8 May 1979, when 10 radio-tagged turtles were released with about 1,500 other turtles. Aircraft tracking was conducted daily for the first 10 days, and then for 3 days to conserve aircraft time and provide relief for tracking personnel. Tracking resumed on an alternate day schedule with 4 of the original 10 turtles being tracked until the 21st day after release. At this time a 1-week break was taken. Tracking resumed 30 days after release with only two of the turtles being located. A vessel was dispatched to verify the attachment of the transmitter to one of the turtles. The transmitter was recovered without being attached to the turtle. Detachment was caused by a broken attachment lanyard. Detachment apparently occurred just before recovery since signals were continuous on the day the transmitter was retrieved, and intermittent on the previous day, indicating that it was attached to a diving animal.

A second vessel was dispatched to locate and verify attachment of the second transmitter; however, verification was not possible due to behavior of the animal. Apparently, the turtle had become sensitive to noise and would dive when approached by the vessels or the search aircraft at low altitudes. This made it impossible to precisely locate the animal. Tracking data from this release are given in Figure 5. The points shown are the aircraft-determined locations at various intervals averaging about every third day. During the 30-day tracking period, some of the animals ranged to a distance of 150 miles offshore.

Results and Conclusions

The experiments were successful in meeting most of the major objectives. Most problems observed with previous tracking attempts were solved. Premature detachment of the transmitter module was a problem with the stainless steel attachment leader. This was solved with the use of monofilament nylon. There was no evidence of detachment with the nylon lanyard.

A remaining problem is with the transmitter package design, which allows the turtle to reach the antenna tip and bite it, causing a pigtail curl in the tip. Fortunately, this had no detrimental effect on transmitter range.

The most significant remaining problem is the limited tracking range due to the receiver antenna mounting on the aircraft. Because most experiments probably will rely on leased aircraft, an antenna system that will mount on any type of aircraft would be desirable.

Acknowledgment

The author gratefully acknowledges James P. McVey, SEFC, Galveston Laboratory, for providing biological consultation and turtles.

Literature Cited

Futch, C.R., and R. Witham. 1977. Early growth and oceanic survival of pen reared sea turtles. Herpetologica 33(4):404-409.

NOAA/NMFS Developments

National Climate Plan Published by NOAA

A 5-year plan to reduce the adverse effect of climatic conditions on the economy and environment, including fisheries, has been released by the Commerce Department's National Oceanic and Atmospheric Administration (NOAA). Prepared by the National Climate Program Office, the plan's goal is to help avert weather-related problems such as food and fuel shortages through improved forecasting and more efficient dissemination of climatic data.

Funds will be drawn from appropriations 11 of the 17 participating agencies receive for climate-related activities. The proposed 1981 budget is $126.7 million. Specific goals of the plan include:

1) Insuring that industries such as farming, construction, recreation, shipping, and fishing receive improved climatic data and use it more effectively;

2) Assessing the effect of increased carbon dioxide on the climate;

3) Studying the extent to which solar and earth radiation modify climatic conditions, and

4) Gathering more data on the oceans' roles in climate formation.

Edward Epstein of NOAA is director of the National Climate Program. Participating in the project are 11 Federal departments, the Agency for International Development, Council on Environmental Quality, National Aeronautics and Space Administration, National Science Foundation, the Environmental Protection Agency, and the Federal Emergency Management Agency. Copies of the plan may be obtained from NOAA's Environmental Science Information Center, 6009 Executive Boulevard, Rockville, MD 20852.

Tagged Albacore Taken Off Hakalau, Hawaii

The first recapture in Hawaiian waters of an albacore caught and tagged off San Diego, Calif., over 2 years ago, has been reported by Richard S. Shomura, Director of the Southwest Fisheries Center's Honolulu Laboratory. According to Howard Takata, the University of Hawaii Sea Grant's Marine Advisory Specialist stationed in Hilo who made arrangements for the return of the tag, the fish was one of nine albacore

caught off Hakalau, Hawaii, by Marlon Pacheco fishing from his boat, the *Dawn L* on 15 October.

Fishery scientists at the Southwest Fisheries Center's La Jolla Laboratory in California have been routinely tagging albacore in California waters for a number of years. To date, 25-30 of these tagged fish have been recaptured by Japanese longliners in the North Pacific. About a dozen tagged fish have been taken in Hawaiian waters but Pacheco's fish is the first tagged albacore caught in the local "ika-sibi" fishery.

Pacheco's albacore was first caught on 25 July 1978 south of San Diego at lat. 31°31'N, long. 118°33'W by a California baitboat (pole-and-line fishing boat). The fish was 32 inches (81 cm) long (fork length) and weighed 26 pounds (12 kg) when tagged and was about 41 inches (106 cm) long and weighed 54 pounds (24 kg) when caught by Pacheco. The straight line distance from the point it was tagged and released to where it was recaptured off Hakalau is approximately 2,100 nautical miles. Since albacore are known to make transpacific migrations between the U.S. west coast and Japan, Shomura speculated that this fish may have made a crossing from California waters to Japan before arriving in Hawaii during the approximately 27 months it was at liberty.

Pacheco received a $2.00 reward rather than a $50.00 reward which was contingent on the return of the fish's head. The value of the head of this particular fish lay in the fact that the fish was one of many, at the time of release, that had been injected with the antibiotic tetracycline for age and growth studies. The tetracycline injection produces a mark on the fish's otoliths (ear bones) which is used as a reference point to count the growth rings.

Because fishery scientists are continuing to tag and release albacore not only off California but also off Japan, local fishermen are urged to carefully examine their catches for tags. Fishery scientists at the La Jolla Laboratory use a red tag to identify fish injected with tetracycline. Information obtained from these tagging experiments provide much vital information on the life history of these valuable commercial fishes, said Shomura.

Marine Fish May Use Tiny "Magnets" to Navigate

Preliminary results of research on tunas and green turtles indicate that small "biological magnets" in the frontal part of the skull may help explain the species' remarkable navigation abilities, reports Richard S. Shomura, Director of the NMFS Southwest Fisheries Center's Honolulu Laboratory. The research is being conducted by University of Hawaii graduate students Michael Walker and Anjanette Perry together with Andrew E. Dizon of the Honolulu Laboratory and J. Kirschvink of Princeton University.

The mystery of how migratory animals can navigate accurately over great distances has long puzzled biologists. Studies on the navigation of migratory birds and homing pigeons, however, have revealed a surprising ability of these birds to sense the geomagnetic field of the Earth and to use it to guide their travels. This geomagnetic "map" seems to be accurate to within about 5 km (3 miles) over most of the Earth's surface and hence may be one of their most important sensory tools.

When these magnetic effects were discovered, no plausible mechanism through which animals might detect and use the weak geomagnetic field was known. Recently, however, a surprising variety of animals including bacteria, honeybees, pigeons, and dolphins have been shown to synthesize small crystals of magnetite or lodestone, a mineral containing iron. The tiny, iron-rich particles in the body of the animals act like simple compass needles in the Earth's magnetic field and may be the key to the sensory mechanism which guides the animal's incredible migratory behavior.

Using the paleomagnetic facilities at the Hawaii Institute of Geophysics, including an ultrasensitive magnetometer utilizing a liquid helium temperature device which can detect the presence of microscopic amounts of magnetite anywhere in a tissue sample, Walker, Perry, Dizon, and Kirschvink recently conducted a joint search for similar magnetic crystals in migratory Pacific tunas and green turtles. They used nonmagnetic dissecting tools such as plastic picnic knives and shards of glass and found tens of millions of magnetic crystals in the head of these animals — enough material to provide tunas and turtles with an extremely accurate magnetic map sense. In the tunas (yellowfin, skipjack, and kawakawa) the magnetic material was very precisely and repeatedly isolated in or upon the frontal bone of the skull, said Dizon.

This discovery of the small biological magnets suggests that a magnetic sense ought to be looked for in animals. In experiments conducted at the Kewalo Research Facility, Walker and Dizon have already discovered an unconditioned magnetic response in yellowfin tuna, and Perry is experimenting to see if such a response can be detected in green turtle hatchlings. Detailed Pacific-wide data on magnetic lineations on the sea floor and magnetic storms produced by solar winds are available, and it would be interesting to determine whether these magnetic parameters influence the migratory patterns of marine animals, said Shomura. If these migratory patterns of marine animals are indeed correlated with these magnetic parameters, these studies could be of great value in predicting the distribution and movements of commercially important fishes such as the tunas, concluded Shomura.

These experiments to detect unconditioned magnetic responses in marine animals are but a few of the many important research activities that are continuing at the Kewalo Research Facility. Past research at the facility has not only provided new scientific data on the behavior and physiology of the tunas but has also provided much practical aid to the local fishing industry, said Shomura.