1. Title of Project **Pilot survey of deepwater reef fishes off North Carolina using a two-stage, adaptive design.**
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8. Project dates: Begin 5/15/09   Completion 12/31/10
9. Other participant(s), affiliation & complete addresses (including zip code):
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10. Brief summary of the situation or problem to be addressed:

Project Overview

    This is a proposal to demonstrate a fishery-independent sampling technique that can help determine the relative abundance and species composition of a deepwater reef fish complex that is difficult to quantify. Data will be collected inside- and adjacent to the Snowy Wreck Marine Protected Area (MPA). This will serve two purposes: 1) demonstrate the effectiveness of a sampling technique that can be used to census the deepwater reef fish complex anywhere in the U.S. South Atlantic, using SONAR gear, hooks and chevron traps, and 2) incorporate the first stage of a before-after control-impact (BACI) type sampling design to compare information on relative abundance and composition of fishes inside and outside the MPA.

    The status of reef species in U.S. South Atlantic deep waters (>70 m) is difficult to assess. Landings of fishes such a snowy grouper and blueline tilefish are intermittent, scattered across a geographically wide area, and thus difficult to representatively sample. There are also inherent challenges in collecting reliable fishery-dependent data through commercial and recreational logbooks and landings. Progressively more restrictive quotas to end overfishing of deepwater species often result in landings that do not reflect the true stock status of these species. Thus, catch quotas have placed an increasingly greater emphasis on collecting fishery-independent data that samples populations of deepwater reef species. Fishery-independent samples of deepwater reef species in the U.S. South Atlantic, however, are difficult or impossible to obtain because of the lack of funded survey programs operating in deepwater. Due to difficulties in obtaining information truly representative of population parameters of deepwater species, it is important to investigate novel means by which these fishes can be most effectively sampled in this region. The National Oceanic and Atmospheric Administration has recently called for the development of new, advance technologies to assess fish stocks.

    The North Carolina Fishery Resource Grant project # 07-FEG-15 was funded to investigate a novel fishery-independent approach to predict catch-per-effort of deepwater reef fishes from fish acoustic (SONAR) information collected with scientific-grade SONAR equipment. Collection of acoustic and catch-per-unit-effort (CPUE) data inside the Snowy Wreck Marine Protected Area (MPA) occurred in 2007 and 2008 with traps and hook and line. Quantitative analysis of acoustic data (using *Echoview* software) has recently been commenced. The goal of the forthcoming analysis is to develop a mathematical model that predicts CPUE (proxy for fish abundance) as a function of intensity (db/m^2) of backscattered acoustic energy. In advance of modeling, a preliminary visual inspection of the raw data indicates that CPUE is related to the size of acoustic marks. Thus, use of high-end SONAR gear shows promise of being able to predict relative abundance (CPUE) of deepwater reef fishes from a much larger number of fish aggregations where acoustic data were collected but were not fished. The predicted CPUE information can then be used as a tool for fishery-independent monitoring of deepwater species in the U.S. South Atlantic.

    There is reason not only to strengthen the existing x-y relationship by gathering more hook and line data but also to investigate other gears that can more effectively sample deepwater and be used to develop a reliable acoustic energy-CPUE relationship. Chevron traps may be this gear. Chevron traps have been used as part of

the fishery-independent MARMAP program to sample reef fishes in the U.S. South Atlantic. The intent of the proposed work is to develop models to the extent that managers can feel confident in collecting acoustic data that can be used to reliably predict the abundance of important deepwater reef fishes.

Amendment 14 to the South Atlantic Fishery Management Council's (SAFMC) snapper-grouper fishery management plan will establish MPAs along the continental shelf break in the U.S. South Atlantic. It is the intent of Amendment 14 to help reduce overfishing of more common deepwater species (snowy grouper, for example) and serve as refuge for rare species such as speckled hind and Warsaw grouper. The largest and most northerly of these areas is the Snowy Wreck MPA. In the years or decades ahead, any evaluation into the effectiveness of the MPA will best be made by having data by which to compare average reef fish acoustic energy (dB/ m2) from both inside and nearby outside the MPA.

This is a proposal to use a novel census technique for deepwater reef fishes and lay the framework for a BACI sampling design by sampling inside (experimental site) and adjacent to (control site) an MPA before its closure. Sampling inside and outside the MPA now will allow a future study to make a similar spatial comparison of CPUE and acoustic backscatter after the MPA has been closed for some years.

11. Purposes (objectives) of the project:
a) Develop a predictive model to estimate abundance of deepwater reef fishes from acoustic (SONAR) and trap data.
b) Augment existing model development by collecting more hook and line data.
b) Compare model fits between hook-and-line sampling and trapping.
c) Compare estimates of acoustic data collected from shelf break samples in Snowy Wreck MPA to those collected at a control site as a "before" snapshot.

12. What work do you intend to do, and how do you plan to accomplish it?
The acoustic sampling in Snowy Wreck MPA conducted in 2007 indicated that the greatest percentage of deepwater reef biomass was concentrated along a roughly two mile-wide swath at the continental shelf break (as opposed to off the break in deeper water). This appears to typify other areas of shelf break habitat in North Carolina. For this reason, our acoustic and trap sampling will focus specifically on the shelf break area (~60-120 m deep) within the MPA and in two control areas immediately adjacent to the MPA. Each of the two control areas will be immediately adjacent (southwest and northeast) of the MPA. Each of the two control areas will have SW-NE axes 7.5 nm in length. Since the MPA has a SW-NE axis of 15 nm, the total shelf break distance sampled during each transect inside it will equal that sampled in both control areas.

Before the start of sampling in 2009, an EFP permit will be requested and received from the National Marine Fisheries Service so that hooks and chevron traps may be legally deployed to collect CPUE data inside and outside of the MPA. The application for the EFP to deploy traps will contain language that the reef fish will not be sold.

We will make 40 day trips (~2 per month) from roughly May 2009 through December 2010. Half of the 40 trips will be spent collecting acoustic data. The 30 x 2 nm box will be sampled with acoustics in a direction parallel to the break at 0.25 nm intervals; one 30 nm transect will be sampled each of these eight days.

The remaining 20 days will be spent trapping on a subset of marks identified from the previous day's acoustic sampling. The methods of chevron trapping will follow the MARMAP survey as closely as possible, including trap and mesh size, bait type, and soak time (90 minutes per trap). Due to required soak times and the distance of the MPA offshore, time constraints will allow us to soak up to 12 traps per day. Each 30 nm transect will be divided into 2.5 nm subsections. Four subsections will be randomly selected to fish with traps. One subsection will be randomly selected within each of the control areas and two within the MPA. If no marks were identified in a randomly chosen subsection, another subsection will be randomly chosen. With each of subsection, three acoustic marks will be randomly selected to fish with traps. Such a stratified random sampling design using 2.5 nm subsections will ensure that trap soak times are limited to 90 minutes while also sampling the MPA and both control areas in one day. Any free time during days spent acoustic sampling or trapping will be used to gather hook and line CPUE data to add to the current predictive model.

Upon retrieval of each trap, fish will be identified and measured (total length, mm). Live fish will be tagged (internal anchor tags) and released. Such auxiliary data on locations of fish captures and recaptures may

provide fisheries managers with valuable information on fish movement within the MPA. Persons reporting tagged fish will be able to use the same phone number as established for North Carolina Sea Grant FRG project 07-FEG-01. Tags will be reimbursed through December, 2011. Dead and badly pressure-traumatized fish will be provided to the NMFS Beaufort lab for their studies of reef fish age and growth.

Acoustic energy data will be used to develop a predictive model with CPUE data from traps. Estimates of CPUE will be made for those sites where aggregations of fish are determined using SONAR but no trapping took place. Relative abundance (measured by CPUE) will then be estimated with associated variances. Predictive models will be compared between hook and line data and trap data. Average acoustic energy (a proxy for biomass; dB/m^2) will be compared between the MPA and the combined control sites.

13. Explain how the expected results will address the problem and/or enhance fishery resources.

Over the history of the South Atlantic Bight reef fishery, the stock status of the deepwater snapper-grouper complex has been largely unknown. This project will demonstrate a portable fishery-independent approach to more effectively census deepwater reef fishes in the U.S. South Atlantic. If the technique, hook and lining and/or trapping in combination with SONAR, works as a way to estimate CPUE over large areas, it may prove to be a valid new fishery-independent monitoring tool for the US South Atlantic.

Signature _Tom Bryan_   Date _2-18-09_