Progress Report and Revised Budget

Deployment of an acoustic data logger on commercial fishing vessels to evaluate the potential of fishing-induced declines in local pollock abundance

by

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October 15, 2003

PROJECT DESCRIPTION

We undertook a "proof of concept" project to evaluate the feasibility of installing acoustic data loggers on catcher/processors in the EBS pollock fishery to study localized depletion of pollock. The project is developing a prototype data logger that interfaces with the ship's 38 kHz echo sounder and captures the acoustic backscatter returns. In 2002, we developed the system and installed it on three catcher/processors (Island Enterprise, Kodiak Enterprise, and Alaska Ocean). The system has been tested and implemented and works quite satisfactorily. The backscatter data is post-processed and integrated with observer and logbook data. A preliminary analysis has been conducted that shows that the devices record information that is correlated with pollock catches. Further work will include classifying the searching behavior of the vessel, identifying pollock aggregations detected while searching, and evaluating what inferences, if any, can be made concerning the rate at which those aggregations are reduced in abundance. We believe that this project has resulted in successful implementation of the proof of concept project and in 2003 we moved into the second "operations" phase, where the system was installed on multiple fishing vessels. The project is moving forward in developing more sophisticated analytical tools for inferring the temporal dynamics of pollock spatial pattern using multiple data sources. We propose to hire a technician to assist with data processing and a graduate student with an adequate quantitative background to engage in this type of analytical work.

FUNDING TO DATE

In 2001 this project (SFOS 01-054) was proposed to the PCC Research Center for multiyear funding. The PCC Research Committee approved funding ($23,229) for this project for one year (mainly salary). PCC further requested the investigators to locate other funding for requested equipment. Fortunately, we were able to obtain equipment from a NOAA Technology Grant in 2001 and were able to equip 3 vessels (Island Enterprise, Kodiak Enterprise, and Alaska Ocean) for data collection in 2002 and beyond.

PCC provided additional funding in 2002 ($57,477) to continue this project to evaluate the technology and to develop analytical tools. In 2003 the PCC provided continued funding of $63,968 for this project.

The budget for 2003 included salary for Quinn and Wespestad, travel to the field and for research meetings, and 3 months salary for a Ph.D. graduate student to perform analysis of the acoustic data collected from the ships equipped to collect data. The principal investigators met in Seattle in January, 2003 to review the progress of the project and for future planning. Dr. Tony Booth, Rhodes University, Grahamstown, South Africa, was brought into the project in 2003 and will be provided $5,000 to assist with development of an analytical framework.

To date we have not been able to locate a quantitative student to work on the project. However, we were able to obtain a grant from the Alaska Fisheries Science Center for 2 additional years of student funding for this project. Consequently, it may be easier to attract a student with a guaranteed level of 3 years of support. Currently, two potential applicants have expressed interest and will probably apply to SFOS in Fall, 2003.

OPERATIONS IN 2003

In 2002 acoustic data collection and storage systems were installed on three PCC vessels to test the system. This trial period was used to test and debug the systems and to investigate the feasibility of data collection and the quality of data collected. We were able to rapidly fix problems that developed at the early stages of deployment. One problem was that the computers and operating software were dated on some of the vessels. However, industry cooperative research funding from the Alaska Fisheries Science Center enabled us to upgrade the systems and enable data capture and storage.

In 2003, an additional 4 vessels were equipped with acoustic data logging systems, bringing the total number of PCC vessels equipped to 7, or nearly half the fleet. There are currently at least 2 additional vessels that can be added to the project, but we cannot increase data collection until we have the ability to process and analyze the data already collected.

Vessel Name	ES 60	Year Equipped
Alaska Ocean	√	2002
American Dynasty	√	2003
American Triumph	√	2003
Arctic Fjord		
Arctic Storm		
Highland Light	√	
Island Enterprise	√	2002
Kodiak Enterprise	√	2002
Northern Eagle	√	
Northern Glacier		
Northern Hawk		
Northern Jaeger		
Ocean Rover	√	2003
Pacific Glacier		
Seattle Enterprise		
Starbound	√	2003

Data were collected by retrieving the RAW data files created by the vessels' Simrad EK-60 echo sounder during commercial operations. Approximately 360 Gigabytes (GB) of RAW data have been collected in 2003. Initial processing of the RAW data through Echozip software has reduced file size by on average 85%. We are storing both the processed and RAW data at the Alaska Fisheries Science Center (AFSC) on servers maintained by the Office of Fisheries Information Systems. We have designed and implemented the commercial fishing vessel acoustic database (CFVAD) in order to facilitate storage, tracking, and retrieval of the data.

In 2003, we began to make inter-vessel comparisons. We have begun analyzing the data to determine how comparable EK-60 data from one vessel is with EK-60 data collected from other vessels. The first step of this process was to query the North Pacific groundfish observer program database (NPAC) to find dates where vessels were fishing in close proximity. We selected days in which at least two vessels were fishing within 40 km of each other. These dates were then cross-checked with the CFVAD for matches. The data corresponding to these dates were retrieved and integrated using Echoview software. The integration involved reviewing data

for quality, excluding areas that were not readable due to surface interference, setting a surface line at 15 meters below the surface to eliminate surface noise, setting and proofing a bottom line at 0.5 meters above a maximum backscatter threshold, and integrating between the surface line and bottom line over 250 meter intervals. The integration provided an integrated backscatter value (NASC) for each 250 meters of track. Once integration was complete we were able to select the most promising 24-hour period for more in-depth analysis. The selection was based on quality of data and proximity of vessels to one another.

The 24-hour period selected was in the winter fishery and had two vessels (A and B) fishing within a 40km x 40km area (Figure 1). ARCGIS software was used to plot data onto a map of the Bering Sea and create a 1 km^2 grid of 1600 cells for the 40x40 km^2 area. Vessel A collected data in 258 of the 1600 cells and Vessel B collected data in 257 of the 1600 cells. The vessels collected data in 82 of the same 1 km^2 cells. For each vessel the mean NASC was calculated for each cell in which data were collected. The natural logarithm of the mean NASC values were normally distributed (Figure 2) and revealed that the mean log transformed NASC and variance of the log transformed NASC were not statistically discernable between the two vessels. The significance of these findings has not yet been fully explored. Further analysis is necessary before any firm conclusions can be made.

Dr. Booth, who spent 8 months with Terry Quinn in Juneau, under the auspices of the Fulbright program, will be assisting us in developing an efficient data-mining algorithm for extracting the important information from the disk drives. This work provides a necessary intermediate step for obtaining useful information that a student can then develop into a thesis project. The project investigators met in January, 2003 in Seattle to plan 2003 activities. Quinn also attended the American Fisheries Society meeting in Quebec in August 2003 to learn about similar projects.

Dr. Wespestad traveled to Bergen, Norway to present some of the work to date on this project to researchers at the Norwegian Institute of Marine Research who are interested in establishing a similar program. The scientists in the technological development section of IMR expressed a strong interest in potential future collaborative work. Wespestad also presented a general seminar to the Institute of Marine Research and the Norwegian Fisheries Department on the state of Bering Sea fisheries and management under the new cooperative fisheries system. Wespestad also presented a paper at the ICES annual science conference in Tallinn, Estonia, which included PCC research on the application of commercial vessel acoustic data for stock assessment work.

PROPOSED RESEARCH IN 2004

In 2004 we plan to attempt to calibrate the hydroacoustic system on at least one vessel, and possibly two. We hope that with a thorough system calibration we can standardize the data collected and make inter-vessel comparisons. To conduct a vessel calibration requires anchoring a vessel over water with at least 30 m depth under the vessel so a calibration sphere can be positioned under the echosounder transducer. Preliminary discussions with company operation managers indicate that it may be possible to conduct calibrations in Puget Sound prior to departure for the Bering Sea. If tidal current is not strong, a vessel can be held in position by the

ship's anchor and a trawl door lowered to the bottom. The calibration will require funds ($5000) to cover additional vessel or crew costs.

A data technician will be hired to work at the Alaska Fisheries Science Center with the AFSC investigators. The technician will collect and compile data from the 2003 and 2004 fisheries, and begin initial screening and analysis of data. This work will facilitate the work of the graduate student selected to develop the analytical tools to analysis the data and to provide graphic visualizations.

BUDGET

Previously Awarded Budgets in 2001 to 2003 and Proposed 2004 Budget.

	Awarded		Awarded		Awarded		Proposed	
SALARIES AND BENEFITS	2001		2002		2003		2004	
	Months	Amount	Months	Amount	Months	Amount	Months	Amount
Quinn	0.5	5009	1	10517	1	11358	1	11,534
Student	1	1196	3	4860	8	14416		
TRAVEL		1500		14000		14000		
SUBCONTRACT								
Wespestad		13000		13000		13000		
Booth						5000		
Data Processing Technician @$15.24/hr.							12	30,480
SUPPLIES		0		0		3000		
EQUIPMENT Workstation, Software		0		12000		3000		
Vessel Calibration								5,000
TUITION		3024		3100		194		0
TOTAL		**23,229**		**57,477**		**63,968**		**47,014**

Budget Justification

The budget for 2004 includes 1 month of salary for Quinn, and a subcontract for a data technician to work at the Alaska Science Center to collect, compile, and prepare the data for analysis. We request and anticipate a rollover of previous funds, which provides for total student funding up to 3 years and funds for a full workstation and the acoustic data processing package called Echoview.

To date, the logging system deployed on seven midwater trawlers during 2002 and 2003, has yielded a considerable quantity of data (>1 terabyte). Condensing this quantity of data into useful information involves: 1) downloading and cataloging the data as it is returned; 2) initial processing of the data to exclude unneeded portions; 3) filtering the data to exclude non-biological echo returns; 4) archiving the data on large-capacity storage drives. The contractor will assist with this process, and may be assigned additional projects, such as summarizing the database and compiling a report.

The contractor should possess familiarity with desktop computers and the Windows operating system and software. Familiarity with basic database skills, an ability to work with large datasets, and be meticulous in tracking and cataloging data are essential. The contractor should be proficient with some of the tools necessary for developing and managing a large acoustics database. This includes use of the software Echoview, a package for processing and analyzing acoustic surveying data.

The contractor will work under the supervision of Dr. J. Ianelli, one of the project cooperators. The pay rate proposed is equal to a federal government GS-5 (step 1) rate for a Seattle area employee, multiplied by 1.2 to cover benefits and self-employment tax. Dr. Ianelli would like to employ a Mathew Kookesh, a university student seeking additional training and experience in fisheries. Mr. Kookesh has been volunteering time to work with REFM Division and has been a valuable asset. He has a combination of skills including experience with fisheries and data collection and processing with acoustic equipment. These skills are especially unique, and highly desirable for this project and the AFSC/NMFS.

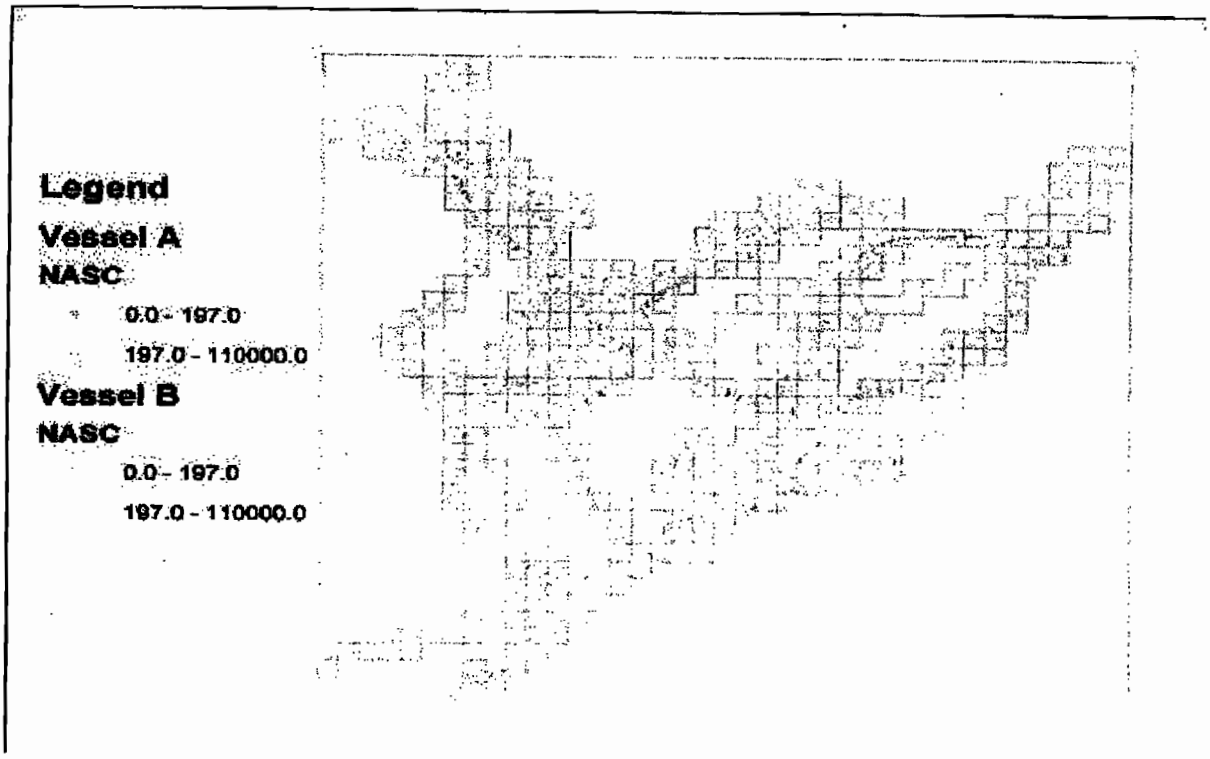

Figure 1. 40km x 40km area with trackline and integrated backscatter over 250 meter intervals and 1km x 1km active cells.

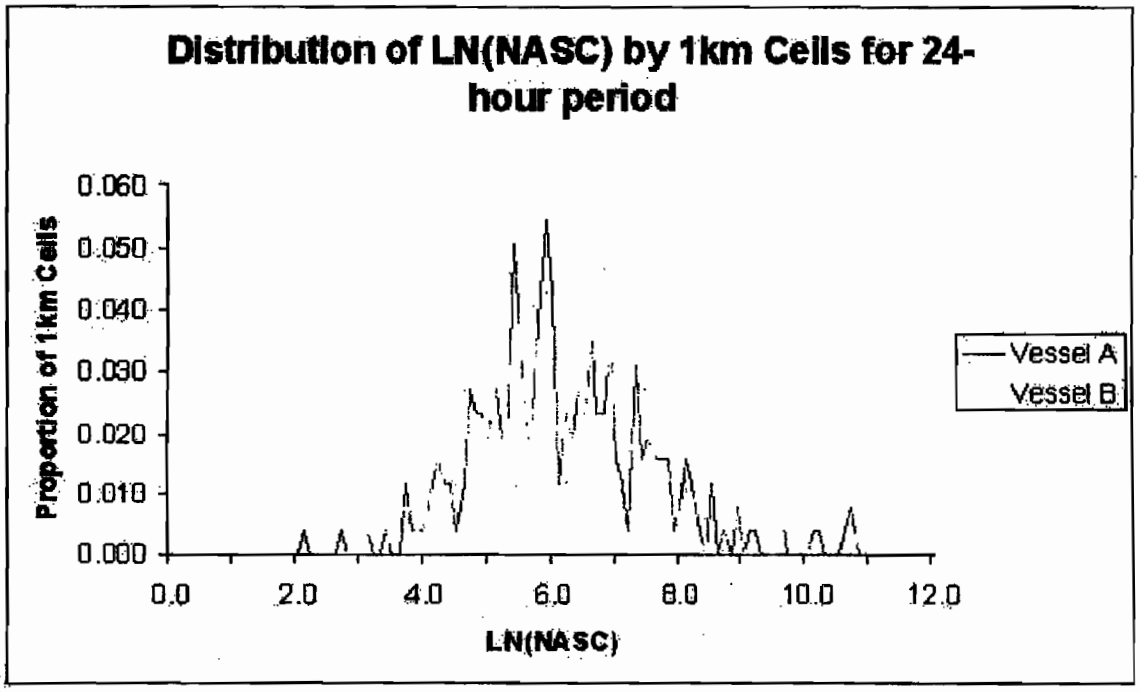

Figure 2. Distribution of backscatter between vessels