SouthEast Acoustics Consortium Report 2012

Report of the Inaugural Workshop and Activities of the SouthEast Acoustics Consortium

13-15 March 2012
Florida International University
Biscayne Bay Campus
North Miami, Florida

http://seac.fiu.edu

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Executive Summary

The SouthEast Acoustics Consortium (SEAC) was conceived as a regional working group that brings together researchers from academic institutions, federal and regional fisheries and environmental management agencies and private industry to advance the use of active acoustics (e.g., fishery sonar, echosounders) for studying the coastal and marine environments. SEAC held the inaugural workshop at the Florida International University – Biscayne Bay Campus in North Miami, Florida, from 13-15 March 2012. Sixty-two participants from various organizations, including universities, federal and state agencies, and industry representatives from thirteen US states, Puerto Rico, Norway, and Tasmania, Australia, attended the workshop. Four primary topic sessions were organized to address coastal ecosystem research and management needs for Atlantic and Gulf of Mexico waters of the southeast US and US Caribbean:

- Stock Assessments and Fisheries Management
- Ocean Observatories and Data Management
- Integrated Ecosystem Assessments
- Trending Technology and Education

Topic sessions included two keynotes addresses, 21 presentations and open discussion regarding the state of technology, data gaps and the potential or realized applications of active acoustics to fill needs of fisheries and ecosystem management.

The topic session on Stock Assessments and Fisheries Management highlighted aspects of fisheries acoustics that could contribute to the stock assessment process. The need to be proactive in advancing new technologies and sampling methods and using all available information to improve survey design and assessments was addressed. Presentations identified parameters derived from acoustics that could feed into existing models, as well as the integration of complementary active and passive technologies for detecting fish and characterizing habitats.

The topic session on Ocean Observatories and Data Management covered two broad areas: 1) the use of acoustic sensors in stationary platforms to aid fish behavioral studies and 2) management of data and archiving. The use of active acoustics on stationary platforms to observe marine organisms is still in its infancy. Interpreting the acoustic signals and attributing to organisms or taxon remain the largest challenge. Additionally, limitations of handling data streams from a few fixed locations were discussed. Developing methods for archiving and processing these large datasets were identified as a significant need.

Presentations in the Integrated Ecosystem Assessments topic session highlighted applications of acoustics that could contribute to synoptic data on ocean basin dynamics and the structure and function of coastal ecosystems. The studies described in this topic session inform place-based management or enhance our understanding of ecosystem processes. Speakers highlighted new approaches that exploit active acoustics to: 1) understand fish habitat use and delineate essential fish habitat in coral reefs and Marine Protected Areas, 2) better understand predator-prey interactions in marine mammal populations, and 3) explore the capacity of low-cost acoustic technologies for identifying

habitat types such as submerged aquatic vegetation, hard bottom and other structured seafloor habitats.

The Trending Technologies and Education session covered new advances in data access, workflow processes and acoustic data processing. In addition, new technologies such as optical, broadband, and frequency ranging systems were introduced. Opportunities for student training in the area of seafloor mapping were highlighted, as well as the need to develop mechanisms for increased collaboration and sharing of information, expertise and ideas.

The inaugural SouthEast Acoustics Consortium Workshop was successful in bringing together scientists, resource managers, industry representatives, and students to better understand the potential of emerging active acoustic technologies as they apply to the marine environment. Specific requests by participants for further Consortium development included: (1) continued development of SEAC website (http://seac.fiu.edu) as an information portal, including availability of workshop presentations, (2) communication and discussion through the creation of email listserv (seac@fiu.edu) and membership in the international fisheries hydroacoustic forum (http://www.hydroacoustics.net), and (3) reconvene a biennial workshop, planned for 2014. Already, new collaborations have emerged: research cruise support, operating procedures on new vessels, and joint grant awards to participants who met for the first time at the workshop. The foundation laid at this meeting will serve to support a growing community of researchers and practitioners in this field in the Southeast US to meet the many needs of coastal managers in this region.

Sponsors

We are very thankful that Florida International University's, Marine Sciences Program provided meeting space and technical support for the inaugural SEAC workshop. The registration-free workshop was made possible by numerous monetary and in-kind contributions by several entities. Student travel was graciously provided by Sea Grant offices in Florida, Louisiana, North Carolina, and South Carolina. We recognize generous contributions by Hydroacoustic Technology, Inc., Biosonics, Inc., Continental Shelf Associates, Kongsberg Maritime AS, Myriax, Pty. Ltd. (Echoview), and Furuno USA.

Workshop Participation

Participants of the 2012 SEAC Workshop held in Miami, Florida 13-15 March 2012.

Participants traveled from Alabama, Alaska, California, Connecticut, Florida, Louisiana, Massachusetts, Michigan, Mississippi, North Carolina, South Carolina, Virginia, Washington, Puerto Rico, Tasmania-Australia and Norway.

1. Opening of the 2012 workshop

1.1. Opening remarks and welcome

Kevin Boswell, co-founder and faculty host at Florida International University opened the meeting and welcomed all participants to North Miami, Florida. He recognized his co-organizers and the sponsors for their contributions to the workshop. Michael Heithaus, Dean of the Marine Science Program at FIU, welcomed participants and expressed his appreciation for the work members are conducting in this field. Kevin identified four primary management drivers that motivated the formation of the Consortium and the inaugural workshop.

- *Stock Assessment Improvements*: Feasibility of acoustics to provide indices for use in stock assessments or ancillary variables to improve survey design for resource assessments
- *Integrated Ecosystem Assessments*: Synoptic observations across trophic levels and biological organization (e.g., prey fields for top predators and marine mammals; characterizing essential fish habitat)
- *Ocean Observatories and Energy Platforms*: Stationary, real-time measures of pelagic fauna and oceanographic features and potential impacts (positive/negative) of energy development
- *Ecosystem Impacts, Response and Restoration*: Repeatable survey techniques to detect impacts and trends over ranges of space and time scales.

The topic sessions for the workshop were designed around these primary management drivers. An additional topic session was identified that would highlight emerging and trending technologies and opportunities for education, training and outreach. Kevin thanked the attending participants and those who were not able to attend for the immediate and positive response in the short time since the workshop was first announced. He ended his remarks by presenting an agenda for two days of presentations and a third day of demonstrations, emphasizing the intention to have time for informal discussions among participants.

1.2. Workshop Agenda

SOUTHEAST ACOUSTICS CONSORTIUM WORKSHOP AND FORUM
13-15 MARCH, 2012
FLORIDA INTERNATIONAL UNIVERSITY
MIAMI, FL

Tuesday March 13, 2012

8:00 AM	Arrive		
8:15	Welcome and Introductions	Michael Heithaus Kevin Boswell	Florida International University
8:45	Keynote	Michael Jech	NMFS Northeast Fisheries Science Center
Stock assessments and fisheries management *Warren Mitchell*			
9:30	Jose Rivera	Attempts to Identify Red Hind (*E. guttatus*) within 1 m Off bottom with hydroacoustic techniques	
9:50	John Walter	Data needs for stock assessments	
10:10	David Naar	Advanced survey technologies for Gulf of Mexico reef fish	
10:30	Break		
10:50	Chris Gardner	Mapping hard bottom reef fisheries habitat off northwest Florida-needs, methods, and status	
	Discussion		
12:00	Lunch		

Ocean observatories and data management *Laura Kracker*		
1:20 PM	Doran Mason	Advanced Coral Reef Ecosystem Observations
1:40	Roger Rulifson	Combining ADCPs with Acoustic Arrays to Enhance Interpretation of Fish Movements
2:00	Victoria Price	Use of High Resolution Sonar to Quantify Attributes of Predation at Ecologically Relevant Space and Time Scales
2:20	Break	
2:40	Luke McEachron	Acoustic data holdings from the Florida Fish and Wildlife Research Institute
3:00	Bob McClure	Echosounder applications
3:20	Scott Hecht	From collection to archive: Initial steps in creating an archive for NMFS' active acoustics data
3:40	Sarah Fries-Torres	DIDSON observations of juvenile goliath grouper
	Discussion	
4:30	Social	

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SOUTHEAST ACOUSTICS CONSORTIUM WORKSHOP AND FORUM
13-15 MARCH, 2012
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MIAMI, FL

Wednesday March 14, 2012

8:30 AM	John Quinlan	Perspectives	NMFS Southeast Fisheries Science Center
Integrated ecosystem assessments *Chris Taylor*			
9:10	Chris Taylor	Fisheries acoustics applications for coral reef fisheries management and marine reserves	
9:30	Bill Lindberg	Toward efficient mapping of reef fisheries habitat across spatial scales	
9:50	Doug Nowacek	Integrating observations of prey fields and physical oceanography into the study of cetacean foraging ecology	
10:10	Break		
10:50	Bruce Sabol	Development of Submersed Aquatic Vegetation Mapping Capability Using a Low-Cost Uncalibrated Echosounder	
11:10	Danielle Morley	Reef fish spawning aggregations in the Florida Keys	
11:30	Erin LaBrecque	Use of opportunist EK60 data from NOAA marine mammal surveys: how to keep a dissertation afloat	
	Discussion		
12:00	Lunch		

Trending technology and education *Kevin Boswell*		
1:20 PM	Toby Jarvis	A workflow for processing hydroacoustic data
1:40	Scott Harris	Training and Applying Acoustic Remote Sensing Techniques for Seafloor Mapping and Habitat Delineation in the Southeastern U.S.
2:00	Jeff Condiotty	Kongsberg Technology for the Water Column
2:20	Break	
2:40	Patrick Nealson	Improving Signal-to-Noise Performance in Hydroacoustic Monitoring Systems Through the Use of FM Slide/Chirp Signals
	Discussion	
4:00	Chris Taylor	Closing remarks

Thursday March 15, 2012

DEMONSTRATIONS		
9:00 am - 3:00 pm	On the dock	Vendors: Biosonics, Echoview, Furuno ,Simrad/Kongsberg, HTI
		Equipment: Biosonics DT-X Echosounder, Didson, HTI Model 241, Simrad EK60 & EK15, Kongsberg M3, WASSP

2. Topic and Discussion Sessions

2.1 Keynote address J. Michael Jech: Moving forward with acoustics for managing living marine resources

The inclusion of advanced sampling technologies, such as acoustic and optical methods, into fisheries assessments within NOAA is an ongoing process. There are several reasons for this, and I will examine some of these through the experiences of attempting to incorporate multi-frequency acoustic data into an Atlantic herring assessment. In addition, there is strong motivation for collecting and using data for improving stock assessments, potentially at the expense of longer-term and broader-scale uses and opportunities. I will look at ways that acoustic data can be used for other applications and objectives, such as ecosystem- based management. With budget and resource constraints imposing, sometimes severe, restrictions on our ability to survey using historically-consistent sampling methods, it is imperative that we become more efficient and effective at surveying our living marine resources, and I will explore how advanced sampling technologies can have positive impacts on improving our understanding of these resources.

2.2 Stock Assessments and Fisheries Management

2.2.1. Jose A. Rivera, Todd Kellison, Richard S. Appledorn, Michelle Sharer, Michael Nemeth, Tim Rowell, Daniel Mateos, and Patrick Nealson: Attempts to identify Red Hind (E. guttatus) within 1 m off bottom with hydroacoustic techniques

Quantifying fish abundance and size structure at spawning aggregation sites is critical for assessing stock status, but methods must overcome limitations posed by weather and labor-intensive diver-based surveys. Hydroacoustic surveys, using advanced split-beam sonar technology to quantify both the number of fish and their relative size, would seem to offer a practical alternative. However, these techniques were originally developed for mid-water surveys and not to detect fish in close proximity to the bottom. Led by José A. Rivera, in collaboration with Patrick Nealson of Hydroacoustic Technology Inc., the Caribbean Coral Reef Institute has teamed with NOAA since 2010 to test the ability of split- beam technology to determine the density and size structure of red-hind, a moderate-sized grouper, at annual spawning aggregation sites on the west coast of Puerto Rico and at Mona Island. The study focuses on detecting fish within 3 ft off the bottom. Data from the hydroacoustic surveys are calibrated against diver-based surveys, led by Dr. Michelle Scharer. Initial surveys led to constant adjustments in instrument calibration and signal processing to separate the bottom signal from that of the fish. Results to date have been very promising. Hydroacoustic survey results have been consistent with those of the divers for both density of red hind and their size structure. Importantly, these results come from those fish detected within 3 ft off the bottom. Surveys made across the red hind spawning aggregation site have shown a

clear demarcation of the boundaries of the aggregation based on the abundance and location of detected fish. Continued work is further quantifying the accuracy and precision of hydroacoustic derived data while also exploring the effect of behavioral changes on the ability to detect the fish. For example, red hind are more active courting and defending territories during twilight hours, so they are more likely to be off the bottom at that time. Conversely, during periods of strong current the fish tend to seek shelter in crevices or behind large sponges, and this may lower the probability of detection. These studies have direct application in helping assess reef fish resources and strategies for sustainable use in Caribbean Island environments.

2.2.2. John Walter: Data needs for stock assessments

Despite the substantial value of acoustic technology, most stock assessments in the Gulf of Mexico and Southeast region make limited use of acoustics. This may stem from three factors: 1) the vast difference in scale between the population level of the stock assessment and that of many acoustic studies; 2) the short time series of available acoustic information, relative to the time scale of the assessment; and 3) lack of clarity of the multiple ways that acoustics can chip away at key model uncertainties right now. Issues (1) and (2) will only find solutions over time, however for issue 3 there are multiple ways that acoustics can fill data gaps for stock assessment in the short term. In this talk I disassemble the stock assessment model to lay bare key places where acoustics can support assessments. I describe how the models make almost exclusive use of relative information. Next I describe how acoustics may be immediately valuable for estimation of selectivity and catchability which are the scalars that translate relative information to the population level. I then describe how acoustics may be quite valuable in providing parameters for Bayesian prior distributions that are often used in many models. When possible I use examples from recent stock assessments in the region to demonstrate how acoustics might fill in data gaps. Some of these include direct estimation of tilefish burrow density, size-selectivity of red snapper captured on hook gear, minimum spawning population size estimation among others.2.1.3. David Naar, Steve Murawski, David Mann, Carrie Wall, Sarine Manoukian, David Hollander, Ernst Peebles, Bill Hogarth, and Rob Walker: Advanced survey technologies for Gulf of Mexico reef fish.

2.2.3. David Naar, Steve Murawski, David Mann, Carrie Wall, Sarine Manoukian, David Hollander, Ernst Peebles, Bill Hogarth, and Rob Walker: Advanced survey technologies for Gulf of Mexico reef fish

We will present the usefulness of active sonars, passive acoustic sonar arrays, and passive acoustic sonar mounted on a glider, for purposes of determining benthic habitats, defining marine protected areas, locating fish spawning sites, monitoring artificial reefs, locating fish in the water column, and locating submerged oil during the BP Oil Spill in 2010. The locations of these surveys range around Florida from Pascagoula MS to beyond Jacksonville FL. The range in depths from 1000 m to 10 m. We will show

examples using 300 kHz and 70-100 kHz multibeam bathymetry and backscatter surveys to define benthic habitats of shallow and deep corals and associated fish in the water column (Allee et al., 2011). We will show examples of a passive acoustic array on the west shelf of Florida and defining the spatial and temporal activity of certain fish (Wall et al., in press) as well as monitoring the red grouper activity on the seafloor (Wall et al., 2011). We will show examples of how we used low frequency (24 kHz) single-beam sonar on the R/V Weatherbird II to identify the submerged oil plume backscatter layer during the BP Oil Spill (following the methods of Johansen et al., 2003). We will show photographs of the newly installed Simrad EK-60 echosounder, which FIO plans to calibrate and operate in archival mode whenever possible. This digital 38 kHz split-beam aperture system will be of great use for purposes of locating and assessing fish abundance. This digital system would also be a much better tool to locate and record backscatter layers related to submerged oil than the previous analog system that was used. Finally, the EK-60 in conjunction with the planned development of a new camera sled, should allow better calibration and verification between acoustics and visual observations (NOAA project being led by Murawski and others).

2.2.4. Chris Gardner, Patrick Raley, Doug DeVries, and David Naar: Mapping hard bottom reef fisheries habitat off northwest Florida - needs, methods and status

The west Florida shelf (WFS) supports some of the most valuable reef fish fisheries in the U.S. Gulf of Mexico. However, very little of its area has been mapped with sufficient resolution to accurately locate and quantify the hard/live bottom habitat these fisheries are so strongly tied to. Such maps are essential for designing an efficient fishery independent survey of reef fishes, enabling pre-stratification by habitat, and thereby minimizing variance and optimizing survey resources. Accurate habitat maps will also be critical for ecosystem based fisheries management and marine spatial planning. In support of a recently expanded fishery independent reef fish survey, the Panama City NMFS lab began mapping cross-shelf transects on the northern WFS using multibeam and side scan sonar. Three transects ~ 1.5-2.5 X 30 nm (18-70m depths) were mapped with a 300 kHz multibeam sonar and nineteen single swath cross-shelf transects ~20-30 nm X 150 m (7-47m depths) were mapped using a 600 kHz side scan sonar. An inexpensive geo-referenced live video drop camera, stationary video camera array, and occasionally an ROV were used for visual ground truthing. Over seventeen hundred new reef sites have been discovered and analyzed in detail. Physical attributes (area, relief, rugosity, and proximity to neighboring reefs) of each reef were measured and categorized into a relative, standardized score to provide a repeatable, quantifiable measure to use in a weighting scheme when randomly selecting sites for sampling. Information on habitat associations will be invaluable for increasing precision and accuracy of survey abundance estimates by revealing important strata for both survey design and data analysis.

2.2.5. Topic Summary - Stock Assessments and Fisheries Management

Within the "Stock Assessment and Fisheries Management" session, a keynote speaker and four scientists presented results from ongoing and recently-initiated research. Recurring general themes included the importance of collecting information useful at stock-sized spatial scales, challenges related to acoustic gear limitations and species identification, and an ever-present need for additional habitat information. Example data were presented for a range of federally-managed species (e.g., red grouper, red snapper, golden tilefish), southeastern US and Caribbean habitats (e.g., deepwater coral reefs, low-relief "live" bottom), and applied gears (e.g., split-beam, side-scan, and multibeam sonar). Novel survey technology approaches were described that would be especially applicable within future stock assessments (e.g., quantifying fish spawning aggregations, informing selectivity and catchability parameters, calibrating relationships between advanced sampling technologies and traditional fisheries assessment methods). Using acoustic methods to quantify habitat was discussed at various spatial scales, from describing local characteristics of a spawning aggregation site, to informing the spatial stratification of surveys across a species range.

2.3 Ocean Observatories and Data Management

2.3.1. Doran Mason: Advanced Coral Reef Ecosystem Observations

2.3.2. Roger A. Rulifson, Jennifer L. Cudney, Ryan Mulligan and Andrea Dell'Apa: Combining ADCPs with Acoustic Arrays to Enhance Interpretation of Fish Movements

Continental shelf waters off the Outer Banks of North Carolina are suspected to serve as a migratory corridor for a number of species that make extensive movements along the U.S. east coast. The continental shelf at Cape Hatteras in particular is very narrow, making it an ideal "choke point" location to deploy acoustic receivers that can be used to track marine animals. An array of Vemo VR2W acoustic receivers were deployed in the Hatteras Bight between 2009 and 2011 to track migration and local movement patterns of spiny dogfish (Squalus acanthias), a small abundant coastal shark that makes regular seasonal movements between mid-Atlantic and New England waters. These sharks are known to be highly sensitive to local environmental conditions. Therefore, acoustic doppler current profilers were also deployed with the acoustic array to characterize sea conditions during detection periods. ADCPs record water speed, direction, and temperature. ADCPs were deployed at shallow, mid-depth, and deep sites in 2009 and at a mid-depth site along the array in 2010. Broadly characterized, current patterns at deep and shallow sites were similar and suggested across-shelf flow of water masses. Fish detections tended to be more common when the currents were moderate (0.2-0.4 m/s) and flowing eastward. However, there were often periods of

time when the surface and bottom waters were moving counter to each other. Two animals showed up just after major shifts in directionality of movement of the water column at depth. The acoustic array was also deployed near Hatteras Inlet, and therefore tidal forces likely play a significant role in the local environmental conditions. Comparisons of the timing of acoustic detections against tidal data suggest that some animals tended to reappear in the area at specific times during a tidal cycle while in overwinter habitats.

ADCP data, along with other environmental data (e.g.- satellite sea surface temperature (SST), tide data, weather conditions, and the relative abundance of prey at specific time periods), will enhance our understanding of what drives local movements in this dynamic region. Acoustic receivers also logged data owned by other research institutions that tagged Atlantic sturgeon, American shad, cownose ray, hickory shad, sand tiger shark, sandbar shark, bull shark, and spiny butterfly ray. We encourage these data owners to also consider the deployment of passive acoustic devices like ADCPs to provide context to acoustic detections.

2.3.3 Victoria Price, Peter Auster, and Laura Kracker: Use of High Resolution Sonar to Quantify Attributes of Predation at Ecologically Relevant Space and Time Scales

Predator-prey interactions are difficult to study in the ocean due to limitations in the space and time requirements for observations. Small-scale direct underwater observations by divers (<10m2) and large-scale hydroacoustic surveys (100s - 1000s m^2) are traditional approaches. However, large piscivorous predators identify and attack prey at the scale of tens of meters. Dual-Frequency Identification Sonar, or DIDSON, is a high-resolution acoustic camera operating in the MHz range that provides detailed continuous imaging of objects out to 30 m range. Observations using DIDSON can provide an intermediate spatial scale viewpoint at specific sites by providing a larger picture over long periods of time. The fine-scale aspects of predation (such as predator and prey group size, predation rates, use of landscape features by both predator and prey, etc) and indirect predator interactions (e.g, the driving of prey to the bottom by midwater predators where they are then fed on by demersal predators) are critical to understanding the reef community structure as a whole. This greater understanding can aid in developing more comprehensive management strategies. Group size, predation rate, and other attributes of predation events were assessed from data collected in 2009. Here I assess the utility of DIDSON for observing predation in reef communities to close the gap between traditional small and large scale observation methods.

2.3.4 Luke McEachron: Acoustic data holdings from the Florida Fish and Wildlife Research Institute

The Florida Fish and Wildlife Research Institute actively leases GPS track logs from long-line fishermen on the west coast of Florida. In an effort to map hard bottom on the west Florida shelf, kernel densities are created from these tracks with the assumption that

long-liners are fishing over hard bottom areas. We mapped commercial fishing densities with acoustic data primarily sourced from our Fisheries Independent Monitoring (FIM) program and our partnerships with the University of South Florida (USF). FIM conducts side-scan surveys during their regular sampling and has a series of small datasets that can be pieced together like a quilt. FIM's data compliment USF's data which are typically larger, continuous datasets. By combining commercial fishing densities with USF and FIM acoustic data, we can easily identify data gaps and priority research areas on the west Florida shelf.

2.3.5 Bob McClure: Echosounder Applications

The opportunities afforded by ocean observatories are exciting for both scientists and resource managers in many fields. Terrestrial, atmospheric, and astronomical observatories have the advantage of "not being underwater". Until recently, the best continuous, long-term observations an ocean scientist could hope for were often based on sending out a sensor and retrieving it at a later date to download and explore the results (a message in a bottle). Recently, scientists have been pursuing and implementing cabled ocean observation systems – undersea power and communication networks with the capacity to host dozens or hundreds of sensors, capable of continuous monitoring and recording of variables that were only sampled briefly or by chance in the recent past. Traditional hydroacoustics in the ocean environment has focused on the collection of acoustic data from mobile surveys for the assessment of "fish" stock abundance and distribution – often in support of resource assessment and management. More recently, research on habitat and non-commercial resources has grown in importance and research has continued to support both of these areas. Most recently, with the implementation of cabled ocean observatories, a variety of opportunities for both research and resource management has become possible and the scale of observations has increased dramatically. With a focus on echosounder technology, we will explore different applications of hydroacoustics, system considerations and modifications, and platforms either currently deployed or in development.

2.3.6 Scott Hecht: From collection to archive: Initial steps in creating an archive for NMFS' active acoustics data

Last summer a survey was conducted to assess the need for an archive to house NOAA National Marine Fisheries Service's (NMFS) active acoustics data. Meetings were at each science center with scientists and data managers involved in acoustics research. Key objectives of the survey included: 1) evaluation of NMFS science center capabilities and needs regarding active acoustic data; 2) description of NMFS' ME70 multibeam activities for water column and habitat; 3) alignment of survey with NMFS data management activities; and 4) identification of partnering opportunities. The primary finding was that NMFS is in need of an archive to safe guard high volume, routine active acoustic data. To meet this need, a pilot project was initiated to archive an ME70 dataset at NOAA's National Geophysical Data Center. Initial results of the pilot project and direction of future archive activities will be discussed.

2.3.7 Sarah Fries-Torres: DIDSON observations of juvenile goliath grouper

2.3.8 Topic Summary - Ocean Observatories and Data Management

Current research and future needs related to Ocean Observatories and Data Management were discussed in the afternoon session. These talks highlighted the potential applications as well as the limitations related to ocean observatories. Research highlighted in this session included the implementation of a realtime observation network in a coral reef ecosystem that couples information on fish with environmental data to track specific events and develop ecosystem indicators. Along the Atlantic seaboard, deployment of acoustic receivers to track coastal sharks in conjunction with data on sea conditions from ADCPs (current speed and direction, water temperature, and tidal flow) provides context for interpreting animals movements. The use of high-resolution sonar to decipher fish behavior demonstrates how sonar technology can be used to quantify predation and prey responses at relevant temporal and spatial scales. On the west Florida shelf, combining side-scan sonar mapping with GPS track logs from commercial fishing vessels and fishery independent acoustic surveys provides detailed information on the location and characteristics of benthic fish habitats and helps identify data gaps and priority research areas. The properties of sound in water, the basics of active acoustic technology, lends itself to capturing continuous, fine-scale information on many biological and physical features of the water column that supports a wide-range of research and management questions. Because of the efficient nature of acoustic surveys, data management, standards, metadata and archiving will play an increasingly important role in fisheries acoustics.

2.4 Keynote Address: John Quinlan: Perspectives

2.5 Integrated Ecosystem Assessments

2.5.1. Chris Taylor, Laura Kracker, Erik Ebert, John Burke, Shay Viehman: Fisheries acoustics applications for coral reef fisheries management and marine reserve research

Active acoustics (e.g., fisheries sonar, fish finding echosounders) have a 50 year history in fisheries research, but a relatively short history in coral reef ecosystems. Visual surveys by divers form the foundation for fish and habitat assessments in coral reef and hardbottom habitats. The level of detail provided by eyes underwater is unsurpassed by nearly any existing technology and management of our resources would not be possible without these efforts. But logistical constraints in bottom time, mission duration and increasing costs are placing more limitations on spatial coverage. We'll show some examples of how we can enhance visual surveys of reef fishes by pairing visual observations with remote sensing surveys of fish communities using fishery sonar. Large-scale surveys using sonar help to place the fine-scale observations by divers into a larger landscape context. Remaining challenges in coupling acoustic and optical approaches in reef environments will be discussed. Examples will come from recent missions in in the Florida Keys and Flower Gardens National Marine Sanctuaries.

2.5.2. Bill Lindberg, Mary Christman, Russ Watkins, Doug Marcinek, Zy Biesinger: Toward efficient mapping of reef fisheries habitat across spatial scales

Large, mobile reef fish use hard-bottom habitats across spatio-temporal scales, e.g. gag (*Mycterperca microlepis*) can occupy small home ranges (<5,000 m2) for a few months and undergo ontogenetic habitat shifts covering >150 km over several years. Prior field experiments enabled us to assess, in relative terms, the intrinsic habitat quality at sampling sites independent of gag densities. And telemetry studies showed that gag have a capacity for homing, with home range sizes and space utilization being functions of the landscape quality surrounding resident reefs. However, underwater visual census of gag across a range of habitat qualities revealed high quality reefs with unexpectedly low gag numbers during a period of stock decline. Efficient mapping of reef fisheries habitat at scales matching habitat selection and utilization is imperative for empirical studies and modeling of spatial dynamics within the gag stock, as well as for fisheries independent monitoring (FIM) of reef fish stocks, in general.

In addition to locating potential sampling sites with 600 kHz side-scan sonar and creating mosaics of side-scan imagery around study sites, digitized in GIS, we executed cross-shelf swath transects in a spatial sampling design to estimate the geographic distribution of inner-shelf hard-bottom habitat in the NE Gulf of Mexico. The intent was to extract landscape metrics as covariates for analyses of gag abundances at standardized sampling stations, in part, to help improve FIM sampling efficiency and the

precision of resultant indices of abundance, but also to aid studies of cross-shelf connectivity and to inform public investments in more advanced oceanographic bottom mapping. Unfortunately, the accuracy of commercial classification software was inadequate for automated processing of acoustic data at sufficiently fine-grained scale. Therefore, we developed an alternative spatial autologistic regression approach using data from previously digitized reference sites, and are now refining that algorithm toward a proof-of-concept using different acoustic data sets with digitized imagery in GIS.

Within the region several groups are using similar systems for similar purposes and a great need exists to standardize protocols for data acquisition, management and processing. With new and refined classification algorithms now available, comparative accuracies need to be assessed objectively using the same data sets compiled from the active research groups.

2.5.3. Doug Nowacek, Ari Friedlaender, David Johnston, Andrew Read: Integrating observations of prey fields and physical oceanography into the study of cetacean foraging ecology

Relatively little research has combined the study of cetacean foraging behavior with concurrent measurements of prey fields and physical oceanography, but new research tools are providing such opportunities. We have studied the foraging ecology of humpback whales (*Megaptera novaeangliae* - Mn), short-finned pilot whales (*Globicephala macrorhynchus* - Gm) and Blainville's (Md) and Cuvier's (Zc) beaked whales. We combined behavioral data from multi-sensor tags (Mn and Gm) and a bottom-mounted array (Md and Zc) with synoptic measurements of the acoustic volume backscatter of potential prey using calibrated EK-60 echosounders and described the physical environment using ADCP, CTD, and, in one case, a turbulence profiler. We deployed 15 tags on Gm for a total recording time of over 113h. Echolocation buzzes, representing prey capture attempts, occurred 7.1 times per dive and 14.3 times per hour. Overall, whales foraged at depths where biomass and/or single targets were greatest, but not all foraging decisions were based on vertical variation in biomass. In 2009 and 2010 we deployed 21 digital recording tags on humpback whales for over 350 hours around the Western Antarctic Peninsula and collected concurrent measurements of Antarctic krill (*Euphausia superba)* distribution and biomass. Overall, we found that the frequency of lunges on a given dive increases with dive depth, supporting an energetic cost of lunging at depth. For beaked whales, we sampled the prey field with an 8 km, 4-leaf clover sampling pattern so as to examine the spatiotemporal scales and relationships among turbulence levels, biological scattering layers, and beaked whale foraging activity. We found a strong correlation among increased prey density and ocean vertical structure relative to increased click densities. Quantitative descriptions of the distribution of prey are critical to interpreting cetacean foraging ecology.

2.5.4. Bruce Sabol: Development of submersed aquatic vegetation mapping capability using a low-cost uncalibrated echosounder

Previous work with a research-grade calibrated acoustic sounder system and global positioning system (GPS) resulted in development of the Submersed Aquatic Vegetation Early Warning System (SAVEWS). This system demonstrated rapid and accurate detection and characterization of canopy height and coverage of rooted submersed aquatic vegetation (SAV), however, the high cost (over $20,000) of the hardware resulted in a limited user community. Since initial development, the cost of combined echosounder/GPS systems capable of generating digital output has fallen to less than $2,000. We have undertaken the task of developing a new processing algorithm to automate the characterization of SAV canopies using such a low-cost uncalibrated dual frequency system. Fundamental differences in signal characteristics between the research-grade and the low-cost acoustic systems have necessitated a very different algorithmic approach. We describe this approach and demonstrate some early processing results. The new algorithm (designated SAVEWS Jr.) is in beta testing by several organizations in different parts of the country. An initial release version will be made available to the SAV community this year.

2.5.5. Danielle Morley, Todd Kellison, Chris Taylor, Art Gleason, Alejandro Acosta: Using acoustics to examine reef fish aggregations in the Florida Keys

Fish spawning aggregations (FSAs) are a critical step in the life history of several commercially important grouper and snapper species throughout the Florida Keys. It has been shown that aggregations in other areas are susceptible to overexploitation. To ensure proper management of these resources, FSAs within the Florida Keys are being evaluated using an array of sampling tools (acoustic equipment, aerial surveys, scuba divers, etc.). The following objectives are being examined: 1) whether reported FSA sites share common habitat characteristics, 2) determine the level of fish utilization at these aggregations and, 3) locate any additional aggregation sites. Findings from this work will be used to aid resource managers in determining the efficacy of current marine reserve locations and provide information to further protect these resources.

2.5.6. Erin LaBrecque: Use of opportunistic EK60 data from NOAA marine mammal surveys: how to keep a dissertation afloat

As the goals of living marine resource conservation and management change from single species to ecosystem-based, more emphasis is being put on interdisciplinary studies. Many of the National Marine Fisheries Service (NOAA Fisheries) marine mammal ship-based surveys now routinely collect oceanographic, plankton, nekton, and both passive and active acoustic data. By collecting and analyzing these data, scientists can gain a better understanding of the ecology of marine mammals and provide scientifically sound recommendations for their conservation and management.

Biological patchiness is a prominent feature of the marine environment and tends to increase in intensity in the vicinity of dynamic oceanographic features and abrupt

topographies. Depending on the spatial and temporal scales under investigation, patch structures are the result of a range of physical (e.g. advection and diffusion) and biological (e.g. growth, predator-prey interaction) processes. I am investigating the patch dynamics of middle trophic level biomass in relation to the shelf break front and cetacean sightings in the southern section of the Middle Atlantic Bight to elucidate ecosystem processes at a regional spatial scale. In situ oceanographic, hydroacoustic, and marine mammal sighting data were collected during a large-vessel line-transect survey in the summer of 2006. Transects covered the continental shelf, slope, shelf break and pelagic regions of from Virginia to Cape Lookout, NC. Hydroacoustic data at 38 kHz and 120 kHz were opportunistically collected with a Simrad EK60 Echosounder system. Preliminary results indicate concentrations of cetacean sightings on the western edge of the shelf break in the vicinity of the shelf break front. Throughout most of the survey area, echoes of individual scatters were not discernible but biological patches and layers were apparent and seemingly more concentrated in the shelf break region. We hypothesize that the middle trophic level patchiness in the region of the shelf break is the result of the upwelling associated with the shelf break front. This patchiness, in turn, influences the distribution of cetacean sightings.

2.5.7. Topic Summary - Integrated Ecosystem Assessments

Presentations in the integrated ecosystem assessment session highlighted ways that active acoustics are filling data gaps to inform place-based management and understanding ecosystem processes and services. Fishery sonar can be used to cover broad areas and search for events or targets like spawning aggregations quickly and efficiently, or to extrapolate the visual observations on distribution of fish biomass in coral reef. Active acoustics can also be used to observe prey resources in concert with tagging technologies used to understand movements of predators and marine mammals. In an era of declining budgets and the need for increased efficiency, there was broad consensus that considerations for opportunistic data collection or piggy-back studies on large research ships should become more common practice. Finally, low-cost sonar systems have a place in reconnaissance missions to discover or delineate essential fish habitat.

2.6. Trending Technology and Education

2.6.1. Toby Jarvis: A workflow for processing hydroacoustic data

There are different types of hydroacoustic data (single-/dual-/split-beam, multibeam, imaging sonar) and a range of applications for them (biomass, fish counting, sizing and tracking, ecological metrics etc.). Amidst this diversity, a 6-stage workflow can be identified that provides a handy roadmap when processing any type of data for any application. In this presentation, an overview was offered detailing this workflow with accompanying hints of specific techniques that are currently being employed within each stage.

2.6.2. Scott Harris: Training and applying acoustic remote sensing techniques for seafloor mapping and habitat delineation in the southeastern U.S

The BEnthic Acoustic Mapping and Survey (BEAMS) program at the College of Charleston has been conducting hydrographic training and seafloor mapping within strong undergraduate geoscience and marine biology programs. In parallel with scientific objectives for the South Atlantic Bight, the training has been largely conducted aboard research vessels in association with the CofC BEAMS, Transects and GUSTO programs, as well as with many cruises of opportunity with NOAA and SC DNR. Combined training within a strong remote sensing, GIS, and geology program in the geosciences, our students have been well-received at graduate programs nationally and internationally. Many continue to work with NOAA, SC-DNR, and private foundations. Well-supported by the College, Charleston students benefit from training by faculty, as well as experts from software companies, hardware developers, and other groups with additional expertise.

2.6.3. Jeff Condiotty: Kongsberg Technology for the Water Column

The diverse products from Kongsberg (Simrad Fisheries) were presented in which multiple platforms from ship borne to autonomous vehicle were shown. Kongsberg's range of acoustics sonar systems are designed to address multiple survey / research endeavors. From the detection of the bottom with high resolution wide hydrographic swath multibeam systems to estimating fish populations & individual fish size with fisheries research systems, examples were shown on how these products are showing overlap in multiple markets and applications.

2.6.4. Patrick Nealson: Improving signal-to-noise performance in hydroacoustic monitoring systems through the use of FM slide/chirp signals

The ability to provide both high spatial resolution and maximum detection range is a desirable attribute of hydroacoustic systems used for fisheries or biological oceanographic research. Typically systems configured to maximize range employ a high transmit power and a relatively long (higher energy) CW pulse duration. The use of a long pulse duration reduces the ability to resolve closely-spaced targets. Acoustic systems that use FM slide, or "chirp" signals with corresponding matched filter processing can achieve high spatial target resolution without sacrificing maximum range. The HTI Echo Sounder using an FM slide signal achieves a 17 dB improvement in the hydroacoustic system signal-to-noise ratio relative to a conventional CW pulse signal. An overview of the implementation of the FM slide signal in the HTI echo sounders will be discussed and example data from field studies will be presented.

2.6.5. Topic Summary - Trending Technology and Education

Authors participating in this session brought attention to developments in both the technology for collecting acoustic data in addition to developing techniques for handling

complex ecosystem survey data. Within this session, several new and promising sonar systems were presented, in addition to two systems designed for acquiring broadband response data from fish targets. While continued efforts towards advancements in technology and analysis are necessary to address mounting questions, programs focused on education and training in acoustic principles are paramount. To date, there exist only a few academic-based training opportunities for emerging acousticians in the SE US, though institutions like the College of Charleston are contributing to this need.

3. Concluding Remarks and Recommendations for Consortium Development

From 13-15 March 2012, the inaugural workshop of the SouthEast Acoustics Consortium convened with a broad purpose of bringing members together to share ideas. The workshop planning team thanks the participants, speakers, facilitators, and rapporteurs for their contributions. The professional and collegial atmosphere during the three-day workshop was conducive to a very productive and positive meeting, setting the stage for future collaborative endeavors. By attracting 62 participants, including many students, the workshop met these Consortium objectives:

- ✓ To inventory activities, interest, expertise, and assets related to active acoustics.
- ✓ To inform regional managers and science leads on the state of the science and emerging acoustic technologies.
- ✓ To identify data gaps and management needs and the potential to fill those gaps using acoustic technologies.
- ✓ To encourage education and training through academic and research opportunities.

Speakers presented cases where acoustic survey methods enhance the scientific study of southeastern U.S. and Caribbean coastal environments. Challenges specific to our region were repeatedly acknowledged, such as detecting fish in coral reef environments and designing surveys that adequately match the spatial scales of life-stages and animal movement. It was acknowledged that an active acoustics approach is not a 'silver bullet,' but certainly warrants inclusion in the suite of scientific gears with broad capabilities for observing the marine environment. Emerging regional issues such offshore energy development and ocean observing systems indicate the applicability of acoustic gears likely will expand. Presentations by educators and commercial vendors provided insight into the next generation acoustic technology and the professional skills needed to advance the use of these tools.

Workshop presentations are archived on the SEAC website http://seac.fiu.edu

At the conclusion of the workshop presentations, participants engaged in a group discussion regarding SEAC's future format and objectives. Among the topics of interest were: 1) how to keep the Consortium alive, 2) creation of a contact group and online forum, 3) a call to formally identify regional/scale-dependent research needs, 4) Consortium engagement in outreach and social media, 5) creating an archive for SEAC accomplishments, 6) creation of a public SEAC calendar, 7) dissemination of employment-related topics (e.g., advice for job seekers, research cruise opportunities), and 8) the creation of a loaning library for acoustic gears. There was strong agreement that participants wanted to foster communication and remain connected as members of SEAC.

The timing and location of future SEAC gatherings was discussed. Regarding workshop frequency, a show of hands indicated that a biennial schedule was favored most. A proposal was made to identify hosts for a 2014 meeting, with an official call for that host going out in early 2013. Opportunistic gatherings were discussed such as co-meetings with other regional and national scientific groups, but no obligations were made.

3.1 Epilogue

In the six months following the workshop, Consortium members have reported on several significant outcomes attributed to the formation of this group:

- A three-day training course on acoustic data processing was held in conjunction with the workshop.
- Novel collaborations have been initiated; at least two research proposals have been funded.
- A student who attended the workshop was hired by one of the participants.
- Dialog commenced between SEAC members and a charter research vessel regarding standardizing acoustic system operating protocols.
- Collaboration was developed that led to an experiential course on marine bioacoustics, including active acoustics, with SEAC members contributing in several ways from teaching to loaning gear.
- A relationship established between participants resulted in an opportunity for three college students to sail on a NOAA research mission.

Finally, to build on this workshop and develop the Consortium, two methods for enhancing communication among members have been established. A SEAC listserv is now hosted by Florida International University: SEAC@fiu.edu. The objective of the listserv is to facilitate timely communications between members. Initially, email addresses provided by workshop attendees comprise the list; but recipients of this report, interested scientists and students are encouraged to join. Contact kevin.boswell@fiu.edu for more information. An online location to discuss topics of interest to the members of the Consortium was proposed within an international fisheries hydroacoustics users' forum: http://www.hydroacoustics.net. A sub-forum for SEAC will be created to facilitate regional discussions and exchange. Consortium members are encouraged to join the forum, examine topics in greater depth (e.g., gear calibrations, acoustic theory), and start new discussions.

4. Technology Demonstration

The final day of the workshop was used to demonstrate a selection of active acoustics and sonar technologies at the research dock of the FIU Biscayne Bay Campus. Manufacturer representatives were available to answer questions about existing and emerging products and applications:

- *Hydroacoustic Technology, Inc. (http://www.htisonar.com)*
  - *Model 24x splitbeam echosounder with FM-chirp*
- *Biosonics, Inc. (http://www.biosonicsinc.com)*
  - *DT-X splitbeam echosounder*
- *Kongsberg Underwater Technology, Inc. (Simrad Fisheries, http://www.simrad.com)*
  - *EK60 splitbeam echosounder*
  - *EK15 singlebeam echosounder*
  - *Simrad/Mesotech M3 multimode multibeam sonar*
- *Continental Shelf Associates (http://www.conshelf.com)*
  - *Unmanned Surface Vehicle*
- *Echoview - Myriax, Party Limited (http://www.echoview.com)*
  - *Echoview echosounder and sonar data processing software*
- *Furuno USA for Electronic Navigation Ltd. (http://www.WASSP.com)*
  - *WASSP Wide Angle Sonar Seafloor Profiler*

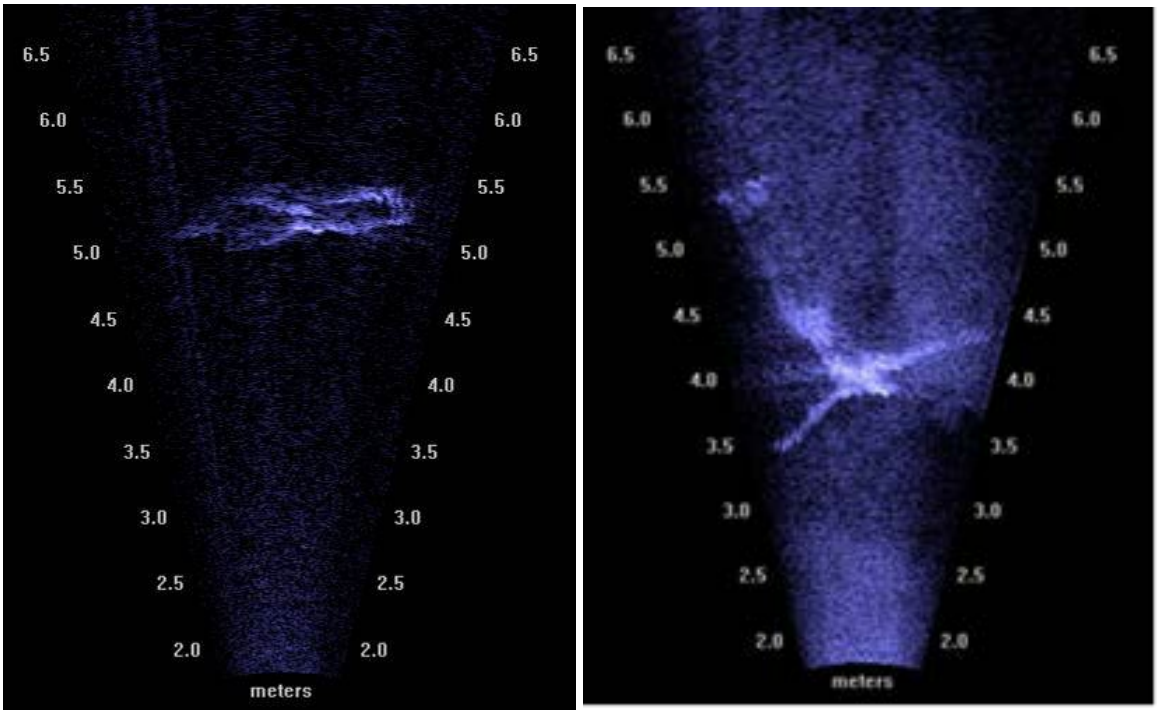
Workshop participants gather on the FIU research dock and research vessel.

During inclement weather, participants received an offline demonstration of the WASSP multibeam sonar capabilities by Dean Silver (Furuno, USA).

Bob McClure (Biosonics, Inc) empties rainwater from the keyboard of a rugged laptop following heavy rain storms that interrupted the day's demonstration.

Representatives from Continental Shelf Associates and workshop participants deploy a remotely operated surface vehicle.

Chris Taylor (NOAA NCCOS Beaufort, NC) prepares a flexible overboard mount for deploying the Mesotech M3 multibeam sonar and Simrad EK60 splitbeam transducer.



Workshop participant Toby Jarvis (Myriax Pty Ltd, Tasmania Australia) volunteers as an acoustic target in a DIDSON imaging sonar demonstration.

5. List of Participants

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