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Final report for continued development of the SEAMAP data archive

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

Final Report for Continued Development of the SEAMAP Data Archive

by

Ben Best, Patrick Halpin, and Andrew Read

September 2007

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13. ABSTRACT ***(maximum 200 words)***

Environmental laws and public concern require that the U.S. Navy conduct operations and training such that impacts to marine mammals are minimized and any adverse impacts mitigated. To that end, an archive of marine mammal distribution and movements is needed. The digital geo-referenced data archive known as Spatial Ecological Analysis of Megavertebrate Animal Populations (SEAMAP) is the world's largest public archive of marine mammal, seabird, and sea turtle observations. This report documents the incorporation of 31 new datasets from inside and outside the U.S. EEZ to SEAMAP over the period June-June 2006/7. Additionally, this report describes the adaptation of new data types (e.g., marine mammal photographic identification) to the SEAMAP archive, and describes plans to adapt acoustic data (e.g, ARP, HARP) to the archive. Finally, enhancements over the period June-June 2006/7 to the interfaces for users of and data providers to SEAMAP are described.

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Final Report

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Tasks 1 & 2: *Incorporation of new marine mammal survey data sets from the U.S. EEZ and outside the U.S.*

A total of 31 new datasets were acquired from June 1, 2006, through May 31, 2007, summarized by Tables 1, 2, and Figure 1. Of the 10 datasets in the U.S., 2 are from government agencies, 6 from non-profit organizations and 2 from universities.

Table 1. Summary of new datasets and records by taxa acquired for the year contract period.

Country	Datasets	Marine Mammals	Seabirds	Sea Turtles	Total
US	10	7,520	1,429	17,116	27,419
International	21	3,225	40,251	12,245	56,063
Total	31	10,745	41,680	29,361	83,482

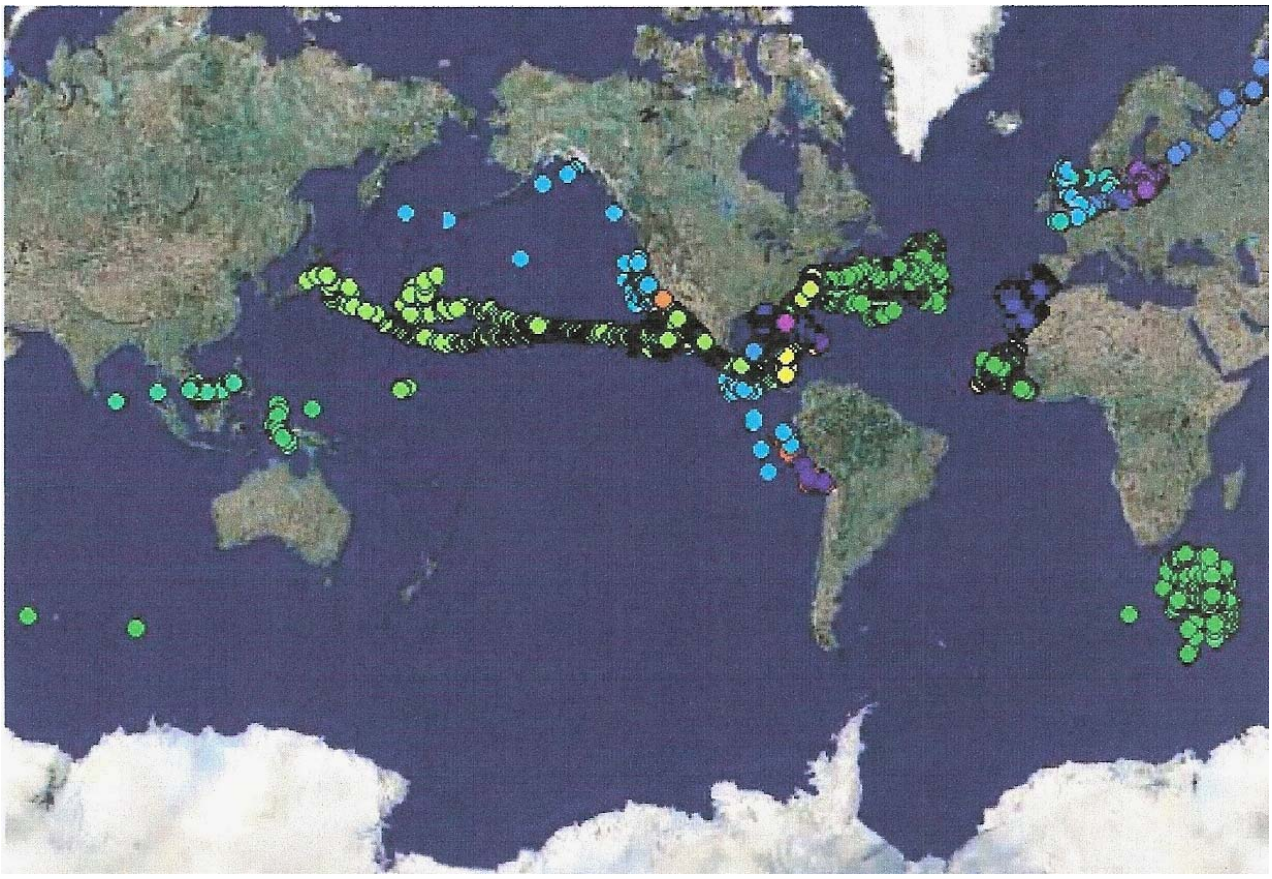

Figure 1. Global distribution of records colored by dataset acquired during the contract period.

Table 2. Full listing of datasets added to SEAMAP during the contract period (6/1/2006-2007).

ID	Name	Platform	Taxa	Records
99	Cascadia Research Blue Whale Photo IDs for US West Coast, 1972-2002	boat	mammals	6560
316	Duke North Atlantic Turtle Tracking	tag	turtles	11080
317	Pacific Turtle Tracks: Grupo Tortuguero	tag	turtles	2828
326	Bahamas Marine Mammal Research Organisation Turtles Sightings	boat	turtles	101
327	Bahamas Marine Mammal Research Organisation Strandings	boat	mammals	89
328	Bahamas Marine Mammal Research Organisation On-transect Sightings	boat	mammals	185
329	Bahamas Marine Mammal Research Organisation Opportunistic Sightings	boat	mammals	2194
330	Bahamas Marine Mammal Research Organisation Aerial Sightings	plane	mammals	17
336	Casey Key Loggerheads - 2005-2006	tag	turtles	1645
341	USAKA Turtle Release Program	tag	turtles	30
343	Baltic Porpoise Acoustic Surveys 01-02	boat	mammals	462
344	Baltic Porpoise Sightings 01-02	boat	mammals	55
346	Cabo Verde (Proyecto Aegina): male and "Hortensia" loggerheads	tag	turtles	2021
347	Islas Canarias (Proyecto Aegina): juvenile loggerheads	tag	turtles	1187
349	Cayman Islands 2003	tag	turtles	1561
350	Cayman Islands 2004	tag	turtles	719
358	Baltic Seabirds Transect Surveys	boat	birds	23629
360	UNCW Right Whale Aerial Survey 05-06	plane	animals	1575
364	Migratory patterns of Yucatan Peninsula hawksbills	tag	turtles	406
367	Cape Verde (Cabo Verde) 2004 : Loggerhead Turtles	tag	turtles	3114
368	Loggerhead Turtles: Bald Head Island 2003	tag	turtles	2026
373	Vietnam Sea Turtle Tracking Project	tag	turtles	287
375	Pacific Sea Turtle Tracking - Aquarium of the Pacific	tag	turtles	26
377	Russian Barnacle Geese	tag	birds	202
379	Mote Marine Laboratory - Sea Turtle Rehabilitation Hospital	tag	turtles	831
381	Palau Marine Turtle Conservation and Monitoring Program	tag	turtles	31
384	European Seabirds at Sea - Trip 9408HE (Trial)	boat	animals	16132
386	Sperm whales off Peru during IMARPE surveys (1995-2002)	boat	mammals	38
387	Killer whales off Peru during IMARPE surveys (1995-2003)	boat	mammals	14
390	Casey Key Loggerheads-2007	tag	turtles	1386
392	Marion Wanderers	tag	birds	1014

Task 3: *Incorporation of novel data types*

We have developed a prototype interface for display of sea turtle nesting data, similar to stranding data, for the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). WIDECAST plans to collect nesting data from 42 countries and territories in the Caribbean, which will become the biggest sea turtle data collection for this area. The number of nests by species and year are incorporated into an interactive mapping interface that credits the individual provider to the dataset (Figure 2). Some sites have beach photos as well. The WIDECAST dataset is representative of datasets collected by a large network of volunteers, non-profit organizations, academic institutions and governmental agencies. Credit must be given for individual contributors while aggregating the data to a larger level.

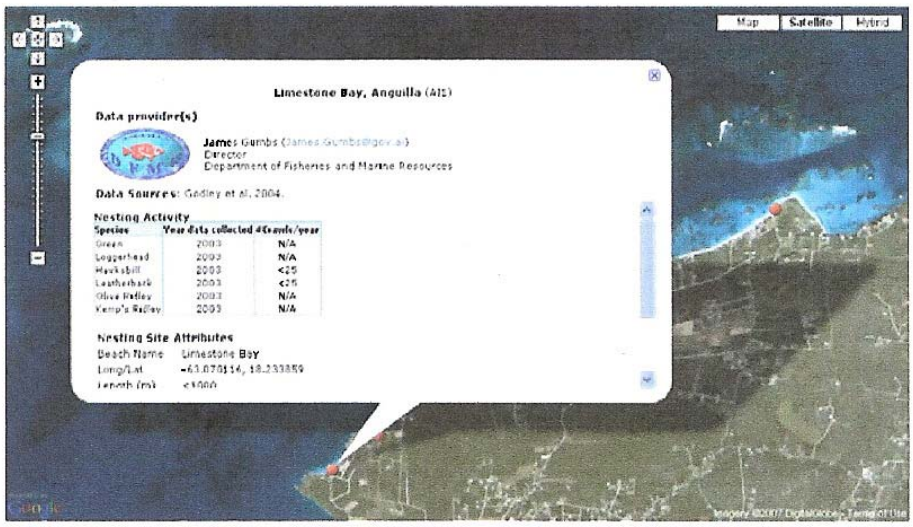

Figure 2. Interactive map of nesting data type for the WIDECAST sea turtle network.

Photographic identification (Photo-ID) datasets are similarly community driven. These data are important to understanding the behavior and migratory movements of marine mammals. They are different in many respects from traditional line transect surveys and unique in their association with digital photographs (Figure 3). We have been coordinating with Kim Urian of the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC, http://moray.ml.duke.edu/faculty/read/mabdc.html) to accommodate the necessary data schema and functionality of this data type (Figure 5). The MABDC is a consortium of approximately 15 research groups, ranging from New Jersey to Florida, who work together to study coastal bottlenose dolphins. A common task for the catalog reviewer as well as individual providers is matching of fin photographs with individuals already in the catalog. Previously handled by strictly desktop software and processed with a static circulation form, we have developed a prototype online interface for fin matching where the relevant researchers confirm the fin matching with interactive, dynamic, content-rich online form (Figure 4), exemplifying the use of editing workflows to add value to observational data. The lead SEAMAP developer of this system, Ei Fujioka, demonstrated and discussed the Photo-ID prototype with the MADBC community at the Southeast Atlantic Marine Mammal Symposium in March of 2007 where it was received with high approval.

Figure 4. Photo-id data type showing photo for geo-referenced observation and identification of an individual dolphin.

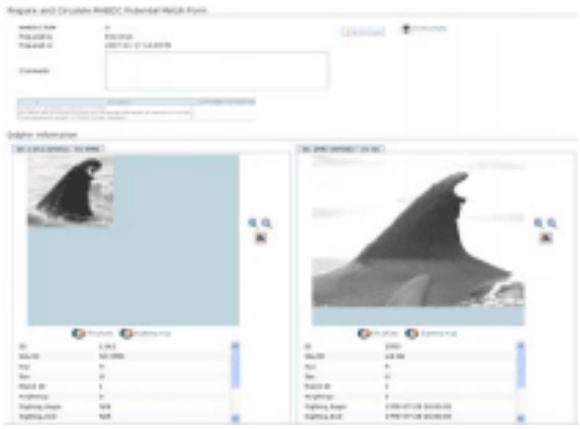

Figure 3. Photo-id matching of dolphin fin photographs with individuals already in the catalog.

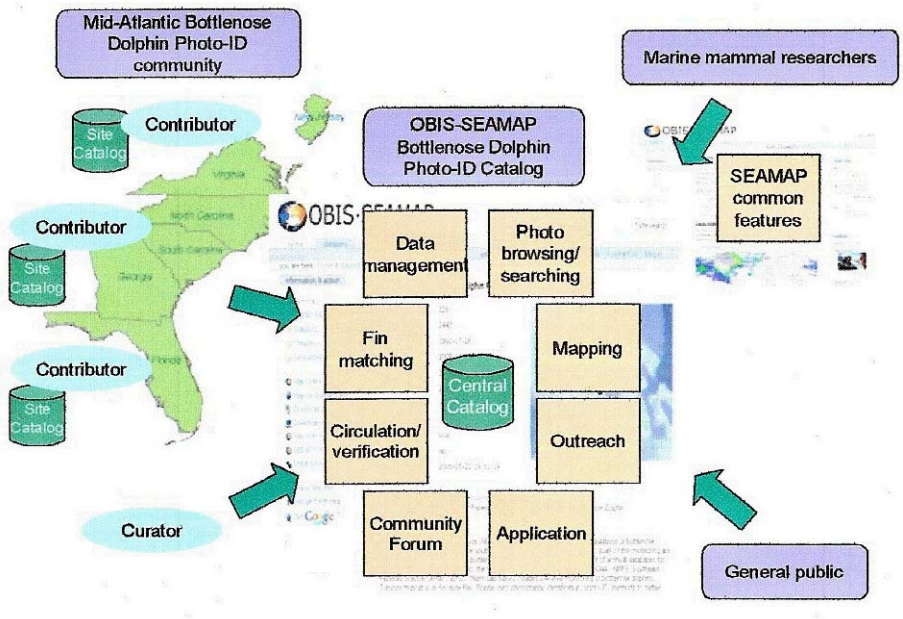

Figure 5. Overview of Photo-ID community members (rounded boxes) and functional aspects (square boxes) for prototype MADBC catalog in OBIS-SEAMAP.

Acoustic location data can provide observations of marine mammals in times and areas where traditional survey methods are not possible. Types of acoustic monitoring systems for potential inclusion in SEAMAP include: moored single stations, such as pop-up ocean bottom recorders, such as the Acoustic Recording Package (ARP) and High-Frequency Acoustic Recording Package (HARP); bottom-mounted fixed arrays; towed arrays and autonomous gliders. Storage and mapped representation of these data require addressing: (1) how to visualize long-term records obtained from a single monitoring site; (2) how to reflect uncertainty in two- and three-dimensional position estimates derived from listening arrays; (3) how to deal with both archival and real-time monitoring systems; and (4) what novel types of meta-data are required to describe these systems and their limitations. These issues were not resolvable within the year contract period, but will be addressed through subsequent SEAMAP funding from NSF through NOPP. We have been in discussion with the Macaulay Library of the Cornell Laboratory of Ornithology who contributed a letter of support for collaborating in this endeavor (Figure 6).

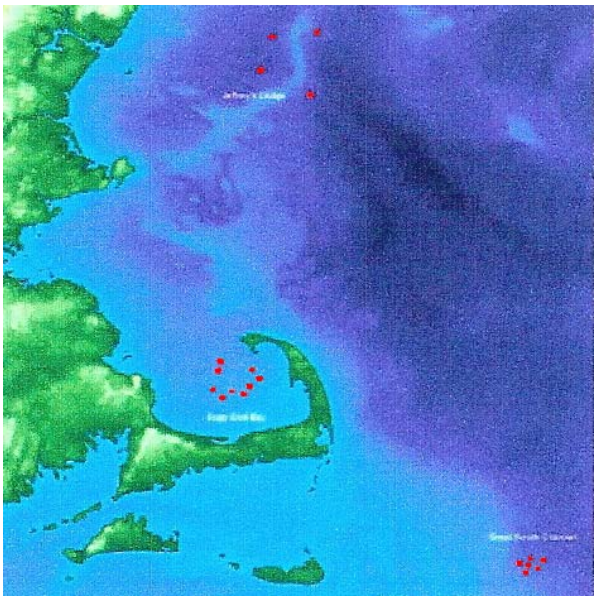

Figure 6. Location of acoustic monitoring stations deployed to detect right whales in New England (2004-2005). Figure courtesy of Dr. Chris Clark, Cornell University.

Task 4: *Interact with scientific communities.*

We presented on SEAMAP at the December, 2006 International Conference on Ecological Informatics in Santa Barbara, CA where we were invited to contribute to a special issue in the journal of Ecological Informatics. The manuscript was accepted with minor revisions, which were submitted in June:

Best, B. D., P. N. Halpin, E. Fujioka, A. J. Read, S. S. Qian, L. J. Hazen, and R. S. Schick. 2007 *in press*. Application of Geospatial Web Services within a Scientific Workflow: Predictive Modeling of Marine Mammal Habitats. Ecological Informatics.

Abstract. Our ability to inform conservation and management of marine species is fundamentally limited by the availability of relevant biogeographic data, use of statistically robust predictive models of species habitat ranges, and the presentation of results to decision makers. Despite the ubiquity of presence-only models, where available, survey effort should be included in the modeling process to limit spatial

bias. The biogeographic archive therefore should be able to store and serve related spatial information such as lines of survey effort or polygons of the study area, best accomplished through geospatial web services such as the Open Geospatial Consortium (OGC) Web Feature Service (WFS). Ideally data could then be easily fetched by modelers into a scientific workflow, providing a visually-intuitive, modular, reusable canvas for linking analytical processes without the need to code. Species distribution model results should be easily accessible to decision makers, such as through a web-based Spatial Decision Support System (SDSS). With these principles in mind, we describe our progress to date serving marine animal biogeographic data from OBIS-SEAMAP (http://seamap.env.duke.edu), and consuming the data for predictive environmental modeling of cetaceans. Using geospatial web services to automate the scientific workflow process, marine mammal observations from OBIS-SEAMAP are used to sample through date-synchronous remotely-sensed satellite data for building multivariate habitat models using a variety of statistical techniques (GLM, GAM, and CART). We developed custom scientific workflows using ESRI Model Builder, ArcGIS geoprocessor, R statistical package, Python scripting language, PostGIS geodatabase, and UMN MapServer. These model outputs are then passed to an SDSS with spatial summary capability. Custom products will be open-source and freely available. In the future, we hope to integrate technologies such as OGC WCS, OPeNDAP, and Kepler. The principles and lessons described here can be broadly applied to serving biogeographic data, species distribution modeling, and decision support within the ecological informatics community.

Task 5: *Enhance portal functionality.*

The SEAMAP system will continue to evolve technically by enhancing the interfaces for users, data providers, and other portals. We have focused development on open-source software and open standards for data exchange, while accommodating for the most common commercial clients, e.g. Microsoft Excel and ESRI ArcGIS. We intend to expand these interfaces to meet the latest standards in technology, while promoting interoperability, particularly within the eco-informatics community.

The portal website has been steadily improved over the contract period. Most notably, the interactive mapper has been upgraded with advanced functionality using AJAX and Google Maps (Figure 7, http://seamap.env.duke.edu/prod/mapservice/googlemaps/seamap_gm.phtml). You can now upload local geospatial data into the map (in the form of shapefiles or KML files). The online help has been dramatically improved with a task-oriented view. Maps with specific oceanographic layers (e.g. SST, Chl or SSH) and biological records (e.g. by dataset, species, time, …) can be saved with an ID for future retrieval or sharing with others. The saved map can also be consumed with WMS clients such as ArcGIS Desktop. Regions of interest can be input through a variety of methods (interactive clicking, entering coordinates or polygon file upload) for subsequent querying of the SEAMAP archive. For a full set of the upgrade features see http://seamap.env.duke.edu/help/online_mapping/index_gm.html.

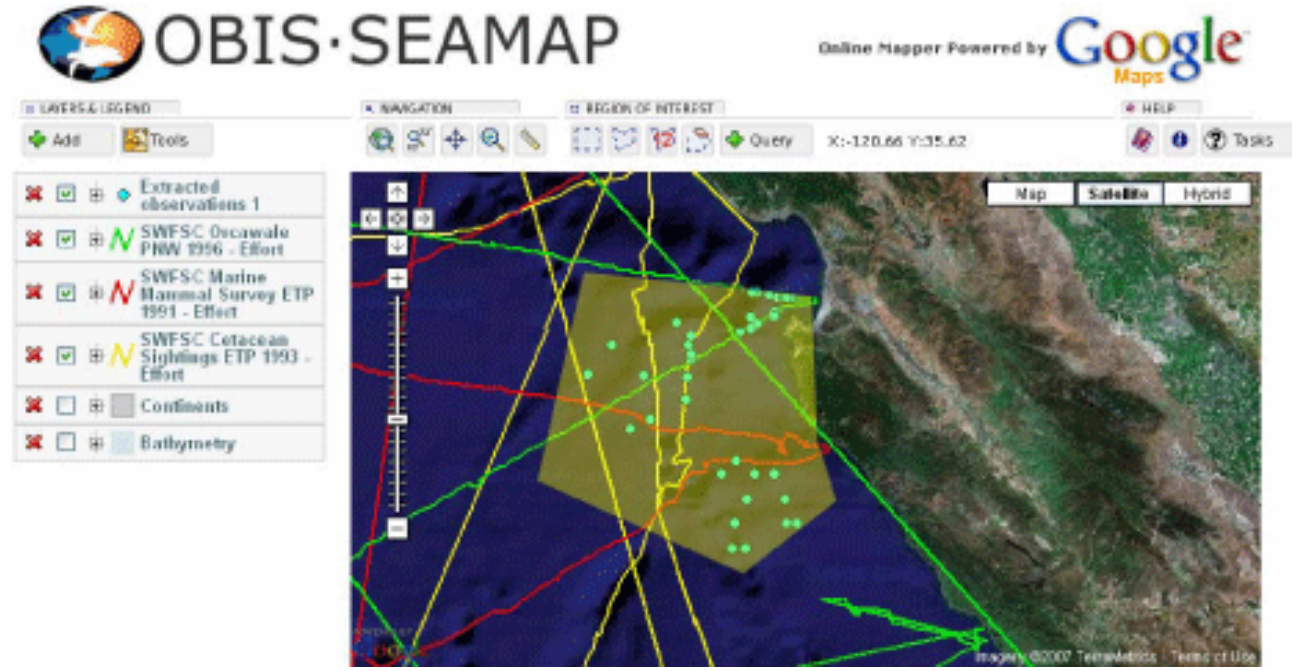

Figure 7. Upgraded SEAMAP interactive mapper displaying a region of interest, or polygon, drawn to query for humpback whales off Monterey Bay, CA and return the observations and survey effort from available datasets.

Initial Distribution List

1.	Defense Technical Information Center 8725 John J. Kingman Rd., STE 0944 Ft. Belvoir, VA 22060-6218	2
2.	Dudley Knox Library, Code 013 Naval Postgraduate School Monterey, CA 93943-5100	2
3.	Erin Oleson Scripps Institution of Oceanography University of California La Jolla, CA	1
4.	John Hildebrand Scripps Institution of Oceanography University of California La Jolla, CA	1
5.	John Calambokidis Cascadia Research Collective Olympia, WA	1
6.	Greg Schorr Cascadia Research Collective Olympia, WA	1
7.	Erin Falcone Cascadia Research Collective Olympia, WA	1
8.	Ching_Sang Chiu Office of Naval Research Washington, DC	1
9.	Curtis A. Collins Naval Postgraduate School Monterey, CA	1
10.	Thomas A. Rago Naval Postgraduate School Monterey, CA	1

11.	Tetyana Margolina Naval Postgraduate School Monterey, CA	1
12.	Chris Miller Naval Postgraduate School Monterey, CA	1
13.	John Joseph Naval Postgraduate School Monterey, CA	1
14.	Katherine Whitaker Pacific Grove, CA	1
15.	Frank Stone N45 Washington, D.C.	1
16.	Jay Barlow Southwest Fisheries Science Center, NOAA La Jolla, CA	1
17.	CAPT Ernie Young, USN (Ret.)	1
18.	Dale Liechty N45 Washington, D.C.	1
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