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# *EVOS ANNUAL PROJECT REPORT*

***Project Number: 02584***

***Project Title:*** Evaluation of Airborne Remote Sensing Tools for GEM Monitoring

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***Time Period Covered by Report:*** March 2002 to the present

***Date of Report:*** October 1, 2002

***Work Performed:***

Data collection for this project was completed during the 2002 field season over two sampling periods: May and July in coordination with GLOBEC research cruises. These data included: lidar (light detecting and ranging using a green laser), SST from an infrared radiometer, ocean color and index of ChlA from a MicroSAS and derived from RGB video, video imagery from simultaneous RGB and thermal infrared video cameras, and visual sightings. The data derived from these sensors and incorporated into databases from the processed data include: locations, relative size, and density of fish schools and patches of zooplankton, SST, ChlA, location and dynamics of ocean fronts, and location and numbers of marine mammals and seabirds. Also archived is coordinated data from shipboard collections used to validate and interpret airborne derived measurements.

The objectives for this project were:

1. Determine the types of information that can be collected from remote sensing instrumentation and the limitations of the collection.

This determination has been made and will be described fully in the final report (extended deadline December 2003).

2. Interpret the information collected in an ecological sense;
   a. Describe general distribution patterns of plankton, fish, and predators
   b. Determine the spatial relationships of the biological features to one another
   c. Describe ocean structure in terms of chlorophyll, SST-SSS, and ocean fronts.
   d. Determine how the biological structure is related to the ocean structure

We are in the process of completing these tasks.

3 Evaluate the extent of data collected and cost-effectiveness per unit area

This determination has been made and will be included in the final report.

4 Evaluate the limitations and usefulness of the interpretation in relation to GEM questions.

This task is not completed.

There are two deviations from the originally proposed project. First, we have asked to extend the final reporting deadline to December of 2003. Secondly, we have requested that the final report for this project be combined with the final report for the overlapping project funded by NOAA under the Steller Sea Lion Research Initiative. The NOAA project was much larger and extended the study area for aerial remote sensing over much of the GEM-defined region. In addition, the NOAA project funded sampling for two years over 3-4 sampling periods each year, in contrast to the single data stratum proposed under EVOS. As a result, the data products of the combined projects will be a more comprehensive report that a single report for EVOS. Under the combined final report, we will include several draft publications relevant to EVOS project objectives as apposed to a single publication for the EVOS project alone. Progress reports, including work funded by the combined EVOS-NOAA SLLRI monies, can be accessed at the following site:

***http://www.afsc.noaa.gov/Stellers/theme_assessment.htm***

and clicking on the title: "Comparison of prey availability and ecology in Steller sea lion foraging regions: a coordinated aerial remote sensing study".

***Future Work:*** No additional field work is planned. Instead we are focusing on data archival, data analysis, and report preparation. The following publications are in process for the combined EVOS GEM and NOAA SLLRI projects:

1. The effect of storms events on biological structure in the surface waters over the western continental shelf of the Gulf of Alaska. Co-authors Churnside and Brown
   This paper will demonstrate how storm events potentially change foraging fields for Stellar Sea Lions. The implications are that during particularly stormy years, prey availability and thus foraging success would be affected.

2. Regional comparison of oceanic biological structure between eastern Kodiak Island and northern Southeast Alaska. Lead author; E. Brown with host of co-authors
   This paper compares the marine ecosystem in a region with healthy Steller sea lion population (Southeast Alaska) with a region with a depressed population (Kodiak). This is a core paper that may provide clues or eliminate hypothesis concerning bottom up control that regulates sea lions. In the absence of coordinated ship data, we will analyze only data derived from the airborne platform.

3. Spatial variability in Chl A, biological structure, and SST in surface waters across the Gulf of Alaska basin and shelves. Lead author; E. Brown.
   This paper directly addressed objective 8 and was presented at the January workshop in Anchorage. The power point file for this presentation file has been posted (via the efforts of Lowell Fritz) on the AFSC NMFS web server.
4. Ship avoidance of capelin (*Mallotus villosus*) and walleye pollock (*Theragra chalcogramma*) and the implications for ship-board survey results. Lead author; J. Churnside.

This paper describes results from synoptic airborne and shipboard surveys in an area known to be dominated by pollock and another dominated by capelin. In each flyover, we recorded the surface structure and changes in signal strength as a function of distance to the ship. Preliminary results were shown in the last interim report. These results have severe implications for interpretation of shipboard results of two intermixed species including one that has known ship avoidance behavior (capelin) and another that does not (pollock). The behavior of these two species is very different as capelin are tightly schooled and exhibit dynamic horizontal and vertical movements while pollock are loosely aggregated and do not exhibit dynamic movements. In this case, acoustic signal may be improperly interpreted if proportion of capelin signal is derived from deep-water trawl catches that contain capelin yet ship avoidance behavior excluded that proportion of capelin from acoustic signal. This phenomenon has been documented in Iceland, especially during the summer when capelin exhibit near-surface distributions as they feed on plankton blooms. If sea lions are utilizing capelin in the summer and research on foraging ecology depends on ship-board results, the potential for error may be high.

5. Using airborne remote sensing to map zooplankton standing stocks, associated ocean conditions, and to develop community-level optical signatures. Lead author; E. Brown.
   This paper was presented at the joint ICES-GLOBEC conference on zooplankton that occurred in late May of this year. One of the most important uses of airborne remote sensing will probably be in the study of zooplankton. Establishing the spatial and temporal scale of zooplankton population and community structure dynamics. Slow moving ships are often not able to capture both types of scale as communities can exist over hundreds of kilometers while changes can occur in a matter of days in respond to storms, changes in hydrography, wind mixing, and grazing. Airborne techniques show great promise in helping to establish both scales simultaneously. Here we show data from a coordinated ship-airborne survey that occurred in the GLOBEC study region in the northern Gulf of Alaska. Significant correlations were found between depth-specific lidar signal and depth-specific zooplankton densities or abundance only when compared as species groups. Differences in the correlation coefficients between signal and density or abundance of species groups were attested to differences in optical signatures among groups. Correlations were also documented between oceanographic data collected by airplane and zooplankton density or abundance data collected by ships. These results pave the way for new methods of studying plankton at sea.

***Coordination/Collaboration:*** For the EVOS portion of the remote sensing project, have worked and will continue to work with Tom Weingartner (Chief Scientist GLOBEC NGOA) and Ken Coyle (Acoustician and GLOBEC zooplankton specialist) in comparing airborne and shipboard data. We have already performed a comparative analysis of GLOBEC zooplankton data and data derived from lidar (see May 2003 talk below). Our overflights were coordinated with the GLOBEC LTER cruises in 2000 and 2002 and data sharing continues.

***Community Involvement/TEK & Resource Management Applications:*** This project does not have a TEK component. We hope that the web site at:
***http://www.etl.noaa.gov/programs/marine/***

provides educational opportunities for those interested in marine remote sensing.

***Information Transfer:*** No publications have been completed so far under this project. The final report will have drafts of 3 papers for journal submissions. During the course of this project, the following presentations were given at various meetings:

January 2003 EVOS/GLOBEC/NOAA SSL Meeting:
"Spatial Variability in Ocean Productivity and SST Across the GOA Basin and Shelves", Brown, Montes, and Churnside. (see presentation at
***http://www.afsc.noaa.gov/Stellers/pptpresentations.htm*** )

May 2003 ICES/PICES International Zooplankton Conference:
"Using airborne remote sensing to map spatial variability in zooplankton patch size, standing stocks, associated oceanographic conditions, and to identify zooplankton communities by optical signatures", Brown, Montes, Churnside, and Coyle.

May 2003 International ASPRS Meeting:
"Effects of topography and storm events on nekton and plankton structure in near surface waters of Western Gulf of Alaska", Brown, Montes and Churnside.

In addition, we will be giving the following talk at the SEARCH meeting in October:
"Using airborne remote sensing, coupled with satellite and shipboard data, to map changes in coupled physical and biological processes in the ocean", Brown, Montes, Churnside, and Collins

The web site at: http://www.etl.noaa.gov/programs/marine/ provides some project information and progress. Processed data from 2000-2002, included data funded by this study, will be archived at three spatial scales in the IMS database with web browse-capable retrieval. These data include lidar, SST from the infrared radiometer, ocean color from MicroSAS and from RGB video, and header data for video imagery. This is planned for November of this year.

***Budget:*** There has been no change to the total amount allocated to this budget. The only change is that travel funds slated for a scientific meeting were used to fund field data collection travel instead.

***Report Prepared By:*** ***Evelyn D. Brown***
***Project Web Site Address:*** http://www.etl.noaa.gov/programs/marine/