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6. AUTHOR(S)

James T. Harvey

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Moss Landing Marine Laboratories
P.O. Box 450
Moss Landing, CA 95039-0450

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13. ABSTRACT *(Maximum 200 words)*

Large cetaceans are particularly difficult to tag because they spend a great deal of time underwater, are difficult to approach, and the tagging process can alter the whale's behavior. We developed a new method of delivering tags for placement on large whales. Sea lions were trained to carry a harness and attached camera system along with carrying a suction-cup tag in a mouth piece. Using a 16 foot gray whale model, sea lions were trained to place the tag about 1 m behind the blowhole on the dorsum. Sea lions were trained for open-ocean release, traveling next to or on the vessel, responding to acoustical signals, and placing the tag on the whale model as it was pulled through the ocean at 2-3 knots. Successful placement in the correct position occurred 95% of the attempts. The sea lions will next be trained with a live gray whale housed at SeaWorld of California before moving back into the ocean for training for summer 1998. The attchment system seems to be an effective method for tagging large whales in various conditions (e.g. rough weather, at night, and when the whales are underwater).

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FINAL REPORT

Grant #: N00014-94-1-1075 R&T Code: 4113011

PRINCIPAL INVESTIGATOR: Dr. James T. Harvey

INSTITUTION: Moss Landing Marine Laboratories

GRANT TITLE: Development of a new delivery and attachment system for tagging large cetaceans

REPORTING PERIOD: Final Report

AWARD PERIOD: August 1, 1994 through July 31, 1997

OBJECTIVE: To develop a delivery and attachment system for tagging large whales using trained California sea lions.

APPROACH: Sea lions are trained to carry a specially designed, custom-fit bite plate with an attachment device and tag (Conboy 1975). The animals are trained to deliver the tag to a location one meter behind the blowhole on the mid-dorsal line of a wild whale. This location is optimum for attachment because the tag's antenna is vertical, therefore, best signal propagation, and the tag emerges at each whale breath. Successive approximations were used to teach the sea lion the proper position on a model whale moving in calm water (e.g. off the Monterey Bay Aquarium, Monterey). The model is a gray whale replica (approximately 5 m long). The model is towed from a vessel, from which personnel are capable of controlling its depth. Movement of the pectoral fins and boat speed control the model's vertical position in the water column and dives to shallow depths (less than 5 m). Vertical motion of the model is necessary because the sea lions can only place tags when the whales are underwater and because it more closely approximates live whale motion.

The sea lions are trained to properly respond to acoustic signals necessary to communicate with the sea lion underwater (i.e. away from visual and oral commands) and distances from the vessel. The signals communicate turn left or right, tag the whale, and return to the boat using different tones and pulsing patterns.

The sea lions are trained for transportation into the sea by riding tethered on the deck of a small vessel (approximately 6 m length), swimming alongside this vessel, and riding in a specially designed transport cage. Once in the ocean, sea lions are trained to leave the vessel, responding to commands that lead them to free-swimming whales, and ultimately to the placement of the tag in the optimum location. Once the sea lion has achieved its task it returns to the vessel. The vessel will remain approximately 100 m from the whales during tagging. This will

allow us to view the location and some behaviors of the trained sea lions and observe tag placement and attachment success without needless disturbance of the whale. During tagging, the sea lion carries a video camera on its back attached to a harness. The camera faces forward and will therefore allow us to monitor tag placement and the reaction of the whale. The film may also provide a photo identification of the whale subject and may allow us to determine additional data such as size and sex.

ACCOMPLISHMENTS: Two California sea lions (*Zalophus californianus*), initially being trained and housed at UCSC have been moved to an ocean pen off Monterey, California. These sea lions are in the process of being trained to attach small radio tag/TDR packages to the dorsum of large cetaceans.

After a lengthy process of acquiring numerous permits (ie: Monterey Bay Marine Sanctuary, Coastal Commission, Coast Guard, NMFS, and APHIS) a sea water pen was constructed and anchored off Monterey, CA in July of 1996. This pen provides housing for the sea lions during open-ocean training. These trained sea lions and facilities are an excellent precursor to the development of the proposed tagging methodology.

Two sea lions (one adult male trained by NOSC, Kailua, Hawaii and one female rehabilitated by Sea World trained by ourselves) currently are trained for advanced husbandry behaviors (e.g. present body parts, basic obedience, blood and stomach sampling), advanced ocean transport behaviors (e.g. enter cages, ride in boats, and trucks, etc.). They have been trained to wear a standard harness that can be attached to a tether or have monitoring equipment and camera packs placed on it. The sea lions have been fully trained to cooperate when free-released in the ocean from a boat or from the home pen. They have been trained to respond to under water signals generated by an underwater speaker.

The animals have also been trained to tag small models of whales in the tanks where they were initially housed at Long Marine Laboratory, Santa Cruz, California. This involved building several stages of increasingly mobile and realistic model whales which could be moved both horizontally and vertically in the water column. The sea lions have successfully mastered placing suction-cup tags in the appropriate dorsal location on even the largest and fastest moving models. This training was expanded to a 5-m gray whale replica which is towed through the ocean by one vessel while the sea lion (wearing a video camera back-pack) approaches and tags the model from a second boat. They have a tag placement success rate of about 95% in this scenario and the video footage clearly shows the model whale and the tag placement success.

Both sea lions have been extensively trained to cooperate and interact with other wild marine mammals. During trips to sea of as much as 6 hours in duration the sea lions have worked with

harbor seals, groups of wild sea lions, pods of Risso's dolphins and common dolphins. During these encounters the trained animals followed, approached, and filmed the wild subjects at the command of the trainers.

To date, we have had only one encounter with a pod of humpback whales which did not result in any tags being placed. However, in January 1998 the sea lions will travel to San Diego Sea World for an intensive three weeks of training with a live, captive, gray whale. We hope to completely desensitize the sea lions to the large presence of the whale and train them further to tag and film the whale. This experience should complete the necessary training for the sea lions to begin tagging and filming wild whales in the upcoming 1998 field season.

CONCLUSIONS: Although it has taken longer than expected to develop, this method of tagging and recording the underwater behavior of whales shows considerable promise. Unforeseen permitting obstacles were largely responsible for delays in progress, as the animals were not moved to the ocean until the end of 1996. Nevertheless, in the year that the project has been at sea the sea lions have been trained for nearly all of the behaviors involved in the development of this new technology. With the training at Sea World using a live whale subject, this project should be fully operational. The project concept has won world-wide acclaim for its ingenuity and has been documented internationally in the media including a documentary by National Geographic Television (airing nationally March 29, 1998).

SIGNIFICANCE: All tagging systems currently used to tag large cetaceans have problems. To use projectile tags you must approach whales somewhat closely, often for prolonged periods to obtain a good shot. Projectile tags usually are placed in sub-optimum locations on the side of whales because the whale is off to one side of the vessel. Whales tagged using this methodology may be harassed during tagging, and some individuals may never make themselves available for tagging. Therefore, information from these tagged whales may be biased.

Although tags applied to whales using a pole can be placed in an optimum location, only a few species of whales are conducive to this methodology. Gray whales in lagoons of Baja California that closely approach boats, humpback whales caught in fishing nets, and feeding or resting right whales have been tagged using this system (Mate 1987). There are few whale species and locations where this methodology is applicable.

Use of trained sea lions to attach tags to large cetaceans offers greater flexibility than other tagging methods. Species that are difficult to approach or remain underwater for long periods may be tagged. A photo ID of the tagged individual can be collected along with other individual information using the camera pack worn by the sea lion. The placement of tags is in the

optimum location, and tagging may occur in differing sea states. Whales probably will be less disturbed by this method than tagging from a vessel. Because most individuals within a population may be tagged, there probably is less bias associated with tagging only animals that can be approached closely with a vessel. Finally, larger instruments can be delivered and attached to whales. This tagging system will provide the best opportunity to place and retrieve VHF and satellite tags, time-depth-recorders, or other instruments on many species of large cetaceans under many conditions.

AWARD INFORMATION: This project has been selected by the Deputy Commissioner General of the U.S. Information Agency to represent the U.S. at the World's Fair 1998 as the official mascot of the U.S. Pavilion. The marine thematic pavilion will feature a presentation and exhibit of the project.
This project was also honored by the International Marine Animal Trainer's Association with two awards at the 30th annual conference in 1997. Awards were given in the categories of Best Trained Behavior of the Year and Best Research/Husbandry Behavior.

PUBLICATIONS AND ABSTRACTS:
1.Hurley, J.A. and Holmes, N.H. (1997). A review of the psychological principles and training techniques associated with desensitization. Marine Mammals: Public Display and Research Journal. (In press).

2.Hurley, J.A. and Harvey J.T. (1997). Using trained sea lions to record the underwater behavior of whales. Formal presentation to the American Fisheries Society 127th annual meeting.

3.Hurley, J.A., Wurts, S.W., and Harvey, J.T. (1997). Training California sea lions (Zalophus californianus) to record undersea phenomena for research purposes. Formal presentation to the International Marine Animal Trainers Association 25th annual meeting.

4.Norman, H., Hurley, W.C., Wurts, S.W., and Hurley, J.A. (1997). Voluntary flipper tagging of a California sea lion (Zalophus californianus). Poster presentation to the International Marine Animal Trainers Association 25th annual meeting.

5.Clark, L., Passamaneck, Y., Hurley, J.A., Hurley, W.C., Wurts, S., Williams, T.M., Costa, D.P. (1995). Highlights of training assisted research at Long Marine Lab. Poster presentation to the 23rd annual IMATA conference.