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PROTOTYPE SATELLITE-LINKED MARINE MAMMAL (PORPOISE) TRACKING SYSTEM

WORKSHOP SUMMARY

November 8, 9, 1976

DRAFT

National Marine Fisheries Service
Southwest Fisheries Center
8604 LaJolla Shores Drive
LaJolla, California 92037

INTRODUCTION

WHEN: November 8, 9, 1976

WHERE: National Marine Fisheries Service, Southwest Fisheries Center
8604 LaJolla Shores Drive, LaJolla, California 92037
Auditorium Phone FTS 893-6203, Commercial (714) 453-2820

AGENDA: THE AGENDA TOPICS ON NOVEMBER 8 WERE:

- Overview of marine mammal tracking program
- Review of research assessment behavior, physiology, taxonomy and migration studies directed toward the eastern tropical Pacific porpoise stocks
- Review the proposed porpoise tracking technical plan
- Review proposed design requirements

THE AGENDA TOPICS ON NOVEMBER 9 WERE:

- Develop a detail work plan to include, as a minimum:
  - Participant detail work statements
  - Work agreements
  - Transmitter and antenna design and development
  - Packaging of transmitter components
  - Capture, Handling techniques of porpoise
  - Attachment techniques of package and test requirements
  - Data handling and special processing routines
  - Schedule of activities and events
  - Review cost estimates

PURPOSE: THE PURPOSE OF THE WORKSHOP WAS:

- To review marine mammal tracking program
- To review proposed porpoise tracking plan
- To develop detail work plan

ATTENDEES AND CONTACT LIST:

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NEED:

1. Why track marine mammals?

Marine mammals in particular have become the subject of considerable public concern due to their emotional appeal and apparent high levels of commercial exploitation, in which they are either the object of the hunt as with the large whales or are killed indirectly. In order to assure that the stocks are properly protected and managed it is necessary to increase our knowledge of the life history and population status of these animals. A conventional tagging program can generally provide information on the identification, movements, distribution, age, sex, and growth of marked animals. These types of data are particularly lacking and difficult to obtain for marine animals.

In addition to the need for the biological data, there is now a legal requirement to obtain this type of data under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. In order to meet our responsibilities under these acts, it is necessary to use the best information available, to determine which information is lacking, and to actively pursue pathways to obtain that information. Particularly in the case of cetaceans which are highly mobile and widespread, it has been extremely difficult to obtain the data necessary to determine their status.

2. How does this data contribute toward determining the status of these animals?

The status of an animal can be viewed in a quantitative sense in terms of absolute numbers at a particular time and in a qualitative sense in terms of reproductive capacity, and changes in reproductive rates, behavior, etc. Proper management should be based on sound knowledge of the biology of the animals in order to anticipate the repurcussions of any management action. A marking and tracking program, used in conjunction with a sampling program, could provide much of the information needed to develop more reliable estimates of the status of the stocks.

3. What species or groups are adaptable to tracking with satellite-linked telemetry?

Most marine mammals are appropriate targets for this type of technology because they must surface to breathe. Of course, the animal must break the surface long enough to allow transmission of the signal. In my opinion, this technology is most needed for studies of widely ranging cetaceans such as the large cetaceans and pelagic porpoises for which this type of data is extremely difficult to obtain. Certain pinnipeds such as the northern fur seal, which migrate from the Bering Sea to the West Coast and south to the Channel Islands, are also appropriate candidates as are sea turtles. The most crucial need which presently confronts us is, however, the need for information of the porpoise stocks of the eastern tropical Pacific.

4. Why use satellites for tracking?

Marking and tracking marine animals present special problems because it can be difficult to initially capture them for marking and usually there are relatively few platforms from which to resight and/or recover the marked animals, particularly the wide-ranging oceanic species. Conventional marking provides location, time, and biological data from two points--the marking and recovery sites. The capability to continuously track marine animals would greatly enhance our knowledge of their life history and ecology as well as aid in assessing the stocks.

The cost of vessel or flight time for tracking marked marine mammals over extended periods of time is prohibitive. In addition, the large research vessels are often unable to keep up with the faster marine mammals and, in tracking them, alter the animals' behavior and could alter their normal movements. Planes can keep up with the animals but are of limited use in tracking oceanic species. Satellite tracking of marine mammals could allow for essentially continuous tracking with essentially real-time data on their movements over an extended period of time.

Thus far knowledge of the boundaries of the stocks is derived primarily from sightings from the tuna fisher, tag returns, as well as data collected during research cruises. A satellite tracking program could provide substantial additional data to delineate stock movements and association with tuna (through catch statistics), etc.

5. What is the current cost of tracking in the conventional manner?

The NMFS is not currently conducting a major porpoise tagging effort but has placed in excess of 3000 tags and has had a 3 percent recovery rate which is quite good compared to most tagging programs. The cost has been nominal with dart tags costing about $1.00 each. The tagging effort has been primarily of an opportunistic nature with observers aboard tuna vessels placing the tags. The major cost of a conventional tagging and recovery system is the cost of vessel time if free time is not available.

In 1975 a SWFC estimate of the number of animals which needed to be tagged to give population estimates as well as data on movements, etc., was 10,000 porpoises assuming no tag shedding. The cost was estimated at $58K and 100 days of vessel time. In order to obtain reliable information on population size through actual recover of tags from porpoise killed in the fishery, 200,000 porpoises needed to be tagged at a cost of $296K plus 500 days of vessel time.

An indirect cost benefit of a satellite system would be the value of the rapid turn-around time since knowledge of the location of the stocks makes access to the stocks by research vessels possible. There is also the benefit of knowing where the animals were at any particular time and for how long. This knowledge might allow for a correlation with certain environmental factors thereby making distribution predictions possible.

DISCUSSIONS AND FINDINGS

RESULTING FROM THE WORKSHOP, A SUMMARY OF THE DISCUSSIONS ARE AS FOLLOWS:

- THINGS WE DISCUSSED AND KNOW ABOUT THE ANIMAL -

1. Porpoise swim at speeds up to 20 knots.
2. They are extremely agile; i.e., can turn 90° at near full speed.
3. Diving depths sometime reach 700 meters (1000 psi).
4. The size of the abdominal cavity is greatly reduced as the animal dives.
5. The respiration rate varies from as long as once every four minutes to as short as five times per minute. The mean being 1.6 seconds.
6. The body temperature is approximately 101°F.
7. The heart beat varies from 40 per minute during a dive to a maximum of 170 per minute during a respiratory cycle.
8. Data from implanted telemeter systems indicate that the animal sleeps for periods of 20 to 30 minutes during which he cycles from the surface to depths of 20 feet.
9. The dorsal fin has a large arterial tree more heavily concentrated near the aft portion.
10. There are several areas on the body of the animal that serve as heat exchangers. The dorsal fin being one of these areas.
11. The major part of the dorsal fin is made up of a cartilage material similar to that found in the human nose.
12. The entire body of the porpoise has evolved into an optimum hydrodynamic configuration.
13. Any permanent openings through the dermis layers nearly always induces infection and results in a sluffing of the tissue.
14. Porpoise are highly susceptible to parasites both internal and external. External parasites are removed by rubbing.
15. The average life span of the animal is estimated to be approximately 20 years.
16. The gestation period for the animal is approximately 1 year.

17. The calves normally accompany the mother for two years.

18. Sex determination is accomplished by capture of the animal. There is no distinctive color or configuration body characteristic which can be related to sex.

19. Porpoise have a highly refined hydroacoustic system used to search for food and navigate.

20. The animals are playful in nature and can be expected to jump on one another in a random fashion.

21. Mating behavior for the animals is belly to belly.

22. The animal's leap out of the water is made at approximately 45°. The height of the leap can reach 8 feet.

23. It is generally agreed that a porpoise can sustain a weight load of 1.5 pounds provided the package is made naturally buoyant, evenly distributed and hydrodynamically configured.

24. The animal is highly susceptible to trauma and shock during capture. This is particularly prevalent with younger animals.

25. Surfacing time for porpoise averages 1.6 seconds.

26. A marine Mammal Permit could be obtained in 4 months.

27. Long term effects concerning attachment of porpoises to porpoises are not well understood.

28. Delphanis wounds tend to heal within 10 days.

29. The Navy has has a transmitter package attached to a porpoise up to 22 days.

30. Fowling is a problem for tursiops tags.

31. A radio transmitter has been attached to a killer whale for 5 months.

32. The spinner and spotter porpoise comprise 94 percent of the stocks--common species are next.

33. Freeze brand tagging technique appears to be the most successful approach thus far in tagging porpoise. There are still problems with plastic tags.

- THINGS WE DISCUSSED AND KNOW ABOUT THE ELECTRONICS-

1. The transmitter must have a minimum output power of 0.6 watts.

2. The frequency of the carrier is 401.2 MHz.

3. The power source must be capable of providing power for a one-year period during which time the transmitter will be turned on for a 4-hour period one day each week.

4. The power system must be interrupted by a magnetic switch; the purpose of which is to start the clock circuit at the appropriate time.
5. The transmitter must be keyed by a saltwater switch that sees an open circuit between the antenna and the transmitter housing.
6. The electronics must contain a clock circuit which will allow the transmitter to be keyed only during the 4-hour period once a week.
7. The electronic system should ideally be designed utilizing hybrid circuitry, however, weight and volume permitted, conventional IC's may be used (i. e., 1. 5 pounds 6-8 cu. in.).
8. Lithium batteries seem to be the optimum type power supply.
9. The electronic package will be exposed to temperature changes from 5°C to 33°C.
10. The antenna must be cut to the proper frequency (approx. 6") and designed such that it will withstand the environment with a minimum hydrodynamic drag.
11. The electronic packaging must withstand pressures of 1000 psi and cushioned with a foam-like material to prevent chaffing of the animal's skin.
12. The design of the electronics must be such that it can be adapted to fit within the attachment package.
13. The system design should be such that a minimum change is required to utilize the TIROS satellite as opposed to the NIMBUS.
14. Normal transmission periods (duty cycle) for NIMBUS transmitters is one second on-60 second off.
15. The volume, not weight, is the constraint on the package designs.
16. Shape of the transmitter package should have low drag and low profile.
17. A flexible tape antenna should be considered as the NIMBUS transmitter antenna.
18. NASA has one hybrid prototype transmitter that is 71 percent efficient.

- THINGS WE DISCUSSED AND KNOW ABOUT THE SATELLITE:

1. The receivers aboard the satellite must see a 0. 6 watt signal for a full second with a minimum of 4 transmissions during the pass in order to establish position of the transmitter.
2. For the Eastern Tropical Pacific a window of 2 hours either side of noon is adequate for transmission times.
3. The satellite has a foot-print of approximately 2000 x 1500 nmi.

4. Two hundred NIMBUS transmitters can be used in one field of view (1500 x 2000 nmi).

5. The TIROS satellite requires a 3 watt output signal from the transmitter package.

6. Accuracy for locating the transmitter is 5 KM RMS.

AS A RESULT OF THE WORKSHOP DISCUSSION THE FOLLOWING SPECIFICATIONS HAVE BEEN IDENTIFIED AS THE TRANSMITTER DESIGN REQUIREMENTS:

- TRACKING DURATION: One year for operational systems; should be adjustable.
- TRACKING INTERVALS: Minimum weekly.
- TRANSMISSION INTERVAL: To be determined, but no less than once every four seconds; dependent on surfacing rate.
- WEIGHT IN AIR: Less than 1.09 kg (could possibly be as much as 2.25 kg with minimum hydrodynamic drag).
- WEIGHT IN WATER: Neutral to slight positive buoyance.
- SIZE: 6 cubic inches.
- SHAPE: Hydrodynamically designed to minimize effects on animal behavior and movement.
- PRESSURE TOLERANCE: Rated to depths of 700 meters for pressure vessel.
- TEMPERATURE TOLERANCE: 7°C to 33°C.
- RECOVERABILITY: No requirement except that the transmitter package must separate from the animal after a predetermined tracking period.
- ANTENNA DESIGN: Probably whip type; possibly flex tape antenna.
- TRANSMITTER OUTPUT POWER: To be determined; probably 0.6 watt for NIMBUS three watts for TIROS.
- TRANSMISSION FREQUENCY: Designed for NIMBUS-6 (401.2 MHz) but convertible to TIROS-N (402.1 MHz).
- TRANSMISSION PERIOD: One second.
- MAGNET SWITCH: Allows operator to activate transmitter at the time of attachment.
- SALT WATER SWITCH: Turns transmitter on when antenna breaks water.
- CLOCK CIRCUIT: Permits the tranmitter to operate for a 4 hour period once a week. Set for satellite overpass time.

CONCLUSIONS

FROM THE WORKSHOP DISCUSSIONS THE FOLLOWING WERE CONCLUDED.

- The Proposed Project Plan requires modification. The time and funds listed are inadequate to accomplish a creditable job. However,
- The Project should continue with a modified prototype feasibility demonstration in FY77.
- Research areas that require longer term study or additional funds should be identified and support established to proceed in these areas. Examples are animal attachment techniques, transmitter hybrid circuits, antenna design, etc. This research should be done with a systematic and coordinated approach.
- The most constraining study area is the development of the Porpoise/Transmitter attachment technique. This problem will definitely require more time and resources to resolve. If this problem is not resolved, it could jeopardize the entire project.
- Research redundancy should be avoided by utilizing the expertise of the participating agencies. The proposed study or work areas should be assigned agency leads as follows:

U.S. NAVY	ATTACHMENT STUDY
U.S. NAVY/NDBO	PACKAGING STUDY
NDBO/NASA	TRANSMITTER STUDY
NASA	SATELLITE LINK STUDY
NMFS	DATA REQUIREMENTS
NMFS	TEST REQUIREMENTS
NMFS	MANAGEMENT AND COORDINATION

- Marine mammal workshops of this nature are useful in sharing experiences and results of study areas. Continuing this type of effort will aid in providing operational requirements for other marine mammal tracking programs.