Radar-based Detection, Tracking and Speciation of Marine Mammals From Ships

Dr. Douglas F. DeProspo
Areté Associates
1550 Crystal Drive, Suite 703
Arlington, VA 22202
Phone: (703) 413-0290 FAX: (703) 413-0295 E-mail: ddeprospo@arete.com

Dr. Joseph Mobley
University of Hawaii-West Oahu
96-129 Ala Ike
Pearl City, HI 96782
Phone: (808) 454-4716 FAX: (808) 454-4715 E-mail: jmobley@hawaii.edu

Dr. Wai Hom
The Johns Hopkins University Applied Physics Laboratory
Air Defense Systems Department
11100 Johns Hopkins Road
Laurel MD 20723-6099
Phone: (240) 228-5288 E-mail: wai.hom@jhuapl.edu

Dr. Mike Carron
SACLANT Undersea Research Centre
APO, AE 09613-5000
E-mail: carron@saclantc.nato.int

Award Number: N00014-04-1-0729
http://www.lsro.org/ECOUS/frames_home.asp

LONG-TERM GOALS

In addition to ship strikes, another cause of marine mammal injury and death is from exposure to high acoustic source levels, e.g., those encountered during Navy-sponsored Low Frequency Active (LFA) sonar tests. Irrespective of the method of mammal injury or death, the act of injuring or killing whales can and does result in litigation proceedings. This is a consequence of the legal protection that Cetaceans (whales and dolphins) are granted in U.S. waters by the Marine Mammal Protection Act of 1972 (as amended in 1994), with some species additionally protected by the Endangered Species Act of 1973.

Previously developed mitigation technologies, such as passive acoustic and visual observation, although promising, still fall significantly short of achieving the detection performance necessary to achieve full marine mammal mitigation. Radar surveillance technology, being developed under the current supported program, represents a fundamental paradigm shift and new approach toward the goal of achieving robust marine mammal mitigation. Figure 1 shows an example of two humpbacks detected at a range of 8 km. in both a high-powered EO telescope (right-panel) and in simultaneous,

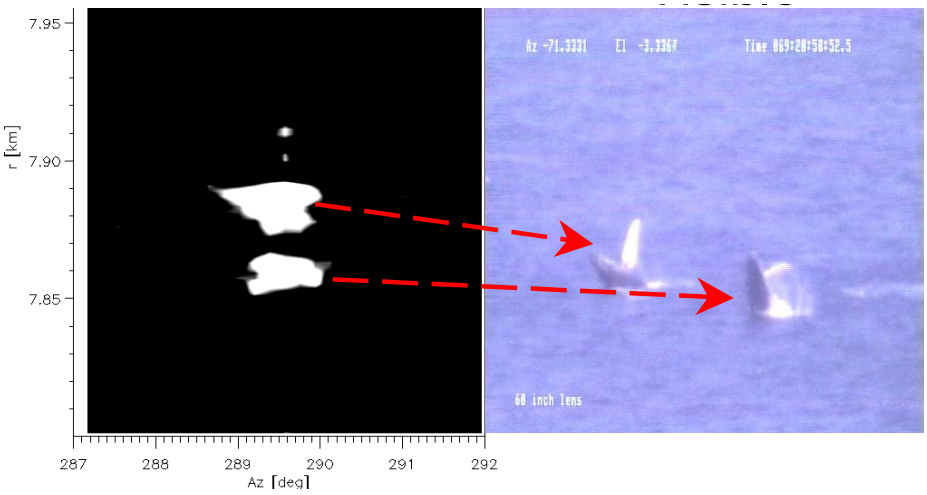

Figure 1 Right Panel: Visible image of two humpback whales. Left Panel: Simultaneous radar image of the same two whales.

co-registered radar imagery (left-panel) during a prior funded cliff-based demonstration of this technology [1].

The eventual long-term goal of this work, if successful under the baseline and option programs, is to develop and transition this new radar surveillance technology to both the military and commercial fleets. The primary benefit would be the mitigation of harmful effects on marine mammals due to acoustic testing and ship strikes.

OBJECTIVES

The overall objective of the baseline effort, initiated approximately August 1, 2004, is to establish the ability of current or planned ship-based radars, augmented by specialized signal processing, to detect, discriminate and track (geo-locate) a number of different marine mammal species (e.g., great whales, schooling dolphins, etc.) under a variety of representative sea environments (e.g., Atlantic, Pacific, Mediterranean, etc.). Key to this assessment will be an initial, ship-based radar demonstration experiment planned for May, 2005 in the Mediterranean Sea.

If successful under the baseline effort, the main objective of a follow on effort would be to develop a prototype, near-real-time computer code stream capable of supporting the marine mammal mission under realistic and operational circumstances. Demonstration and validation of the performance of this near-real-time code stream would be performed under an at sea experiment similar to the exercise conducted under the baseline program.

APPROACH AND WORK PLAN

Our approach, under the current baseline program, is to establish, through a robust program of experiment, modeling and simulation, the ability of current or planned ship-based radars to detect, discriminate and track against a significant number of mammal species. Underpinning the execution of this technical approach are three key capabilities: The ability to model the radar signature of marine mammals as well as those of competing ocean clutter; the ability to design specialized and implementable signal-processing algorithms to enable the detection, tracking and discrimination of

marine mammals; the ability to design and execute complex sea-tests in mammal-rich environments for demonstration and validation.

Individuals key to the execution of the baseline program include:

1. Dr. Douglas DeProspo (Areté Associates): Overall project lead and coordinator.
2. Dr. Clayton Chinn (Areté Associates): Expert on specialized radar signal processing algorithm development and radar signal modeling.
3. Dr. Joseph Mobley (University of Hawaii): Expert on marine mammal behavior and biological characteristics (focus on Pacific and Atlantic species) and visual observation techniques.
4. Dr. Michael Carron (SACLANT Undersea Research Centre): Expert on marine mammal behavior and biological characteristics (focus on Mediterranean species) and visual observation techniques.
5. Dr. Wai Hom (Johns Hopkins University Applied Physics Laboratory): Expert on radar hardware/software interface development.

Specific work to be executed during FY05 includes:

1. Theoretical mammal radar detectability will be quantified on a per-mammal-species basis.
2. An initial at sea demonstration experiment will be performed to demonstrate proof-of-concept and to validate theoretical detectability predictions against several mammal species.
3. A near-real-time code stream will be delineated to execute the mammal detection, discrimination and tracking mission. This code stream would be developed and tested under the follow on option effort, if funded.
4. Candidate platform/sensor combinations will be identified which are capable of supporting the sensor sampling and platform requirements necessary to effectively execute detection and tracking of marine mammals.

WORK COMPLETED

The Areté Associates' lead team was under grant for approximately two months during Fiscal Year 2004. During that time initial work under this grant focused on planning the execution of an initial, ship-based radar demonstration experiment planned for May, 2005 in the Mediterranean Sea. Secondary work focused on beginning to assemble the biological characteristics of several species of marine mammals likely to be encountered during the Mediterranean test. These characteristics will be key in creating theoretical radar signature models for these species which then can be compared to collected data.

RESULTS

No significant technical results have been achieved as of this point in the program.

IMPACT AND APPLICATIONS

National Security

Improved ability of naval forces to operate effectively during active sonar tests as well as during operational exercises, in areas containing marine mammals. The Coast Guard will also realize benefit

via improved mammal awareness, thereby avoiding potential ship strikes, during the execution of its Maritime Domain Awareness Mission.

Economic Development

It is envisioned that ultimately a value-added radar surveillance hardware/software product package will be transitioned to private sector fleets, including fast ferries and oil exploration ship platforms, both of which utilize maritime surveillance radars. Primary benefit will be in the form of law suit mitigation; collision avoidance improvement in the case of fast-ferry induced ship strikes and improved environmental awareness for oil exploration platforms utilizing acoustic sounding to identify new petroleum reserves in mammal populated waters.

Quality of Life

Quality of life of marine mammals will be enhanced via the successful transition of this new radar technology to the government and private sectors. As discussed above, this technology will serve to mitigate risk to marine mammal species in the vicinity of acoustic testing as well as those in the vicinity of shipping lanes. Additional benefit could be realized in the form of improved capability for marine mammal census; migration of this new radar technology to aircraft platforms would enable the ability to search areas as large as 10,000 nm^2 in 8 hours to categorize marine mammal populations.

RELATED PROJECTS

1) Areté Associates' Office of Naval Research (ONR) STTR Phase II Contract No. N00014-02-C-0360, regarding "Radar Detection of Marine Mammals at Long Standoff". Contract was completed November 1, 2004.
2) Scientific Solutions, Inc. ONR STTR Phase III Contract No. N00014-04-C-0451 regarding "Integrated Marine Mammal Monitoring and Protection System (IMAPS)". Contract is still active.

REFERENCES

1) DeProspo, D.F., "Radar Detection of Marine Mammals at Long Standoff-Phase II STTR Option Analysis of Project Humpback Data". Areté Associates Internal Report (ARE-05-3439-005-FR), November 8, 2004 (Final Report delivered to the Office of Naval Research (ONR)).

2) DeProspo, D.F., Mobley, J., Forsyth, C., Chinn, C., Hom, W. and Soto, A. **"**Using Radar to Detect and Track Humpback Whales: Results of Project Humpback". 15th Bienniel Conference of the Biology of Marine Mammals, Greensboro, N.C., 15-19 December, 2003 (Invited presentation with abstract published).

3) DeProspo, D.F., Mobley, J., Forsyth, C., Chinn, C., Hom, W. and Soto, A. "Project Humpback: A radar-based, humpback detection and tracking experiment". Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, Texas, 12-16 May 2003. (Invited presentation with abstract published).