the refuge inhabitants and their interaction with the marine resources. The

information generated on distributional range, migrations, and seasonal changes in distribution, yield, and age composition will be essential for establishing the policies needed for successful management.

Hopefully, the knowledge and understanding gained on the structure and function of insular ecosystems will be useful in assessment of insular resources elsewhere in the Pacific.

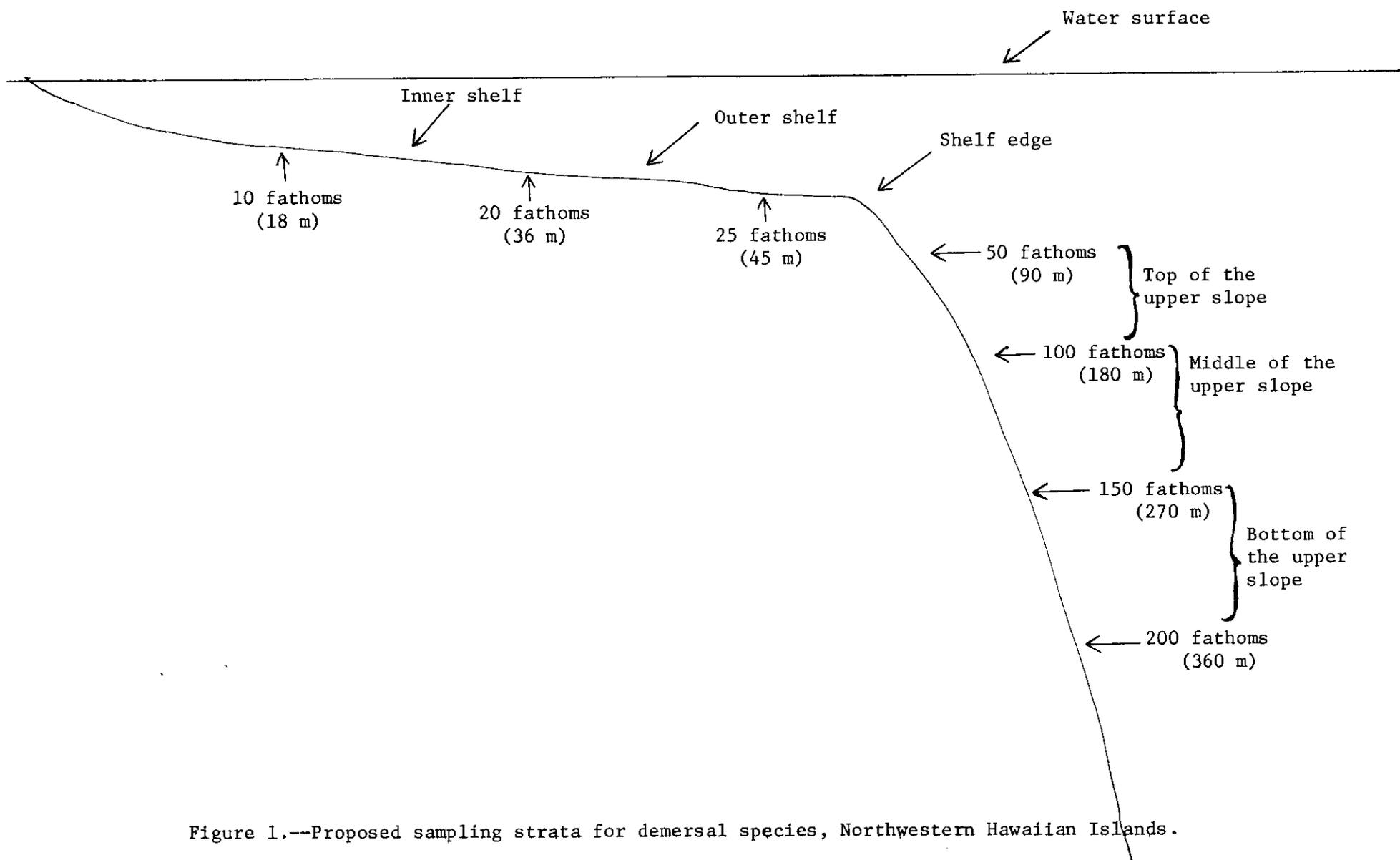
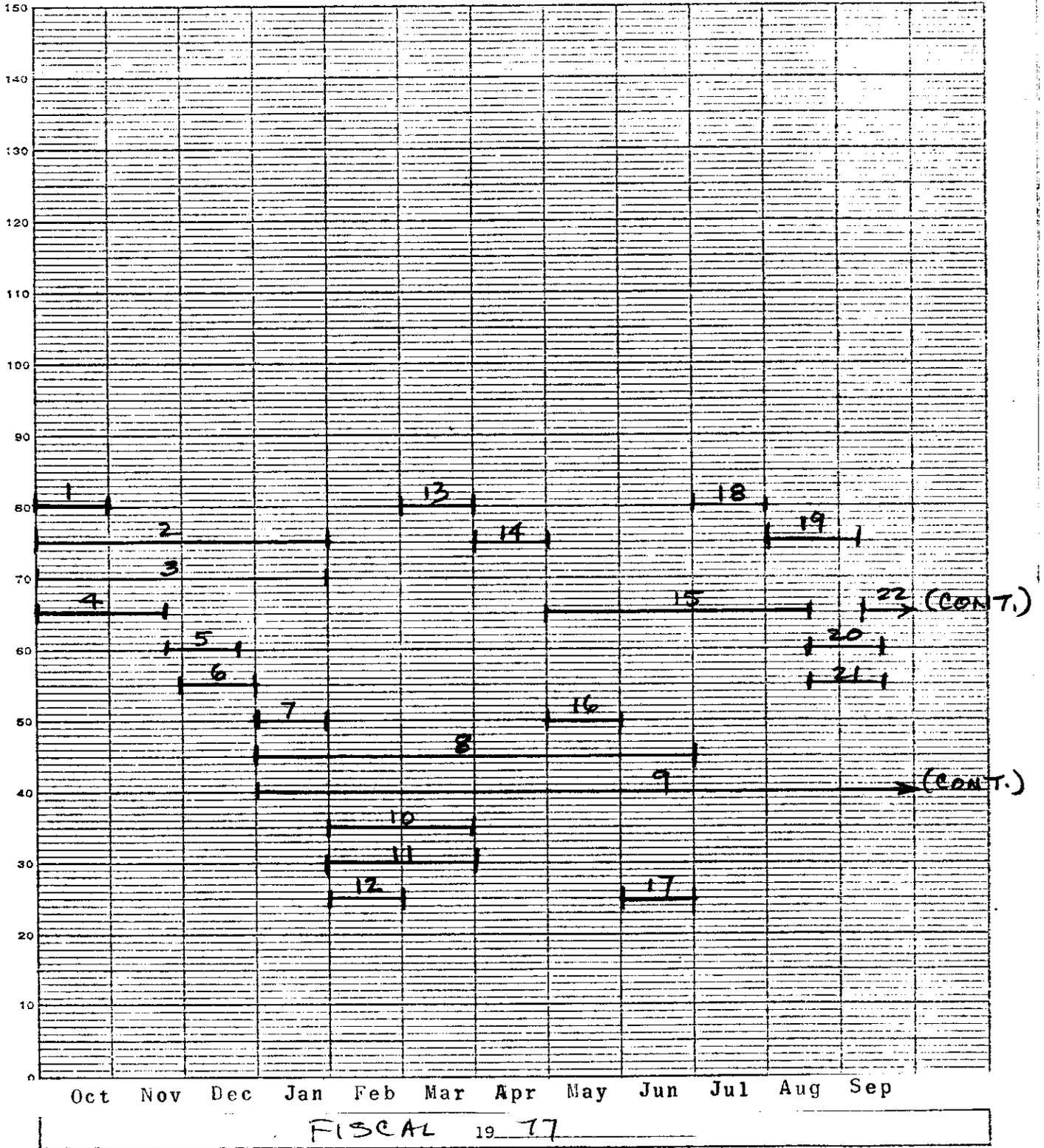


Figure 1.--Proposed sampling strata for demersal species, Northwestern Hawaiian Islands.



Explanation of PERT chart

1. Finalize program proposal.
2. Preparation of background document of the Northwestern Hawaiian Islands.
3. Preparation of field procedures manual and log forms for field use.
4. Cruise TC-76-06-73. At end of cruise, turn in completed Cruise Report and Press Release.
5. Preparation of Narrative Report for cruise TC-76-06-73, hold post-cruise meeting.
6. Repair all scientific gear and fishing equipment used on cruise TC-76-06-73.
7. Precruise planning for cruise TC-77-03-76, determine cruise strategy, circulate preliminary cruise instructions 90 days prior to start of cruise, accumulate supplies, order gear as necessary.
8. Establish data base management system.
9. Analyses of field data including catches from bottom fish trawl, trolling, plankton and midwater trawls, fish traps, lobster pots, and handline; sample of otoliths collected for aging of tropical fishes; and oceanographic and topographic data. Results to be prepared for publication.
10. Explore contract fishing for pelagic and some demersal fishes using pole-and-line, trolling gear, and handline.
11. Explore ciguatera and market testing of species caught in waters of the Northwestern Hawaiian Islands.
12. Revise Cruise Instructions as necessary, TC-77-03-76.

13. Issue final Cruise Instructions, TC-77-03-76.
14. Prepare all gear and equipment for cruise, TC-77-03-76.
15. Cruise TC-77-03-76. At end of cruise, turn in completed Cruise Report and Press Release.
16. Precruise planning for cruise TC-77-04-77, determine cruise strategy, circulate preliminary cruise instructions 90 days prior to start of cruise, accumulate supplies, order gear as necessary.
17. Revise Cruise Instructions as necessary, TC-77-04-77.
18. Issue final Cruise Instructions, TC-77-04-77.
19. Prepare all gear and equipment for cruise, TC-77-04-77.
20. Preparation of Narrative Report for cruise TC-77-03-76, hold post-cruise meeting.
2. Repair all scientific gear and fishing equipment used on cruise TC-77-03-76.
22. Cruise TC-77-04-77. At end of cruise, turn in completed Cruise Report and Press Release.