COASTAL RECREATIONAL FISHING LICENSE

ANNUAL PERFORMANCE REPORT

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Grant Award #:
DENR Contract # 2225

Grant Title:
Development of a Performance-Based Submerged Aquatic Vegetation Monitoring and Outreach Program for North Carolina

Grant Award Period:
May 1, 2009 to June 30, 2010

Performance Reporting Period:
Progress Report #2: November 2009 to March 2010

Project Costs:
Award

Phase I award:	$110,738
Phase II pending:	$196,951
Total:	$208,689

Expenditures for the Period:

Category	**Expenditures**
Personnel	
Fringe	
Travel	
Equipment	$ 6,325.40
Supplies	
Construction	
Contractual	$ 2,810.15
Other	
Total Direct	
Indirect	
TOTAL	$ 8,135.55

Total Cumulative Expenditures:	$ 8,135.55
Total Remaining Balance:	$102,602.45

Description of Work**:**

The North Carolina Coastal Habitat Protection Plan (CHPP) (Street et al. 2005) identified the need for an SAV monitoring program as a future priority in North Carolina. Subsequently, the CRFL Strategic Plan identified SAV monitoring as a priority (see CRFL Strategic Plan Management Goal--Habitat, Objective 2, Strategy H.2.3). This goal calls for monitoring of submerged aquatic vegetation (SAV) habitats throughout the coastal area including distribution and health of SAV habitats. To date, SAV monitoring efforts in N.C. have largely been small, isolated, short-term research oriented studies. There has never been a comprehensive and synoptic statewide monitoring program to the assess status and trends of SAV.

In 2007, the first-ever NC coast-wide aerial digital imagery survey was coordinated and funded by a cooperative interagency agreement between APNEP, NCDMF, NCWRC, NOAA, and USFWS to map the distribution and abundance of SAV. Remote sensing of SAV by any method necessitates quantitative ground truthing for validation and statistically valid error assessments of interpreted imagery. Consequently, there is an immediate need to develop statistically valid, practical and affordable techniques for monitoring and ground truthing SAV. The overall goal of this project is to develop performance based SAV monitoring protocols for the state of North Carolina. This project has four main objectives:

1) Develop and test a sampling protocol for a long-term, in-the-water probabilistic based method to monitor the distribution and change in SAV habitat in coastal waters statewide, and evaluate the relationship between environmental conditions and SAV distribution;
2) Determine the feasibility of developing a protocol with a performance measure capable of detecting at least a 10% inter-annual change in SAV abundance;
3) Compare a point-intercept visual census technique using low-light underwater cameras with a hydro-acoustical technique to determine the most appropriate method of monitoring and data acquisition;
4) Draft a long-term statewide monitoring plan for SAV.

Originally, there was a fifth goal incorporating an outreach effort to disseminate information and educate and inform resource managers and the public on the value and status of SAV and the critical role of monitoring and conserving SAV habitat. This goal was not funded in the first year of the project.

Project Status/Work Accomplished:

For each objective, describe tasks scheduled for the reporting period and the activities undertaken to complete them. Describe the specific accomplishments, and list products (publications, web pages, data, technology, etc.) completed during the reporting period. Attach copies of the publications, as appropriate.

A. General Planning and Mobilization

Since October 2009, staff conducted two project meetings in Greenville at ECU to present and discuss protocol and technique development, accomplishments, and the results of analyses based on completed field work. Presentations covering all aspects of the project were delivered and discussed. At these meetings the project staff also considered study site selections for future field work, equipment modifications, data manipulations, budget and

equipment purchasing, and project deviations. Additional planning was conducted by phone and email communications throughout the reporting period.

B. Specific APNEP Tasks

A new video camera, field (rugged laptop) computer and a custom designed pole camera mount were purchased and delivered to NOAA staff for use during the project. APNEP continues to work with NCSU, ECU, and NOAA to administrate the project through contacts 2432 & 2428.

C. Specific NOAA/NCSU Tasks

The project objectives addressed by each task are listed in parentheses.

Task 1 (Objective 1):
Configure and test video data acquisition equipment.

Outcome **-** The new video camera, field (rugged laptop) computer and a custom designed pole camera mount was configured and tested for use in field data acquisition. As a result data acquisition efficiency was improved.

Task 2 (Objectives 1 & 2):
A comprehensive analysis was competed for the field monitoring data using video transects and in-situ diver surveys at a high-salinity SAV site in Carteret County.

Outcome **-** Enabling evaluations of: 1) the equipment performance and capabilities, image quality, 2) limitations of the environmental conditions (e.g., tide, wind, water depth, boat speed), 3) the time/cost required to mobilize, acquire, process and interpret the video data, 4) the effect of transect direction and position (shore normal vs. shore parallel), 5) the statistical properties of the data (e.g., spatial and transect variability), 6) a full power analysis to evaluate the capability of detecting a 10% change in SAV coverage at the study site. The results from our first analysis of a high-salinity SAV site indicated that our ability to detect a 10% change in SAV at a sufficient power (0.8) would require 50 transects. 7) Results of the power analysis were evaluated by the staff to modify future sampling protocols and study site selections and compare SAV coverage from video surveys to SAV coverage from acoustic data acquired in the next section D.

Task 3 (Objective 2):
A statistically valid experiment was designed and initiated to calibrate intra- and inter-observer video classification. Appropriate interpretation of monitoring data acquired by video requires a comprehensive understanding of sampling variation. Observer classification is a potential source of sampling variation that must be quantified.

Outcome **-** Video data of varying quality acquired at the high-salinity SAV site in the first phase of the study (see Task 2) was compiled into a series of 12 different segments for viewing and analysis by replicate novice and experienced interpreters. This experiment is testing whether there are significant differences in observers and whether there is a dependence on image quality. We are also evaluating how long it will take to train observers to classify video and estimating the cost of training and classification time.

Task 4 (Objective 2):
Based on findings in task 2 we have reassessed our sampling approach to now incorporate a combination of the 2007 statewide SAV imagery and another 2006 imagery source, obtained and interpreted by NOAA-CCFHR to identify and select high-salinity sampling sites.

Outcome **-** We determined there are several advantages to this approach. First, the high quality of the imagery allows us to select and sample a wider range of variation in SAV distribution that cannot be accomplished by field work alone. Second, the quality of the digital imagery allows us to extract and analyze the SAV cover information such that we can conduct both intensive and extensive sampling of the site on a computer platform instead of spending hundreds of hours in the field. In order to determine if this was a feasible and quantitative approach we selected and processed a high-salinity SAV image from Bogue Sound in Carteret County as described below in task #5.

Task 5 (Objective 2):
Create a digitized binary habitat from aerial imagery and complete a power analysis for a 10% and 20% change in SAV on simulated transects through the habitat.

Outcome **-** We extracted seagrass distribution data in a 300m x 300m area from the digital imagery using the Iterative Self-Organizing Data Analysis Technique (ISODATA) unsupervised clustering algorithm. In remote sensing clustering algorithms, pixels with similar spectral properties are assigned to subsets (called clusters). ISODATA is iterative because it makes a large number of passes through the dataset until specified results are obtained. The ISODATA algorithm was used to form 100 initial clusters. These clusters were then labeled by personnel experienced in interpreting imagery to derive seagrass coverage. Even though the classification was to be binary (seagrass or bare substrate), it was important in the initial cluster labeling to identify a much larger number of classes. For example, several different classes of seagrass were identified based on natural brightness variation caused by variation in depth. Then iterative ISODATA classifications were performed on each major category individually by masking out all other major categories. Referred to as "cluster busting", the computer is allowed to query the multispectral properties of the masked scene using user specified criteria to identify x mutually exclusive clusters in n-dimensional feature space. By masking out all data but a single category, the spectral variance is greatly reduced, thus decreasing classification errors. After several classification iterations of the masked data, final classification labels were assigned to the spectral clusters. The final product delivers a matrix of geo-spatially referenced pixels containing the information for SAV coverage identical in to the original image and at a scale equivalent to the size of an individual frame in each video image captured in the field (0.3 meter). The output file was then imported in R software environment and programmed to sample the matrix and conduct a power analysis. Two types of surveys were simulated; systematic sampling (SYS) and simple random sampling (SRS). Simple random sampling involved generating random numbers on the base line (the southern terminus of the sampled area) without replacement. For SYS, the starting point for the first transect was randomly sampled from the discrete set $\{1, 2, \ldots, M\}$, where $M = \text{floor}(902/n)$ and n is the number of transects. Following random selection of the first transect location, remaining transects were evenly spaced M pixels apart.

Changes in SAV coverage were simulated by drawing SAV presence for pixel i, Z_i, from a

Bernoulli (Z_i, p) distribution (p was 0.9 for a 10% decline and 0.8 for a 20% decline). Power and type I error was calculated for each procedure by simulating 100 datasets for 5, 10, 15, …, 50 transects and calculating the number of times that statistical tests rejected the null hypothesis of no decline. For SRS, we employed two-sided t-tests. For SYS, we used formula for SRS since there is no unbiased variance estimator available. Overall, this analysis revealed that there was reasonable probability of detecting a population decline of 20% if 15 or more transects were employed. However, nearly twice the effort would be needed to detect changes of 10%

Task #6 (Objective 2):
To further improve our power for detecting change in SAV cover and to increase our sample size and data collection efficiency, we expanded our sampling effort by utilizing computer simulated transects to include the broader range of cover categories in high-salinity SAV distribution.

Outcome **-** Digital multispectral imagery was collected for the study area with Intergraph's Z/I Digital Mapping Camera (DMC). The images covering Bogue, Back (including the Newport River site) and the mainland side of Core Sounds, were captured on May 31, 2006. The aircraft was flown at a height of 3,048m. Imagery with a spatial resolution of 0.3m was produced. DMC is a CCD frame camera with the four spectral bands: blue (400-580 nm); green (500-659 nm); red (590-850 nm) and near infrared (675-850 nm). Core Banks from Cape Lookout to Ocracoke Inlet was captured October 15, 2007, with DMC flown at a height of 7,315m. Imagery with a spatial resolution of 1.0m was produced.

The imagery was loaded into ArcGIS for manual on-screen digitizing. Digitizing scale was typically set to 1:1,500 except where larger homogonous areas required zooming out to a greater extent, which was usually accomplished at approximately 1:6,000. Habitat boundaries were delineated around benthic habitat features (e.g. areas with visually discernable differences in color and texture patterns). The scanned images were occasionally manipulated in terms of brightness, contrast and color balance to enhance interpretability of subtle features and boundaries. This was extremely helpful, especially in deeper water where subtle boundaries or problems caused by turbidity can make features difficult to detect.

Seagrass beds differ in form and size due to a number of effects including current, wave effects and depth. Four of the most common bed forms found within North Carolina are: 1) shoreline fringing, narrow to medium width; 2) open water; 3) beds within open areas of salt marsh and 4) shoreline fringing, wide width. Shoreline fringing narrow to medium width beds are the most common form in many areas of North Carolina. Some of these beds can be several kilometers long and from 10 to 250 m across. They can be patchy or dense, depending on the effects of current and exposure to wind/waves. Open water beds are less common than fringing beds, found in shallow areas sufficiently protected from winds and currents. In some *Spartina alterniflora* marshes, considerable areas of seagrass can be found within open water areas of the marsh. The vast areas of seagrass occur in the wide, shoreline fringing beds that lie up against the sound-side shorelines of the Outer Banks between Cape Lookout and Oregon Inlet. These beds are most often dense seagrass closest to shore and patchy seagrass further out to the deep water edge. They can run up to 10 km along the shoreline and be 2 to 3 km wide. Where they exist they commonly dominate the areal coverage of seagrass for the area. For instance, in Carteret County, NC, the sounds between Bogue and Ocracoke Inlets contain 11,557 ha of seagrass, 8,241 ha, or 71.3% of the Carteret County total is located in the wide fringing beds of Core Banks between Cape Lookout and Ocracoke Inlet.

To date, three SAV cover types have been classified and extracted from the imagery: shoreline fringing narrow to medium width, patchy, and dense with blowouts. These three have been prepared for sampling and power analyses. A power analysis for detecting 10% and 20% change is being conducted to determine minimum sampling effort required as a function of the cover type and variability in the cover. Additional cover types and replicates of cover types are being identified.

Task 7 (Objective 4):
Review available information on state, federal, and international SAV long-term monitoring programs.

Outcome **–** A comprehensive evaluation of the outcomes and costs of all known long-term SAV monitoring programs is being conducted.

D. Specific ECU Tasks:

The project objectives addressed by each task are listed in parentheses.

Task 1 (Objective 1): Configure already existing ECU acoustic echosounder hardware and software to conduct and analyze an acoustic survey of a high-salinity SAV site in Carteret County, NC along with the NOAA/NCSU team listed above in Section C, Tasks 1 and 2.

Outcome - The acoustic survey was completed at the high-salinity site in June 2009. This task included an evaluation of: 1) the BioSonics DTX equipment performance and capabilities, including set-up of the acquisition hardware on the NOAA vessel and evaluation of Visual Acquisition software for acquiring the data; 2) examining software output (ECOSAV algorithm), adjusting the algorithm's parameters and resulting echograms; 3) determining limitations of the environmental conditions (e.g., tide, wind, water depth, boat speed) on echosounder performance, 4) the time/cost required to mobilize, acquire, process and interpret the acoustic data, 5) the effect of transect direction and position (shore normal vs. shore parallel), and 6) the statistical properties of the data (e.g., spatial and transect variability). A map of the SAV, including % cover plant and based on acoustic data obtained at this Carteret County site, was produced.

Task 2 (Objective 1): Conduct and analyze an acoustic and video survey of a low-salinity site in Chowan County (Sandy Point, NC).

Outcome **–** We conducted and analyzed an acoustic survey in July 2009 using underwater video reconnaissance (but not a full video survey using the techniques described in Section C) of a low-salinity site in Chowan County (Sandy Point, NC). We examined the software output (ECOSAV algorithm), adjusting the algorithm's parameters and reviewing resulting echograms. Some issues with the high plant biomass and canopy height near the surface and the transducer were discovered during analysis. Map of the SAV based on acoustic surveys along the Sandy Point shoreline was produced.

Task 3 (Objective 2): Conduct a power analysis using acoustic data.

Outcome – We conducted the power analysis of acoustic data from the high-salinity site in Carteret County to evaluate the capability of detecting a 10% change in SAV coverage at the study site. The results from our first power analysis of acoustic data obtained at the high-salinity SAV site indicated that our ability to detect a 10% change in SAV at a sufficient power (0.8) would require approximately 3 times as many transects (~75 transects) as collected in the 2009 survey (25 transects). Although this would be intensive sampling for the video technique discussed above (~9 days to simply acquire the video images, and even more to analyze it), this is not an unreasonable amount of surveying for the acoustic method and could be completed in a single day's effort.

Task 4 (Objective 3): Comparison of the data from video and acoustic sampling techniques for obtaining SAV coverage at the high-salinity site.

Outcome – The APNEP, ECU and NOAA/NCSU teams examined and discussed limitations of the two methods. Limitations of the acoustic method (canopy height detection limits, i.e, plant height < 3.5 cm cannot be discriminated from sediment background, the lack of SAV species identification) and benefits (low-cost of acquisition and analysis). We compared the acoustic results obtained simultaneously with the video technique limitations (the high cost of acquisition and analysis) and benefits (direct SAV detection at low canopy height and species identification).

Task 5 (Objective 4): Presented the results of the two SAV acoustic surveys (Tasks 1 and 2, high-salinity and low-salinity sites), our power analyses (Task 3), and comparisons of acoustic and video SAV coverage data (Task 4) to the NC SAV Partnership meeting in Fall 2009.

Outcome – The presentation files that ECU, NOAA/NCSU staff produced were distributed and shared with the participants of the NC SAV Partnership and were made available for NCDMF staff to review. We plan a further meeting with NCDMF habitat team to review our studies to date.

Deviations:

If there were changes to the goals/objectives during the reporting period, please detail the circumstance and nature of change. Explain any special problems or circumstances which prevented the accomplishment of scheduled tasks. Describe actions to resolve problems encountered and provide the details of any changes made to goals and objectives of the project.

No significant deviations. Goals and objectives remain the same. Please note that the original proposal to CRLF fund included a request for an outreach specialist to be hired. However, the Fishery Commission's review of the proposal, and the adjustment of the budget, the full-time temporary Educational Outreach Specialist position was not funded to develop, implement and distribute products that fulfill the outreach mission. Also, as noted in the October 29 progress report, funds were transferred to ECU in a sub-contract on September 15, not 1 July, 2009; ECU was reimbursed for work done in June and July 2009 by APNEP, but we did not complete all the surveys planned for the first year in the original proposal. We plan on completing these field surveys in May – June 30 2010. As a result, we are requesting a no-cost extension for the project from CRFL.

Additional Guidance:
If your scope of work is broken into discrete jobs/tasks, please use the Job/Task titles as subheading under which to report accomplishments.