ACOUSTIC ASSESSMENT OF JUVENILE BLUEFIN TUNA AGGREGATIONS: A FEASIBILITY STUDY

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Project objectives and scientific hypotheses:
Our goals are to determine the feasibility of estimating biomass of juvenile Atlantic bluefin (*Thunnus thynnus*) schools in the Gulf of Maine using high frequency (200 kHz) multibeam sonar. This project directly addresses several goals of the NEC, including 1: development and utilization of an ecosystem approach to understanding bluefin tuna fisheries resources, 2. application of new direct assessment methodologies providing fishery-independent information, 3. the pursuit of quantitative information on juvenile ABFT, which represent the future of this highly depleted resource, 4. utilization of the unique skills of commercial bluefin fishermen and spotter pilots, who will be fully engaged in data collection and interpretation, also providing the information needed to understand a rapidly growing recreational fishery.

Methods and work plan:
We proposed a field study in which side-looking 200 kHz multibeam sonar is mounted on a small (35'-40') commercial fishing vessel. Guided by a spotter plane, this vessel will approach and attempt to circumnavigate a school of juvenile bluefin tuna while collecting acoustic backscatter from the school. The data will be used to provide the 3D morphology of the tuna school(s).

In order to extract targets corresponding to fish from the (calibrated) multibeam data, spatially dependent (i.e., as a function of beam angle and range from the sonar head) noise statistics will be calculated. A threshold will then be determined based on a constant probability of accepting false targets (e.g., 1%). Simply put, acoustic backscatter higher than this threshold will be considered fish, with the underlying assumption that the dominant acoustic scatterers in the water column are the tuna. Targets will then be georeferenced using ships position and attitude, generating a cloud of georeferenced targets corresponding to the fish school. These target clouds will then be converted into isosurfaces of constant scattering amplitude, from which school volumes/morphology can be estimated.

In 2009, we will add an additional element to our overall research plan if supplemental resources are made available from a NOAA grant (pending) funding satellite tagging of juvenile bluefin.

Work completed to date:
The project was scheduled to begin the first week of August 08, when we engaged our commercial spotter and commercial tuna boat and crew. Due to NEPA delay, the NEC did not award this grant until September 2008, leaving us with only two sea trial days (4 and 11 Sept, 2009) for use of the sonar system and personnel, and weather and bluefin school sighting conditions quickly deteriorated. We plan to begin field trials in August 2009.

Results to date:
We seek to obtain better information on bluefin tuna packing density and total school biomass or volume (multibeam sonar), with ground truth provided by direct sampling via the recreational fishery. During the two sea trials our spotter pilot directed us to a few

small, near-surface schools from which we obtained several sonar images (see fig. 1) (e.g., spotter estimate 50-80 tons of 60-80 lb fish, between 14:00-15:00 hrs each day). However, school structure was diffuse and the sea state poor for aerial surveillance, and fish were poorly resolved in the aerial photographs. Spotter search tracks indicate densely sampled areas (e.g., 4 Sept., Fig. 2) where schools were localized.

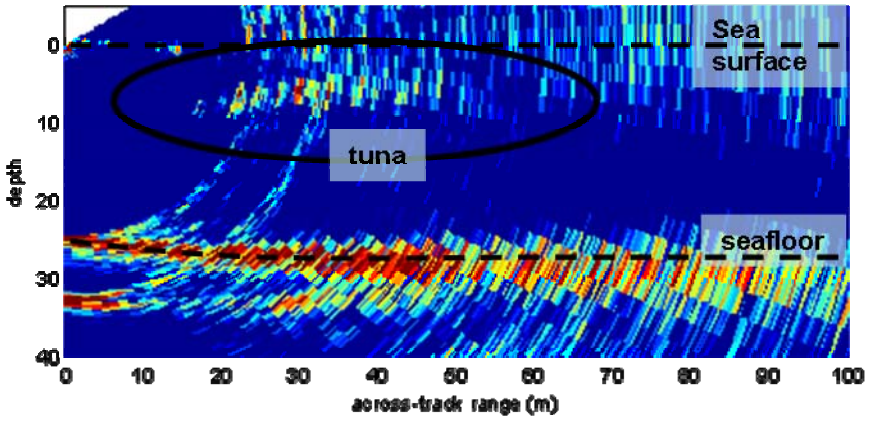

Figure 1. Multi-beam sonar image of juvenile bluefin tuna school targeted off Cape Cod, September, 2008.

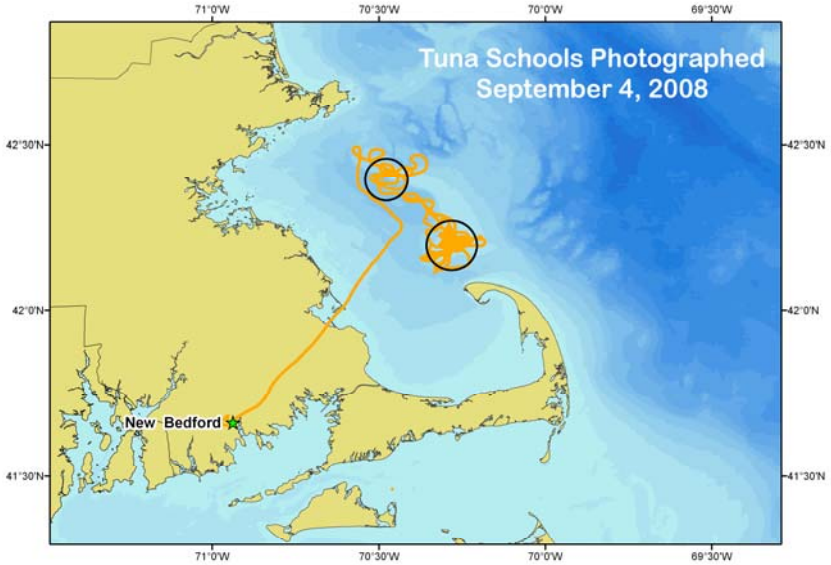

Figure 2. Search tracks of spotter pilot and localized search area for bluefin tuna schools.

A preliminary assessment of the school morphology has been made based on these sonar images (fig. 3), although it is important to note that the movement of the fish is currently coupled into the school imagex. Development of a methodology to properly treat this potential spatio-temporal aliasing problem is underway.

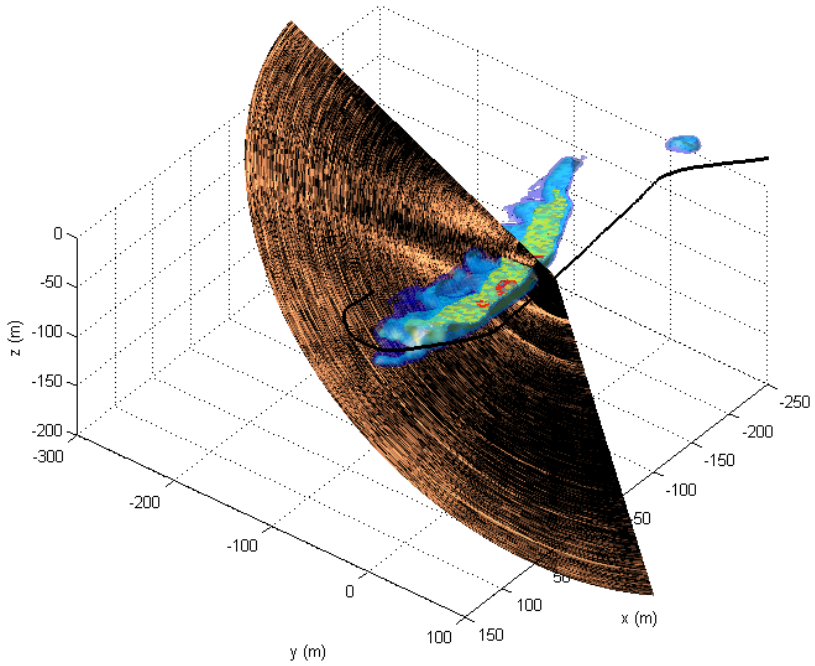

Figure 3. Morphology of tuna school imaged on Sep 11, 2008. Note that the motion of the fish is coupled into this image, elongating the appearance of the school. A single ping (fan-like image) and the ship track (black line) is also shown.

We plan to complete the NEC-funded multibeam project in 2009. If additional resources become available from NOAA (pending) we'll conduct aerial surveillance of bluefin schools using digital still and video cameras (14 bit pixel video) with additional expertise from CCOM digital mosaic mapping experts, Drs. Yuri Rzhanov and Shachak Pe'eri. This expertise will allow us to obtain and compile hi-resolution, geo-rectified images of schools. These new technical approaches utilizing airborne imagery will provide an additional perspective on bluefin schools, and improved detection camera (e.g., low signal-to-noise ratio, greater dynamic range, and filters for water-surface glint). With these tools we can better understand school structures, and potentially create comprehensive, composite images of schools using a comparable radiometric format. This may enable tracking of dynamic changes within the school using two camera frames captured at different times, and may also infer the presence of fish at greater water depths, providing another axis and scale for spatial and density calibration of the multibeam sonar returns (the objective of this NEC study).

Future work:
Sonar approaches appear feasible based on our results so far. If possible, we intend to test still and video documentation of schools concurrent with sonar trials. Along with the aerial surveillance of bluefin schools using highly experienced spotter pilots, CCOM ocean mapping experts Drs. Yuri and Shachak Pe'eri will examine whether we can obtain and compile hi resolution, geo-rectified images of schools. These new technical approaches may help calibrate sonar returns and provide better information on packing density and total school biomass/volume, while ground truth can be provided by direct sampling via the recreational fishery.

We will conduct the majority of the field work for this study in August 2009, followed by data analysis and synthesis for our NRC report and preparation of scientific manuscript.

Impacts and applications:
Bluefin tuna commercial and recreational fishermen have a stake in better understanding of ABFT stock dynamics and local aggregations. In addition, NMFS and ICCAT bluefin tuna stock assessment scientists will have better information on the potential for direct, fishery independent assessment of this resource.

Related projects:
This project is being conducted in association with NOAA-NMFS grants to Dr. Molly Lutcavage, Large Pelagics Research Center

1) Juvenile Bluefin Tuna Initiative: PSAT Tagging and Aerial Reconnaissance, August 1, 2007 to July 31, 2008
2) Juvenile Bluefin Tuna Initiative: PSAT Tagging and Direct Observation, Year 2, September 1, 2009 to July 31, 2011 (pending)

Partnerships:
We are working with two commercial spotter pilots engaged in cooperative bluefin aerial survey and research since 1993, and a full time commercial fisherman (and his pilot) whom we've worked with for at least five years. So far, there have been only two sea trials, for three days of work, including installation of equipment on the FV Lily in Gloucester, MA. Captain Bill Muniz and crew members helped us mount and install our multi-beam sonar and GPS and computer lab, as well as locate and direct the vessel toward bluefin tuna schools for sonar targeting. Spotter pilot George Purmont also flew on each sea trial day and located several juvenile bluefin schools for our trial, and estimated size and tonnage of the school. We consider this very preliminary work with respect to anticipated engagement of our team for the full field project.

Presentations:
Molly Lutcavage, Update on LPRC Co-operative Bluefin Research, US ICCAT Scientific Advisory Committee, Spring Science Meeting, Silver Spring, MD, March, 2009.

Published reports and papers:
None so far.

Data:
Data has not been submitted since we have only preliminary results.