South Atlantic Bight Synoptic Offshore Observational Network

Final Report
to:
National Oceanographic Partnership Program
Office of Naval Research

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LONG-TERM GOAL

The long-term goal is to evaluate underwater video for providing fishery managers real-time visual data on reef fish communities, which will contribute to making and/ or modifying fishery management regulations.

OBJECTIVES

There were several objectives which were to initiate progress toward the long-term goals of the overall SABSOON project and included: 1) identification of environmental conditions associated with the formation of prespawning aggregations of gag grouper, 2) determination of temporal changes in visual indices of abundance of fish species for which no commercial harvest is allowed, and 3) correlation, if any, of resuspended bottom sediments to fish community structure. The scientific objectives required successful establishment of a reliable underwater video system, which can provide near full motion video for long periods of time.

APPROACH

We have established an underwater video research site and associated reef fish community approximately 45 miles off the coast of Georgia. Transmission of digital image data is from a bottom mounted camera system, through a network at the Skidaway Institute of Oceanography (SkIO), and to our laboratory in Charleston, SC via an established USN (Tactical Air Combat Training System) microwave linkage to shore. The video system was deployed in association with some low relief structures to aggregate fish. This "remote sensing" research required the application of image capturing and transmission software and hardware. Deployment and maintenance have

been with the assistance from the Director and dive crews of the Gray's Reef National Marine Sanctuary. Observations of the diversity of one mid-shelf reef fish community over time represents a significantly different approach to monitoring offshore fish populations. Observations and counts of the fish populations were conducted daily and correlated with subsurface oceanographic conditions measured by collaborators at SkIO.

Issues investigated by this research include: seasonal movements of members of the reef fish community, the potential for development of indices of abundance for some migrating populations, and any seasonal behaviors associated with the formation of prespawning aggregations. Information from direct observations via UW video is increasing and may contribute in the future to informed fisheries management decisions on: the relative proportion of specific populations participating in regional spawning movements, any prespawning subpopulations, and residency times of prespawning aggregations. An underwater video camera system offshore allows study of fishes on the bottom throughout the year without the costly trips to a research site in inclement weather. Images of fish and their behavior were available to both scientists and the general public via the World Wide Web through several web sites. The resulting capability has enhanced fisheries biologists' understanding of fish behavior and movements within the region.

WORK COMPLETED

The video system that was designed and fabricated for this research consists of two main parts. A pressure housing, located on the sea floor and a video capture engine, located remotely. Six monochrome video cameras are housed with a micro-controller and a few basic sensors. The micro-controller provides the means to multiplex the 6 analog video signals (NTSC RS-170), one from each camera, to the one coaxial cable running between the pressure housing and the video capture engine. The micro-controller provides the interface to a video titler and sensors. The coaxial cable along with power and communications conductors extended from the sea floor to the video capture engine.

The video capture engine is a computer running under the Windows NT operating system. A console application controls a video frame grabber, which takes the analog video signal and converts it to digital images. The system has the ability to capture multi-frame or single frame images based on parameters set by the user. The micro-controller in the pressure housing will receive commands from the video capture engine for camera selection, titling data, and system status updating. The embedded computer also acts as a web server. The video system is controlled through the web server. File transfer and system parameter updates are made possible by an interface between the web server and the console application controlling the video system using pcANYWHERE.

Small black and white security cameras (Supercircuits PC-23C) with low light capabilities (to 0.04 lux) and relatively low resolution (460 lines) were used. Camera lenses of 8 mm allowed a 12 degree angle of view and the sea bed was in view at about

13.7 m from the camera. Daily observations (~65) were conducted between 1230 and 2130 GMT. Still images ~15 KB (jpg) were recorded and logged at ten minute intervals while 10 sec. video clips ~400 KB (avi) were recorded on the hour from camera No. 5, since only camera No. 5 was directed at reef structure with any reef fish activity. Images were downloaded from the remote computer to the laboratory computer for fish counts and long-term data storage.

The research site was established in 25-28 m of water off central Georgia on May 11, 1999 with the deployment of several large fish attraction units. On August 24, the underwater video cameras, cable and the computer were installed and confirmed to be functioning correctly. The system of cameras, cables and computers were submerged in or in close proximity to salt water and, therefore, represent a high maintenance system. In addition, the communication linkage requires rerouting, upgrading and modifications to ensure increased efficiency and increased access to visible data. We remain a way from our ultimate goal of full motion video, although the SABSOON web site presently allows easy public access (http://www.dnr.state.sc.us/marine/mrri/fishwatch/home.htm) to still images daily, when the system is functioning.

RESULTS

The feasibility of establishing an underwater video research site to observe a natural assemblage of reef fish has been demonstrated. We have learned how to deploy and maintain the underwater video system and remote operation systems. Meeting the scientific objectives of the observational research was dependent on reliability of the system, visibility within the water column, and establishment of a near camera fish community. The camera system has been relatively dependable through several meteorological events (hurricanes Dennis and Floyd; 1999), although high winds and seas do reduce visibility and may obscure the field of view with resuspended fine bottom materials for several days or weeks (hurricane Gordon; 2000).

The correlation of environmental conditions with an observed presence of prespawning groupers (Objective #1) was not accomplished because prespawning groupers have not, as yet, been observed at the research site. Potential for obtaining valuable fisheries management information from observations is dependant on the elimination of both commercial and recreational fishing at the research site and establishment of a permanent reef fish assemblage over a long time period. If the fish species of management concern are rapidly removed from the area by fishing, the primary questions of interest will not be adequately addressed. Every effort has been made to reduce any possibility of fishing and fish removal at the research site by not publishing the location. Populations of adult grouper have been known to increase at sites in the Gulf of Mexico where fishing was non-existent (Lindberg, 1996). Prespawning groupers, which have not been observed yet at the video site, may annually visit established sites along historic migration corridors. One such site, which was visited by large numbers of gag grouper in late November and

early December each year in the 1980's, was the Savannah light tower (Gilligan, personal comm.), which was destroyed by an at-sea collision. The video research site may require several years to establish transient populations of species of management concern. Any information on the timing and spatial extent of a gag grouper aggregation, especially if the fish were in prespawning condition, could contribute significantly to the management of this declining species.

The temporal (seasonal) changes in non-commercial fish species at the research site (Objective #2) were documented for a period of 1.5 years. Images supporting the findings have been archived. Fisheries research data was easily gathered during brief daily counts of fish present near the cameras. Although the species recognition of large commercially and recreationally important species was dependent on the resolution of the cameras, identifications have been relatively easy to date. Large schools of bait-fish were present in most seasons accompanied by schools of predatory amber jacks. The subjects of our interest, snapper and grouper species, have yet to establish resident populations of adults at the site. A description of the annual cycle of species present and their activities at the site was completed. Dates of first observation or presence of fish species are especially important for identification of any prespawning migration to the south by adult grouper. Seasonal changes in the makeup of a fish assemblage near an artificial reef appear much greater than generally believed. A tremendous recruitment of juveniles occurred in spring and summer and was followed by equally large predation by transient species later in the year.

Any relationship between resuspended bottom sediment and fish species present at the research site (Objective #3) was not determined. An undescribed relationship between a local snapper-grouper assemblage and the near-bottom sediment/turbidity levels may exist at mid-shelf locations such as the video camera site. A statistically significant relationship could not be determined by correlating fish counts and species diversity with light and visibility levels measured or estimated at the cameras. Accomplishment of Objective #3 was complicated by the many levels of visibility associated with passing fronts or phytoplankton blooms that were not conducive to quantification of fishes. Much reduced visibility occurs during some seasons, especially winter and spring, when high winds cause resuspension of fine sediments into the water column and during fall when high biological productivity drastically reduces visibility.
Difficulties in species recognition do exist, but they tend to decrease with frequency of sightings under different distance and visibility conditions. Visibility is difficult during periods of low light levels at dawn, dusk and night.

During the most recent year, the underwater video research site was significantly improved by the rearrangement of the large concrete fish habitats into a circle around the video cameras. This has focused the fish activities within the view of the cameras. The importance of the circular site configuration can not be overstated. Movement of the large structures was only accomplished through the generous assistance of the USN Explosive Ordnance Disposal Mobile Unit # 12. Their help was greatly appreciated. Although the cameras have not functioned for over a year, the complete system (cameras, cable and

tower computer) was replaced in May, 2002. This should contribute to further high quality images, video clips and information being transmitted to the internet for both scientific and public use. The reef fish assemblage has matured considerably since the reef units were deployed; this makes the research results more valuable to managers. During the year, important observations were made on fish interactions within the natural reef fish assemblage that may not have been available to divers because of the weather/ sea condition or changes in the normal behavior of animals in the presence of divers. Unfortunately, the fall season when the video system was inoperable coincided with the time of grouper migrations, potentially through the research site and available to the cameras' view. Divers have reported a small resident population of juvenile groupers associated with the site. Their presence during the fall season may attract adults moving along the coast. In addition, an upgrade was initiated for the web site that makes the daily images available to students and the general public. We continue to collaborate with web masters in an attempt to have past images archived to allow public access to all past images.

IMPACT/APPLICATION

Our ability to maintain underwater video and data transmission systems in harsh marine environments for extended periods demonstrates the reliability of the system for long-term fishery observations and research applications. The development of both extensive resident and transient fish populations at the existing video research site has contributed to the understanding of non-fished assemblages of recreationally and commercially important reef fish species. The increased diversity and abundance of top-level preditors with time has greatly increased the value of fish observations to the fishery management community. Observations suggest that adult recruitment of several species to unfished habitats can establish a rich assemblage within several years. The high temporal resolution of continual and near real-time video data has indicated that changes in species composition and abundance have been related to seasonal recruitment and occasional stochastic predation events. Transient species such as tuna and loons contribute a great deal to the annual mortality of small and juvenile reef fish species. Also, changes in seasonal environmental parameters have been related to the presence and absence of fish species that normally make up the reef fish assemblage.

Fishery management information from visual observations will accumulate over time. Observations of rare fish species of the snapper and grouper management complex may allow some estimate of temporal increases in populations of species which are illegal to commercially harvest. An example of useful data would be temporal changes in the relative abundance (counts) of the red porgy, Pagrus pagrus. The red porgy was once one of the most important commercially landed species in the South Atlantic Bight region. At present, population levels are so low from overfishing, that a moratorium on fishing for this species has been established by the South Atlantic Fishery Management Council. There is a good probability that a fishery closure will be in place for up to 18 years. Only one red porgy has been observed at the video site within the 1999-2000 year. During that

or a similar period, traditional fisheries data from any illegal harvest will be unavailable, therefore any improvement in the population size in response to the fishery regulations in place would have to come from fishery independent counts/estimates, such as non-harvest video observations. At present, no harvest is allowed for speckles hind (*Epinephelus drummondhayi*), jewfish (*E. itahara*), warsaw grouper (*E. nigritus*). All these species are considered "over-fished" and by definition are rare individuals with low population levels. Any change in the observation frequencies of the presently rare species, possibly resulting from the enactment of restrictive fishing regulations, may require a 5-10 year period for beginning recovery of the regional stocks.

Further fishery management information will be provided from the observations of any long-term surplus biological potential or adult spawning stock that may take up residence at the research site over time. These types of data would contribute to decisions on the use of fishery reserves, Marine Protected Areas or unfished areas as management tools to allow part of the total reef fish populations protection from harvest and to ensure spawning of large and commercially vulnerable adult fish.

Fisheries research with the ONR funded video system will continue to provide valuable information to the scientific community into the future until maintenance support from other sources is fully exhausted. Although maintenance of the system is high, the ability to maintain the system for extended periods of up to 1.5 years suggests that the system is reliable for long term observations and research applications. Serious consideration should be given to using a series of strategically located video systems to upgrade coastal homeland security. Images could be transmitted to shore via satellite microwave systems.

TRANSITIONS

Estimates of water visibility offshore from recent images have been used by Gray's Reef Sanctuary and SC DNR divers in planning offshore research efforts. Use of the visual fish assemblage information by management agencies will result from scientific publications of research results. The general public will greatly increase their awareness of fisheries issues when access to the video images is more readily available at the web site.

RELATED PROJECTS

Fishery biologists have been investigating the relationships between environmental conditions and fish populations for many years. Other projects of the South Atlantic Bight Synoptic Offshore Observational Network (SkIO) and the proposed SouthEast Atlantic Coastal Observing System (SEA-COOS) are focused on the meteorological and in situ oceanographic conditions near the video research site; there resulting data ultimately will be integrated into our understanding of fish assemblage dynamics. Also, SC DNR fishery scientists are conducting research on fish assemblages of artificial reefs that are not fished to evaluate the establishment of Marine Fisheries Reserves as fishery management tools. The video system will provide a long temporal data series on fish

abundance and behavior that will not be influenced by either the presence of divers or by removal sampling techniques.

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Abstract: A remote undersera observation tool was developed to take and send images of fish in their natural habitat about 45 mi. offshore of Georgia, and send them through an established microwave system to shore based storage. Still images were taken at 10 min. intervals and 10 sec. video clips were taken every hour. About 20 images each day were displayed on an internet site for public information. The system operated for over 1.5 years with no major problems and is presently working, but not transmitting images regularly. Significant information was obtained on stochastic predation events associated with reef fish assemblages and the seasonal changes in community composition. In the future efforts should be directed at archiving past images to make them available, increasing the microwave bandwidth available for streaming video and investigating automatic annotation underdevelopment at the MBARI.

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The purpose of the modification is to extend the performance period of Grant **N00014-98-1-0808** at no additional cost to the government.

Effective as of the date of this modification, revise the section of the Schedule entitled "Period" to read as follows:

"Period: The Grant is for the period **1 JULY 98 through 30 JUNE 2001".**

All other terms and conditions of the grant remain unchanged.

UNITED STATES OF AMERICA
FOR THE OFFICE OF NAVAL RESEARCH

By: Tommy G. Thomas
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Administrative Grants Officer

Date: 6/1/00