NOAA-Fisheries Advanced Sampling Technology Working Group (ASTWG)
FY04 Annual Report

Executive Summary

The long-term goals of the Advanced Sampling Technology Working Group (ASTWG) are to improve the accuracy and precision of living marine resource assessments by identifying information needs for existing and new stock assessments, identifying new and innovative uses of sampling technologies, and facilitating and conducting research to advance our understanding of the marine environment. ASTWG FY04 priorities were to continue development of an alternative sampling platform (AUV) and multibeam sonar for fisheries surveys, to initiate efforts on evaluating and standardizing the replacement system (Simrad EK/ER60) for the standard echo sounder (Simrad EK500), and to initiate efforts on improving analyses of underwater images.

Although delivery of the NOAA Fisheries AUV has been delayed, significant progress towards training Science Center personnel has been completed. Multibeam calibration experiments conducted during 2004, where significant progress has been made towards quantifying multibeam systems. The underwater image analysis and EK/ER60 workshops were successful forums for sharing state-of-the-art knowledge, fostering communication among government, academic, and industry scientists, and providing opportunities for future collaborations. The Science Centers have already benefited from these workshops through open communication and immediate feedback from the manufacturers.

Summary reports of the national initiatives and Fisheries Science Center advanced technology initiatives are provided in this report to highlight accomplishments by the ASTWG and the Science Centers through funding by the ASTWG.

NMFS AUV for Economical Ecosystem-Based Fish Stock Assessments
(Project Leader: David Demer; SWFSC; 858-546-5603; david.demer@noaa.gov)

Goals

NOAA Fisheries is to acquire and utilize small, relatively inexpensive, portable, multi-instrumented Autonomous Underwater Vehicles (AUVs), deployed from or independent of a survey vessel, in a variety of marine ecosystem investigations. Fisheries AUVs will also facilitate, possibly for the first time, simultaneous *in-situ* measurements of acoustic target strength and fish species, size, and orientation from stereo images. Additionally, AUVs will allow essential measurements be made in boundary areas near the sea-surface (e.g. mapping of epi-pelagic fish schools), the sea-floor (e.g. rockfish or coral reef fish), and in coastal areas inaccessible from a large vessel. There are many other applications.

Priorities

The AUV should include a sensor suite appropriate to concurrently explore biological, physical, chemical, and geological aspects of the oceans and to elucidate their interrelationships. The AUV platform should improve the efficiencies of many routine studies, expand some to more critical time- and space-scales, and make other investigations feasible for the first time.

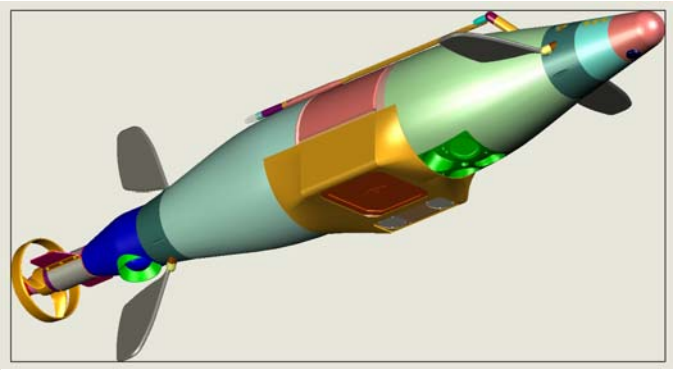


Figure 1. The Fetch IIIx AUV from Sias-Patterson, Inc. with custom Fisheries instrumentation including a 38 kHz split-beam echo sounder, stereo imaging cameras and strobe, a CTD, Doppler velocity log, GPS, and 900 MHz ethernet telemetry. The $362k survey platform is to be delivered in January 2005.

Approach

Procure and use a commercial Autonomous Underwater Vehicle (AUV), customized with Fisheries instrumentation and conforming to the following general specifications: small, hand-deployable, modular payload, commercial off-the-shelf (COTS) design; 0.35 m diameter; 2.03 m long, 118 kg displacement; speed: 2 - 10 knots; duration: 20+ hours at 2.2 knots; maximum depth: 150 m; fisheries instrumentation: 38 kHz split-beam echo sounder, 300 kHz ADCP, CTD; and stereo imaging with illumination.

Work Completed

The NMFS Autonomous Underwater Vehicle (AUV) model Fetch IIIx has been custom built by Sias-Patterson to the above specifications. AUV training and pre-delivery testing was conducted at Sias-Patterson, Yorktown, VA, from 4 - 6 October. David Demer, and Steve Sessions and Derek Needham, the principal AUV technicians, attended from SWFSC; and David Detlor and Al Shimada observed from the Office of Science and Technology. Additional training for one AUV-specialist from each Center was also conducted from 8 - 12 November at SWFSC. In attendance were: Sessions, Needham, Mike Jech (NEFSC), Charles Thompson (SEFSC), Kevin Wong (PISC), Demer, Patrick Ressler (NWFSC), and Scott Furnish (AFSC). Two days of classroom training on the NMFS Fetch IIIx AUV was followed by field training on the Fetch I model (the Fetch

IIIx was not yet operational). Delivery of the NMFS Fetch IIIx AUV to SWFSC is currently anticipated in late January 2005.

Results
Training deployments of the Fetch I AUV were made off of the Scripps Institution of Oceanography's pier, and off the fishing vessel Outer Limits.

Impact Applications
Concurrent assessments of multiple marine trophic levels, their essential habitats, and ecosystem variability due to natural and anthropogenic causes are increasingly necessary for fisheries management. Most of these studies would benefit from more observations than can be accommodated by the fleet of NOAA research vessels, Therefore, to economically and physically conduct such multidisciplinary studies on the most appropriate time- and space-scales, NOAA Fisheries is developing and acquiring a suite of alternative survey platforms including instrumented small-craft, buoy arrays, and autonomous underwater vehicles (AUVs) to augment the NOAA fleet. Some of the AUV projects discussed for 2005 include improved target strength estimation of west coast rockfish, Bering Sea pollock, and Atlantic herring; and characterization of fish avoidance reaction to traditional versus the new quiet survey vessel.

Transitions
Following acceptance testing in the San Diego area in spring 2005, west- and east-coast demonstration projects will be conducted in summer and fall 2005. The procedures for application, committee selection, and use of AUV are to be developed by the next meeting of the ASTWG. This system for resource sharing will be first tested and refined using proposals from Centers collaborating on the demonstration projects.

Related Projects
The ASTWG is planning to add the following sensors to the AUV in FY2005: a passive acoustic array; obstacle avoidance sonar, and sidescan sonar. Also being considered is a mock-up NMFS AUV for display in the Smithsonian Museum. Mark Patterson, co-founder of SPI and co-inventor of Fetch IIIx will be collaborating with the Advanced Survey Technologies (AST) and U.S. Antarctic Marine Living Resources Programs (AMLR) at SWFSC. In January and February 2005, they plan to use SPI's Fetch I AUV to help estimate krill biomass and characterize canyon habitat in the near-shore areas of the Antarctic Peninsula, where land breeding predators directly compete with the international fishery.

Publications
The San Diego Union Tribune highlighted the AUV training operations (http://www.signonsandiego.com/uniontrib/20041111/news_1m11remote.html), which were hosted at SWFSC in November, 2004. The Fisheries AUV is also to be showcased in an imminent NOAA Report.

Expenditures
FY04: $128.5k including $3.5k for AUV-training travel; $2k for travel to Sias-Patterson, Inc.; and $123k for principal AUV technician contract (Steve Sessions).

Broad Bandwidth Characterization of Fish for Improved Estimations of Biomass
(Project Leader: David Demer; SWFSC; 858-546-5603; david.demer@noaa.gov)

Goals

Multiple-frequency echo sounders are used to survey fish distribution and abundance. Fish density is estimated from the total energy echoed from a fish aggregation, divided by the energy echoed from an individual fish. The aim is to improve the acoustical survey method.

Priorities

Improved techniques are need for: 1) separating the energy echoed from coexisting species, or species identification (SID); and 2) characterizing the acoustic reflectivities of the various species, or target strength estimation (TSE).

Approach

A new method for broad bandwidth characterization of fish may improve both SID and TSE. The technique should be developed and then applied inside a hyperbaric chamber, to measure the pressure dependence of broad bandwidth sound scatter from fish. A catalog of broad bandwidth scattering spectra and total target strengths of numerous targeted and coexisting species can then be measured to improve their acoustical classification and quantification.

Work Completed

The uncertainty was characterized for measurements of total target strength spectra of standard metal spheres. These results confirmed that the method had potential for conveniently characterizing the frequency response of sound scattering from marine organisms. The method elucidated significant differences between the average scattering spectra of two similarly shaped species, anchovy and sardine (Conti and Demer, 2003). A hyperbaric chamber has been designed and procured for the study of pressure-dependent scattering spectra.

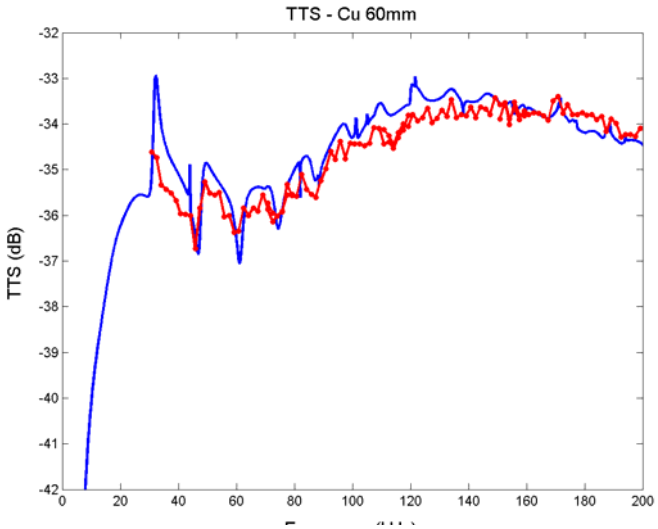


Figure 1. Total target strength spectra for a 60 mm diameter sphere (red) compared to theoretical predictions (blue). Similar measurement on fish and zooplankton may provide means for acoustical classification and improve target strength and thus biomass estimations.

Results

Investigations thus far have produced the first broad bandwidth absolute measurements of total target strength for standard metal spheres and good measurement accuracy and precision (Demer *et al.*, 2003). It was also shown that multiple frequency echo sounders can be used to remotely distinguish monospecific aggregations of anchovy and sardine.

Moreover, the technique has been used for to characterize acoustic scatter from sea-bass, Antarctica and northern krill, squid, myctophids, rockfish, and salmon.

Impact Applications

By exploiting such differences in scattering spectra, researchers from SWFSC are developing non-lethal survey techniques for protected species such as rockfish (http://www.publicaffairs.noaa.gov/nr/pdf/dec2003.pdf). Moreover, a new physics-based scattering model for Antarctic krill (Demer and Conti, 2003a) was validated using the measurement technique on live *Euphausia superba* (Demer and Conti, 2003b). The improved scattering model resulted in two-fold increase in the krill biomass estimate (Demer and Conti, 2004).

Transitions

Details of the method and multiple applications have been published in peer reviewed journals, and presented in domestic and international forums. Measurements in the hyperbaric tank are to be made in collaboration with other Centers.

Related Projects

The new technique can also be used to measure the sound speed and volume of the media in an enclosure. Also, it was recently developed to measure absolute absorption cross-sections (σ_a) over a broad bandwidth (Conti *et al.*, 2004), as highlighted in popular articles from *Science News* (http://www.sciencenews.org/20031115/fob3.asp), which was translated into French, Italian, and Spanish by Courier International, and *Discovery* (http://www.discover.com/web-exclusives/acoustics1201/).

Publications

D.A. Demer, S. Conti, J. De Rosny and P. Roux, "Absolute measurements of total target strength from reverberation in a cavity," *J. Acoust. Soc. Am.*, 113(3):1387-1394 (2003)

S.G. Conti and D.A. Demer, "Wide-bandwidth acoustical characterization of anchovy and sardine from reverberation measurements in an echoic tank," *ICES J. Mar. Sci*. 60:617-624 (2003).

D.A. Demer and S. Conti, "Reconciling theoretical versus empirical target strengths of krill; effects of phase variability on the distorted wave Born approximation," *ICES J. Mar. Sci*., 60(2):429-434 (2003a)

D.A. Demer and S.G. Conti, "Validation of the stochastic distorted-wave Born approximation model with broad bandwidth total target strength measurements of Antarctic krill," *ICES J. Mar. Sci*., 60:625-635 (2003b)

S.G. Conti, P. Roux, D.A. Demer, and J. De Rosny, "Measurement of the scattering and absorption cross sections of the human body," *Applied Physics Letters*, 84(5) (2004).

D.A. Demer, and S.G. Conti, "New target-strength model indicates more krill in the Southern Ocean," *ICES Journal of Marine Science*, (in-press).

Expenditures

FY04: $84.5k including $17.5k for Masters student (Ben Maurer); and $67k for hyperbaric tank, plumbing, pumps, chiller, and sensors).

Instrumented buoy arrays for improved near-shore ecosystem investigations
(Project Leader: David Demer; SWFSC; 858-546-5603; david.demer@noaa.gov)

Goals
Concurrent and long-term assessments of multiple marine trophic levels, their essential habitats, and ecosystem variability due to natural and anthropogenic causes are increasingly necessary for fisheries management. The aim is to provide these studies with more long-term observations than can be accommodated by the fleet of NOAA research vessels.

Priorities
Multidisciplinary studies must be economically conducted on the most appropriate time- and space-scales. NOAA Fisheries is to develop inexpensive data buoys to augment the NOAA fleet.

Approach
A low-cost, light-weight, modular instrumented buoy is to be designed, fabricated and tested for use in a near-shore moored array. Instrumentation should include dual-frequency echo sounders, an ADCP, GPS, and ethernet radio modem. The buoy should also have a strobe, a radar reflector, solar panels, wind generator, and windows-programmable power management circuit. Data should be telemetered to a ship or land-base multiple miles away.

Work Completed
A dual-frequency echosounder buoy has been designed and constructed with the above specifications.

Results
The light-weight instrumented buoy can be deployed for many weeks or months with remote control and data collection via ethernet radio link.

Figure 1. Autonomous data buoy for near-shore ecosystem investigations.

Impact/Applications
Fish or zooplankton abundance, currents, and water properties can be concurrently and economically monitored for weeks or months in near-shore regions.

Related Projects
Five buoys of this design (two fitted with dual frequency echo sounders and three with ADCPs) will be deployed off the Antarctic Peninsula from January to March 2005 in collaboration with the SWFSC/AERD, and funded by NSF's Office of Polar Programs.

Expenditures
FY04: $44.5k including equipment, supplies, and engineering services for development and construction of a dual-frequency echo sounder buoy.

Multibeam Calibration
(Project Leader: Michael Jech, NEFSC, 508-495-2353, michael.jech@noaa.gov)

Goals
The long-term goal of this project is to develop multibeam sonar for quantitative measures of fish and zooplankton spatial distributions and abundances and habitat characterization.

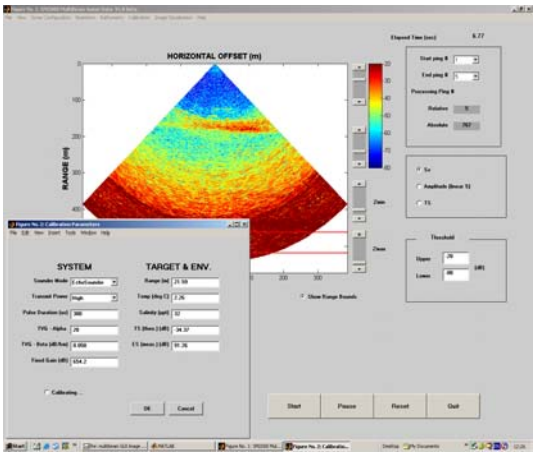
Priorities
Deriving quantitative measures from multibeam sonar will require significant efforts on many different fronts, of which calibration is a critical component. This project's priority was to develop calibration procedures, protocols and analysis tools, which can be applied to all multibeam sonar systems.

Approach
We contracted Dr. Dezhang Chu of the Woods Hole Oceanographic Institution (WHOI) through the Cooperative Institute for Coastal and Oceanographic Research (CICOR) to develop multibeam calibration. The project was a collaborative effort between WHOI, NEFSC, NWFSC, and industry who provided instrumentation and operational expertise.

Work Completed
Calibration experiments were conducted during the winter and spring of 2004 using Simrad SM2000 (90 and 200 kHz) and Reson SeaBat 8101 (240 kHz) multibeam systems. A Graphical User Interface (GUI) based data processing software package has been developed, and a final report will be submitted to the NEFSC for review.

Results

A Graphic User Interface (GUI) developed for analyzing multibeam calibration data. A 2D image of a fish school (data provided by L. Hufnagle, NWFSC) detected at 170-200 m below the sonar (SM2000/90 kHz). The color represents the Sv values after quantitative calibrations have been applied. The lower-left panel shows an editable calibration window, which allows the user to enter the necessary calibration parameters.



Impact/Applications
The interest generated by the scientific community in using multibeam sonar for measurements of the water column and the efforts of this project towards quantifying multibeam systems have been noticed by multibeam manufacturers and 3rd-party software

developers, who are now focusing efforts towards developing multibeam systems with water-column capabilities and software analysis packages.

Transitions

Calibrations and system evaluation are a critical component of using acoustical systems for quantitative measurements. Procedures, protocols, and analysis methods generated during this project will improve our ability to use multibeam sonar for fisheries surveys.

Related Projects

The contract to Dr. Chu for multibeam calibration supplemented on-going collaborative research and experiments among NOAA-Fisheries Science Centers (NEFSC and NWFSC), WHOI, and University of New Hampshire.

Publications

Chu, D., K.G. Foote, T.R. Hammar, L.C. Hufnagle, Jr., and J.M. Jech. 2004. "Calibrating a 90-kHz multibeam sonar: illustrating protocols". Oceans 2004 MTS/IEEE Conference Proceedings, pp. 438-442.

Presentations

Chu, D., K.G. Foote, T.R. Hammar, L.C. Hufnagle, Jr., and J.M. Jech. 2004. "Calibrating a 90-kHz multibeam sonar: illustrating protocols". OCEANS 2004 MTS/IEEE, Kobe, Japan, November 2004.

Foote, K. G., Chu, D., Baldwin, K. C., Mayer, L. A., McLeod, A., Hufnagle, L. C., Jr., Jech, J. M., and Michaels, W. 2003. "Protocols for calibrating multibeam sonar." ASA, Austin, TX, USA, November 2003. [J. Acoust. Soc. Am., 114, 2307 (2003) (A)].

Chu, D., Foote, K. G., Baldwin, K. C., Mayer, L. A., McLeod, A., Hufnagle, L. C., Jr., Jech, J. M., and Michaels, W. 2003. "Calibration trials with multibeam sonars." ASA, Austin, TX, USA, November 2003. [J. Acoust. Soc. Am., 114, 2308 (2003) (A)].

Expenditures

Funds ($75K) were contracted to Dr. Chu of the Woods Hole Oceanographic Institution via the Cooperative Institute for Coastal and Oceanographic Research. Dr. Chu received these funds in Oct. 2003 and the contract was for one-year.

EK500 – EK/ER60 Evaluation
(Project Leader: Michael Jech, NEFSC, 508-495-2353, michael.jech@noaa.gov)

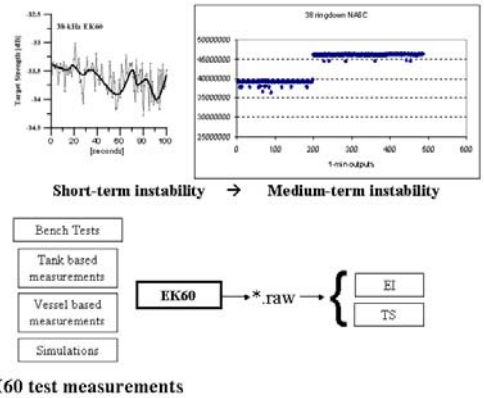
Goals
The Simrad EK500 is the standard scientific echo sounder used by NOAA-Fisheries for quantitative fisheries surveys, and the Simrad EK/ER60 is the upgrade system that will replace the EK500. The goals are to evaluate and compare the two systems.

Priorities
Priorities for this project during FY04 were to develop a plan for future measurements and experiments comparing and evaluating the EK500 and EK/ER60 echo sounders.

Approach
The ASTWG sponsored a workshop to learn about prior and on-going efforts by the user community, manufacturer, and 3rd-party software developers, present results of these evaluations and comparisons, develop and prioritize future evaluation experiments, and foster communication and collaboration among the participants.

Work Completed
Representatives from NOAA-Fisheries, industry, academia, and other governmental agencies participated in a workshop held July 14-15, 2004 at the AFSC. A final report has been submitted to the ASTWG. A network-based 'listserve' has been established at the NEFSC to foster communication and collaboration among participants and other interested users.

Results
Illustrative representation of potential concerns with EK/ER60 system performance and stability (upper panels), test measurement categories (lower left), and data flow and essential data products (lower right). Upper panels display target strength measurements during a calibration trial (note: solid line was drawn by eye) and step in s_A values observed during a survey.



EK60 test measurements

Impact/Applications
Results of this workshop and subsequent communication among the users, manufacturer, and 3rd-party software developers have netted improved understanding and documentation of the EK/ER60 operation and data-processing algorithms. Collaborative efforts and experiments have been initiated as a result of this workshop.

Transitions
Evaluation and comparison of the EK500 and EK/ER60 are critical components of transitioning to the new echo sounder for determining the accuracy and precision of acoustical estimates and maintaining consistency in long-term surveys. Results of these evaluations will be implemented in the NOAA National and Regional Fisheries Acoustics National Protocols.

Related Projects
Experiments conducted by the NEFSC were done in conjunction with on-going collaborative research and experiments with the Woods Hole Oceanographic Institution.

Publications
Jech, J.M, K.G. Foote, and D. Chu. "Comparing two 38-kHz scientific echo sounders." (*in review* ICES J. Mar. Sci.).
Jech, J.M., D. Chu, K.G. Foote, T.R. Hammar, and L. Hufnagle, Jr. 2003. "Calibrating Two Scientific Echo Sounders". Oceans 2003 MTS/IEEE Conference Proceedings, pp. 1625-1629.
Jech, J.M., K.G. Foote, D. Chu, and S.P. Liberatore. 2003. "Comparing Two Scientific Echo Sounders". Oceans 2003 MTS/IEEE Conference Proceedings, pp. 1630-1632.

Presentations
Jech, J.M. and D. Chu. 2003. "Comparisons of Simrad EK500 and EK60 echo sounder calibrations", ICES FAST WG, Bergen, NO, June 2003.

Expenditures
Funds ($35K) were spent on travel to the workshop for one representative per Science Center and for invitation travel for four participants.

Regional Support of FY04 ASTWG:- Alaska Fisheries Science Center
(Representatives: Chris Wilson, 206-526-6435, Chris.Wilson@noaa.gov; David Somerton, 206-526-4116, David.Somerton@noaa.gov)

Goals
The goals of the Alaska Fisheries Science Center (AFSC) are to work in concert with the ASTWG to improve the accuracy and precision of living marine resource assessments by identifying information needs for existing and new stock assessments, identifying new and innovative uses of sampling technologies, and facilitating and conducting research to advance our understanding of the marine environment.

Priorities
The FY04 priorities for the AFSC were to participate in efforts to continue development of alternative sampling platforms, initiate efforts on evaluating a replacement system (Simrad EK/ER60) for the standard echo sounder (Simrad EK500), and begin efforts on improving analyses of underwater images.

Approach
In addition to hosting two workshops that addressed the ASTWG working group national initiatives regarding characterization of the Simrad EK60 and underwater image analysis, the AFSC was involved in several regional activities to develop alternative sampling platforms and improve remote sampling devices. The development and use of alternative sampling platforms included work with a buoy and tethered body, whereas remote sampling efforts included upgrading a sonar device (i.e., DIDSON). These developments will be used on projects that seek to improve the quality of stock assessment efforts.

Work Completed
Acoustic buoy upgrade. An acoustic buoy used in studies to address fish avoidance to underwater radiated noise and equipped with an echosounder and associated electronics was upgraded to include the following: Simrad EK60 echosounder, local area network (LAN), wireless ethernet bridge and Avocent KVM-over-IP extender for buoy-to-vessel communications, tilt sensor; data acquisition system (i.e., NOAA Scientific Computer System software), radar transponder, and digital voltmeter.

Buoy field work. A field experiment was conducted during 26 July to 6 August with the acoustic buoy to evaluate the behavior of walleye pollock in response to cues from vessels engaged in trawling operations. The work was accomplished aboard a 40-m long chartered fishing vessel, *Aldebaran* in the Bering Sea. The free-drifting buoy was used to observe pollock abundance and vertical distribution patterns as the vessel towed a bottom trawl past the buoy.

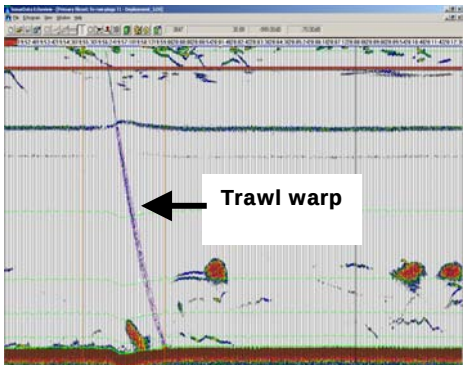
Tethered transducer system upgrade. Efforts to upgrade a lowered transducer system to collect better *in situ* target strength measurements included refurbishment of a winch to deploy the conducting cable and 38 kHz split beam transducer. The tethered transducer is currently housed in a modified towed-body. Plans continue for the development of a gimbaled transducer cage for the system.

DIDSON hardware upgrade. A hardware upgrade was made to the dual frequency identification sonar (DIDSON). The upgrade provided for fish behavior observations at increased depths.

Results

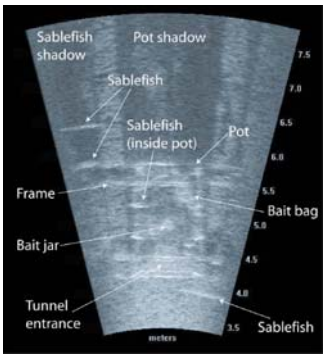
Acoustic buoy upgrade and fieldwork. The upgraded acoustic buoy was used successfully during the trawl-avoidance fieldwork during summer 2004 to begin investigations on whether walleye pollock respond to bottom trawls from approaching commercial vessels typically used during AFSC groundfish surveys. The acoustic buoy was deployed on 6 occasions, and the trawl was towed past the buoy a total of 24 times. The buoy performed well during the study. Unfortunately, weather and fish conditions resulted in little useful data to evaluate the effect of trawling on fish behavior. Analyses of the data are currently underway. Plans for additional fieldwork are under discussion.

Idealized bottom trawl passing beneath acoustic buoy.



Buoy echogram showing trawl warp and four pollock schools. One pollock school is in contact with bottom immediately in front of trawl and three other schools are well above the bottom. Additional work is needed to determine whether avoidance reactions resulted in the movement of the one school closer to the sea floor.

DIDSON hardware upgrade. The upgrade allowed observations of fish interactions with baited fishing gears, which may affect the performance of survey and commercial fishing gears.



DIDSON image of fish around a baited pot

Impact/Applications

The refinement of the AFSC acoustic-buoy system will serve as an alternate sampling platform for use in investigations of fish avoidance to vessel/trawls. The tethered transducer system and DIDSON will both provide novel methods of remote sensing that will benefit acoustic survey methods and related investigations at a large range of spatio-temporal scales.

Expenditures
The Alaska Fisheries Science Center was allocated $180K in FY04 for ASTWG activities. Funds were used to: upgrade the acoustic-buoy ($31.3K), conduct acoustic-buoy bottom trawl field experiment ($8.3K), refurbish tethered transducer winch ($6.5K), DIDSON hardware upgrade ($5.9K), and travel for S. Furnish to AUV training ($2.5K) and C. Wilson to an ASTWG meeting. A portion of the ASTWG FTE ($21.0K) was used to fund the annual salary/benefits for S. McEntire who worked on the development of video systems, design and specifications for cable and winch for side scan sonar and video efforts, and other unique advanced technology systems utilized by researchers in the RACE and REFM Divisions.

Regional Support of FY04 ASTWG: Northeast Fisheries Science Center
(Representatives: Michael Jech, 508-495-2353, Michael.Jech@noaa.gov; William Michaels, 508-495-2259, William.Michaels@noaa.gov)

Goals
The goals of the ASTWG supported efforts at the NEFSC are to build advanced technology infrastructure and to improve the accuracy and precision of living marine resource assessments through the use of optical and acoustical technologies.

Priorities
Priorities during FY04 were to hire an advanced technology FTE, to participate in ASTWG national initiatives, to improve methods for scaling echo energy using in situ target strength measurements, and to improve underwater video methods for verifying acoustical backscatter.

Approach
Our approach is to integrate acoustical and optical methods to improve apportioning and scaling echo energy to species-specific abundance estimates.

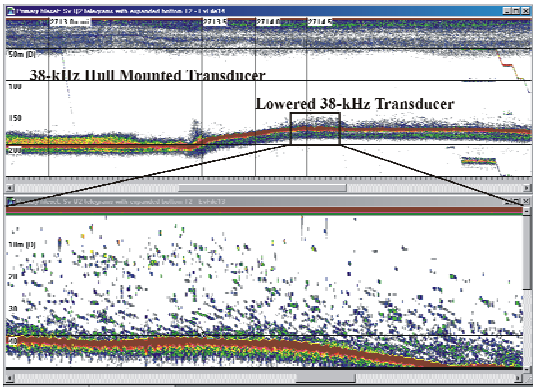
Work Completed
An electronics engineer (ZP-03) was hired and will begin in Feb. 2005. M. Jech convened the EK60 Evaluation workshop and continues to chair the EK60 Evaluation Study Group (SG-EK) ($2.5K). A 38-kHz and a 120-kHz Simrad echo sounders and deepwater transducers, and a laptop for data acquisition were purchased ($104K). In support of the national Multibeam Initiative, M. Jech and W. Michaels will participate in a multibeam training course ($7.2K). In support of the national Image Analysis Initiative, W. Michaels participated in the workshop ($1.5K). M. Jech participated in the AUV training ($3.0K) in support of the AUV initiative. In support of the ASTWG, travel for M. Jech ($3.0K) to two meetings and travel for W. Michaels ($1.5K) were funded.

Impact/Applications
Methods to implement *in situ* acoustic target strength data are under active investigation to improve abundance estimates of Atlantic herring. Implementation of these data will

have immediate bearing on the Atlantic herring assessments and on future acoustical surveys at NEFSC.

Transitions
NEFSC efforts in support of the national ASTWG initiatives and regional projects will improve our ability to monitor economically important fish stocks and begin ecosystem-based management for conservation of our living marine resources.

Results
In situ acoustical data collected on Atlantic herring (*Clupea harengus*) using a 38-kHz transducer lowered to 150 m depth. The upper panel displays echo integration data collected with the hull-mounted transducer and the lower panel displays the increased resolution obtained using the lowered-transducer.



Expenditures
In support of the regional projects, a water-chiller unit ($2.4K) for maintaining live fish, a cod end aquarium ($6.8K) for collecting live fish, supplemental monies for Echoview licenses ($7.7K), and two contracts for data processing ($7.6K) were funded. The remaining funds were carried over by the NEFSC for ASTWG projects.

Regional Support of FY04 ASTWG: Northwest Fisheries Science Center
(Representatives: Guy Fleischer, 206-860-3289, Guy.Fleischer@noaa.gov; Earl Prentice, 206-842-5434, Earl.Prentice@noaa.gov)

Goals
The goals of the Northwest Fisheries Science Center (NWFSC) are to work in concert with the ASTWG to improve the accuracy and precision of living marine resource assessments by identifying information needs for existing and new stock assessments, identifying new and innovative uses of sampling technologies, and facilitating and conducting research to advance our understanding of the marine environment.

Priorities
Priorities during FY04 were to solicit and interview candidates for the advanced technology FTE, to participate in ASTWG national initiatives, to improve methods for scaling echo energy using in situ target strength measurements, develop underwater imaging methods for fish capture behaviors, and to develop techniques for assessing important groundfishes in untrawlable areas of the West Coast.

Approach
In addition to participating in two workshops that addressed the ASTWG working group national initiatives regarding characterization of the Simrad EK60 and underwater image analysis, the NWFSC was involved in several regional activities to develop advanced technologies for improved stock assessment efforts. These efforts included the acquisition of a sonar imaging device (DIDSON) for initial application to assess gear designed to reduce bycatch, the acquisition of a video plankton recorder (VPR) to investigate zooplankton communities by means of an imaging system that simultaneously collects images of plankton and information on the physical properties of the water column, the deployment of various fishery and habitat sensor gear, including the ROPOS ROV, as part of a deepwater advanced technology cruise, and the acquisition of fishery acoustic equipment for expansion of current capabilities. NWFSC scientists collaborating, with scientists at WHOI (Foote & Chu), NEFSC (Jech) and UNH (Mayer), developed a method to calibrate multibeam sonar for quantitative water column use. These developments will be used on various projects that seek to improve the quality of stock assessment and ecosystem management efforts.

Work Completed
NWFSC lead an interdisciplinary team of scientists from Washington, Oregon, and California on an advanced technologies research cruise to explore a deepwater ecosystem, Cherry Bank, off the coast of Southern California. During this cruise, scientists will use in situ acoustic and optical instruments to better understand how these technologies can inform and improve assessments of fisheries and their ecosystems. Scientists also mapped the underwater terrain using the vessels' advanced mapping system. In addition, an advanced scientific remotely operated vehicle (ROV), with an array of sophisticated sampling equipment, enabled scientists to view benthic habitats and communities and collect specific samples of rock, sediment, and benthic organisms for later examination and analysis.

The DIDSON imaging device was delivered and is a testing and initial deployment phase.

NWFSC scientists, in cooperation with industry representative and fishermen, developed a widow rockfish (*Sabastes entomelas*) survey plan designed to investigate potential alternative methods of widow rockfish assessment along the West Coast. Initial surveys are planned for early 2005. This plan relies on the deployment of active fishery acoustics to survey the aggregations of widow rockfish, with additional deployment of multibeam and passive acoustics systems also planned.

Acquisition of 70 kHz fishery system for principle initial applications of broadband acoustics uses for fisheries assessment to (1) investigate use of broadband for near bottom echo detection in otherwise 'dead zone' and (2) use of broadband frequency response for discrimination of different backscatters - specifically for rockfish as part of the cooperative widow rockfish study.

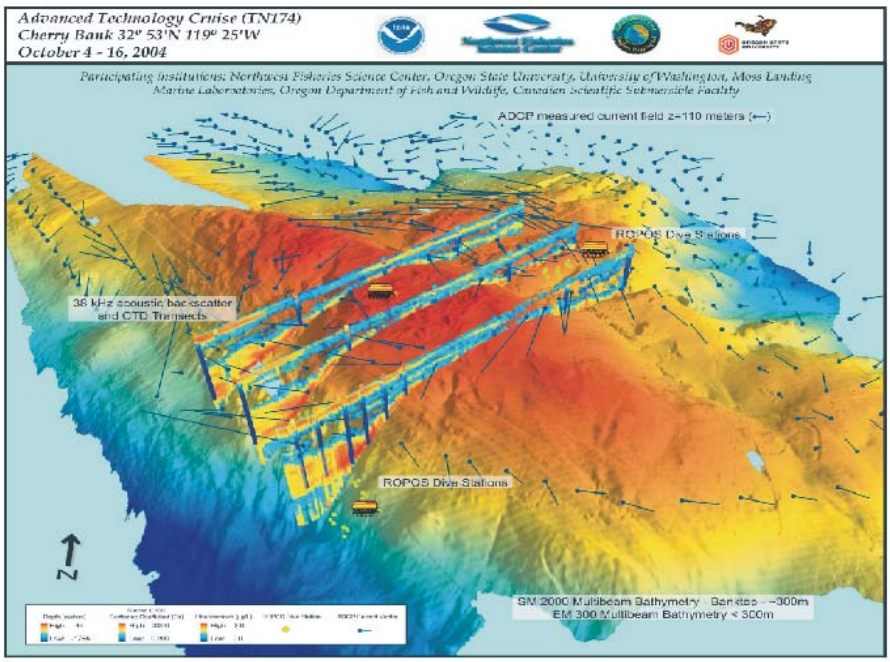
Lectures by Ken Foote were given on “Modeling high-frequency acoustic backscattering by fish and other targets" at NWFSC during January 2005. The lectures were attended by colleagues from NWFSC, AFSC, DFO, Canada, and the University of Washington.

Participation in the ASTWG sponsored AUV training by Patrick Ressler.

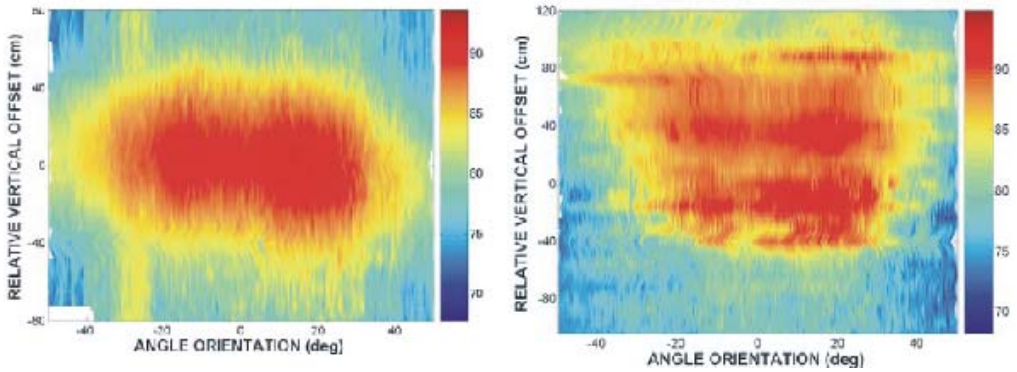
No suitable candidates were found for the Advanced Technology position; the position is continued to be advertised.

Results

Application of the suite of advanced technologies by the interdisciplinary team of scientists provided a unique profile of the geological, physical, chemical, and biological systems of Cherry Bank.



Beam patterns for the 90-kHz multibeam system are shown below.



Impact/Applications
Advances of the coordination of the application of a suite of advanced technologies by the interdisciplinary team of scientists were successful. Our goal was to explore the challenges in coordinating the acquisition, storage, and integration of these data.

Better understanding of backscattering properties of fish, in concert with empirical measurements, will advance our ability to assess the status of West Coast groundfish stocks.

Transitions
Calibrations and system evaluation are a critical component of using acoustical systems for quantitative measurements. Procedures, protocols, and analysis methods generated during the multibeam calibration project will improve our ability to use multibeam sonar for fisheries surveys.

Expansion of fish survey efforts into untrawable areas is an important step to improving the assessments of the West Coast groundfish stocks.

Publications
K. G. Foote, D. Chu, T. R. Hammar, K. C. Baldwin, L. A. Mayer, L. C. Hufnagle, Jr., and J. M. Jech. In press. Protocols for calibrating multibeam sonar. The Journal of the Acoustical Society of America.

Jech, J.M., D. Chu, K.G. Foote, T.R. Hammar, and L. Hufnagle, Jr. 2003. "Calibrating Two Scientific Echo Sounders". Oceans 2003 MTS/IEEE Conference Proceedings, pp. 1625-1629.

Presentations
"Calibrating a 90-kHz multibeam sonar: illustrating protocols," by D. Chu, K. G. Foote, T. R. Hammar, L. C. Hufnagle, Jr., and J. M. Jech. Proc. MTS/IEEE Oceans 2004 Conf.

"Optical Imaging and Analysis at the Northwest Fisheries Science Center" by Waldo Wakefield. ASTWG sponsored Underwater Image Analysis workshop.

"Estimating the Density of Thornyheads, Sebastolobus spp., Using a Towed Video Camera Sled" by Robert Lauth and W. Waldo Wakefield (presented by Waldo Wakefield). ASTWG sponsored Underwater Image Analysis workshop.

Expenditures
70 kHz system (transducer and GPT) - $39,760. Funds were also used to support travel (1 person) to NMFS Advanced Technology Working Group sponsored SG-EK workshop on Simrad($548.50), travel (1 person) to NMFS Advanced Technology Working Group sponsored Workshop on the Analysis of Underwater Video Observations ($822), travel (1 person) to NMFS Advanced Technology Working Group sponsored AUV training ($750), and travel to ASTWG meetings ($1500). Contract to Ken Foote was supported in part ($40,000) for training and backscatter research.

Regional Support of FY04 ASTWG: Pacific Islands Fisheries Science Center
(Representative: Michael Seki, 808-983-5393, Michael.Seki@noaa.gov)

Goals
The goal of the ASTWG supported program at the Pacific Islands Fisheries Science Center (PIFSC) is to develop and support an infrastructure that (1) enables advanced sampling technologies research and development at the Science Center, and (2) to strengthen these capabilities through partnerships with academia and other research institutions, and through national coordination within NOAA Fisheries.

Priorities
A priority for the Science Center was to build the in-house capability of utilizing active acoustic survey methods for the improvement of fisheries stock assessments and advancement of ongoing efforts to define and characterize ecosystem parameters.

Approach
Two pilot projects using fishery-hydroacoustic surveys with a Simrad EK60 split beam dual frequency scientific echosounder have been launched. Both projects, (1) an assessment of settled, juvenile pink snapper (*Pristipomoides filamentosus*) populations to nursing habitats in the main Hawaiian Islands and (2) assessment of resident bigeye tuna (*Thunnus obesus*) populations targeted by commercial handline fishers at isolated seamounts in the Hawaiian Islands, have direct linkages to the NMFS stock assessment improvement program (SAIP). The projects involve tractable populations that support both short and long term goals. For short term goals, we look (1) to hire staff and develop the technical expertise of using fishery acoustics for population assessments at the PIFSC and (2) to procure and configure a *portable* echo sounding system that can be transported to and operated from smaller launches and commercial vessels of opportunity. Target characterization will consume much of the early phases of the survey work. For snappers, the shallow nature (60-90 m) and mud-based substrate of the habitat will allow the use of mixed-gas diving and drop cameras to facilitate identification of species that correspond to the sonar targets. Acoustic surveys for tunas will likely rely on simultaneous direct fishing on research and cooperative commercial fishing ventures to ground truth targets. In the long term, we hope these efforts translate to the development of a non-lethal, fishery independent means of conducting assessments of not only these discrete populations but also other related commercially important resources that we are charged to manage.

Work Completed
In FY-04, the PIFSC was allocated a total of $170K for ATWG activities, including labor, travel to national workshops, and regionally for projects related to EK60 evaluation and integration. Consistent with the Center's ASTWG goals, priorities, and spending plan, the PIFSC contracted Dr. Reka Domokos through the University of Hawaii-NOAA Joint Institute of Marine and Atmospheric Research (JIMAR) with partial monies ($95K) allocated for the ASTWG-FTE. Dr. Domokos attended the ASTWG Seattle-acoustics workshop and the Simrad direct EK-60 training conducted in association with Fish Expo. The Center capacity build-out in FY-04 also included the procurement of a portable split-

beam Simrad EK-60 echosounder (38 kHz GPT) ($42K) for use off small boats in shore-based studies or commercial fishing vessels as described above and a service contract ($31K) awarded to Dr. Kelly Benoit-Bird at Oregon State University to facilitate building the acoustics operational capabilities at the Center. Note that these latter expenditures account for the usage of funds available through salary lapse.

Related Projects
The acoustics program also supports other projects underway in the Science Center. Studies to characterize the behavior and biomass of the oceanic sonic scattering layer (SSL) using information collected by the hull mounted EK-60 (38 kHz and 120 kHz GPTs) aboard the NOAA ship *Oscar Elton Sette* are being conducted as part of pelagic ecosystem and habitat assessments (see results in 'Presentations' below).

Presentations
Dr. Domokos gave a presentation on the "Oceanographic characterization of the American Samoa longline fishing grounds for albacore tuna, *Thunnus alalunga*" at the JIMAR Pelagic Fisheries Research Program Principle Investigators Meeting.

Regional Support of FY04 ASTWG: Southeast Fisheries Science Center
(Representatives: Christopher Gledhill, 228-762-4591, Christopher.T.Gledhill@noaa.gov; Peter Sheridan, 850-234-6541, Pete.Sheridan@noaa.gov)

Goals
The goals are to develop the infrastructure for advanced sampling technologies to improve stock assessments.

Priorities
The first priority of the SEFSC is to improve fishery independent data on reef fish stocks within the Gulf of Mexico, Florida Keys and Caribbean.

Approach
Fishery independent surveys are conducted for reef fish using visual methods. A survey of the Florida Keys is conducted annually using SCUBA diver census methods. A survey of shelf-edge banks along the continental shelf is conducted annually using baited stationary video cameras. Both of these surveys can be improved by the development of stereo camera methods to obtain accurate measures of fish length.

Work Completed and Results
A physicist was hired on October 17, 2004 to fill the advanced technology position within the center. A contract was awarded to the Physics Department of the University of Miami to develop a diver-held stereo camera system. A report on the development of a stereo camera system is attached.

Related Programs

Development of a stereo camera system would benefit both the programs to monitor coastal and open-water sharks, deep-water groupers and snappers, and marine mammals. Each of these programs requires more accurate methods to measure the size of animals either captured or observed.

Presentations
A review of the shelf-edge bank video survey for reef fish was presented at the NMFS optical imaging workshop.

Transitions
A stereo camera system is being constructed to be field tested in 2005. Software to process stereo images has been purchased.

Relation to national projects
Stereo camera development will support the effort to survey within boundary areas using the AUV.

Expenditures
Total FY04 funds were $166,500, of which $31,250 were buried within SAIP funds. The salary lapse for the advanced technology FTE of $135,000 was used to support an electrical engineer ($103,654 salary and benefits), contract work to the University of Miami to develop a stereo camera system ($24,999) and travel to ASTWG workshops and meetings (image analysis workshop - $4,377; travel to ASTWG meeting and EK60 workshop $1,970).