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TITLE

Recruitment, Growth and Developmental Habitat Requirements of Green Turtles in Their Nearshore Foraging Pastures

PRINCIPAL INVESTIGATOR

George H. Balazs
Hawaii Institute of Marine Biology and
Honolulu Laboratory
National Marine Fisheries Service

Office Phones: (808) 247-6631 and 946-2181
Home Phone: (808) 395-6409

DURATION

Sea Grant Year 16

MOTIVATION

Previous research carried out by this investigator has yielded considerable information on the life history and ecology of green turtles (Chelonia mydas) at their breeding and basking areas in the remote Northwestern Hawaiian Islands (Balazs, 1976; Balazs, 1980a; Balazs, 1980b; Dizon and Balazs, 1982; Whittow and Balazs, in press). As part of the Northwestern Hawaiian Islands Fisheries Investigations undertaken during Sea Grant Years 10 through 12, this work fulfilled the program's basic need for management oriented data on green turtles in the northwestern segment of the archipelago.

A significant and somewhat unexpected finding of these past studies was the identification of key coastal sites along the Kau District of the island of Hawaii that constitute highly productive foraging habitat for both immature and adult green turtles (Figure 1). These rich algal pastures at the extreme southeastern end of the archipelago have been shown to produce the most rapid growth rates thus far recorded in Hawaiian green turtles, or any other green turtle population examined elsewhere to date (Balazs, 1979; Balazs, 1982). It is therefore likely that turtles living along the Kau coastline are making major contributions to the seasonal migratory breeding colony that occurs at

French Frigate Shoals in the Northwestern Hawaiian Islands. A greater proportion of recruits to the breeding colony could be expected to result from these superior foraging areas. In addition, higher levels of reproduction could be expected once the turtles reach sexual maturity, since the interval needed between breeding migrations (2 years or more) would be shorter than for turtles residing at less productive coastal sites. The reasons for the higher rates of growth in the foraging pastures of the Kau District are not presently known. The principal food source used by the turtles is believed to be Pterocladia capillacea, a red alga that thrives along certain lava rock coastlines where fresh water percolates into the ocean. This submarine discharge of groundwater may very well supply elevated levels of nutrients that promote algal growth (see Johannes, 1980).

Comparatively little work has been focused on green turtles, or any other sea turtle species, while they are in foraging pastures where they spend the vast majority of their life. In addition to the author's own work here in Hawaii (Balazs, 1979; Balazs, 1982), accounts of foraging pasture studies are limited to Schmidt (1916) for the Virgin Islands, Carr and Caldwell (1956) for west Florida, Burnett-Herkes (1974) for Bermuda, Limpus and Walter (1980) for Australia, and Mendonca (1981) and Mendoca and Ehrhart (1982) for Mosquito Lagoon in east Florida. Bjorndal (1980) and Mortimer (1981) have presented information on the feeding ecology of green turtles at several sites in the Caribbean.

It is clearly far more difficult and time consuming to undertake research of sea turtles in their marine habitat, as opposed to nesting sites where the adult females converge on land and can be easily observed and tagged. The voluminous body of literature dealing with the tagging of nesting turtles reflects this important point. Nevertheless, there is now widespread agreement among sea turtle researchers and resource managers that studies must be

directed toward immature and adult turtles in foraging pastures if further essential knowledge of the species is to be acquired (Hirth, 1971; Carr et al., 1978; Hopkins and Richardson, 1981; Bjorndal, 1982).

Nearly all sea turtles are currently listed under the U. S. Endangered Species Act. Although population declines have occurred as the result of several adverse factors, there is nevertheless good reason to believe that green turtles, especially in the Hawaiian Islands, can be restored and properly managed for the benefit of both man and turtles. Recent work by Thayer et al. (1982) indicates that green turtles are likely to play a significant role in the cycling of nutrients by reducing the decomposition time of the marine vegetation used as forage. This "short-circuiting" of the detritus cycle represents a beneficial link between the abundance of turtles in nearshore habitat and the enrichment of the ecological system as a whole.

The overall motivating factor of this proposal is the desire to fulfill a recognized and important need for specific information on green turtles in their nearshore foraging pastures. Given the known need for this work, the question then is "where" can it best be conducted, and with what research talents. The advantages of having this investigator use foraging pastures along the Kau District as the focus of an in-depth, year-long, investigation are summarized as follows. Each of these persuasive factors are viewed as a component part of the investigator's overall motivation to do the research.

1. The comparatively rapid growth rates exhibited by turtles living in the Kau pastures, and the potentially major contribution they make to the breeding colony at French Frigate Shoals;

2. the presence of sufficient numbers of both adults and immature turtles aggregated at specific sites along the Kau coastline so as to make the research cost effective;

3. the substantial amount of previous tagging conducted at French Frigate Shoals, the site where adults living in Kau pastures migrate to breed;

4. the presence of a pool of over 100 immature turtles that were captured, tagged, measured and released during earlier exploratory work in the Kau pastures by this investigator and by students of the Marine Option Program at the University of Hawaii-Hilo campus;

5. the accessible nature of these pastures, and their relative safety as an area to undertake research (i.e., few sharks and good weather);

6. the investigator's proven ability to study, capture and tag turtles in the marine environment;

7. the investigator's use of a superior corrosion-proof turtle tag made from Inconel alloy (see Balazs, 1982). These tags are the only ones ever produced to date. They are the result of an experimental batch that the investigator arranged to have manufactured in 1976 by the National Band and Tag Company of Newport, Kentucky;

8. the relatively undeveloped and undisturbed nature of the ecological system that comprises the Kau foraging pastures;

9. the demonstrated assistance and goodwill to sea turtle researchers that is exhibited by the local residents of the Kau District;

10. the availability of a portable scuba compressor, tanks, an inflatable boat, outboard motors, an underwater camera and other basic equipment from the Northwestern Hawaiian Islands Fisheries Investigation suitable for use in a foraging pasture study;

11. the marking that was conducted in 1982 on 1,300 hatchlings at French Frigate Shoals using a promising scute grafting, or "living tag," procedure developed by Hendrickson and Hendrickson (1981). The recruitment of some of

these known-age turtles from the pelagic environment is expected to occur in the Kau pastures during the 12-month period covered by this proposal.

The National Marine Fisheries Service, the Fish and Wildlife Service, and the Hawaii State Department of Land and Natural Resources each have interests and responsibilities in the management of Hawaiian green turtles. The Principal Investigator's salary will be paid by the National Marine Fisheries Service (Southwest Fisheries Center, Honolulu Laboratory) for the duration of this proposed research (Sea Grant Year 16).

GOALS

Overall

The overall project goal is to acquire important baseline data on the ecology and population dynamics of green turtles living in rich foraging pastures along the Kau District of the island of Hawaii. This information will have direct application to the future management of Hawaiian as well as other populations of green turtles.

Specific

1. To locate, map and characterize the specific habitat currently being used by green turtles for foraging and sleeping purposes.
2. To sample and determine the levels of nutrients contained in the submarine groundwater discharge occurring along the coastline.
3. To census the resident turtle stocks by size category (juvenile, sub-adult and adult) at each of the key habitat sites.
4. To estimate the carrying capacity of the available habitat for green turtles in order to predict how much the local aggregations could expand if recruitment was not a limiting factor.
5. To substantially strengthen and refine the existing body of growth data by recapturing and remeasuring immature turtles that were tagged along this coastline at an earlier date.

6. To determine the rates of recruitment of juveniles from the pelagic to the nearshore habitat that occurs during the course of the 12-month study.
7. To identify the specific food sources being utilized by the turtles, as well as the approximate daily levels of consumption by each size category.
8. To identify and, to the extent possible, quantify the factors responsible for natural mortality of the turtles.
9. To ascertain the effectiveness of the "living tag" marking procedure on those hatchlings that arrive as new juvenile recruits along the coastline.

METHODS

The basic methodology used to accomplish the project's goals will involve six study visits to the Kau District by the Principal Investigator for a duration of 10-15 days each. A small field camp will be established during each trip in proximity to the area being intensively investigated. Much of the research will revolve around the capture of turtles, either by hand using scuba or by setting large-mesh tangle nets at strategic pathways between feeding and sleeping areas. Tangle nets will be carefully monitored to prevent injury to the turtles. A large proportion of this work will have to be conducted at night when the turtles are more susceptible to capture. Standard body measurements and weights will be recorded on all turtles. The dietary components will be determined by sampling the stomach contents through a plastic tube inserted down the esophagus (Balazs, 1980c). All turtles will be double tagged, or retagged, using numbered Inconel alloy tags bearing a return mailing address.

Key feeding sites will be located by hiking the coastline and making direct observations of the shallow (<5 meters) nearshore waters where algal growth is most abundant. Lava rock cliffs along the area will provide

excellent lookouts for using binoculars to spot turtles while they are foraging. Green turtles frequently swim to the surface to breath while they are actively feeding.

Underwater surveys with scuba, and by towing a diver from an inflatable boat, will be carried out to compile detailed habitat maps of foraging and sleeping areas. The algae and invertebrate growth available to turtles as forage at each benthic community will be sampled and identified. Larger samples will also be collected to estimate standing crop densities of Pterocladia capillacea and other algae found to be heavily used by turtles as food.

Permanent transects will be designated and mapped to aid in censusing aggregations of turtles. The number of turtles of each size category will be counted during surveys with scuba (or while being towed) for a given time over a set distance. The generally excellent clarity of the ocean water along the Kau coastline will enhance this portion of the study.

Information on natural mortality that results from predation, or possibly disease, will be tabulated through observations of lesions, scars and any pathological signs present on the turtles captured or sighted. At select sites, several large baited hooks will be set to sample sharks and examine their stomachs for the presence of turtle remains.

Samples of the groundwater discharge occurring in the nearshore waters will be sampled and analyzed for nitrates, phosphorus and other nutrients. Sites of discharge in the Kau District are easily located along the lower intertidal zone. Nutrient levels of the seawater will also be sampled nearby, as well as at coastal sites in Kau where there are no foraging pastures or resident turtles.

COOPERATIVE ORGANIZATIONS

The Marine Option Program of the University of Hawaii-Hilo campus will be substantially involved in all aspects of the project. Research activities will be used by undergraduate students as partial credit toward certification in the Marine Option Program. A limited number of stipends will be made available for financial compensation to these students. Dr. Walter C. Dudley will coordinate this aspect of the project.

Cooperative assistance in the form of in-kind services and support is anticipated from the National Marine Fisheries Service, the Fish and Wildlife Service, the Hawaii State Department of Land and Natural Resources, and the National Park Service. A portion of the Hawaii Volcanoes National Park is located along the Kau coastline.

TRAVEL JUSTIFICATION

Travel between Honolulu and the Kau District is essential in order to accomplish the proposed research and oversee field activities undertaken in cooperation with undergraduate students of the Marine Option Program.

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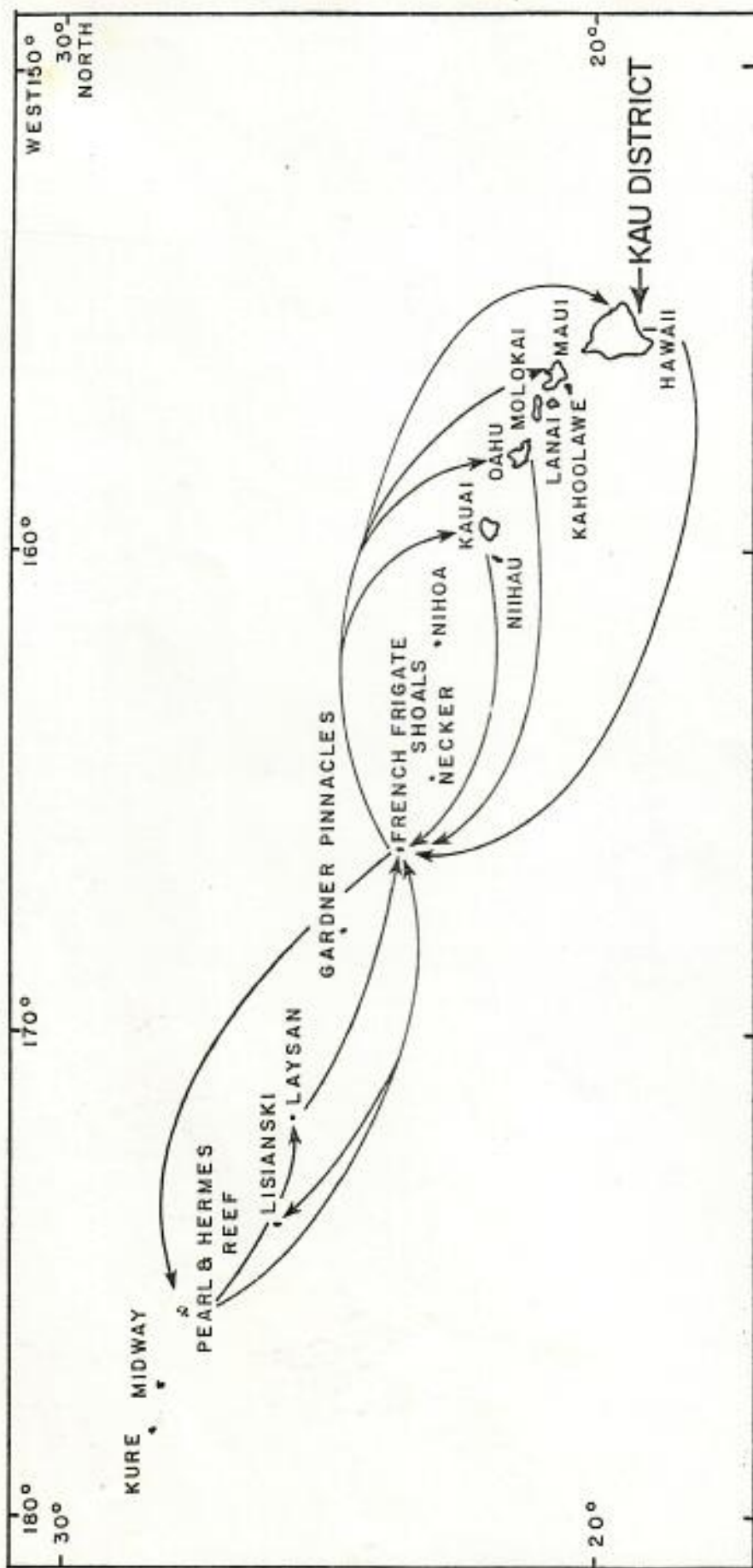


Figure 1. Map of the Hawaiian Archipelago showing the location of the Kau District on the island of Hawaii at the southeastern end of the chain. The various arrows show the breeding migrations of adult green turtles to and from French Frigate Shoals as documented by tagging studies.

BIOGRAPHICAL INFORMATION

FOR

GEORGE H. BALAZS

Professional Positions:

Fishery Biologist, 1980-present
Honolulu Laboratory
National Marine Fisheries Service
(IPA Contract with the University of Hawaii)

Assistant Marine Biologist (R3), 1976-80
Hawaii Institute of Marine Biology
University of Hawaii

Jr. Marine Biologist (R2), 1971-76
Hawaii Institute of Marine Biology
University of Hawaii

Research Assistant, 1967-69
Department of Animal Sciences
University of Hawaii

Degrees: Bachelor of Science - 1967
Animal Sciences
University of Hawaii

Master of Science - 1969
Animal Sciences (Nutrition)
University of Hawaii

Professional Affiliations:

Deputy Chairman, 1979-present; Member, 1976-79
Marine Turtle Specialist Group of the
International Union for Conservation of
Nature (IUCN)

Member, 1974-present
Society for the Study of Amphibians and Reptiles

Honorary Consultancies:

South Pacific Commission
Joint SPC/NMFS Workshop on Sea Turtles in the
Tropical Pacific Islands - December, 1979

Scientific Advisory Committee
World Conference on Sea Turtle Conservation - November, 1979

South Pacific Commission
Biology and Farming of Sea Turtles - February, 1979

Served as a Reviewer for the Editors of:

Herp Review
Pacific Science
Micronesica
Aquaculture
Herpetologica
Reproductive Biology and Diseases of Captive Reptiles
Aest. Wildlife

Served as a Reviewer of Grant Proposals for:

National Science Foundation
World Wildlife Fund - U.S.
New York Zoological Society
International Union for Conservation of Nature

Grant Awards:

World Wildlife Fund - October 1981

Sea Grant College Program, 1977-79
University of Hawaii

Office of the Marine Affairs Coordinator, 1976-79
State of Hawaii

National Geographic Society, 1978-79
(With Dr. G. C. Whitton)

New York Zoological Society, 1973-74

Date and Place of Birth:

February 26, 1943
Detroit, Michigan

Family Status:

Married in March of 1963
one child 4 years old

Office Addresses:

National Marine Fisheries Service
P.O. Box 3830
Honolulu, Hawaii 96812
(808) 946-2181

Home Address:

992 Awaawaanoa Place
Honolulu, Hawaii 96825
(808) 395-6409
Resident of Hawaii for 17 years

Hawaii Institute of Marine Biology
P.O. Box 1346
Kaneohe, Hawaii 96744
(808) 247-6631

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