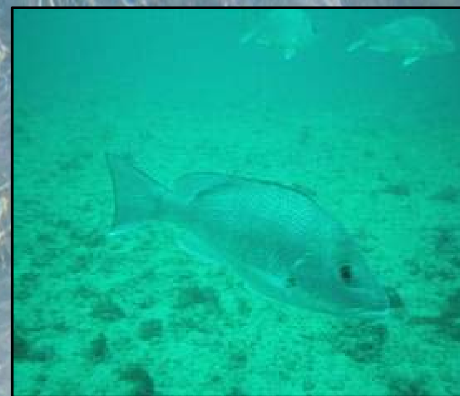

South Atlantic Fishery Independent Monitoring Program Workshop

November 17-20, 2009
Beaufort, North Carolina

Sponsored by:
South Atlantic Fishery Management Council
and
NOAA Fisheries, Southeast Fisheries Science Center

Final Report: South Atlantic Fishery Independent Monitoring Program Workshop

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Hosted by the:

National Marine Fisheries Service, Southeast Fisheries Science Center
and
South Atlantic Fishery Management Council

Erik H. Williams and John Carmichael, Editors

Front Cover: Photographs provided by Chris Gardner (top left, showing deployment of a Chevron trap), Marcel Reichert (top right and middle, showing images from a still camera), and Ted Switzer (bottom, showing deployment of a camera array).

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Executive Summary

On November 17-20, 2009 a workshop was held at the NMFS/SEFSC Beaufort Laboratory in Beaufort, NC to develop recommendations for the design of a multispecies, fishery-independent survey(s), focused on the snapper-grouper complex within the U.S. South Atlantic territorial waters. The goals of the workshop were to recommend components of a fishery-independent program which will:

1. Enable evaluation of response(s) of fish populations to management actions.

2. Provide useful spatiotemporal indices of abundance, length-frequency and age distributions, for as many species as possible within the snapper-grouper complex.

3. Provide data that can be utilized in ecosystem approaches to fisheries management.

The workshop included participants with a wide array of expertise including survey experience, commercial fishing, fishing gear methods, snapper-grouper biology, statistical sampling designs, and ocean-going vessel operations. Presentations on key topics such as sampling methods, assessment data needs, existing sampling programs, and emerging sampling techniques were made to provide a common base from which all participants could continue discussion and deliberation.

Following this initial introduction, workshop participants were divided into working groups devoted to gear types, statistical design, and life history characteristics to address Terms of Reference for their topic. Representatives from each group provided daily updates to the entire workshop panel during plenary sessions as the workshop progressed, with subsequent discussion allowing all members to participate in all aspects of the workshop. Once the work groups completed their Terms of Reference, workshop participants convened in plenary session to summarize and coalesce group recommendations and address the final Terms of Reference that applied to the workshop as a whole.

Although budget and personnel concerns were set aside for planning and development, participants recognized that such concerns are legitimate and, if ignored, could jeopardize otherwise well-laid plans. Therefore, the participants agreed to develop an overall monitoring program that consists of numerous modules, each of which can be considered in terms of cost and benefit when inevitable budget realities arise. The final recommendations reflect this modular approach, and include many components which together form a comprehensive survey of the snapper-grouper resource of the South Atlantic. Taken individually, some of these components focus on a few species, a particular habitat type, or specific region, while others cover a broad range of habitats, areas, and species.

The workshop recommended the following components for a survey of the snapper-grouper complex within U.S. South Atlantic territorial waters.

(1) Cape Hatteras, NC to Port St. Lucie, FL

a. Estuarine (5 m) – Channel nets, Witham, bridge net, otter trawl, seine (n = unknown).
b. Shelf and Shelf-break (10 - 140 m) - Bongo and neuston sampling (n = unknown).
c. Shelf (10 – 70 m) – Z trap, chevron trap[1], short bottom longline, video-camera array (hereafter "video array"; n = 3000 sites).
d. Shelf-break (70 – 140 m) – Z trap (out to 90 m), chevron trap (out to 90 m), short bottom longline, long bottom longline, video array (out to depth limitation) (n = 500 sites).
e. Deep offshore (> 140 m)—Wreckfish reel (n = unknown).

(2) North of Cape Hatteras

a. Shelf –break (70 - 140 m) - Bongo and neuston sampling (n = unknown).
b. Shelf-break (70 – 140 m) – Z trap (out to 90 m), chevron trap (out to 90 m), short bottom longline, long bottom longline, video array (out to depth limitation).

(3) Port St. Lucie, FL to Dry Tortugas, FL

a. Estuarine (5 m) – Channel nets, Witham, bridge net, otter trawl, seine.
b. Shelf and Shelf-break (10 - 140 m) - Bongo and neuston sampling (n = unknown).
c. Shelf (10 – 70 m) – Z trap, chevron trap, short bottom longline, visual survey, video array.
d. Shelf-break (70 – 140 m) – Z trap (out to 90 m), chevron trap (out to 90 m), short bottom longline, long bottom longline, bandit rig, video array (out to depth limitation).

(4) Year Round Mapping – Entire Area

a. Shelf, shelf-break and beyond (30 – deep m)

(5) Bycatch, Tagging, and Hooking Mortality Studies

The general consensus was that recommended sample sizes in each module, or gear and area combination as they developed, should not be reduced because to do so could greatly limit the resolution of the survey and result in excessive uncertainty. Instead, each individual module should be considered for focused funding, with the understanding that the recommended sample sizes within a module represent minimum adequate sampling and therefore the module must be fully implemented if it is implemented at all. All participants agreed the core area for nearly all the snapper-grouper species is from Cape Hatteras, NC to St. Lucie, FL. The workshop participants strongly recommended that at an absolute minimum, the shelf area from Cape

1 Note applicable to all components where trap gear will be utilized: the working group recommended comparative research to compare the efficacy and utility of Z traps versus chevron traps. Thus, initially both trap designs might be used, but following comparative research a single design would be chosen for subsequent sampling.

Hatteras, NC to St. Lucie, FL (1c above) must be part of the survey. No smaller sampling area was recommended.

During the workshop there was limited discussion of costs, focusing on broad-view parameters such as number/size of vessels, number of personnel, number of sea days, and sample sizes for each gear type. Costs were not estimated for the full survey, which included many more components, but instead focused on the core areas and gear types. Vessel cost is based on the use of existing vessels. The gear and areas focused on for cost estimates correspond to items 1c-d, 2b, and 3c-d above. Based on these areas/gear the estimated costs (in millions of dollars) are as follows.

Category	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Vessels	$5.76	$6.05	$6.35	$6.67
Field Personnel	$1.65	$1.73	$1.82	$1.91
Shore Personnel	$1.91	$2.01	$2.11	$2.22
Sampling Gear	$1.58	$0.39	$0.41	$0.43
Equipment and Supplies	$0.56	$0.59	$0.62	$0.65
Total	$11.46	$10.77	$11.31	$11.88

These costs do not include any year round mapping or additional bycatch, tagging, or hooking mortality studies. These costs could be reduced by focusing on the core area 1 above. The workshop did not consider or estimate how much that reduction might be. It is the recommendation from this workshop that the components 1c-d, 2b, and 3c-d above be the primary focus for any future survey design, but consideration should be given to the other components mentioned above. These cost estimates do not take into account any ongoing fishery-independent sampling efforts, such as MARMAP, and existing gear and equipment (i.e., cost estimates include funding for efforts currently led by MARMAP).

Preface

On November 17-20, 2009, a workshop was held at the NMFS Southeast Fisheries Science Center (SEFSC) Beaufort Laboratory in Beaufort, NC to develop recommendations for the design of a multispecies, fishery-independent survey(s), focused on the snapper-grouper complex within U.S. South Atlantic waters. Although fisheries scientists and managers in the South Atlantic have long agreed that a comprehensive survey of reef fish resources is needed, obtaining the resources necessary for such an undertaking has proven difficult. Fishery resource assessments in the region have been forced to rely on the limited coverage provided by independent monitoring programs such as MARMAP and SEAMAP, and in many cases to rely solely upon fishery-dependent observations. A critical stage was reached during 2008 as the South Atlantic Fishery Management Council (hereafter Council) considered controversial regulations to end overfishing of red snapper, including the possibility of closing large areas to all snapper-grouper effort.

The lack of survey observations creates several issues when considering both the consequences of actions, such as large closed areas and harvest moratoriums, and the ability to evaluate such actions. First, assessment uncertainty is increased when fishery-independent survey values are lacking, and such uncertainty is often used to challenge the need for management actions.

Second, due to the lack of fishery-independent monitoring, assessments of South Atlantic resources rely heavily upon fishery-dependent measures of abundance, such as those developed from the headboat survey, that will irrevocably change following large-scale closed areas that drastically alter effort patterns. This will have widespread consequences for future stock assessments which will in turn hinder efforts to evaluate existing regulations.

Third, there is considerable uncertainty regarding potential changes in the red snapper stock that occurred over the last several years, largely due to the lack of timely and independent measures of abundance. Because trends in fishery data cannot be evaluated against trends in independent effort, as is necessary to separate population response from fishery changes, questions are raised as to the magnitude of action currently required to end overfishing of red snapper.

Finally, managers have come to realize that prohibiting possession of a fish species will remove the primary data sources for a stock, all of which are tied to harvest observations and reports from the fishermen, and thus make it virtually impossible to evaluate population responses to regulations. This inability to measure progress, despite severe regulatory restrictions, raises concerns that the real consequences of such actions over the long term are more severe than suggested by initial evaluations that presume the stock will improve and management will respond accordingly. Having experienced this very situation with speckled hind, warsaw grouper, and goliath grouper, the Council recognized the need to implement additional population monitoring to offset data losses tied to the management regulations under consideration.

As a result of these multiple factors, the SEFSC and the Council agreed to work together and to allocate the necessary resources to hold a workshop dedicated to designing the framework of a comprehensive fishery-independent monitoring program for reef fish resources in U.S. South Atlantic waters. A deadline for activities was provided with the general guidance that the monitoring program should be described in Amendment 17A to the Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region, the amendment considering actions to end overfishing of red snapper. A steering committee was convened representing both the Council and SEFSC and drawing heavily on those with experience assessing, researching, and monitoring reef fish stocks. Membership included Council staff; SEFSC staff including representatives of the ecosystem and population dynamics teams from the Beaufort Laboratory, the surveys group at the Pascagoula Laboratory, and the life history group at the Panama City Laboratory; and South Carolina Department of Natural Resources Marine Resources Monitoring, Assessment, and Prediction Program (MARMAP) staff. The steering committee met regularly via conference call beginning in July 2009 to identify key participants, develop a project schedule, and draft objectives.

As objectives and interest grew, the steering committee recognized that it would be necessary to divide the overall workshop panel into work groups so that multiple tasks could be addressed simultaneously and each participant's contributions could be maximized. This led to identification of three work groups: statistical design; gear; and life history. Terms Of Reference (TOR) were developed for each group to provide clear tasks and objectives; the reports drafted by the groups to address their TORs provide much of the information that follows in this report. Workshop participants were divided into groups based on their areas of interest and expertise. Such divisions are never absolute, so some participants contributed to multiple groups over the course of the workshop.

The workshop began in plenary with a series of presentations to set the tone of the meeting and bring all participants to a common starting point with regard to the type of information expected from fishery-independent monitoring, ongoing survey efforts in the area, and techniques used in other areas for monitoring similar species. The next session addressed general boundaries for the survey so that each group could work separately toward a common goal. Finally, the overall approach and group TORs were reviewed to ensure all participants understood the approach and expectations. From there, the plenary adjourned and the individual working groups began their work as described in their reports.

The working groups conducted in-depth discussions for a two-day period on the major topics for the overall survey approach. At the beginning of the second day of group meetings a plenary session was held in which the working group leaders summarized their group's progress to that point. After the two days of group meetings, a plenary session was convened to receive final reports from the groups and begin the discussion and development of a comprehensive survey framework, following the recommendations from the working groups. A special group was convened to address specific sample sizes and develop a straw man structure for the comprehensive survey. The results of this straw man were presented to all the workshop participants, with some modifications based on discussions. The final hours of the workshop were then spent with yet another sub-group to discuss expenses. Running low on time, this group focused its efforts on estimating general costs for vessel time, equipment, and staff for the core areas on the shelf and shelf-break. These costs were presented to all the workshop participants in plenary session.

The workshop concluded on November 20, 2009. This report was drafted and circulated to the steering committee and working group leaders for comments and represents the efforts and contributions of all the workshop participants. We thank all those who contributed their time and effort to this report.

Gear Working Group Report

Report editor: Marcel Reichert

Moderators:
Marcel Reichert and Todd Kellison
Working group participants (alphabetical order):

Name	Affiliation	Title
Steve Amick	Charter	Fishery Captain
Charlie Barans	SCDNR	Fishery Biologist (retired)
Chris R. Brown	SCDNR	R/V Captain
Ken Brennan	NMFS-Beaufort	Coordinator
Brien Cheuvront	NCDMF/SAFMC	Council member
Leslie M. Davis	Headboat/Charter Fishery	Captain
Maurice Davis	Headboat Fishery	Captain
Doug DeVries	NMFS-Panama City	Research Fishery Biologist
Chris Gledhill	NMFS-Pascagoula	Research Fishery Biologist
Dave Gloecker	NMFS-Miami	Fishery Biologist
Robert Johnson	Headboat/Charter Fishery	Captain
Kathy Knowlton	GA-DNR	Fishery Biologist
Todd Kellison	NMFS-Beaufort	Research Fishery Biologist
Bob McMichael	Florida WC	Research Administrator
Warren Mitchell	NCSU	Fishery Biologist
Roldan Munoz	NMFS-Beaufort	Fishery Biologist
Marcel Reichert	SCDNR	Fishery Scientist / SSC member
Zeb Schobernd	NMFS-Pascagoula	Fishery Biologist
Byron White	SCDNR	Marine Biologist
Erik Williams	NMFS-Beaufort	Research Fishery Biologist

1. Introduction

The Gear Working Group compiled a list of gear and survey types that it felt were appropriate to sample the focal species (species in the Council’s snapper-grouper fishery management unit, see Life History Working Group table) in their habitat (mostly live bottom). Each gear type and relevant attributes were discussed and the working group created a matrix with attributes of gear and survey types that it felt had the most potential for fishery independent surveys (see Table 1). The working group acknowledges that the listed gear types do not represent all possible available gear and survey types, but felt that those included represent the most appropriate for developing fisheries independent indices of abundance for the focal species. The group also recognizes that the provided information with respect to the gear and survey description is incomplete at best, but felt that further descriptions can be obtained from literature and other sources if needed.

The working group (and plenary) also discussed the critical need for habitat mapping/characterization (see 2.3) and considered and listed vessel characteristics (see 2.4).

The working group and plenary sessions recognized 5 geographical areas:

- N. of Cape Hatteras (deep),
- Cape Hatteras to St. Lucie Inlet, shelf area,
- Cape Hatteras to St. Lucie Inlet, shelf edge and deeper,
- St. Lucie Inlet to the Dry Tortugas, shelf area, and
- St. Lucie Inlet to the Dry Tortugas, shelf edge and deeper.

And three general habitat types:

- live bottom shelf habitat (10 m to shelf edge ≈200 m),
- deep live bottom habitat (>≈150 m, or > 60 south of St. Lucie Inlet)
- deep soft bottom habitat (180-300 m), and
- shallow coral reef habitat (<60 m south of St. Lucie)

Artificial reefs, sanctuaries, and marine protected areas were not discussed separately, but rather included in the overall considerations. However, if and when sampled, they should be classified as special sampling areas (i.e., strata) and possibly treated separately in the analyses, but if the same gear and sampling methods (relative to the over-all area) are used, data from MPAs should be included in indices (see Field et al., 2006). The working group recognized that sampling these areas will have unique logistical challenges such as

- interfering with recreational and commercial fishing (especially for artificial reefs),
- possible habitat damage using particular gear (e.g. traps and longlines),
- removal of resources (in sanctuaries and MPAs), and
- potential for loss of sampling gear (esp. near artificial reefs).

2. Gear and survey types.

A list of gear and survey types and characteristics was compiled (Table 1). This report does not include a detailed description for all gear types. Additional information is available in the workshop documents, literature list, and http://www.fao.org/fishery/topic/3384/en.
Gear types indicated with an asterisk (*) are included in Table 1.

2.1. Survey gear for larval, juvenile, and/or YOY fish

Most gear types discussed were those designed for sampling in inshore waters and are effective for a limited number of focal species that have an estuarine dependent life phase such as gag, and possibly red grouper, black grouper, black sea bass and few other species. Larval and juvenile abundance data have not been used as an index in SEDAR stock assessments of snapper-grouper species in the Southeast region. South Atlantic Bight Recruitment Experiment (SABRE) data (see: Fisheries Oceanography 1999 v.8 (Suppl. 2)) and NOAA ichthyoplankton sampling in Beaufort, NC (Warlen et al., 1994) may provide information for further consideration.

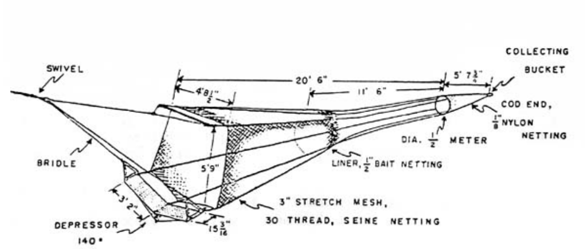
Beach seine and crab scraper

Few focus species collected in previous and ongoing surveys. Gear also has limitations as to potential sampling habitat and area.

- Recommendation: Considered, but not recommended.

Isaacs Kidd MidWater Trawl (IKMT) and Methot trawl (midwater trawl)

The IKMT is designed specifically to collect biological specimens in the midwater zone. It is approximately 20 ft long, with a series of hoops decreasing in size extending from the mouth of the net to the rear (cod) end, which measures an additional 5 ft in length. The hoops maintain the shape of the net during towing. The rectangular mouth of the net is approximately 5 ft wide by 6 ft high, and is attached to a wide, v-shaped, rigid diving vane or depressor. The vane keeps the mouth of the net open during towing and exerts a depressing force, maintaining the trawl at a designated depth. An IKMT can be towed at speeds as high as 5 knots.

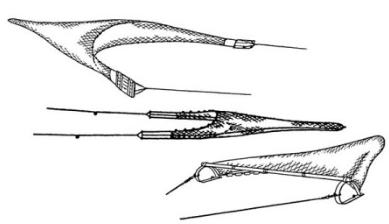


Schematic diagram of an
Isaacs-Kidd midwater trawl.

The IKMT's largemouth opening and capacity for fast towing speeds enables it to capture relatively large and more active organisms, while its fine mesh allows it to sample organisms not retained in the larges trawls (Modified text and image from: oceanexplorer.noaa.gov/.../trawl/trawl.html).
Potential to sample larvae and juveniles, post sampling processing time consuming and costly.

- Recommendation: Considered, but not recommended.

Small otter trawls, 1-2 m beam trawls *



See: www.FAO/fishery/geartype/2065/en

See literature for description (e.g. Kuipers, 1975). These gear types have potential for near shore or estuarine juvenile surveys. There are several past and ongoing State projects (GA-DNR, NCDMF, FL GOM coast, and others). However, with exception of GOM trawl surveys over grass beds, few focus species have been collected, with gag being the species mostly caught.

- Recommendation: Consider for use.

Channel nets (block or stop nets) *
Description: Net is funnel-shaped, similar to a trawl. Size can vary, depending on area sampled (depth, current, etc). Traditional design for commercial fishery is 4 m deep, 20-40 m in length. Made of 5/8" dipped nylon mesh, anchored with 25-50 lb Danforth anchors. Net has bridle, at mouth (wings), one polyball on each wing, connecting to anchors by polypropylene or nylon anchorline (with chain at terminal end of anchorline. One polyball above each anchor. Potential for young of the year (YOY) sampling, mostly gag. The gear has the potential for collaboration with commercial fishermen.

- Recommendation: Consider for use.

Hook and line *
The working group considered this gear for possible YOY survey. Standardization may be very difficult. A variety of rigs, bait and rods have been used. Can be very useful to collect biological samples, especially over sensitive habitat such as coral.

- Recommendation: Consider for use.

Witham traps*
Witham traps (also referred to as Witham collectors) consist of air conditioning filter material folded over a PVC frame. Passive gear deployed in creeks. Gear has low, highly variable catches. Ongoing project (NC-SC-GA) and data available for 1995-1997 and 2007-current (see: Serfling and Ford (1975) and http://www.dnr.sc.gov/marine/mrri/MARMAP/MMgag.html,

- Consider for larval and juvenile survey.

Minnow Trap
Passive gear, few focal species collected. There are more effective alternatives available.

- Considered, but not recommended.

Bridge nets*
Passive gear, widely used, time consuming and expensive post sampling processing.

- Consider for use.

Bongo net (water column)*
Description: Gear consisting of paired plankton nets, used to sample larval fishes at all depths. Each net can be the same or different mesh size. The gear cost is relatively inexpensive and deployment simple, however, post-processing and storage can be expensive. The identification of larvae of many focal species, especially groupers, is problematic. No current ongoing sampling program in the region.

- Considered for larval survey, but unless as part of a ecosystem survey, the group did not consider including an ichthyoplankton component in the survey design.

Neuston net (surface)*
Description: see literature. Deployment is simple and gear cost relatively low. However, post-processing and storage can be expensive. The identification of larvae of many focal species, especially groupers, is problematic. No current sampling program in the region.

- Considered for larval survey, but unless as part of a ecosystem survey, the group did not consider including an ichthyoplankton component in the survey design.

Light traps
There are various designs (see literature). Passive gear, only works at night for positively phototactic species, low and highly variable catches, identification of larvae of many focal species, especially groupers, is problematic.

- Discussed, but not recommended.

2.2. Survey gear for adult fish

2.2.1. Traps and nets

There was a general discussion on trap efficiency, especially relative to catching large snappers and groupers. The consensus was that traps probably do not efficiently catch large snapper and groupers, but that the size at which larger individuals are not collected efficiently depends on the size of the trap, its design (e.g. trap opening), and species specific behavior towards traps. The group also concluded that traps are effective in collecting fish for biological information. Furthermore, they can be used in a consistent manner, making them good candidates for developing indices of relative abundance.

Florida Trap, Mini Antillean S-trap, and Morton trap
See description of Florida Trap, Mini Antillean S-trap in MARMAP gear workshop document, and Morton trap in appendix. There are more effective alternatives available. The Morton trap was deemed sensitive to current and potentially cumbersome to deploy and retrieve.

- Considered, but not recommended

Blackfish traps or black sea bass traps*
Design: see MARMAP document and literature. Historically used in surveys and ongoing commercial use. Blackfish traps were discussed, but the group felt that other traps, such as the chevron traps, sample a wider range of species and sizes. Considered, but not recommended as primary sampling gear.

Z-traps*
Construction and design described in literature in the 1970s. The trap has two opposing throats, baited with live or dead bait. If chosen for survey, mesh type should replicate the chevron traps with 35 mm x 35 mm square mesh plastic-coated wire. Deployment and Retrieval: Z-traps are baited with a combination of whole or cut bait (herrings (*Brevoortia* or *Alosa* spp., family Clupeidae)). The traps are tethered individually using 8-mm (5/16 inch) polypropylene line to a polyball buoy and a Hi-Flyer buoy attached to a 10-m trailer line. Traps are retrieved with a hydraulic pot-hauler.

The group concluded that the design may improve catch rates over chevron traps for large individuals. In the presence of even moderate bottom current, the two opposing throats may increase the chances that the bait plume will attract fish to the two trap funnels. However, its original design is larger than chevron traps; may be difficult to stack / deploy from smaller vessels. This trap is currently not in use. There was some discussion about modifying the Z-trap to make the dimensions closer to that of the chevron trap, but that may affect the size of the fish that is caught. On the other hand, it is unknown if the chevron trap catches wouldn't resemble those of the Z-trap if constructed with the same dimensions of the original Z-trap.

- Recommendation:
- This trap should be deployed concurrently with chevron traps for at least one year, to compare catches and selectivities, then possible adopted if catches are more representative of actual populations, as revealed by less selective video data supplemented with longline data. The group did not reach a consensus as to the dimensions that should be used, but general dimensions of the Z-trap and chevron trap should be the same for a proper comparison.

- The plenary session recommended that a Cooperative Research Program (CRP) trap comparison study be designed in collaboration with commercial fishermen in the region as soon as possible.

Chevron traps*

Design (see MARMAP document, Collins, 1997, and other literature): Chevron traps are arrowhead shaped (maximum dimensions of 1.5 m x 1.7 m x 0.6 m.; 0.91 m^3 volume) and constructed of 35 mm x 35 mm square mesh plastic-coated wire. Chevron traps have one entrance funnel ("horse collar"), and one release panel to remove the catch. Deployment and Retrieval: chevron traps are baited with a combination of whole or cut bait (herrings (*Brevoortia* or *Alosa* spp., family Clupeidae)). Bait is suspended on four stringers (approximately 4 herrings per string) within the trap and also placed loosely in the trap (approximately 8 additional herrings). The traps are tethered individually using 8-mm (5/16 inch) polypropylene line to a polyball buoy and a Hi-Flyer buoy attached to a 10-m trailer line. Traps are retrieved with a hydraulic pot-hauler.

The current chevron traps as used by MARMAP are equipped with a digital still camera that takes a picture every 5 minutes during the 90 minute deployment. The photos are used to verify bottom type, investigate trap behavior and species composition near the trap.
<u>Advantage:</u> This trap is currently in use and data for 22 year time series have been used for indices of relative abundance for a variety of focal species in various SEDAR stock assessments.
<u>Disadvantage:</u> The size requires large deck space. Traps have 1 throat, possibly decreasing the chances that the bait plume will attract fish to trap funnel. Under current sampling efforts, certain species and/or larger sized fish are not caught in sufficient numbers or consistently enough to develop useful indices of abundance (which could be a result of trap performance, survey sample size, geographic concentration of samples, or some combination thereof).

- Recommendations:
- Continue the use of the chevron trap with still camera on the shelf area, but use it concurrently with the Z-trap to compare catches.
- Use the chevron trap concurrently with video arrays to compare data from both assessment methods.

2.2.2 Hook and line

Kali Pole Longline
See MARMAP document for design and deployment. Cumbersome to use and there are effective alternatives available.

- Considered, but not recommended.

Long Bottom Longline*
Construction and design (see MARMAP document): Long bottom longlines (LBLs) are constructed of 3.2-mm galvanized cable (1,525 m long), deployed from a longline reel with 1,220 m of cable used as groundline and the remaining 305 m buoyed to the surface.
The groundline consisted of a 10 kg weight attached to the terminal end, 100 gangions (composed of an AK snap, approximately 0.5 m of 90 kg monofilament (200 lb test) and a tuna circle hook at 12-m intervals) attached to the groundline, and another weight at the groundline's buoy end. Circle hook size: 14/0.
Hooks are baited with whole squid. LBLs are deployed while running with the current at a speed of 4-5 knots in areas of smooth bottom with mud substrate (e.g. tilefish grounds). The LBL is retrieved using a hydraulic pot hauler.
LBLs (using variations to the above design) are widely used in surveys and by the commercial industry. MARMAP uses this gear to sample golden tilefish (but also snowy grouper, blackbelly rosefish, and various other species in rocky bottom) over soft (muddy) bottom habitat between 180 and 300 m depth. The gear is deployed from the R/V Lady Lisa, a former shrimp trawler.
The group deemed the use of LBLs on live bottom and coral reefs undesirable due to potential snagging and habitat damage.

- Recommendation: Continue the use of the long bottom longline to sample the deep soft (muddy) bottom habitats targeting golden tilefish along the entire proposed geographical range.
- Recommendation: Consider coordinating with or altering long bottom longline methodology to match that of the NMFS SEFSC longline shark survey.

Short Bottom Longline*
Construction and design: The short bottom longline (SBL) consists of 25.6 m of 6.4-mm treated solid braid Dacron (polyester) groundline on which 20 gangions (#5 or #7 hooksCHECK HOOK SIZE MR) on 18 inches of 200 lb monofilament line are placed 1.2 m apart, which is then attached to polypropylene line and buoyed to the surface with polyball buoy and a trailer Hi-Flyer buoy. The SBL is baited with whole squid. The gear is deployed by stretching the groundline along the vessel's gunwale with 10 kg weights attached at the each end of the line. Up to 6 SBLs are deployed, one after the other, before the first line is retrieved. This is a gear type used by MARMAP since 1979, mostly in areas of vertical relief near the shelf (>90 m depth).

There was considerable discussion about using the SBL on the shelf area to supplement the trap and possible video surveys. If the gear is to be used in shallower, low relief areas the group recommended considering the following modifications: basic MARMAP SBL (as above) with possible modifications including hook size (6/0 circle hooks only), and leader size (180' lb test mono, 1 meter long). Leader connected with smaller gangion clip. Modifications to bait include Peruvian squid wings (tough bait) or cut bait (little tunny). Squid could be salted to make tougher (longer lasting) bait. This gear should be tested for one year.

There was also some discussion about doubling the length of the SBL to increase the number of hooks. There was consensus that this should not affect catchability and catch per unit effort (CPUE) estimates (unit fish/(hook*hr)), but perhaps some comparison is needed. Some in the group expressed concern about the length missing parts of the live bottom, and of how to deploy this gear from the vessel.

- Recommendations:
  - Continue use of short bottom longline at shelf edge as was done by MARMAP in the past. Use short bottom longline on shelf in addition to (chevron and Z-) traps and video arrays, possibly in a modified version (different hook sizes and rig).
  - Consider increasing the length of the short bottom longline, increasing the number of hooks and possible catches.

Bandit / snapper reel*

There are various rigs, hook sizes and bait types in use (e.g. 150-200 lb mono with 2 circle hooks (#10-3), 80-100 lb mono with 2 J hooks (#5)). There was considerable discussion in the gear group and during plenary sessions as to the ability of standardizing this kind of hook and line gear for an index of relative abundance for a wide variety of species. The consensus was that that standardization will be difficult, but may be possible. Selectivity of rigs for particular (groups of) species and the experience of the fisher were of particular concern. If this gear is to be considered for an index, the group recommended the following: a) establish a standardized gear consisting of an electric or hydraulic reel (latter preferred,variable speed); b) design several leader/hook combinations (e.g., light and heavy); c) test various bait types; d) design rigs with species in mind that are typically not caught by traps; and e) use circle hooks to help with standardization. Field visits to, at minimum, several vessels per state to collect vessel and species specific gear information will be critical.

There was wide agreement that the bandit reel should be used to collect biological samples (hard/soft parts) for life history studies (age/growth & reproduction). The group agreed that there was potential for the fishing industry to participate, but further discussion fell outside the fishery-independent charge of this workshop. There is a maximum vessel size (65 ft; due to maneuverability issues and potentially NOAA contracting requirements) that needs to be considered. This gear has the ability to catch fish off the bottom and could be used for areas shallower than those currently sampled with the short bottom longline by MARMAP.

- Recommendation: Use gear for collection of biological samples, possibly in collaboration with fishing industry, but not for an index.

Wreckfish reel*

A wreckfish reel is basically similar to a bandit reel, it just has a larger line capacity and is used with heavier weight because of much greater depth it is typically used in. The gear is used while drift fishing or motoring into the current, with dead bait, and typically a leader spool off a longline vessel is used to hold the large amount of line required. This gear does not necessarily change vessel requirements (minimum 50 ft) used in bandit fisheries. As the name suggests, it targets deep water species such as wreckfish, but also catches alphonsins and barrelfish. Deployment time is at least 5 minutes, but soak time is minimal. Gear costs are relatively low (< $5K, with minimum crew size) and a variable hook size is possible. Since this sampling is done over deeper waters, sea state can be limiting. The group agreed that this was the only viable gear to collect wreckfish and species from similar depths.

Since this is a relatively small fishery on a small part of the total resource (wreckfish have at least a circum-Atlantic distribution), the group also considered if fishery-dependent sampling/monitoring would suffice for monitoring and management.

- Recommendation: If this resource is to be monitored, the wreckfish reel should be used.

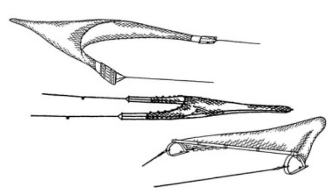
Rod and reel (offshore and inshore)*

The group had concerns similar to (if not greater than) those it had with the bandit reel about standardization with rod and reel. The group discussed the use of headboats to develop a fishery independent index, but acknowledged that standardization issues would be even more problematic because of constantly varying skill levels of the anglers.

The group recognized the value of rod and reel to obtain biological samples, similar to the bandit reel, especially in sensitive habitats such as coral reefs.

- Recommendations: Do not use for the development of an index, but use to collect biological samples where needed.

2.2.3. Trawls and nets



Falcon Trawl, 40/50 Fly Net, Semi-balloon Otter Trawl, ¾- scale Yankee Trawl, and other trawls.

See descriptions in MARMAP document and other literature and web sites. If bottom trawls are to be used the group recommended the use of types that are currently used in GOM and SAB. See other concerns below.

- Considered, but not recommended.

40 ft shrimp trawl (SEAMAP trawl) and SAB SEAMAP trawl

These trawls are used in ongoing surveys, but over sandy (non-live) bottom habitat. SEAMAP rarely collects focal species (snapper-grouper complex) but samples predominantly over soft bottom in depths < 10 m. The use of trawls over life bottom habitat was briefly discussed but rejected because of habitat destruction concerns.

- Recommendation: Do not use trawls over live bottom habitat to avoid habitat damage.

Gill nets

Passive gear with bycatch and live bottom habitat damage issues.

- Considered, but not recommended

2.2.4. Other survey methods

Rotenone, other chemicals, and dynamite
Destructive, non-selective, and severe environmental impacts.

- Recommendation: do not use

Visual surveys*
Requires scuba divers, running transects of various lengths or 'point count' (stationary) and recording data on underwater paper or with cameras. Both methods (transects versus point-counts) have advantages and disadvantages; considerable literature is available to assess optimal survey approaches depending on project objectives. Fish quantity and size, plus habitat info is recorded. A diver has a 360 degree view compared to video, and can look under ledges or around relief increasing the area assessed. It is a non-destructive method, but provides no biological samples, although spearfishing may provide some. There is an ongoing diver survey in the FL Keys (annual) and Dry Tortugas (biennial). The post processing is limited (data available quickly). There is a need for thorough training, but the training methods are well established and standardized. There was some discussion of the implications of logistics (e.g. safety regulations), limited depth, and visibility limitations. Weather can also considerably affect (reduce) sample size.

- Recommendation: Continue the diver survey in Florida and expand north to St. Lucie Inlet, but supplement with hook and line sampling for biological sampling. Explore use in shelf area in conjunction with trap, short bottom longline, and video surveys.

Video (arrays)*
This method has been used extensively along the west coast of Florida (GOM), with several gear designs in use. The video array is baited (squid or Atlantic mackerel) and consists of four cameras (a one or more stereo video cameras (to measure fish length), and to the remainder high-def video cameras) housed within in a metal frame. Recording time at the bottom is 30 minutes and the method provides a stationary "point count". The array can be deployed deeper than scuba divers, as long as light is sufficient for recording. The methods are well established and also provide habitat information. Video data from this gear have been used in some recent high profile Gulf SEDARs and updates. It is a non-destructive method, and thus other methods are needed to collect biological data. The disadvantages are that the array is costly (up to $80K-$100K), sampling and analysis is affected by visibility, the post processing is labor intensive and costly, and the recordings require a large amount of electronic storage (50 GB for 1 drop with 4 cameras). A potentially long analysis time may affect the availability of information for SEDAR assessments. Deployment is affected by extreme weather conditions.

- Recommendations: Continue the development of the method. Use in conjunction with traps and long lines, or diver surveys. At least 2 arrays should be present on each shelf research vessel).

Still cameras (on traps)*
MARMAP has been collecting information on bottom habitat and fish species using still cameras mounted on chevron traps. These cameras take a picture every 5 minutes during deployment. Currently the cameras are predominantly used for habitat confirmation and trap behavior

(movement due to rough weather), but there is a possibility that the information can be used to investigate fish communities.

- Recommendation: Continue the use of still cameras on traps (incl. Z-traps). Analyze fish community information and compare with video array information in same location.

ROVs and AUVs*

The group recognized the high potential for using these technologies in the future, but considered cost of purchase, deployment and post sample analysis prohibitively expensive. Also, biological samples cannot be obtained. Another issue is the allocation of sampling effort; ROVs or AUVs would enable the collection of more information at individual sites at the cost of sampling fewer sites. For a large-scale survey with the objective of estimating indices of abundance, there is likely to be greater between-site variability than within-site variability, and sampling of more sites (greater overall sample size) would be better than more complete sampling of fewer sites in terms of minimizing variance associated with an index of abundance

- Recommendation: Support for purchase of equipment and (further) development of survey methods for future use.

Towed cameras*

Towed cameras could provide a transect survey, but there is limited control of the camera. The group discussed that diver surveys and video arrays are currently more efficient methods, while ROVs and AUVs have better future potential as a survey method. Towed cameras may be helpful in verifying bottom, but provide no biological samples.

- Recommendation: If present, use to verify bottom as a supplemental survey device, otherwise not recommended for use.

Acoustics*

Acoustic survey methods were extensively discussed by the gear group. No standardized surveys are known that annually sample fisheries resources along the southeast US Atlantic coast. Acoustic gears are unbaited, non-invasive, non-destructive, and provide the ability to cover large areas and produce repeatable surveys of fish densities and distribution of fish biomass associated with hard bottom and reef habitats. For snapper-grouper species, juvenile and larger life stages are available to this gear, however, there are currently limitations in species identification of acoustic signals. The quantification of acoustic backscatter near bottom substrate can be a source of sample selectivity (i.e., “acoustic dead zone”). Similarly locations where depth changes quickly or fish are variably unavailable to sampling (e.g., side lobe interference, acoustic shadow, and cryptic fish behavior). Aside from these limitations, few logistical conditions and limitations were noted due to the gear’s resilience to deployment. Costs were quoted as low as $80K to outfit a small research vessel or vessel-of-opportunity for independent operation ($50k split-beam sonar system, $20-30K processing software).

Multibeam sonar is much more expensive and primarily available on large-class research vessels. Sample depth does not limit this gear in the sampling region. Vessels should be 30’ or greater to serve as a suitable platform; two to three personnel are required for sampling. Data processing time may be equivalent to data acquisition, though at times processing time may exceed acquisition time; however, this is not likely to differ from data management given previously described gears. Deployments per day are unlimited, but sample independence is affected by ship survey speed and the definition of a spatial sampling unit. Season of the year for deployment is unlimited for important species. Current sampling with different gear to ground truth species composition is required for fisheries acoustics applications, and would require further development in. Much development is needed before this method can be used to provide estimates of abundance for focal species. However, the group recognized the value of this gear for identifying hardbottom habitats in the region (see also Habitat Mapping below) as well as providing general non-specific habitat use patterns and provide indicators of abundance of forage species and trophic support to focal species in the region.

During group discussions, priority data needs were discussed regarding three acoustic sampling objectives:

1) Using acoustic gear to identify sampling habitat (See below under 2.3.).

2) Using fisheries acoustics to develop indices of abundance:

Acoustics: It was agreed among the primary comment providers (C. Gledhill, T. Kellison, W. Mitchell) that species-specific data useful in to index abundance are currently unfeasible. Acoustic gear was not given a rank of importance warranting immediate implementation. It was noted that the snapper-grouper complex along the southeast US Atlantic coast has not received acoustic research attention as in other NOAA regions (i.e., modeling species-specific target strengths or other acoustic signatures), and comments were pessimistic concerning the ability of any contemporary fisheries acoustics survey gear to differentiate one priority species from another. Specifically, T. Kellison voiced negative concern about identifying individual species in the snapper-grouper complex based upon empirically measured target strength. C. Gledhill suggested additional research on using multiple frequencies to assist species identification. C. Barnes commented that fish target strengths measurements for the snapper-grouper complex are confounded and problematic due to fish orientation and dorsal aspect availability to gear deployed from the hull of research vessels.

3) Using fishery acoustics gears to study spawning aggregations:

Positive comments were made regarding the unique ability of acoustic gears to detect spawning aggregations of fish. It was noted that species composition sampling would be less challenging when aggregations are mono-specific. A sampling program coincident with spawning would be time-of-year-, location-, and lunar-phase-specific; therefore complementary but separate from the development of standard fishery-independent indices. A monitoring program to quantify annual spawning events at important locations was discussed as a research objective, and as a potential for cooperative research project between fishers and resource management agencies.

- Recommendations: Support further development of this method for survey purposes.

3. Other considerations

3.1 Habitat mapping

The workshop recognized that accurate habitat maps are critical and recommends initiating a program to ultimately map the entire region. Comments endorsing habitat identification by mobile acoustic methods were widely supported in the Gear group (D. DeVries, C. Gledhill, T. Kellison, W. Mitchell, M. Reichert). Habitat identification was also identified as a data need by the Statistics group. It was stated, and widely supported, that a "habitat mapping program" be recommended as a priority research need to complement efforts to produce species specific indices of abundance. D. DeVries commented that side-scan sonar is a very efficient, cost-effective method to rapidly identify hard/live bottom habitat in the depths encountered in NOAA Panama City lab surveys (10-40m). Single and split-beam fisheries sonars are also capable of providing bottom type information. Ideally, hydrographic survey standards would be used to survey for hard bottom habitats to provide data suitable for mapping the region but also serve in navigation, safety and charting services for NOAA.

- Recommendations:
  - Each research vessel participating in the monitoring should have acoustic equipment on board to provide bottom type (mapping) information while sampling.
  - Design and implement a regional bottom mapping survey to support efficient sampling design and assist with assessments.

3.2 Vessels

The group discussed the type and size of research vessels needed for monitoring (see also Table 1).

Requirements for sampling vessels (the shelf area):

- Sufficient accommodations for vessel crew plus (6-9) scientific crew.
- Ability to complete research cruises up to 14 days (possibly with port call)
- Icemaker
- Sufficient freezer space to store bait and samples
- A-frame, pot hauler, crane, reel/drum for long line.
- Dual navigational software (for vessel and scientific crew)
- Up to date communication equipment (e.g. satellite phone/internet)
- Dry and wet laboratory space for sample processing and computer/electronic recording
- Size of vessel depends on sampling strategy/logistics; for example, MARMAP currently deploys 6 traps or 6 lines per set, which requires a vessel >100'
- A working back deck relatively close to the water surface will increase the efficiency and accuracy of deployment and reduce damage to gear
- Ability for (efficient) communications between pilot house and work platform (back deck).
- Continuous stable 110V supply for sensitive sample and recording electronics

- Ability to store and deploy a variety of gear. Vessel crew should be familiar with, if not experienced in, setting all selected types of survey gear

Vessels sampling the deeper areas may have additional requirements.
If multiple vessels are to be used to sample the area, it will be highly desirable that all vessels are using similar equipment, especially relative to navigation (accuracy of positioning), sample recording and processing (e.g. sampling logs, etc.), and communication.
Although smaller vessels may be adequate, a minimum size of 100 ft with ample back deck and laboratory space is recommended. This allows for longer cruises (which increases sampling efficiency), sufficient room to store all gear, and space for work-up of biological samples. Gonadal tissues need to be processed fresh and cannot be frozen for accurate histological information. Furthermore, stomachs need to be processed quickly to avoid deterioration of stomach contents.

2.5. Miscellaneous remarks and recommendations:

Both the gear working group and the plenary session discussed several other aspects relevant to sampling and overall project management.

- It is important to consider what effect adopting new gear and survey types will have on existing indices of relative abundance obtained from ongoing surveys, especially if these ongoing surveys are abandoned in lieu of new ones.
- Night time sampling was discussed. Although any visual sampling method (e.g. diver survey or video array) cannot be conducted at night, other sampling at night (especially for biological samples) would increase sample size and efficiency. Longer trips and high sample volume would require processing of biological samples at night (following MARMAP protocol). A final recommendation regarding routine night time sampling was not made.
- Several programs and labs currently involved in fisheries independent monitoring and analysis (e.g. MARMAP, SEFSC) do not have physical space to expand. Concerns were raised about where regional and central programs physically were going to be housed. There should be a central management location that houses (among other things) a unit responsible for the logistical coordination, central data storage, and analyses in preparation of SEDAR.

Literature

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Table 1. Summary of gear type characteristics as discussed during workshop. See above for gear description.

	Strata						ability to provide data for index within 1 yr	ability to collect	ability to collect
Gear	**Ichthyoplankton (all areas)**	**Estuarine / nearshore**	**Shelf**	**Deep**	**South FL #**	**South FL deep**	**of implementation**	focal species	biological samples
Seine		2					No	1	Yes
Otter trawl (small)		2					No	1	Yes
Beam trawl (1-2m)		3					No	1	Yes
Bridge net	2	2					No	1	Yes#
Channel nets (block or stop nets)		1					No	1	Yes
Witham	2	2					No	1	Yes
Bongo net	1						No	3	Yes#
Neuston	2						No	3	Yes#
Z-trap			1		2		No	3	Yes
Blackfish trap		3	3		3		No	2	Yes
Chevron trap			1		2		Yes	3	Yes
Long bottom longline				1		1	Yes	1	Yes
Short bottom longline			1	2	1	2	Yes	3	Yes
Bandit / snapper reel			1*		1		No	3	Yes
Wreckfish reel				1		1	No	1	Yes
Rod and reel (including electric reels)			2		2		No	3	Yes
Visual survey			1		1		No	3	No
Video array			1		1		No	3	No
Still camera							No	3	No
ROVs							No	3	No
AUVs							No	3	No
Towed camera							No	3	No
Acoustics							No	3	No*

categories (see report for details)
1 : most appropriate or desired gear or survey types
2 : alternative choice of #1 is not to be used
3 : least desirable of the selected gear or survey types
empty fields : inappropriate or highly undesirable gear or survey types
* : there was much discussion and concern in the gear working group about variability and standardization

: The consensus in the group was that visual surveys should be used for an index, and hook and line gear to collect biological samples. Traps and long lines raised concerns with respect to coral damage

categories (focal species)
1 : single or few
2: few to dozen
3: majority of focal species

Note: takes into account location of deployment

#: identification of some species (groupers) currently problematic

*: species identification problematic

Table 1. (Continued)

Gear	Ongoing survey?	Bait type?	Selectivity	Life stage targeted?
Seine		none	Targets species with estuarine life stage (e.g. gag) - shallow waters only	Juveniles or YOY
Otter trawl (small)	No	none	Targets species with estuarine life stage (e.g. gag) - shallow waters only	Juveniles or YOY
Beam trawl (1-2m)	No	none	Targets species with estuarine life stage (e.g. gag) - shallow waters only	Juveniles or YOY
Bridge net	Yes	none	Targets species with estuarine life stage (e.g. gag)	Eggs, larvae, post larvae, early juv.
Channel nets (block or stop nets)	No	none	Targets species with estuarine life stage (e.g. gag)	Juveniles or YOY
Witham	Yes (Keys)	none	Targets species with estuarine life stage (e.g. gag)	Post larvae and juveniles
Bongo net	No	none	Water column ichthyoplankton	Eggs, larvae, post larvae, early juv.
Neuston	No	none	Targets surface waters.	Eggs, larvae, post larvae, early juv.
Z-trap	No	Live or dead (varies)	Targets larger adults	Adults
Blackfish trap	No	Live or dead (varies)	Doesn't effectively sample juveniles & larger groupers / snappers	Adults, some species YOY
Chevron trap	Yes	Dead (clupeids)	Doesn't effectively sample juveniles, and larger groupers / snappers of some specific species	Adults, some species YOY
Long bottom longline	Yes	dead (squid)	Targets golden tilefish; also catches other species (e.g. snowy grouper, blackbelly rosefish, some sharks, etc.)	Adults
Short bottom longline	Yes	dead (squid)	Targets larger adults (depending on hook size)	Adults
Bandit / snapper reel	No	Dead (varies)	Targets adult snapper / grouper of all sizes; high diversity of catch	Adults
Wreckfish reel	No	Dead (varies)	Targets adult deep water species such as wreckfish	Adults
Rod and reel (including electric reels)	No	Dead (varies)	Targets adult snapper / grouper of all sizes; high diversity of catch (depending on rig, bait, and hook size	Adults
Visual survey	Yes (Keys)	N/A	All but very criptic species. Possible diver avoidance / attraction	All
Video array	Yes (GOM)	dead (squid or/and mackerel)	All but very criptic species. Possible avoidance / attraction (bait issue)	All
Still camera	Yes (~ MARMAP)	MARMAP - on baited traps	All but very criptic species. Cameras on traps: baited trap attraction	All
ROVs	No	none	All but very criptic species. Possible gear avoidance / attraction	All
AUVs	No	none	All but very criptic species. Possible gear avoidance / attraction	All
Towed camera	No	none	All but very criptic species. Possibly more avoidance than other "visual" methods	All
Acoustics	No	none	Issues surveying fish on the bottom (dead zone) or high relief (in acoustic shadow)	All
		between brackets:		
		(group of) species		

Table 1. (Continued)

Gear	Target Target habitats	Limiting physical Conditions	Cost	deployment Depth (m)
Seine	Near shore, estuarine, shallow	Shallow only	$100 and up	<2m
Otter trawl (small)	Near shore, estuarine, shallow	Shallow only	$1000 and up	<15m
Beam trawl (1-2m)	Near shore, estuarine, shallow	Shallow only	$1500 and up	<15m
Bridge net	Creeks, shallow	Shallow only, surface access.	$ 250 and up	<5m
Channel nets (block or stop nets)	Creeks, inlets, shallow	Shallow only	$3,000	<15m (?)
Witham	Creeks, shallow	Shallow only	$100	<5m
Bongo net	All	Integrating watercolumn	$250 and up	?
Neuston	All	surface waters only	$500 and up	<1m
Z-trap	Shelf, hard bottom	Strong current and high waves	$850	15m to shelf edge
Blackfish trap	Shelf, hard bottom	Strong current and high waves	$155	15m to shelf edge
Chevron trap	Shelf, hard bottom	Strong current and high waves	$850 (with high-flyer and line)	15m to shelf edge (between 90 and 300m)
Long bottom longline	Mud / soft bottom, beyond shelf edge	Snagging (over live bottom and relief), strong current and high waves	$1600 (1 mile of gear; 100 hooks)	200-300m (currently, but can be deployed shallower and deeper)
Short bottom longline	Shelf, hard bottom	Strong current and high waves	$300 (includes high-flyer and 20 hooks)	90 - 200m (currently, but can be deployed shallower and deeper)
Bandit / snapper reel	Shelf, hard bottom	Varies (can be fished under most conditions)	$1,200	No limitation
Wreckfish reel	Hard bottom, deep beyond shelf edge	Varies (can be fished under most conditions)	$1,200	No limitation
Rod and reel (including electric reels)	Hard- and softbottom, shelf to shelf edge	Varies (can be fished under most conditions)	$200-400 per outfit	<150m
Visual survey	Shelf, hard bottom (depth limited)	Visibility; light (daytime only), current (rare)	High; labor-intensive	<60m (mostly < 45m)
Video array	Shelf, hard bottom (light limited)	Visibility; current; only daylight hrs	$80,000	<150m (but as deep as 600, light limted))
Still camera	Shelf, hard bottom (light limited)	Visibility; current; only daylight hrs	$380 and up	<70 (official housing limit, but can has been deployed to 100, deeper with other housing, light limited)
ROVs	Shelf, hard bottom (light limited)	Visibility; current	$75,000 and up (inexpensive available)	No limitation (except for $$)
AUVs	Shelf, hard bottom (light limited)	Visibility; current	$75,000 and up (inexpensive available)	No limitation (except for $$)
Towed camera	Shelf, hard bottom (light limited)	Visibility; current	$75,000 and up (inexpensive available)	No limitation (except for $$)
Acoustics	All	Few	$80,000 -$150,000 depending on system	Dependends on frequency, no limits
			See report for details	

Table 1. (Continued)

Gear	Variability	Vessel type required	Scientific field Personnel required* #	Post sampling processing* per sample or collection	Soak time
Seine		none	2	Relatively quick and cheap. L/H *	Variable
Otter trawl (small)		15' -21'	2 - 3	Relatively quick and cheap. L/H *	1-10 minutes
Beam trawl (1-2m)	Relatively low	none to 15' -21'	2	Relatively quick and cheap. L/H *	1-10 minutes
Bridge net		none	2	Time comsuming and expensive	30 min. to hrs
Channel nets (block or stop nets)		??	?	Relatively quick and cheap. L/H *	30 min. to hrs
Witham		12' -17'	2	Relatively quick and cheap. L/H *	days
Bongo net		12 ft and up	2	Time comsuming and expensive	minutes (depth dep.)
Neuston		12 ft and up	2	Time comsuming and expensive	minutes
Z-trap	Relative high (data available)	40' and up*	4+	CPUE readily available. L/H *	1-2 hr
Blackfish trap	Relative high (data available)	35' and up*	2 - 4	CPUE readily available. L/H *	Short (1 hr or less)
Chevron trap	Relative high (data available)	35' and up*	4+	CPUE readily available. L/H *	90 minutes
Long bottom longline	Relative high to moderate (data available)	40' and up*	3+	CPUE readily available. L/H *	90 minutes
Short bottom longline	Relative high (data available)	35' and up*	4+	CPUE readily available. L/H *	90 minutes
Bandit / snapper reel	Relative high (data available)	35' and up*	2+	L/H *	Varies (short)
Wreckfish reel	Relative high (data available)	35' and up*	2+	CPUE readily available. L/H *	Varies (short)
Rod and reel (including electric reels)	Relative high (data available)	35' and up*	2+	L/H *	Varies (short)
Visual survey	Relatively low	~ 30'	3+	CPUE readily available.	~ 30 min
Video array	Relatively low	35' and up*	4	Time comsuming and expensive	45 min
Still camera	Relatively low	35' and up*	3+	Time comsuming and expensive	Varies (30 to 90 min)
ROVs	Moderate	35' and up*	3+	Time comsuming and expensive	Variable
AUVs	Moderate	35' and up*	3+	Time comsuming and expensive	Variable
Towed camera	Moderate to high	35' and up*	3+	Time comsuming and expensive	Variable
Acoustics	Relatively low*	30' and up, depending on equ	2 - 3	Time comsuming and expensive	Variable
	Variability: expected variability of	* see notes in report	*: Vessel crew not included	L/H * : Post processing time	
	catches within one non varying location		depending on gear and	and cost for life history samples	
			survey, vessel crew assist	depends on # of species selected	
	*: depends on type of data, no species		with sampling		
	specific information				
			# : Numer of sci. staff		
			depends on amount of		
			procesing done on board		

Table 1. (Continued)

Gear	Deployments per day	Season?	Standardization	Collection of quantitative qualitative or relative data
Seine	Variable	based on spawning or migration season	medium (?)	qualitative/relative
Otter trawl (small)	Variable	based on spawning or migration season	good	Quantitative (/m2)
Beam trawl (1-2m)	Variable	based on spawning or migration season	very good	highly quantitative (/m2)
Bridge net	1 or 2	based on spawning or migration season	good	qualitative/relative
Channel nets (block or stop nets)	??	based on spawning or migration season	good	qualitative/relative
Witham	6-8 are visited/dy	based on spawning or migration season	low to medium	qualitative/relative
Bongo net	Variable	No limitations other than weather	low to medium	Quantitative (/m3)
Neuston	Variable	No limitations other than weather	low to medium	Quantitative (/m2 or /m3)
Z-trap	??	No limitations other than weather	good	qualitative/relative
Blackfish trap	??	No limitations other than weather	good	qualitative/relative
Chevron trap	18-24 (current MARMAP)	No limitations other than weather	good	qualitative/relative
Long bottom longline	4 to 8	No limitations other than weather	good	qualitative/relative
Short bottom longline	18-24 (current MARMAP)	No limitations other than weather	good	qualitative/relative
Bandit / snapper reel	Many	No limitations other than weather	Low w/o addional constraints	qualitative/relative
Wreckfish reel	Many	No limitations other than weather	Low w/o addional constraints	qualitative/relative
Rod and reel (including electric reels)	Many	No limitations other than weather	Low w/o addional constraints	qualitative/relative
Visual survey	8 to 10	No limitations other than weather	good	Quantitative (/m3)
Video array	8 to 15	No limitations other than weather	good	qualitative/relative
Still camera	Up to 24	No limitations other than weather	good	qualitative/relative
ROVs	Variable	No limitations other than weather	good (?)	Quantitative (/m3) (?)
AUVs	Variable	No limitations other than weather	good (?)	Quantitative (/m3) (?)
Towed camera	Variable	No limitations other than weather	medium	Quantitative (/m3) (?)
Acoustics	Variable	No limitations other than weather	very low (currently)	N/A yet
			Standardization: addresses the use of method for index of abundance.	

Table 1. (Continued)

Gear	Has gear been used for index of abundance in assessments	Notes
Seine	?	Limited use (only few species)
Otter trawl (small)	?	Limited use (only few species)
Beam trawl (1-2m)	? (flounder in Europe)	Limited use (only few species)
Bridge net	?	Limited use (only few species)
Channel nets (block or stop nets)	?	Limited use (only few species)
Witham	no	Limited use (only few species)
Bongo net	?	Use may be limited due to labor extensice post-sampling-porcessing.
Neuston	?	Use may be limited due to labor extensice post-sampling-porcessing
Z-trap	no	Current XZ-trap design is larger and thus more cumbersome than chervon trasp, redesigning may eliminate advantage over chevron traps.
Blackfish trap	yes (in region for focal species)	Commercial fishers use varied soak times and habitats; regional differences.
Chevron trap	yes (in region for focal species)	Long term data set available for many focus species
Long bottom longline	yes (in region for focal species)	Data available for tilefish
Short bottom longline	yes (in region for focal species)	Long term data set available for variety of focus species (e.g. amberjack, snowy grouper and others)
Bandit / snapper reel	no	Catchability varies with rig type and fisher experience; if drifting, time on site is important variable.
Wreckfish reel	no	Catchability varies with rig type and fisher experience; if drifting, time on site is important variable.
Rod and reel (including electric reels)	?	Catchability varies with rig type and fisher experience; if drifting, time on site is important variable.
Visual survey	?	Need to utilize methods to establish and standardize fish ID and length estimation expertise. Rigorous standard training procedures are available
Video array	? (gag in GOM?)	Considerable processing time. Consider availability of data in time for SEDAR assessments. Question of group member: have video surveys been used as an index in stock assessments?
Still camera	?	Currently used mostly to assess habitat.
ROVs	?	Expensive and much development for use is ongoing
AUVs	no	Expensive and much development for use is ongoing
Towed camera	?	limited manouverability.
Acoustics	no (rockfish on west coast?)	Need calibration for species ID; good for spawning aggregations
	Comment: not restricted to region or US.	

Statistical Sampling Design Working Group Report

Report editor: Kyle Shertzer

Moderator:
Kyle Shertzer

Working Group Contributors: Robert Freeman, Terrell Gould, Christine Jensen, Kyle Shertzer, Sean Keenan, Rob Cheshire, Gretchen Bath-Martin, Lisa Wood, Pat Geer, Jessica Stephen, Joey Ballenger, Paul Conn, Robert Cardin, Jim Waters, Amy Schueller, Josh Loefer, Paul Rudershausen, Chris Taylor, Scott Crosson

Discussion and Recommendations

The three primary charges for this working group were to recommend 1) a potential sampling framework, 2) strata for use in the design, and 3) sample sizes. The working group considered several possible sampling frameworks (Table 1), and recommended a stratified random approach. The working group listed factors that should be considered in the design. Many of these factors could be treated as covariates when using the data to develop an index of relative abundance. Several are worth considering as strata in the design, in particular latitude and depth. Further considerations and recommendations on the stratified random design are outlined below. Before a survey is implemented, the final design should undergo an outside review by professionals specialized in statistical design.

Sampling Universe

1. Suitable habitat for species of interest. Reefs should include natural and artificial (ship wrecks or designated artificial reefs) structure. One caveat when using artificial structure is that locations of artificial reefs are much better known than those of natural reefs, and much of the artificial structure is nearer to shore. This skew in spatial distribution would affect proportions of known suitable habitat in each stratum, and thus could bias the distribution of sampling effort toward areas with artificial reefs, if not properly accounted for in the design.
2. Map of locations could come from a variety of sources. A high priority recommendation is that available information be synthesized with initiation of FI program. Some possible sources of information are the following:
    a. SEAMAP (Figure 1)
    b. MARMAP (Figure 1)
    c. USGS (Figure 2)
    d. Fishermen (recommend series of workshops to get input from fishermen)
    e. USF/Keys remote sensing
    f. Habitat probability maps (e.g., Figure 3)
    g. NOAA Ocean Exploration or NURC studies (S. Ross, UNCW)
    h. Council habitat maps
    i. RSMAS logged bathymetry from Harbour Branch vessel

j. C. Manooch's data (e.g., snowy grouper habitat)
k. VMS data

Strata

1. Latitude versus land/watersheds/bathymetric features (Capes)
    a. Cape Canaveral (another break at Miami if Keys are included in program), Cape Fear, Cape Hatteras
        i. Pros: They are potentially biologically meaningful
        ii. Cons: Vary in spatial extent (Cape Canaveral to Cape Hatteras is very large), May not be consistent over long time periods (due to species range shifts),
    b. 1- or multi-degree latitude
        i. Pros: Similar to existing categories (commercially), forcing broader distribution of effort
        ii. Cons: not biologically meaningful,
    c. Recommend zoogeographic boundaries (Figure 1)
        i. Hatteras -> north
        ii. Capes Hatteras to Cape Canaveral (or nearby)
        iii. Cape Canaveral to Miami
        iv. Miami through Keys,
    d. Effort in strata proportional to known or predicted reef fish (suitable) habitat for snapper-grouper species – analysis yet to be done.

2. Depth
    a. Some depths will likely determine separate surveys, gears.
    b. Depth for offshore survey division determined by life history or assemblages?
    c. Possibly 5 depth strata?
        i. Estuarine – 5 m
        ii. Inshore: 5 m-30 m
        iii. Shelf: 30-70 m (Note: 70 m, red grouper, gag, vermillion snapper, and gray triggerfish catches are lower)
        iv. Shelf-break: 70-140 m
        v. Deep offshore: >140 m
            1. Deep water species, may need to be more specific for wreckfish,
    d. Effort will be distributed based on proportion of suitable (reef, natural or artificial (wrecks or designated artificial reefs)) habitat within depths,
    e. MPAs should be sampled, use as covariate.

Sampling Within Strata

1. If list of suitable habitat locations is large (not necessarily complete), simple random sampling should be sufficient.
2. If not, may be desirable to divide each stratum into sampling units (squares/cells within a stratum) and search for a suitable location prior to dropping gear (with "suitable location" defined as the presence of habitat rather than the presence of fish). The search could be done by running transects, for example. Probability of sampling a cell could be based on:
    a. Presence/number of known hardbottom (MARMAP, commercial);
    b. Probability of hardbottom occurring (Dunn and Halpin, 2009);
    c. Cell size within strata could be 10 minutes by 10 minutes.

Sample Sizes

1. Simple guidance from binomial sampling (Figure 4). Note that standardizing data for use as an index of abundance typically involves application of a delta-GLM, with variance often driven by the binomial component.
2. Consider randomization study on current MARMAP data to examine sample sizes necessary to achieve CV < 0.2
3. Minimum sample size is gear- and strata-specific (strata size and variability)
4. Need to weight based on presence of rarer species?

Further comments (mostly on the design presented to the plenary on November 19)

1. The randomization process for site selection is unclear and needs further consideration (Purely random? Should logistics be considered? How do predictions of available habitat translate into the probability of selecting sites?). There are tradeoffs between search/steam/set time, sample size (gear deployment events), and the overall interpretability of the survey (i.e., how representative is the sample of the population?).
2. Prior to deciding on grid sizes, consider a simulation study to examine logistical feasibility.
3. A sample size of N=1000 for each stratum appears to be adequate, based on current MARMAP trapping success and simple binomial sampling theory.
4. Consider larger grids in deep water (e.g., 1 nm X 1 nm). In current configuration, longlines are 0.7 nm long.
5. In areas north of Cape Hatteras, current moves more quickly and may cause trouble with some gears (as near the FL Keys).
6. Is N=500 in the northern area appropriate? The ratio of sample size to area covered appears to be out of proportion (higher than in the South Atlantic Bight).
7. The design for a multispecies survey is unlikely to be optimal for any particular species.
8. Dropping cameras prior to removal gear would likely affect catch rates of removal gear.

9. Although the WG recommended including MPAs as covariates in the FI survey, the WG also discussed the desirability of more focused monitoring of MPAs and their effects on abundance, age structure, etc. (perhaps as a separate study).
10. The presumption is that sampling would occur annually. If funds do not allow intense sampling every year, consider a strategy of periodic sampling, such as every three years, with (less intensive) normal sampling during the other two years. (a) Sampling kills fish and the management objective is to save fish. An intensive sampling program conducted annually might cause a nontrivial delay in the recovery of overfished species, especially the rare ones. (b) Normal environmental variability may be high enough that we could not discern annual changes in abundance anyway, but we might be able to detect changes every several years. (c) A periodic sampling program might make the cost affordable. (Note: this idea was not discussed during the workshop, but was suggested later while writing this report.)

Reference

Dunn and Halpin. 2009. Rugosity-based regional modeling of hard-bottom habitat. Mar. Ecol. Prog. Ser. 377:1−11.

Table 1: Sampling frameworks discussed, along with some pros and cons of each. This table represents discussion of the working group, rather than exhaustive lists.

Sampling Frameworks	Pros	Cons
Simple Random	-Relatively easy to design -Statistically simple	-Would likely sample locations unsuitable for fish -Inefficient -Requires high sample size
Stratified Random	-More efficient -Lower variability	-Requires accurate information on strata -Strata may change over time
Adaptive Sampling	-Concentrate effort in good areas/high abundance	-Narrow spatial coverage -Species dependent (behavior, distribution) -Logistically difficult to prosecute -Estimators are more complicated
Double Sampling	-Provide efficient way to cover larger area. Good bang for buck. -Good for overall CPUE for assemblage.	-No biological data provided, if selectivity of gears are different -Species ID is difficult if using acoustics as “fast” method. Would just result in extrapolating a relative measure -Difficult to find appropriate “fast” method if not acoustics.
Unequal probability sampling	-Decreased variance -Better allocation of effort -More efficient sampling	-Requires substantial knowledge the sampling universe and accurately assigned probability
Two-, multi-stage Sampling	-Strata can be chosen based on a probability (unequal probability above) -Can include several sampling designs	

Table 2. List of factors that are important to consider, either as strata or covariates (***** indicates that this factor may be worth considering as a stratum)

i. Depth *****
ii. Latitude*****
iii. Estuarine-nearshore-offshore *****
iv. Shore type (especially for inshore-estuarine)
v. Season * (though may be related to latitude – south may be able to include year-round)
vi. Habitat * (known versus unknown, also see artificial habitats below)
vii. Bottom type (finer description, related to species-specific preferences, use standardized bottom classification standards – NOAA document available)
viii. Artificial kept separate (from natural habitats) *****
ix. Weather/atmospheric/winds
x. Cloud cover
xi. Sea Surface conditions (as related to gear efficiency, fish behavior)
xii. Ground swell, in shallower waters
xiii. Temperature (surface and bottom)
xiv. Pressure
xv. Moon phase
xvi. Tides and Currents
xvii. CHl-a
xviii. Dissolved Oxygen
xix. Time of day, day v. night ***** (for day/night, but time of day is likely a covariate)
xx. pH
xxi. Visibility (especially for video gear efficiency, vertical and horizontal near-bottom)
xxii. Salinity (especially for inshore/nearshore)
xxiii. Nutrients
xxiv. Water column conditions, stratification
xxv. Presence of other critters/predators that may change fish's behavior

Other factors:
Consider life-stages
Fish movements/migrations

Figure 1. Potential sampling locations from SEAMAP and MARMAP. Horizontal lines represent possible configuration for geographic strata.

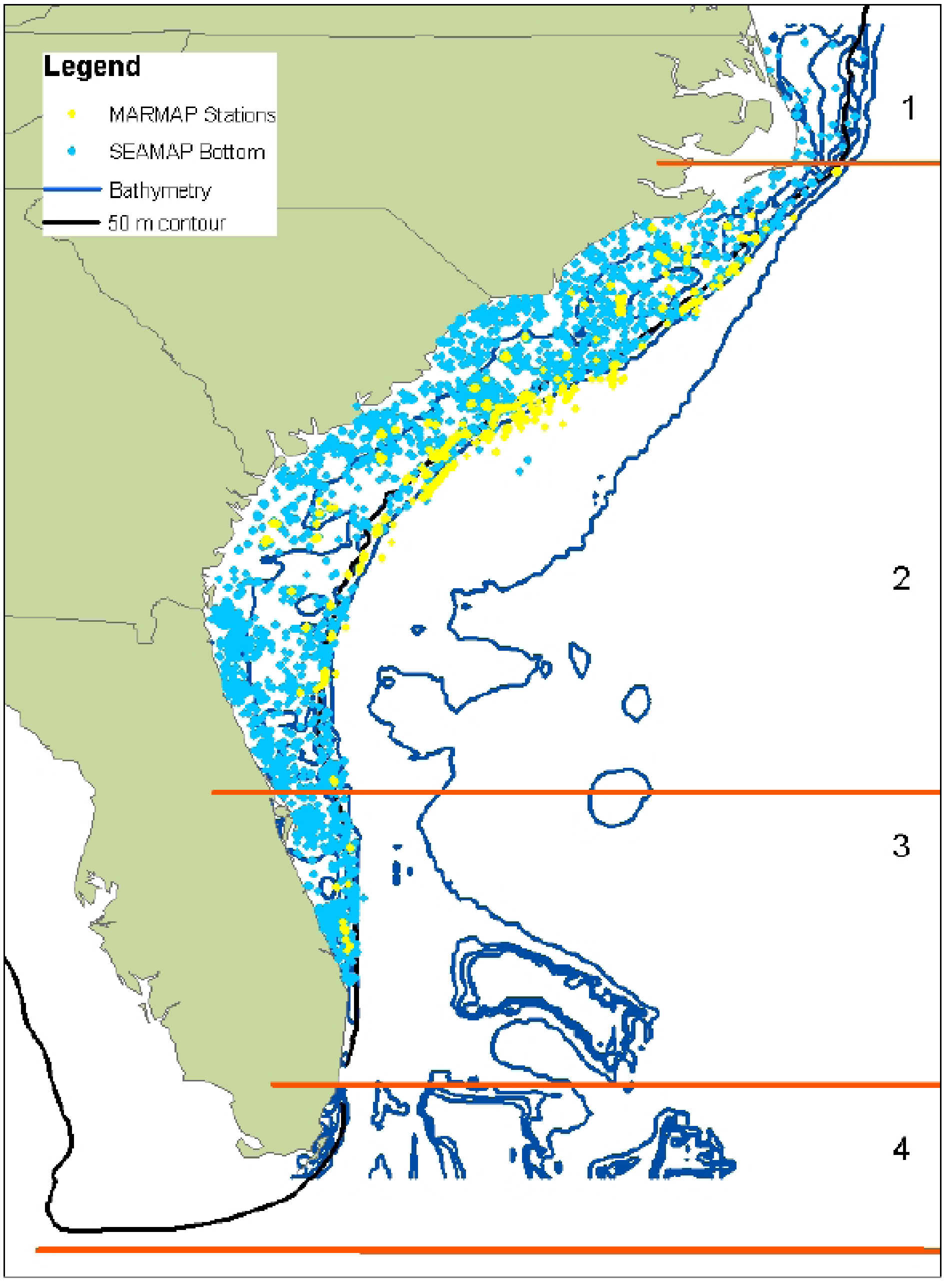


Figure 2. Possible sampling locations from USGS.

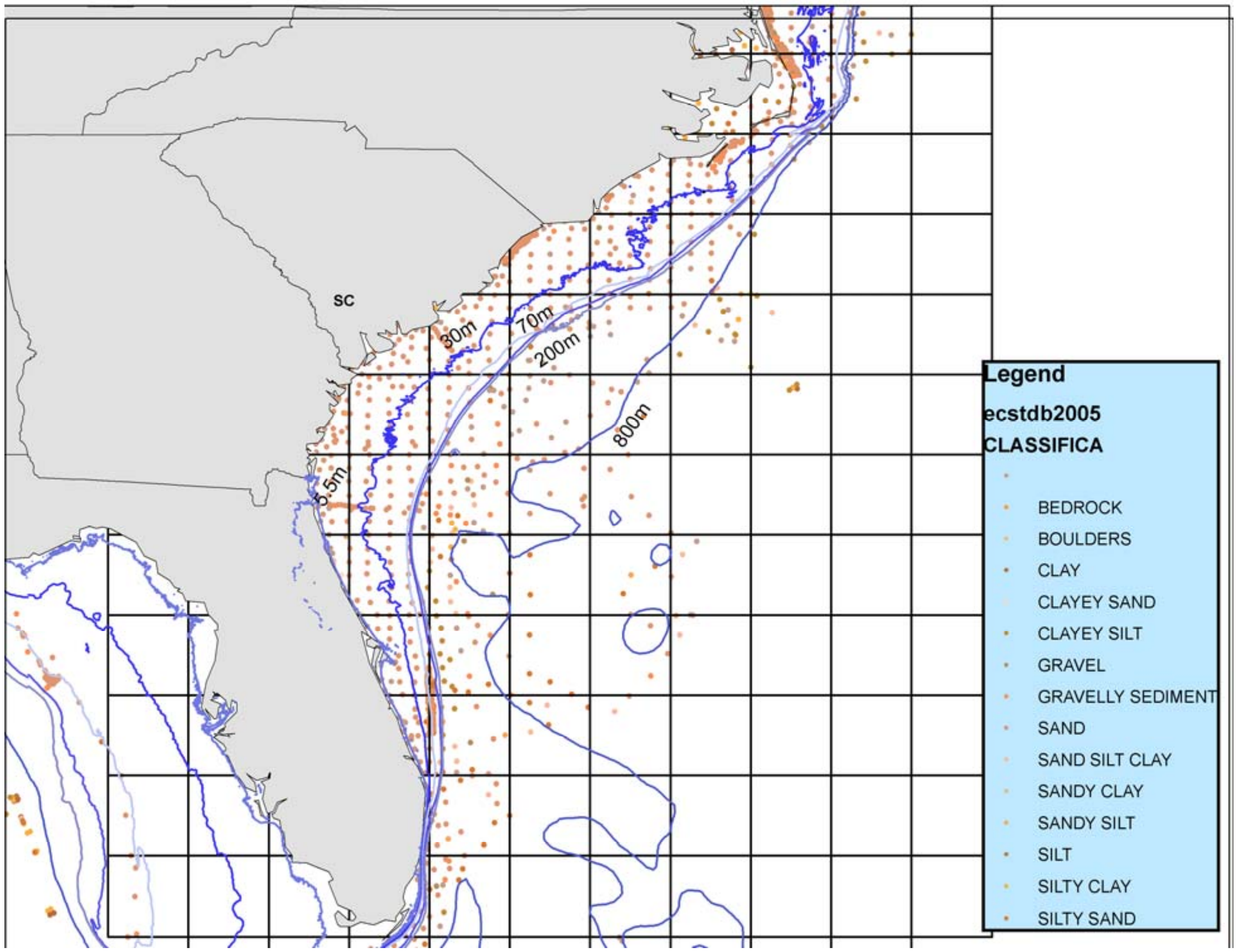


Figure 3. Probability map of hard-bottom habitat, reproduced from Dunn and Halpin (2009).

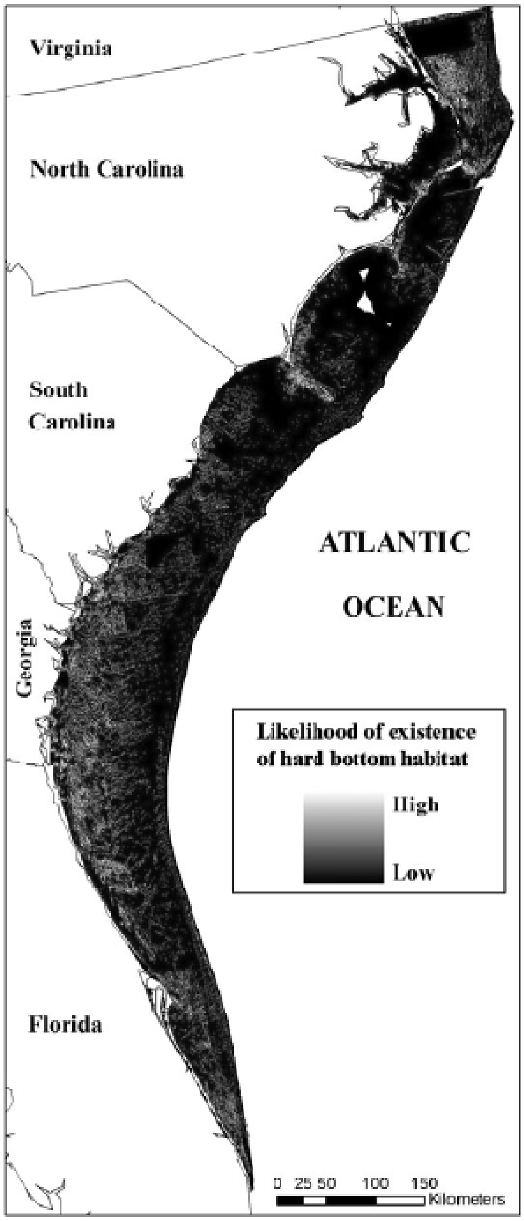
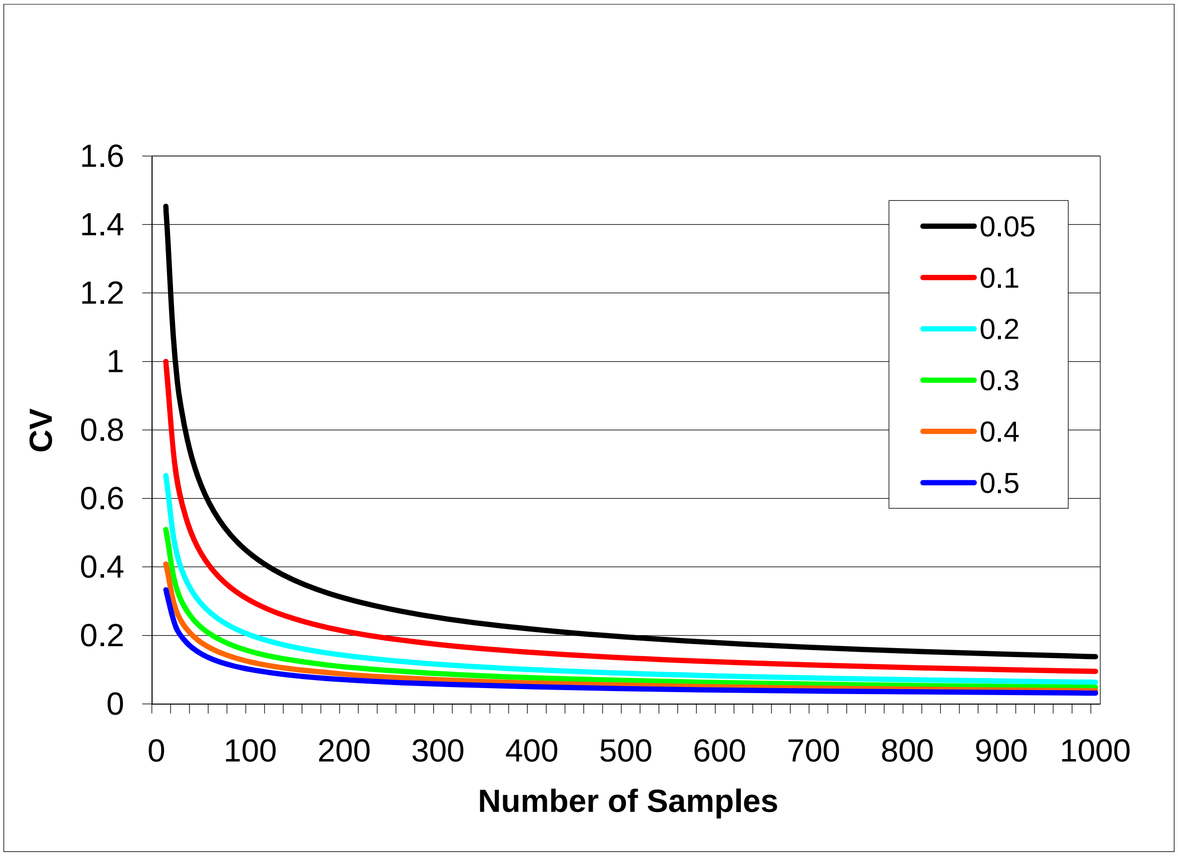


Fig. 4. Final predicted map of likelihood of hard-bottom habitat along the South Atlantic Bight based on the 'stripped' regression mode

Figure 4. Relationship between sample size and CV, based on binomial distribution with probability of success *p* indicated. Proportion success achieved in current MARMAP sampling shown below for several species.



Frequency of Occurrence over last 5 yrs for MARMAP

Long bottom longline	Short longline	Chevron Traps	
	0.003	0.021	Red Snapper
		0.218	Vermillion Snapper
		0.381	Black Sea Bass
		0.331	Tomtate
	0.060	0.005	Speckled Hind
	0.201	0.019	Snowy Grouper
0.132			Tilefish
	0.033	0.414	Red Porgy
	0.042	0.007	Gag
	0.168	0.080	Scamp
	0.069	0.004	Greater Amberjack
		0.252	Triggerfish
		0.115	White Grunt
	0.081	0.058	Red Grouper

Life History Group Report

Report editor: Jack McGovern

Moderator:
Jack McGovern

Working group participants:
Mike Burton, Bobby Cardin, Chip Collier, Kenny Fex, Robert Johnson, Tracy McCulloch, Jack McGovern, Stephanie McInerny, Paulette Powers, Jennifer Potts, Fritz Rohde, Dough, Vaughan, Dave Wyanski

The life history group included individuals who have backgrounds in commercial and recreational fisheries, conducting stock assessments, and studying aspects of the life history of snapper-grouper species.

<u>Terms of Reference</u>

a. For focal species, discuss species- and life-stage-specific considerations pertinent to life-history data collection (e.g., "species x predominantly collected in waters deeper than 40m")
b. Develop recommendations for stratifications that should be considered / implemented in sampling design (e.g., pertaining to depth, latitude, artificial / natural reefs, species associations, inshore / offshore, timing / season of collection)

<u>Life-stage-specific considerations pertinent to life-history data collection</u>

During the initial portion of the fishery-independent workshop, 24 species were identified as "focal species" around which aspects of the Fishery-Independent Monitoring Program would be designed. Most of these species are on the NOAA Fisheries Service's Fish Stock Sustainable Index (FSSI); although several additional species not on the list were added due to their commercial or recreational importance. The FSSI is a performance measure for the sustainability of 230 U.S. fish stocks selected for their importance to commercial and recreational fisheries. Species listed as focal species include: black sea bass and grouper species (gag, snowy grouper, red grouper, black grouper, speckled hind, scamp, warsaw grouper, goliath grouper, yellowedge grouper); snapper species (vermilion snapper, red snapper, yellowtail snapper, mutton snapper, gray snapper); tilefish species (tilefish (golden), blueline tilefish, sand tilefish); and others (hogfish, red porgy, greater amberjack, gray triggerfish, white grunt, wreckfish). The life history workgroup felt sand tilefish should not be included as a focal species because it has limited commercial or recreational importance and is infrequently captured by fishermen.

The life history group discussed attributes of the focal species that could assist in the identification of potential strata for the focal species. Attributes evaluated include: Genetic differences in South Atlantic; degree of migration; effect of depth with fish size (ontogenetic migration); geographic range within South Atlantic; area where most individuals occur;

predominant adult habitat; juvenile habitat; time of peak spawning for females; female spawning season; depth at which spawning occurs; geographic range of spawning activity; mean depth caught; and range in depth reported (Table 1).

Table 1. Attributes of focal species. Abbreviations: CH = Cape Hatteras; Atl = Atlantic; LB = live bottom; AR = artificial reef; Est = estuary; NA = not available; NS = not significant; SAV = submerged aquatic vegetation.

Stock	Stock Genetic Diff in SA	Home Range or Migration	Depth Effect	Area Found	Dominant Area	Adult habitat	Juvenile Habitat	Peak Spawning	Female Spawning Season	Spawning Depth (m)	Spawning Area	Mean depth caught (m)	Min	Max
Black Sea Bass	NS	Small (larger move more)	NA	Fort Pierce to CH/Atl Coast	32-33 N	LB/AR	Reef, Oyster, SAV	Feb-Apr	Feb-Jul, Sep, Nov	15-56	27-34 N	20-35	2	130
Gag	Ongoing	Large	Male Female Separation Larger offshore	SA	SA	LB/Ledge	Est/Reef	Mar-Apr	Dec-May	24-117	26-33 N	20-50	2	152
Snowy Grouper	NA	Unknown	Larger offshore	SA plus VA	SC/NC	Rock, Ledge, Wreck	Inshore of Adult 50 m	Unknown	Apr-Sep	176-232	24-34 N	100-200	30-50	525
Red Grouper	NS	Small	Larger offshore	Keys to NC	Keys and NC	Live, Rock, Sand, AR	Reef, Lesser extent Est with SAV	Feb-Apr	Dec-Jun	30-90	Keys and NC	30-45	20	95
Black Grouper	NS	Small	Larger offshore	Keys to Cape Lookout	Keys	Live, Rock, Ledges, AR	Reef, SAV, Oyster	Jan-Mar	Possibly Year Round	<100	Keys	30-40	9	60
Speckled Hind	NA	Unknown	Larger offshore	Keys to CH	Unknown	Ledges, Rock	Ledges, Rock	Unknown	May-Oct	Unknown	Unknown	75-100	28	165
Scamp	NA	Seasonal Possible	Larger offshore	Keys to Cape Hatteras	Carolinas	Live, Rock, Ledges, AR	Unknown in SA rarely in Estuaries	Mar-May	Feb-July	33-93	29-32 N (sampling effect)	30-50	17	113
Warsaw Grouper	NA	Unknown	Larger offshore	Keys to CH	Unknown	Live, Rock, Ledges, Pinnacles	Live, Rock, AR, Ledges	Unknown	Aug-Oct			70-110	30	500
Goliath Grouper	NA	Moderate	Juveniles use estuaries adults offshore	Keys to Cape Lookout	Keys	Mangroves, Bridges, Coral, AR	Mangroves and Estuaries	Jul	Jun-Dec			20-50	7	100
Yellowedge Grouper	NA	Unknown	Larger offshore	Keys to Cape Hatteras	N FL to SC	Rock and Ledges	Unknown		Apr-Oct	160-194	31 N (sampling effect)	100-200	64	275
Vermilion Snapper	NA	Small	Larger offshore	Cape Canaveral to CH	N FL to Cape Lookout	LB/Rock/AR	20-30 m depth AR &LB	May-Aug	Apr-Dec	18-97	27-34 N	<76	14	163
Red Snapper	Ongoing	Small	May move inshore to form spawning aggregation	Fort Pierce to CH	Fort Pierce to GA	LB/Rock/AR	Live Bottom Low relief	Jun-Sep	May-Oct	24-67	27-33 N	20-50	10	150
Yellowtail Snapper	NA	Unknown	Unknown	Keys to Cape Lookout	FL	Live, Rock, Reefs, AR	Back reefs and SAV	May-Jul	Feb-Oct		S FL	20-40	10	70

Stock	Stock Genetic Diff in SA	Home Range or Migration	Depth Effect	Area Found	Dominant Area	Adult habitat	Juvenile Habitat	Peak Spawning	Female Spawning Season	Spawning Depth (m)	Spawning Area	Mean depth caught (m)	Min	Max
Mutton Snapper	NS	Spawning Aggregation	Larger offshore	Keys to Cape Lookout	Keys S FL	Live, Reef, Sandy Rubble, AR	Est (SAV) and Sand bottom	Jun-Jul	May-Jul/Aug	33	Tortugas	25-35	25	95
Gray Snapper	NA	Spawning Aggregation	Larger offshore	Keys to Cape Lookout	Keys to S FL	Rock, Reef, Hardbottom	Mangroves and Estuaries	Jun-Jul	Jun-Sep		Florida	30-50	5	180
Tilefish	NA	Unknown	Unknown	SA/ Atlantic Coast	FL/GA	Mud	Mud	Apr-Jun	Mar-Nov	190-300	GA/SC (sampling effect)	150-250	80	540
Blueline Tilefish	NA	Unknown	Larger offshore	Keys to NC/VA and northward		Rocks	Rocks	May-Sept	Feb-Oct	48-234	32 N (sampling effect)	150-200	30	256
Hogfish	NA	Small	Unknown	Keys to Cape Lookout	FL	Live, Rock, Ledges	Unknown in SA	Dec-Mar	Possibly Year Round	Variable		Variable	3	75
Red Porgy	NS	Unknown	Larger offshore	Fort Pierce to Cape Hatteras	Carolinas	Live, Rock, Ledges	Unknown in SA	Jan-Feb	Dec-May	26-57	30-33 N (sampling effect)	30-60	9	307
Greater Amberjack	NS	Large	Larger offshore but mixed	Keys to NC/VA	FL	Live, Rock, Reefs, AR, Water Column	Sargassum	Apr-May	Jan-Jun	45-122	Florida	30-50	15	360
Gray Triggerfish	NA	Seasonal Possible	Larger offshore	Cape Canaveral-NC/VA	Central FL to Cape Lookout	Live, Rock, Ledges, AR	Sargassum	Jun-Jul	Apr-Aug	20-75	27-33 N	30-40	20	100
White Grunt	Yes	Unknown	Larger offshore	Palm Beach to FL Keys and SC to Cape Hatteras	S Fl and SC/NC	Live, Rock, Ledges, AR	Unknown in SA	May-Jun	Mar-Sep	22-51	32-33 (sampling effect)	30-50	10	75
Wreckfish	NS	Significant North Atlantic	Juveniles Pelagic Adult benthic	SA extending outside	Charleston Bump	Rock and Ledges	Pelagic	Feb-Mar	Dec-May	433-595	31 N	300-400	44	600

Description of Focal Species

Sea Bass and Groupers

Black Sea Bass

Distribution - Black sea bass occur in the Western Atlantic, from Maine to northeastern Florida, and in the eastern Gulf of Mexico. They can be found in extreme south Florida during cold winters (Robins and Ray 1986). The life history group indicated black sea bass are most common from Cape Hatteras, North Carolina to St. Lucie Inlet, Florida. Separate populations were reported to exist to the north and south of Cape Hatteras, North Carolina (Wenner et al. 1986). However, genetic similarities suggest that this is one stock (McGovern et al. 2002). This is currently the focus of an ongoing study looking at genetic stock structure along the eastern U.S. coast, with an emphasis on the Cape Hatteras boundary (Life History Group; Burton Personal Communication).

Habitat/Depth - This species is common around rock jetties and on rocky bottoms in shallow water (Robins and Ray 1986) at depths from 2 to 130 m (7-427 ft; Sedberry et al. 2006). The life history group also indicates black sea bass are common on artificial reefs. Most adults occur at depths from 20 to 60 m (66-197 ft; Vaughan et al. 1995) and the life history group indicated they are caught most often at depths from 20 to 35 m (66-114 ft). Juveniles can be found in estuaries associated with submerged aquatic vegetation and oyster rubble as well as nearshore reefs.

Spawning - Wenner et al. (1986) reported that spawning occurs from March through May in the South Atlantic Bight. McGovern et al. (2002b) indicated that black sea bass females are in spawning condition from March through July with a peak from March through May. The life history group reported that the spawning season likely extends from February through July with peak spawning occurring from February through April (Life History Group; Johnson Personal Communication). Some spawning also occurs during September and November (Wenner et al. 1976; McGovern et al. 2002). Tagging data indicated some movement of black sea bass predominantly among larger individuals (Sedberry et al. 1998). Sedberry et al. (2006) state black sea bass spawn from 27 to 34 degrees north along the South Atlantic coast from depths of 15 to 56 m (49-184 ft).

Gag

Distribution - Gag occur in the Western Atlantic from North Carolina to the Yucatan Peninsula, and throughout the Gulf of Mexico, and are found through the South Atlantic from Cape Hatteras, North Carolina to the Florida Keys. Juveniles are sometimes observed as far north as Massachusetts (Heemstra and Randall 1993).

Habitat/Depth - Gag commonly occur at depths of 39 to 152 m (131-498 ft) (Heemstra and Randall 1993) and prefer inshore-reef and shelf-break habitats (Hood and Schleider 1992). Adults are often seen in shallow water 5 to 15 m (16-49 ft) above the reef (Bullock and Smith 1991) and as far as 40 to 70 km (25-44 mi) offshore. The life history group indicated gag are most commonly caught between depths of 20 to 50 m (66-164 ft). McGovern et al. (2005) reported extensive movement of gag along the Southeast United States. In a tagging study of over 4,000 specimens, 23% of the 435 recaptured gag moved distances greater that 185 km (116 mi). Most of these individuals were tagged off South Carolina and were recaptured off Georgia, Florida, and in the Gulf of Mexico. Gag are probably estuarine dependent (Keener et al. 1988; Ross and Moser 1995; Koenig and Coleman 1998; Strelcheck et al. 2003). Juveniles (age 0) occur in shallow grass beds along Florida's east coast during the late spring and summer (Bullock and Smith 1991). Sea grass is also an important nursery habitat for juvenile gag in

North Carolina (Ross and Moser 1995). Post-larval gag enter South Carolina estuaries when they are 13 mm TL and 40 days old during April and May each year (Keener et al. 1988), and utilize oyster shell rubble as nursery habitat. Juveniles remain in estuarine waters throughout the summer and move offshore as water temperatures cool during September and October.
Spawning - Off the southeastern United States, gag spawn from December through May, with a peak in March and April (McGovern et al. 1998). Spawning occurs throughout the South Atlantic at depths of 24 to 117 m (79-384 ft; Sedberry et al. 2006). Gag probably make annual late-winter migrations to specific locations to form spawning aggregations (Collins et al. 1987; Keener et al. 1988; Van Sant et al. 1994).

<u>Red Grouper</u>
Distribution – Red grouper occur in the Western Atlantic, ranging as far north as Massachusetts to southeastern Brazil, including the eastern Gulf of Mexico (Robins and Ray 1986). Red grouper generally occur over flat rock perforated with solution holes (Bullock and Smith 1991), and are commonly found in caverns and crevices of limestone reefs in the Gulf of Mexico (Moe 1969). They also occur over rocky reef bottoms (Moe 1969). The life history group indicated red grouper can be found from the Florida Keys to North Carolina. Its distribution is somewhat disjunct and they are most common off the Florida Keys and North Carolina.
Habitat/Depth – Adult red grouper are sedentary fish that are usually found at depths of 5 to 300 m (16-984 ft). Fishermen off North Carolina commonly catch red grouper at depths of 27 to 76 m (88-249 ft) for an average of 34 m (111 ft). Fishermen off southeastern Florida also catch red grouper in depths ranging from 27 to 76 m (90-330 ft) with an average depth of 45 m (148 ft) (Burgos 2001; McGovern et al. 2002). Moe (1969) reported that juveniles live in shallow water nearshore reefs until they are 40.0 cm (16 in) and 5 years of age, when they become sexually mature and move offshore. The life history group indicated red grouper most commonly occur at depths of 30 to 45 m (98-148 ft).
Spawning – Spawning occurs from February through June with a peak in April (Burgos 2001). In the eastern Gulf of Mexico, ripe females are found from December through June with a peak during April and May (Moe 1969). The life history group indicated spawning probably occurs from December through June with a peak from February through April in the South Atlantic (Life History Group, Fex Personal Communication). Based on the presence of ripe adults (Moe 1996) and larval red grouper (Johnson and Keener 1984) spawning probably occurs offshore. Coleman et al. (1996) found groups of spawning red grouper at depths between 21 to 110 m (70-360 feet). Red grouper do not appear to form spawning aggregations or spawn at specific sites (Coleman et al. 1996). They are reported to spawn in depths of 30 to 90 m (98-295 ft) off the Southeast Atlantic coast (McGovern et al. 2002a; Burgos et al. 2007).

<u>Black Grouper</u>
Distribution –Black grouper occur in the Western Atlantic from North Carolina to Florida, Bermuda, the Gulf of Mexico, West Indies, and from Central America to Southern Brazil (Crabtree and Bullock 1998). The life history group indicated black grouper are taken from Cape Lookout, North Carolina to the Florida Keys but are most common in the Florida Keys.
Habitat/Depth – Adults are found over hard bottom such as coral reefs and rocky ledges. The life history group indicated black grouper occur as deep as 60 m (197 ft) and most commonly occur at depths of 30 to 40 m (98-131 ft). Juveniles sometimes occur in estuarine seagrass and

oyster rubble habitat in North Carolina and South Carolina (Keener et al. 1988; Ross and Moser 1995). In the Florida Keys, juveniles settle on patch reefs (Sluka et al. 1994).
Spawning – Black grouper probably spawn throughout the year, however, peak spawning of females occurs from January to March (Crabtree and Bullock 1998). The life history group indicated spawning likely occurs at depths less than 100 m (328 ft).

Speckled Hind
Distribution – Speckled hind occur in the Western Atlantic Ocean from North Carolina and Bermuda to the Florida Keys, and in the northern and eastern Gulf of Mexico (Heemstra and Randall 1993). The life history group reported speckled hind occur along the southeastern United States from Cape Hatteras, North Carolina to the Florida Keys.
Habitat/Depth –Speckled hind are solitary and found in depths from 25 m (98 ft) (Heemstra and Randall 1993) to 400 m (1,312 ft) (Bullock and Smith 1991). Sedberry et al. (2006) reported a depth range of 28 to 114 m (92-374 ft) off South Carolina. Heemstra and Randall (1993) reported that speckled hind most commonly occur at depths of 60 to 120 m (197-394 ft) over ledges and hard bottom. Bullock and Smith (1991) indicated that most commercial catches are taken from depths of 50 m (164 ft) or more. The life history group reported speckled hind are commonly taken at depths of 75 to 100 m (246 - 328 ft). Juveniles occur in shallower waters over rocky bottom and ledges (Heemstra and Randall 1993).
Spawning – Speckled hind are thought to form spawning aggregations. Spawning reportedly occurs from July to September (Heemstra and Randall 1993) and May through August (Sedberry et al. 2006).

Scamp
Distribution – Scamp occur in the Western Atlantic from North Carolina to Key West, in the Gulf of Mexico, and in the southern portion of the Caribbean Sea. Juveniles are sometimes encountered as far north as Massachusetts (Heemstra and Randall 1993). The life history group indicated scamp are found from Cape Hatteras, North Carolina to the Florida Keys.
Habitat/Depth – Scamp are found over live bottom, rocks, and ledges. Scamp are reported to occur at depths of 30 to 100 m (98-328 ft; Heemstra and Randall 1993) and 17 to 113 m (56-371 ft; Sedberry et al. 2006). Juveniles are found in estuarine and shallow coastal waters (Bullock and Smith 1991; Heemstra and Randall 1993).
Spawning – Spawning occurs from February through July in the South Atlantic Bight and in the Gulf of Mexico, with a peak in March to mid-May (Harris et al. 2002). Spawning individuals have been captured off South Carolina and St. Augustine, Florida at depths of 33 to 93 m (108-305 ft). Scamp aggregate to spawn (Gilmore and Jones 1992).

Warsaw Grouper
Distribution – Warsaw grouper occur in the Western Atlantic from Massachusetts to southeastern Brazil (Robins and Ray 1986), and in the Gulf of Mexico (Smith 1971). The life history group indicated warsaw grouper are found from along the southeastern United States from Cape Hatteras, North Carolina to the Florida Keys.
Habitat/Depth –Warsaw grouper are solitary (Heemstra and Randall 1993), usually found on rocky ledges and seamounts (Robins and Ray 1986), at depths from 55 to 525 m (180-1,722 ft) (Heemstra and Randall 1993). The life history group reported observations of warsaw grouper from 30 to 500 m (98-1,640 ft) with most individuals occurring from 70 to 110 m (230-361 ft).

Juveniles are sometimes observed in inshore waters (Robins and Ray 1986), on jetties and shallow reefs (Heemstra and Randall 1993).
Spawning – Warsaw grouper spawn during August, September, and October in the Gulf of Mexico (Peter Hood, NOAA Fisheries Service, personal communication).

Goliath Grouper
Distribution – Goliath grouper, formerly known as the "jewfish", occur in the Western and Eastern Atlantic, and in the Eastern Pacific Ocean. In the Western Atlantic, their range extends from Florida to southern Brazil, including the Gulf of Mexico and the Caribbean Sea. The life history group indicated goliath grouper occurs along the southeastern United States from Cape Lookout, North Carolina to the Florida Keys.
Habitat/Depth – Goliath grouper inhabit rock, coral, wrecks, and mud bottom habitats in both shallow, inshore areas and as deep as 100 m (328 ft) (Heemstra and Randall 1993). Juveniles are generally found in mangrove areas and brackish estuaries. Large adults may also be found in estuaries. They appear to occupy limited home ranges with some movement (Heemstra and Randall 1993). The life history group indicated goliath grouper are most common at depths of 30 to 50 m (98-164 ft).
Spawning – Goliath grouper form consistent aggregations (always containing the largest, oldest individuals in the population), but only during the spawning season (Sadovy and Eklund 1999; Coleman et al. 2000). Aggregations off Florida declined in the 1980s from 50 to 100 fish per site to less than 10 fish per site. Since the harvest prohibition, aggregations have rebounded somewhat to 20 to 40 fish per site. Spawning off the southwest Florida coast occurs from July through September during the full moon. Fish may move distances as great as 100 km (62.5 mi) from inshore reefs to the offshore spawning aggregations in numbers of up to 100 or more on shipwrecks, rock ledges, and isolated patch reefs. In the northeastern Caribbean, individuals in spawning condition have been observed in July and August (Erdman 1976). Bullock et al. (1992) reported that goliath grouper spawn from June through December with a peak in July to September in the eastern Gulf of Mexico.

Snowy Grouper
Distribution - Snowy grouper occur in the Eastern Pacific and the Western Atlantic from Massachusetts to southeastern Brazil, and in the northern Gulf of Mexico (Wyanski et al. 2000). The life history group reported snowy grouper occur from Virginia to the Florida Keys.
Habitat/Depth - Snowy grouper are found at depths of 30 to 525 m (98-1,722 ft; Robins and Ray 1986). The life history group indicated 50 m is a more likely minimum depth for snowy grouper (Life History Group, Fex Personal Communication). Adults occur offshore over rocky bottom habitat, ledges, and wrecks. The life history group indicated adults are most often captured at depths of 100 to 200 m (328-656 ft). Juveniles are observed inshore and occasionally in estuaries (Heemstra and Randall 1993) with shelf edge rocky habitat a likely nursery area for juveniles (life history group).
Spawning - Females in spawning condition have been captured off western Florida during May, June, and August (Bullock and Smith 1991). In the Florida Keys, ripe individuals have been observed from April through July (Moore and Labinsky 1984). Spawning seasons reported by other researchers are as follows: South Atlantic (north of Cape Canaveral), April through September (Wyanski et al. 2000) and April through July (Parker and Mays 1998); and South

Atlantic (south of Cape Canaveral), May through July (Manooch 1984). Wyanski et al. (2000) reported that snowy grouper spawn at depths from 176 to 232 m (577-761 ft).

Yellowedge Grouper

Distribution – Yellowedge grouper occur in the Western Atlantic from North Carolina to southern Brazil, and in the Gulf of Mexico (Heemstra and Randall 1993). The life history group indicated yellowedge grouper occur off the southeastern United States from Cape Hatteras, North Carolina to the Florida Keys with most yellowedge grouper occurring from South Carolina to northern Florida.

Habitat/Depth – A solitary, demersal, deep-water species, yellowedge grouper occur in rocky areas and on sand or mud bottom, at depths ranging from 64 to 275 m (210-902 ft) and are most commonly taken from 100 to 200 m (328-656 ft; life history group).

Spawning – Spawning occurs from April through October in the South Atlantic (Keener 1984; Manooch 1984; Parker and Mays 1998) at depths of 160 to 194 m (525-636 ft; Sedberry et al. 2006).

Snappers

Vermilion Snapper

Distribution - Vermilion snapper occur in the Western Atlantic, from North Carolina to Rio de Janeiro (Potts et al. 1998). The life history group reported vermilion snapper occur from Cape Hatteras, North Carolina to Cape Canaveral, Florida with most individuals from Cape Lookout, North Carolina to northern Florida. This species is not believed to exhibit extensive long range or local movement (SEDAR 2, 2003).

Habitat/Depth - Vermilion snapper are demersal, commonly found over rock, ledge, and live bottom (Allen 1985) and artificial reefs (life history group). Members of the life history group have captured juvenile vermilion snapper in depths of 20 to 30 m (66-98 ft) over live bottom and artificial reef. Allen (1985) indicated vermilion snapper occur at depths from 18 to 122 m (59 to 400 ft), but they are most abundant at depths less than 76 m (250 ft). Sedberry et al. (2006) reported vermilion snapper occur from 14 to 163 m (46-535 ft). The life history group reported that larger vermilion snapper generally occur in the deeper part of their depth range. Individuals often form large schools.

Spawning - This species spawns in aggregations (Lindeman et al. 2000) from April through late September in the southeastern United States (Cuellar et al. 1996). Zhao et al. (1997) indicated that most spawning in the South Atlantic Bight occurs from June through August. The life history group indicated peak spawning likely occurs from May through August and females are in spawning condition from April through December (Life History Group, Fex Personal Communication. Sedberry et al. (2006) indicated vermilion snapper spawn from 27 to 34 degrees north at depths of 18 to 97 m (59-318 ft).

Red Snapper

Distribution - Red snapper are found from North Carolina to the Florida Keys, and throughout the Gulf of Mexico to the Yucatan (Robins and Ray 1986; McInerny 2007). However, small amounts of landings for red snapper are occasionally reported as far north as New York (http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html). The life history group indicated red snapper occur most commonly in the South Atlantic from Cape Hatteras, North Carolina to Fort Pierce, Florida with the greatest zone of abundance occurring from Georgia to Fort Pierce.

Habitat/Depth - Red snapper can be found at depths from 10 to 190 m (33-623 ft; Robins and Ray 1986) and 7 to 240 m (23-787 ft; Sedberry et al. 2006), but the life history group indicated depths of 10 to 150 m (33-492 ft) are more likely in the South Atlantic with the most common depths of capture between 20 to 50 m (66-164 ft). Adults usually occur over rocky and live bottom as well as artificial reef. In the Gulf of Mexico, juveniles inhabit shallow water and are common over sandy or muddy bottom habitat (Allen 1985). Habitat for juveniles in the South Atlantic is not as well known; however, one member of the life history group reported observations of small juveniles in shallow water over live bottom during trawl cruises in the 1980s.

Spawning - White and Palmer (2004) reported that the spawning season for female red snapper off the southeastern United States extends from May to October, peaking in July through September. Members of the life history group suggested peak spawning of females is more likely from June through September. Sedberry et al. (2006) reported red snapper spawning at depths of 24 to 67 m (89-220 ft) and from 27 to 34 degrees north.

<u>Yellowtail Snapper</u>

Distribution – Yellowtail snapper occur in the Western Atlantic ranging from Massachusetts to southeastern Brazil, the Gulf of Mexico, and the Caribbean Sea, but are most common in the Bahamas, off south Florida, and throughout the Caribbean (Allen 1985). The life history group reported yellowtail snapper occurring from Cape Lookout, North Carolina to the Florida Keys. Most United States landings are from southeastern Florida and the Florida Keys.

Habitat/Depth –Yellowtail snapper inhabit waters as deep as 180 m (590 ft), and usually are found well above the bottom (Allen 1985). Muller et al. (2003) stated that adults typically inhabit sandy areas near offshore reefs at depths ranging from 10 to 70 m (33-230 ft). Thompson and Munro (1974) indicated that yellowtail snapper are most abundant at depths of 20-40 m (66-131 ft) near the edges of shelves and banks off Jamaica. Juveniles are usually found over back reefs and seagrass beds (Thompson and Munro 1974).

Spawning – Spawning occurs over a protracted period and peaks at different times in different areas. In southeast Florida, spawning occurs during spring and summer, while it may occur year-round in the Bahamas and Caribbean (Grimes 1987). Figuerola et al. (1997) reported that, in the Caribbean, spawning occurs from February through October, with a peak from April through July. Spawning occurs in offshore waters (Thompson and Munro 1974; Figuerola et al. 1997) and during the new moon (Figuerola et al. 1997). Large spawning aggregations are reported to occur seasonally off Cuba, the Turks and Caicos, and US Virgin Islands. A large spawning aggregation occurs from May through July at Riley's Hump near the Dry Tortugas off Key West, Florida (Muller et al. 2003)

<u>Mutton Snapper</u>

Distribution – Mutton snapper are found in the Western Atlantic from Massachusetts to southeastern Brazil, the Caribbean Sea, and the Gulf of Mexico. They are most abundant around the Antilles, the Bahamas, and off southern Florida (Burton 2002). The life history group reported mutton snapper are found from Cape Lookout, North Carolina to the Florida Keys but are most abundant in southern Florida and the Florida Keys.

Habitat/Depth – According to Allen (1985), mutton snapper can be found in both brackish and marine waters at depths of 25 to 95 m (82-312 ft). Mutton snapper are found over live bottom, rubble, sand and artificial reefs in the South Atlantic (life history group). They are captured on mud slopes off the southeast coast of Jamaica at depths of 100 to 120 m (328-656 ft). The life history group indicated mutton snapper occur from 25 to 95 m (82-312 ft) but occur most commonly at 25 to 35 m (82-115 ft). Juveniles generally occur closer to shore, over sandy, vegetated (usually *Thalassia*) bottom habitats, while large adults are commonly found offshore among rocks and coral habitat (Allen 1985).
Spawning – Spawning occurs in aggregations (Figuerola et al. 1997). Individuals have been observed in spawning condition in the Caribbean from February through July (Erdman 1976). Some spawning occurs from February through June off Puerto Rico, but spawning peaks during the week following the full moon in April and May. Spawning aggregations are known to occur north of St. Thomas, US Virgin Islands, and south of St. Croix, US Virgin Islands in March, April, and May (Rielinger 1999). The life history group indicated mutton snapper spawning off the southeastern United States occurs from May through August with peak spawning during June and July at depths of 33 m (108 ft). Hydrated oocytes were confirmed from fish on Riley's Hump in June 2009, and spawning was physically observed in both June and July 2009 by divers, three days after the full moon at approximately 1630 hrs (Life History Group, Burton Personal Observation).

<u>Gray Snapper</u>
Distribution – Gray snapper, also known as "mangrove snapper", occur in the Western Atlantic from Massachusetts to Brazil, the Gulf of Mexico, and the Caribbean Sea (Burton 2001). The life history group indicated gray snapper occur off the southeastern United States from Cape Lookout, North Carolina to the Florida Keys but are most common off southern Florida and the Florida Keys.
Habitat/Depth – Gray snapper occupy a variety of habitats during their life history (Burton 2001). They occur at depths of 5 to 180 m (16-591 ft) in coral reefs, rocky areas, estuaries, mangroves, and in the lower reaches of rivers (especially juveniles). The life history group indicated gray snapper occur at depths of 5 to 180 m (16-591 ft) but are most common at 30 to 50 m (98-164 ft). Gray snapper often form large aggregations.
Spawning – Gray snapper spawn during July and August in the Florida Keys (Thompson and Munro 1974). In the northeastern Caribbean, individuals in spawning condition have been observed in May, August, and September (Erdman 1976). Off Cuba, gray snapper spawn from June through October with a peak in July (García-Cagide et al. 1994). In Key West, Florida, gray snapper spawn from June to September with a peak in July (Domeier et al. 1996). Hydrated oocytes were confirmed from fish on Riley's Hump in June 2009, and spawning was physically observed in both June and July 2009 by divers, three days after the full moon at approximately 1630 hrs (Life History Group, Burton Personal Observation).

Tilefishes
<u>Tilefish (Golden)</u>
Distribution – Golden tilefish are distributed throughout the Western Atlantic, occurring from Nova Scotia, Canada to southern Florida, and in the eastern Gulf of Mexico (Robins and Ray 1986).

Habitat/Depth – According to Dooley (1978), golden tilefish occur at depths of 80 to 540 m (263-1,772 ft). Robins and Ray (1986) reported the depth range as 82 to 275 m (270-900 ft). They are most commonly found at about 200 m (656 ft), usually over mud or sand bottom but, occasionally over rough bottom (Dooley 1978). The life history group indicated most golden tilefish occur off Florida and Georgia at depths ranging from 150 to 250 m (492-820 ft).
Spawning – Palmer et al. (2004) reported that spawning occurs off the southeastern United States from March through late July with a peak in April. Grimes et al. (1988) indicated peak spawning occurs from May through September in waters north of Cape Canaveral, Florida. Based on Sedberry et al. (2006), the life history group agreed that female golden tilefish spawn from March through November with a peak occurring from April through June. Sedberry et al. (2006) indicated spawning off Georgia and South Carolina occurs at depths of 190 to 300 m (623-984 ft).

<u>Blueline Tilefish</u>
Distribution – Blueline tilefish occur in the Western Atlantic from North Carolina to southern Florida and Mexico, and in the northern (and probably eastern) Gulf of Mexico (Dooley 1978). The life history group stated blueline tilefish are found from Virginia to the Florida Keys along the southeastern United States.
Habitat/Depth – Blueline tilefish are found along the outer continental shelf, shelf break, and upper slope on irregular bottom with ledges or crevices, and around boulders or rubble piles. Reported depths are 30 to 236 m (98-774 ft; Ross 1978; Parker and Mays 1998). Sedberry et al. (2006) reported blueline tilefish at depths of 46 to 256 m (151-840 ft). The life history group indicated blueline tilefish are most often taken at depths of 150 to 200 m (492-656 ft).
Spawning – Spawning occurs from February through October with peak spawning from May through September. Off the Carolinas, spawning occurs at depths of 48 to 234 m (157-768 ft; Sedberry et al. 2006).

Other Species
<u>Hogfish</u>
Distribution – Hogfish occur in the Western Atlantic from Nova Scotia, Canada to northern South America, the Gulf of Mexico, and the Caribbean Sea (Robins and Ray 1986). The life history group reported that hogfish occur in the South Atlantic from Cape Lookout, North Carolina to the Florida Keys.
Habitat/Depth –Froese and Pauly (2003) reported that hogfish are found at depths of 3 to 30 m (10-98 ft) over open bottom, rocky bottom, ledges, and coral reef. However, members of the life history group have observed hogfish at depths as great as 75 m (246 ft).
Spawning – Spawning aggregations have been documented in water deeper than 16 m (52 ft) off La Parguera, Puerto Rico from December through April (Rielinger 1999). García-Cagide et al. (1994) reported that hogfish spawn off Cuba from May through July. Colin (1982) found that peak spawning of hogfish off Puerto Rico is from December through April. Off the Florida Keys, Davis (1976) reported that peak spawning occurs during February and March. Muñoz et al. (2009) observed harem spawning by hogfish off Key West, Florida during March. McBride (2007) used histological methods to examine reproductive tissue from1,662 hogfish and found that females in the eastern Gulf of Mexico and off south Florida spawn in nearly all months, since post ovulatory follicles were present in all months except August and September.

Red Porgy

Distribution –Red porgy occur in both the Eastern and Western Atlantic Oceans (Potts and Manooch 2002). In the Western Atlantic, they range from New York to Argentina, and in the northern Gulf of Mexico. The life history group reported that red porgy occur from Cape Hatteras, North Carolina to Fort Pierce, Florida with most individuals occurring off the Carolinas.

Habitat/Depth – Adults are found in deep water near the continental shelf, over rock, rubble or sand bottoms, to depths as great as 280 m (918 ft). Red porgy are most commonly captured at depths of 25 to 90 m (82-295 ft; Robins and Ray 1986). Sedberry et al. (2006) reported red porgy from depths of 9 to 307 m (30-1,077 ft). The life history group indicated red porgy most commonly occur from 30 to 60 m (98-197 ft). Juveniles occur in water as shallow as 18 m (59 ft; Robins and Ray 1986), and are sometimes observed over seagrass beds (Bauchot and Hureau 1990) but little is known about juveniles and their habitat.

Spawning – Based on histological examination of reproductive tissue, red porgy spawn from December through May off the southeastern United States with a peak in January and February (Harris and McGovern 1997; Daniel 2003). Sedberry et al. (2006) stated red porgy spawn at depths of 26 to 57 m (85-187 ft) off the Carolinas, Georgia, and Florida.

Greater Amberjack

Distribution – Greater amberjack occur in the Western and Eastern Atlantic Oceans and in the Indo-West Pacific. In the Western Atlantic, they occur from Nova Scotia, Canada, south to Brazil, and in the Gulf of Mexico (Paxton et al. 1989; Manooch and Potts 1997a; Manooch and Potts 1997b). The life history group indicated greater amberjack are found from Virginia to the Florida Keys along the southeastern United States. Tagging data indicated that greater amberjack are capable of extensive movement that might be related to spawning activity.

Habitat/Depth – Robins and Ray 1986 reported greater amberjack at depths of 18 to 360 m (60-1,181 ft). The depth range reported by Sedberry et al. (2006) is 15 to 216 m (49-709 ft). The life history group reported greater amberjack most commonly occur from 30 to 50 m (98-164 ft). They inhabit deep reefs, rocky outcrops or wrecks, and occasionally coastal bays. Juveniles and adults occur singly or in schools in association with floating plants or debris in oceanic and offshore waters.

Spawning – Based on the occurrence of migratory nucleus oocytes and postovulatory follicles, spawning occurs from January through June with peak spawning in April and May. Although fish in spawning condition were captured from North Carolina through the Florida Keys, spawning appears to occur primarily off south Florida and the Florida Keys (MARMAP unpublished data). Sedberry et al. (2006) reported greater amberjack spawning at depths of 45 to 122 m (148-400 ft) from January through June with peak spawning during April and May.

Gray Triggerfish

Distribution – The life history group indicated gray triggerfish are found along the southeastern United States from Virginia to Cape Canaveral, Florida.

Habitat/Depth – The life history group indicated gray triggerfish are associated with live bottom and rocky outcrops from nearshore areas to depths of 20 to 100 m (66-328 ft). They also inhabit bays, harbors, and lagoons, and juveniles drift at the surface in mats of *Sargassum* (Moore 2001).

Spawning – Off the southeastern United States, female gray triggerfish are in spawning condition from April through August with a peak of activity during June and July (Moore 2001). Sedberry et al. (2006) indicated gray triggerfish spawn at depths of 20 to 75 m (66-246 ft).

White Grunt

Distribution –White grunt are distributed in coastal waters of the Atlantic Ocean from the Chesapeake Bay to southeastern Brazil, the Bahamas, West Indies, eastern Gulf of Mexico, and the Central American coast (Potts and Manooch 2001). The life history group indicated white grunt are most often caught along the southeastern United States off the Carolinas and from Palm Beach, Florida to the Florida Keys. There are genetic differences between white grunt in the Carolinas and the Florida Keys (Chapman et al. 1999).

Habitat/Depth – White grunt inhabit nearshore sponge-coral ("live-bottom") habitats or offshore rocky outcrop habitats on the continental shelf along the southeastern coast of the United States and the Gulf of Mexico (Powles and Barans 1980; Darcy 1983). White grunt are reported to occur in depths ranging from 18 to 55 m (59-180 ft; Huntsman 1976) and 13 to 97 m (43-318 ft; Sedberry et al. 2006). The life history group indicated white grunt occur from 10 to 75 m (33-246 ft) with most white grunt captured at 30 to 50 m (98-164 ft).

Spawning – Off the Carolinas, females are in spawning condition from March through September with a peak during May and June (Padgett 1997). Spawning occurs at depths of 15 to 54 m (49-177 ft; Sedberry et al. 2006).

Wreckfish

Distribution – Wreckfish occur in the Eastern and Western Atlantic Oceans, on the Mid-Atlantic Ridge, on Atlantic islands and seamounts, and in the Mediterranean Sea, southern Indian Ocean, and southwestern Pacific Ocean (Heemstra 1986; Sedberry et al. 1994; Sedberry 1995; Vaughan et al. 2001). Genetic evidence suggests that the stock encompasses the entire North Atlantic (Sedberry et al. 1996). Active adult migration is also possible as the frequent occurrence of European fishhooks in western North Atlantic wreckfish suggests migration across great distances (Sedberry et al. 2001). The fishery off the southeastern United States occurs over a complex bottom feature, known as the Charleston Bump, that has over 100 m (328 ft) of topographic relief and is located 130 to 160 km (81-100 mi) southeast of Charleston, South Carolina, at 31°30'N and 79°00'W on the Blake Plateau (Sedberry et al. 2001).

Habitat/Depth – Sedberry et al. (2006) indicated wreckfish are found from 44 to 653 m (144-2,142 ft) and fishing occurs off the southeastern United States occurs at depths of 450 to 600 m (1,476-1,969 ft). Primary fishing grounds comprise an area of approximately 175 to260 km^2 (68-100 sq mi), characterized by a rocky ridge and trough feature with a slope greater than 15 degrees (Sedberry et al. 1994; Sedberry et al 1999; Sedberry et al 2001). Juvenile wreckfish (< 60 cm TL) are pelagic and often associate with floating debris, which accounts for their common name. The absence of small pelagic or demersal wreckfish on the Blake Plateau has led to speculation that young wreckfish drift for an extended period, up to four years, in surface currents until reaching the eastern Atlantic, or perhaps that they make a complete circuit of the North Atlantic (Sedberry et al. 2001).

Spawning – Wreckfish spawn from December through May with a peak during February and March. Spawning occurs at depths of 433 to 595 m (1,421-1,952 ft; Sedberry et al. 2006).

Recommendations for stratifications that should be considered / implemented in sampling design

To identify potential strata that could be used to collect life history information from focal species, the life history workgroup examined the geographic and depth distribution of focal species including information on spawning (Table 1). This information was compared to Shertzer and Williams (2008) who used cluster analysis on headboat and commercial logbook data to generate species groupings based on what was caught together on fishing trips. The life history group discussed the 73 species in the snapper-grouper fishery management unit and assigned species to potential strata.

Six potential strata were identified: (1) North Carolina to St. Lucie Inlet, Florida (50 species, 19 focal species); (2) St. Lucie Inlet to Florida Keys (64 species, 19 focal species); (3) Shelf – generally caught at depths < 60 m (197 ft) (65 species, 18 focal species); (4) Deep – generally deeper than 60 m (10 species, 6 focal species); (5) Tilefish; and (6) Wreckfish. The Group felt that Tilefish and Wreckfish could constitute their own separate strata because these species can be targeted separately from other snapper-grouper species. Tilefish (golden) are predominantly taken over mud with longline gear; although, they are also occasionally caught with blueline tilefish, blackbelly rosefish, and snowy grouper. Wreckfish are taken in very deep water where no other snapper-grouper species occur. The life history workgroup also identified nursery habitat for juveniles, when known, for species in the snapper-grouper fishery management unit including: Estuarine or Nearshore (19 species, 8 focal species); *Sargassum* (9 species, 2 focal species); and Shelf edge (3 focal species).

Table 2. Potential strata for species in the snapper-grouper fishery management unit. A priority was assigned to each species based on importance. Process for assigning the priority is described later in the document. N of SL = north of St. Lucie Inlet; S of SL = south of St. Lucie Inlet.

Stock	Focus?	Priority	N of SL	S of SL	Shelf	Deep	Nursery
Black Sea Bass	YES	1	Yes	No	Yes	No	Estuarine/Nearshore
Rock Sea Bass	NO	3	Yes	No	Yes	No	Estuarine/Nearshore
Bank Sea Bass	NO	2	Yes	No	Yes	No	Unknown
Gag	YES	1	Yes	Yes	Yes	No	Estuarine
Snowy Grouper	YES	1	Yes	Yes	No	Yes	Shelf edge
Red Grouper	YES	1	Yes	Yes	Yes	No	Unknown
Black Grouper	YES	1	No	Yes	Yes	No	Estuarine
Speckled Hind	YES	1	Yes	Yes	Yes	Yes	Shelf edge
Scamp	YES	1	Yes	Yes	Yes	No	Unknown
Warsaw Grouper	YES	1	Yes	Yes	Yes	Yes	Shelf edge
Goliath Grouper	YES	1	No	Yes	Yes	No	Mangrove
Yellowedge Grouper	YES	1	Yes	Yes	No	Yes	Unknown

Stock	Focus?	Priority	N of SL	S of SL	Shelf	Deep	Nursery
Rock Hind	NO	1	Yes	Yes	Yes	No	Unknown
Red Hind	NO	1	Yes	Yes	Yes	No	Unknown
Graysby	NO	1	Yes	Yes	Yes	No	Unknown
Coney	NO	1	Yes	Yes	Yes	No	Unknown
Yellowmouth Grouper	NO	1	Yes	Yes	Yes	No	Unknown
Yellowfin Grouper	NO	1	Yes	Yes	Yes	No	Estuarine
Misty Grouper	NO	1	Yes	Yes	No	Yes	Unknown
Tiger Grouper	NO	1	No	Yes	Yes	No	Unknown
Nassau Grouper	NO	1	No	Yes	Yes	No	Unknown
Vermilion Snapper	YES	1	Yes	No	Yes	No	Unknown
Red Snapper	YES	1	Yes	Yes	Yes	No	Unknown
Yellowtail Snapper	YES	1	No	Yes	Yes	No	Estuarine
Mutton Snapper	YES	1	No	Yes	Yes	No	Estuarine
Blackfin Snapper	NO	2	Yes	Yes	Yes	No	Unknown
Silk Snapper	NO	1	Yes	Yes	Yes	Yes	Unknown
Dog Snapper	NO	2	No	Yes	Yes	No	Estuarine
Black Snapper	NO	2	No	Yes	Yes	No	Unknown
Mahogany Snapper	NO	2	No	Yes	Yes	No	Estuarine
Queen Snapper	NO	2	Yes	Yes	No	Yes	Unknown
Gray Snapper	YES	1	Yes	Yes	Yes	No	Mangrove
Lane Snapper	NO	1	No	Yes	Yes	No	Unknown
Cubera Snapper	NO	1	Yes	Yes	Yes	No	Est/Mangrove
Tilefish	YES	1	Yes	Yes	Tilefish	Tilefish	Unknown
Blueline Tilefish	YES	1	Yes	Yes	No	Yes	Unknown
Sand Tilefish	NO	3	Yes	No	Yes	No	Unknown
Hogfish	YES	1	Yes	Yes	Yes	No	Unknown
Puddingwife	NO	3	Yes	Yes	Yes	No	Unknown
Red Porgy	YES	1	Yes	No	Yes	No	Unknown
Whitebone Porgy	NO	3	Yes	Yes	Yes	No	Unknown
Jolthead Porgy	NO	3	Yes	Yes	Yes	No	Unknown
Saucereye Porgy	NO	3	Unknown	Yes	Yes	No	Estuarine
Longspine Porgy	NO	3	Yes	No	Yes	No	Estuarine

Stock	Focus?	Priority	N of SL	S of SL	Shelf	Deep	Nursery
Grass Porgy	NO	3	No	Yes	Yes	No	Estuarine
Knobbed Porgy	NO	2	Yes	Yes	Yes	No	Unknown
Scup	NO	2	Yes	No	Yes	No	Unknown
Sheepshead	NO	2	Yes	Yes	Yes	No	Estuarine
Greater Amberjack	YES	1	Yes	Yes	Yes	Yes	Sargassum
Crevalle Jack	NO	2	Yes	Yes	No	No	Estuarine
Lesser Amberjack	NO	2	Yes	Yes	Yes	No	Sargassum
Bar Jack	NO	3	Yes	Yes	Yes	No	Sargassum
Blue Runner	NO	2	Yes	Yes	Yes	No	Sargassum
Almaco Jack	NO	1	Yes	Yes	Yes	Yes	Sargassum
Yellow Jack	NO	3	Yes	Yes	Yes	No	Estuarine
Banded Rudderfish	NO	2	Yes	Yes	Yes	No	Sargassum
Gray Triggerfish	YES	1	Yes	No	Yes	No	Sargassum
Ocean Triggerfish	NO	3	No	Yes	Yes	No	Sargassum
Queen Triggerfish	NO	3	Yes	Yes	Yes	No	Sargassum
White Grunt	YES	1	Yes	Yes	Yes	No	Unknown
Margate	NO	2	No	Yes	Yes	No	Unknown
French Grunt	NO	3	No	Yes	Yes	No	Unknown
Schoolmaster	NO	3	No	Yes	Yes	No	Est/Mangrove
Porkfish	NO	3	No	Yes	Yes	No	Unknown
Cottonwick	NO	3	No	Yes	Yes	No	Unknown
Sailors Choice	NO	3	No	Yes	Yes	No	Estuarine
Bluestriped Grunt	NO	3	No	Yes	Yes	No	Unknown
Spanish Grunt	NO	3	No	Yes	Yes	No	Unknown
Smallmouth Grunt	NO	3	No	Yes	Yes	No	Estuarine
Tomtate	NO	2	Yes	Yes	Yes	No	Unknown
Black Margate	NO	2	No	Yes	Yes	No	Unknown
Atlantic Spadefish	NO	2	Yes	Yes	Yes	No	Estuarine
Wreckfish	YES	1	Yes	Yes	Wreckfish	Wreckfish	Pelagic

Recommendations for life history data to be collected with fishery-independent sampling program

Sample Workup
When gear is brought on board a research vessel, all specimens should be identified to the lowest possible taxonomic level, measured to the nearest mm using a routine length measurement (i.e. standard length, total length, fork length, or centerline length) and weighed. All specimens for a particular species can be weighed collectively. Individuals weights can be obtained during workup for life history studies. If numerous specimens of a particular species are collected, weight and lengths can be subsampled. Other data that should be collected when sampling include water temperature, salinity, depth, chlorophyll a, backscatterance, dissolved oxygen, air temperature, sea conditions, light phase, barometric pressure, latitude, longitude, date, and time. The life history workgroup recommended that an automated data acquisition system be used to quickly and accurately capture the biological data.

Retention of Species for Life History Studies
The life history workgroup discussed that samples should not be obtained from just the focal species, which currently have the greatest commercial and recreational importance. With increasing restrictions of snapper-grouper species, commercial and recreational fishermen could place increased importance on species that are currently considered to be of limited commercial and recreational importance. The life history workgroup identified three priority levels for the 73 species in the snapper-grouper fishery management unit for the collection of life history samples (Table 2).

- High priority (1) - Focal species or commercially/recreational sought after (i.e. grouper species) (Table 3).
- Medium priority (2) - some commercial or recreational importance potential for future exploitation (i.e. tomtate) (Table 4).
- Low priority (3) - taken in small number, minimal commercial or recreational importance (i.e. grass porgy) (Table 5).

Table 3. High priority species

Gag	Yellowedge Grouper
Red Snapper	Rock Hind
Snowy Grouper	Almaco Jack
Tilefish	Red Hind
Hogfish	Graysby
Red Porgy	Silk Snapper
Yellowtail Snapper	Lane Snapper
Greater Amberjack	Coney
Red Grouper	Yellowmouth Grouper
Black Grouper	Cubera Snapper
Speckled Hind	Yellowfin Grouper
Gray Triggerfish	Misty Grouper
White Grunt	Tiger Grouper
Scamp	Nassau Grouper
Warsaw Grouper	Goliath Grouper

Wreckfish	Mutton Snapper
Black Sea Bass	Gray Snapper
Vermilion Snapper	Blueline Tilefish

Table 4. Medium priority species.

Tomtate	Atlantic Spadefish
Knobbed Porgy	Blackfin Snapper
Bank Sea Bass	Black Margate
Banded Rudderfish	Dog Snapper
Crevalle Jack	Mahogany Snapper
Lesser Amberjack	Sheepshead
Scup	Black Snapper
Margate	Queen Snapper
	Blue Runner

Table 5. Low priority species.

Whitebone Porgy	Bar Jack
Jolthead Porgy	Cottonwick
Ocean Triggerfish	Sailors Choice
Queen Triggerfish	Yellow Jack
French Grunt	Grass Porgy
Saucereye Porgy	Rock Sea Bass
Schoolmaster	Spanish Grunt
Porkfish	Puddingwife
Longspine Porgy	Smallmouth Grunt
Sand Tilefish	Bluestriped Grunt

For high priority species, lengths (standard, total, and fork) to mm, individual weight to gram, hard parts for ageing, and reproductive tissue would be obtained yearly from all specimens and retained for life history studies (Table 6). All specimens within a stratum would be retained for life history studies, unless very abundant, when subsampling would be needed. Currently MARMAP subsamples black sea bass, red porgy, gray triggerfish, and vermilion snapper due to their abundance in survey collections. A subsampling protocol required for statistically valid age sampling for stock assessments is employed by MARMAP.

The life history workgroup recommended fecundity samples be obtained from specimens as needed for assessments (Table 6). Furthermore, it was recommended that stomachs be obtained at least every five years for diet studies (Table 6). The workgroup suggested samples for DNA, mercury, otolith microchemistry, mersitics/morphometrics, juvenile indices, etc. be done as needed (Table 6). The life history workgroup noted that many of these special need samples and age information can be obtained through fishery-dependent sampling. Year-round adult sampling was recommended to identify physical factors that influence recruitment, migration, timing of spawning, timing of spawning aggregation, sex transition, etc. Further, night sampling would be beneficial for some species (i.e. fecundity samples).

Table 6. Data to be collected from high priority (Category 1), medium priority (Category 2), and low priority species (Category 3).

Category	Length	Weight	Age	S&M	Fecundity	Stomach	DNA	Mercury
1	Yearly	Yearly	Yearly	Yearly	As needed*	5 year	As needed	As needed
2	Yearly	Yearly	Yearly	As needed	As needed	As needed	As needed	As needed
3	Yearly	Yearly	As needed	As needed	As needed	As needed	As needed	As needed

*It may be advantageous to place some species on a fecundity schedule.

For medium priority species, length, weight, and age would be obtained for all specimens. Other information would be obtained as needed. For low priority species, only length and weight would be obtained from specimens. All other information would be obtained as needed (Table 6).

Protocol for obtaining life history samples

Sagittal otoliths are removed and stored in coin envelopes. For triggerfish, the first dorsal spine is removed at the joint of the spine (so as to include the entire condyle groove), stored in coin envelopes, and allowed to air dry for 1-2 weeks. Age estimates will be obtained from whole otoliths; only those otoliths that are difficult to read or with more than 7 annuli will be subsequently embedded and sectioned. Sections will be taken from the whole left sagittal otolith, which will be embedded in an epoxy resin and sectioned transversely, leaving a slice of the otolith with an approximate thickness of 0.5-0.7 mm. This slice, with the core area present, will be glued onto a glass microscope slide using Cytoseal. All otoliths will be examined by at least two readers independently and without knowledge of date of collection, size of the fish or other pertinent information. Sections will be read using a dissecting microscope. During examination of the otoliths the number of increments (counts) will be determined, the width of the marginal increment will be categorized (1 for opaque zone at edge, through 4 for a wide translucent zone) and the quality or readability of the preparation will be categorized (A for unreadable, through E for excellent readability). In cases where counts between readers differ, the otoliths in question will be read again and examined simultaneously by both readers to reach consensus. Otoliths in the quality category A, and otoliths with persistent count disagreement between readers will be omitted from the data analyses.

Sex and Maturity

The posterior portion of the gonads will be removed from the fish and fixed in 11% formalin, diluted with seawater and buffered with marble chips, for 2-6 weeks and then transferred to 50% isopropanol for 1-2 weeks. Gonad samples will be processed with an automated (self-enclosed) tissue processor and blocked in paraffin. Three transverse sections (6-8 µm thick) will be cut from each sample with a rotary microtome, mounted on glass slides and stained with double-strength Gill's haematoxylin and counter-stained with eosin-y. Sections will be viewed under a compound microscope at 40-400X magnification and one or two readers will assess sex and reproductive stage using established histological criteria, without knowledge of date of capture, specimen length, and specimen age.

Fecundity

Whole ovaries will be removed, weighed (±1 g), wrapped in cheesecloth and fixed in 10% buffered seawater formalin. To reduce the amount of formalin used to preserve ovaries from large species (e.g., gag or greater amberjack), late developing gonads from 15 females representing a wide size range will be preserved whole in 10% seawater formalin. Fresh and preserved gonad weights will be measured for those ovaries and a regression equation will be developed to convert fresh weight to preserved weight for specimens collected thereafter. For subsequent specimens, a longitudinal strip of tissue from the left ovarian lobe, representing the anterior through posterior portions will be preserved. Methodology for processing the samples will follow Harris et al. (2007). Subsamples of ovarian tissue that will be used for counts and measurements of oocytes will be weighed on a digital scale (±0.00001 g).

To determine whether oocytes are randomly distributed within the ovary, two 75-mg samples will be taken at anterior, middle, and posterior locations in the left lobe of ten fish undergoing final oocyte maturation (migration of nucleus through hydration), for a total of six samples from each fish. A two-way ANOVA without interaction will be used to test for the effects of location and individual fish on oocyte density (number of oocytes per g of ovary).

Oocyte development and size distribution in 5-10 specimens with developing gonads will be assessed per month to identify the fecundity type (determinate vs. indeterminate; see Hunter et al. 1992) in the studied species. Oocyte stages referred to here as hydrated, migratory nucleus (MN), and yolked (stages 2 and 3) (see Hunter et al. 1992) will be identified, counted, and measured using image analysis software. The software will calculate the average radius of each oocyte in a subsample of 180-300 whole yolked oocytes per specimen, which will be then doubled to get diameter.

Because nearly all reef fish species in the Snapper-Grouper fishery management unit studied to date have indeterminate fecundity, it is necessary to estimate batch fecundity and spawning frequency to calculate potential annual fecundity. The hydrated oocyte method of Hunter et al. (1985) will be used to determine batch fecundity. Assuming that oocyte density does not vary with location in the ovary, two 75-mg samples will be taken from randomly-selected locations in ovaries undergoing final oocyte maturation and immersed in water to count the MN and hydrated oocytes. The effect of month on batch fecundity will be examined using ANCOVA, with fish length, fish weight, or fish age as the covariate.

Diet

The entire digestive tract will be collected from each fish from the esophagus to the anus. The digestive tract will be wrapped in cheesecloth, labeled, and fixed in 10% formalin for 14 days. Guts will then be rinsed with tap water and stored in 70% ethanol. Contents of individual guts will be sorted by taxa, counted, and weighed. Prey items will be identified to the lowest possible taxon. To quantify feeding habits, the relative contribution of food items to the total diet will be determined using % frequency of occurrence (F), % composition by number (N) and % composition by weight (W).

Cost associated with expanding fishery-independent sampling

The estimated number of samples to be taken with the new sampling program are provided in Table 7. Costs for age and reproductive samples are provided below.

Ageing
An estimated cost of $4.00 per otolith to process and interpret. This cost does not include required equipment, eg. sectioning saws ($8,000 each), diamond wafering blades ($200.00 each), and dual-head microscopes ($25,000 each).

Reproduction
An estimated cost of $5.00 to produce one slide using the paraffin embedding method and Hematoxylin & Eosin-Y stains. This cost includes all consumable materials needed for processing to interpretation of the histological section.

Table 7. Average number of samples (age and reproductive) collected by MARMAP and estimated number of samples to be obtained by new sampling program.

Gear	# of MARMAP collections per yr	# of life history specimens per yr	New design - # of collections	# of life history specimens in new design	
Traps	350	3,500	1,000	10,000	
Bottom longlines	50	200	500	2,000	
Short longlines	50	100	1,500	3,000	
Hook and Line	n/a	n/a	500	2,500	
				17,500	Total

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Appendix A

MARMAP 2008 Random Sampling Methodology

1. Ratio (expressed as percentage) of specimens processed for life history studies to number of specimens captured from 2000-2007.

Species	2000	2001	2002	2003	2004	2005	2006	2007	Avg
Black Sea Bass	22.77	21.95	30.66	43.03	16.53	39.77	33.99	34.53	30.40
Red Porgy	100	100	100	97.94	94.20	89.31	96.78	93.63	96.56
Vermilion Snapper	60.92	47.63	44.78	93.88	87.57	67.69	76.03	44.31	65.35
Gray Triggerfish	99.26	96.11	94.25	101.52	98.52	99.71	98.76	94.92	97.88

2. We adjusted the average values (percentage of specimens processed for life history studies) slightly to compensate for increased sea days. Expected sea days for 2008 are 60+, with expected actualized sea days at ~40 days.

Year	Actualized Sea Days		Species	Percentage
2000	30		Black sea bass	25
2001	29		Red Porgy	80
2002	26		Vermilion Snapper	66
2003	21		Gray Triggerfish	90
2004	20			
2005	26			
2006	21			
2007	25			

3. Random numbers were created for each species in blocks of 500 or 200 numbers. Random numbers were created using a random number generator website (http://www.psychicscience.org/random.aspx)

Species	Percentage	Blocks
Black sea bass	25 (125 no.)	500
Vermilion snapper	66 (330 no.)	500
Red porgy	80 (400 no.)	500
Gray triggerfish	90 (180 no.)	200

4. Creating datasheets. The random numbers were all stored in an Excel datasheet. For each species the random number range was selected and named. A new tab was created for each species that had sequential numbers in the tables. Sequential numbers were set up with a formula so that only the first number needs to be changed to change all the numbers in the table. A conditional format was applied (this can be created only in Excel 2007, but works in older versions as long as the named ranges are not changed), that looked at the named random number range for each species and if the sequential number was in the list it changed the format for those cells to bold and colored. Excel file name: RandomListsFinal.xlsx

4a. To set the range for the random collections: Formulas Ribbon, Name Manager. Select the range name and make sure it extends to all the values that are in that range.

Sampling Priorities

Full Survey Strata and Gear

The workshop participants agreed that the gear, areas, sample sizes, and additional components listed below would provide adequate sampling to produce reliable annual relative abundance measures for all of the important snapper-grouper fishes in the U.S. South Atlantic.

(1) Cape Hatteras, NC to Port St. Lucie, FL

a. Estuarine (5 m) – Channel nets, Witham, bridge net, otter trawl, seine (n = unknown).
b. Shelf and Shelf-break (10 - 140 m) - Bongo and neuston sampling (n = unknown).
c. Shelf (10 – 70 m) – Z trap, chevron trap, short longline, visual array (n = 3000 sites).
d. Shelf-break (70 – 140 m) – Z trap (out to 90 m), chevron trap (out to 90 m), short longline, bottom longline, visual array (out to depth limitation) (n = 500 sites).
e. Deep offshore (> 140 m)—Wreckfish reel (n = unknown).

(2) North of Cape Hatteras

d. Shelf –break (70 - 140 m) - Bongo and neuston sampling (n = unknown).
e. Shelf-break (70 – 140 m) – Z trap (out to 90 m), chevron trap (out to 90 m), short longline, bottom longline, visual array (out to depth limitation).

(3) Port St. Lucie, FL to Dry Tortugas, FL

f. Estuarine (5 m) – Channel nets, Witham, bridge net, otter trawl, seine.
g. Shelf and Shelf-break (10 - 140 m) - Bongo and neuston sampling (n = unknown).
h. Shelf (10 – 70 m) – Z trap, chevron trap, short longline, visual survey, visual array.
i. Shelf-break (70 – 140 m) – Z trap (out to 90 m), chevron trap (out to 90 m), short longline, bottom longline, bandit rig, visual array (out to depth limitation).

(4) Year Round Mapping – Entire Area

l. Shelf, shelf-break and beyond (30 – deep m)

(5) Bycatch, Tagging, and Hooking Mortality Studies

Priorities

Priorities were discussed briefly at the workshop. The general consensus was that recommended sample sizes in each area should not be reduced, but instead gear and areas should be considered for focused funding. Not discussed at the workshop, but mentioned here, is the idea of sampling every other year (biennial). All participants agreed the core area for nearly all the snapper-grouper species is from Cape Hatteras, NC to St. Lucie, FL. If complete surveys as recommended in this report cannot be supported (e.g.,, due to lack of funding), the paragraphs below provide a potential order of “cuts” to the recommended survey design, with greater numbers indicating lower priorities (i.e., Priority 9 = lowest priority = first cut).

Priority 9: Considering all these factors it is recommended that cuts to this proposed sampling program start with the estuarine areas (1a and 3a above). The costs of cutting this portion of the sampling is the loss of any potential measure of year-class strength for the estuarine dependent fishes (see the life history working group report).

Priority 8: Next lowest priority would be the deep offshore sampling with wreckfish reels (1e above). This portion of the sampling program is focused on one species, wreckfish. By cutting this portion of the sampling program, we lose any fishery-independent measure of wreckfish. This is notable because wreckfish in the South Atlantic EEZ represent a portion of a pan-Atlantic stock, making a fishery-independent sampling program for this species important for management.

Priority 7: The next lowest priority would be the bongo and neuston sampling in the shelf and shelf-break areas (1b, 2a, and 3b above). The cost of cutting this portion of the sampling program would be the loss of valuable icthyoplankton data for many of the snapper-grouper species. These data are very useful in understanding the distribution, timing, and survival of early life history stages for many of the snapper-grouper species.

Priority 6: Further cuts in the sampling program should focus on the bycatch, tagging, and hooking mortality studies (5 above). These studies are intermittently funded through various grants (e.g. MARFIN, CRP, etc.), but the workshop participants thought these kinds of studies should be more continuous, involving multi-year studies. For example, tagging programs work best when they involve large numbers of releases and occur over multiple years, even decades. The cost of cutting this portion of the program is that pieces of valuable information which are needed in stock assessments will continue to be very limited for most of the species in the snapper-grouper complex.

Priority 5: The next lowest priority item would be the coastwide mapping program (4a above). If this module is cut from the sampling program, then the survey will continue to be limited to currently known habitat sites. Unless an alternate means of adding sites to the survey is accomplished, the elimination of this component will limit the overall sampling universe for the survey and could over longer periods of time result in small bias in the survey as the quality and quantity of habitat locations changes due to shifting sands and other ocean bottom changes.

Priority 4: This priority includes sampling for the shelf area south of St. Lucie, FL (3c above). The cutting of this priority will limit the geographic coverage of the survey and potentially eliminating some strictly southern species (see life history working group report). This could also hinder abundance estimates for some species existing in this area by forcing reliance on more northerly areas for abundance estimates. There are limited visual surveys being conducted in this area, however the data appear to be insufficient for most stock assessment needs and biological sampling is almost non-existent.

Priority 3: The area north of Cape Hatteras, NC (2b above) is included in the sampling program because of known snapper-grouper species caught in the shelf-break areas off northern North Carolina and southern Virginia. For some of these species (e.g. snowy grouper and tilefish) this area could be an important source of spawning (although it is unlikely that north-of-Hatteras spawners would contribute to populations south of Hatteras given the oceanography / current structure of the region) as several record sized fish have been landed in recent years. Elimination of this area from the survey will limit and could bias the estimates for many of the deepwater snapper-grouper species (see life history working group report).

Priority 2: The shelf-break area south of St. Lucie, FL (3d above) includes many of the deepwater snapper-grouper species. Elimination of this area from the survey will limit and could bias the estimates for many of the deepwater snapper-grouper species (see life history working group report). This area probably contains more deepwater snapper-groupers than the shelf-break area north of Cape Hatteras, NC and therefore the removal of this area from any sampling program will likely impact the deepwater snapper-grouper abundance estimate more severely.

Priority 1: The shelf-break area from Cape Hatteras, NC to St. Lucie, FL (1d above) is in the core area for snapper-grouper species. Elimination of this area from the sampling program will remove the last location for any data pertaining to the deepwater snapper-grouper species. Furthermore, elimination of this area will affect some estimates for some of the shelf species which are known to stray into these deeper waters (see life history working group report).

The workshop participants strongly recommended that at an absolute minimum, the shelf area from Cape Hatteras, NC to St. Lucie, FL (1c above) must be part of the survey. No smaller sampling area was recommended. Also, the sample sizes mentioned in this report were viewed as a minimum, and therefore reductions in total samples sizes are not recommended.

Estimated Costs

During the workshop there was limited discussion of costs, focusing on broad view parameters such as number/size of vessels, number of personnel, number of sea days, and sample sizes for each gear type. Costs were not estimated for the full survey, which included many more components, but instead focused on the core areas and gear types. **The gear and areas focused on for these cost estimates correspond to items 1c-d, 2b, and 3c-d above only**. Based on these discussions we summarized the estimated costs as follows.

Vessels

The appropriate sized vessel was discussed and the workshop participants generally agreed that a vessel in the size range of 70-100 ft would be best suited for this work. A smaller vessel would run into weather limitations and be unable to operate safely in seas of 4-6 ft, a common occurrence along the southeastern coast. A vessel in excess of 100 ft would probably not be cost effective; costing more per day to run and probably steaming at slower rates relative to a smaller vessel (i.e. covering fewer stations per day).

The cost per day to run a vessel is a critical element in accurately estimating the total cost of the survey. For the calculations in this report we assumed a daily rate of $10,000 per day, which includes the cost of captain, crew, and meals. It should be noted that some workshop participants expressed concerns that this rate could be low and may be closer to $15,000 per day, while other vessels may be available for < $10,000 per day (e.g., R/V Savannah – Skidaway Institute of Oceanography). As will be shown below this daily rate is critical to the overall cost estimate.

A 70-100 ft vessel can be expected to sample 6-8 stations per day, based on operations aboard the R/V PALMETTO during the MARMAP survey. With double gear deployments at each station, the vessel can be expected to collect 12-16 samples per day. The sampling season agreed upon by the workshop participants includes April through October. The life history group and the rest of the workshop participants agreed that sampling the late-fall and winter months was not necessary. However, the life history group mentioned that obtaining samples from the whole year was important for determining seasonal aspects of spawning and determining when increments are formed on otoliths; however, they indicated fishery-dependent samples can be used to fill gaps. Weather is very limiting during the late-fall and winter months off the Carolinas. The April-October period is 214 days; due to weather delays and other logistics a research vessel can expect about 96 days-at-sea. Of course, not all those days are spent sampling given transit requirements, hence the final number of sample days is closer to 72 sample days per year. This results in a rough estimate of 500 stations per vessel per year or 1,000 samples per vessel per year.

The final sampling design agreed upon by the workshop participants, in consultation with the statistical design group members, calls for three latitudinal strata and two depth strata, for a total of six primary strata (only five of which are recommended for sampling). The strata are of unequal size and importance when it comes to reef fishes. The recommended sample sizes for each stratum are shown below:

Geographic Strata	Shelf (10-70 m)	Shelf-break (70-140 m)
North of Cape Hatteras	-	1,000
Cape Hatteras - St. Lucie, FL	3,000	1,000
South of St. Lucie, FL	500	500

This translates into the following number of vessels per stratum:

Geographic Strata	Shelf (10-70 m)	Shelf-break (70-140 m)
North of Cape Hatteras	-	1
Cape Hatteras - St. Lucie, FL	3	1
South of St. Lucie, FL	1	

The estimated cost per vessel per year is $960,000, which multiplied by six vessels operating up and down the southeast coast results in a total vessel cost estimate of $5.76 million.

Annual cost of chartered vessels per stratum

Geographic Strata	Shelf (10-70 m)	Shelf-break (70-140 m)
North of Cape Hatteras	-	$960,000
Cape Hatteras - St. Lucie, FL	$2,880,000	$960,000
South of St. Lucie, FL	$960,000	

Personnel

Personnel cost considerations were broken into field personnel and post-sample processing personnel. The field personnel would be expected to spend 1,156 hours at sea each year. It is expected that 62% of their time will be sea time, while the remaining 38% will be spent for cruise preparations, scheduling, post cruise activities, maintenance, etc. Sampling gear (and probably vessel sizes) will differ for each of the strata and therefore personnel numbers will differ as well. The workshop estimated that the deep and southern most strata would require fewer field personnel. The shelf vessel operations would require a minimum of eight personnel, costing an estimated $333,000 per vessel per year. The shelf-break and southern most strata vessel operations would cost an estimated $216,000 per vessel per year. Therefore the total estimated cost for field personnel would run about $1.65 million per year.

Annual cost of field personnel per stratum

Geographic Strata	Shelf (10-70 m)	Shelf-break (70-140 m)
North of Cape Hatteras	-	$216,000
Cape Hatteras - St. Lucie, FL	$999,000	$216,000
South of St. Lucie, FL	$216,000	

The cost of post-processing personnel can be broken down into stomach content analysis, video analysis, data entry (QA/QC), life history sample processing, and overall analysis and management. For stomach content analysis it was estimated that approximately 10,000 samples per season would probably be collected. This results in an estimated $182,000 for student-level labor and $78,000 for an analyst of this data. Video analysis requires six hours of analysis per sample. The full survey is expected to collect 2,000 samples, which would require processing by 12 personnel, amounting to $218,000 for student-level labor per year. Data entry, quality assurance/quality-control measures, and analysis requires two full time professionals (e.g. IT person and academic) and two full time technicians, totaling $229,000. The post-processing of life history samples (e.g. otoliths and gonads) is estimated to cost about $4.00 per sample. With an estimated 20,000 samples per year, the total estimate for otolith and gonad samples is $160,000 per year. This does not include reading, data entry, and analysis of this data, which is estimated to require five technicians and one professional level researcher, costing $261,000 per year. Finally, there would be a need for total and regional project management. Logistics, administrative support, and technicians at the regional level would cost about $134,000 per geographic strata, totaling $402,000. Overall survey management would require professional, administrative, and logistical support of roughly five personnel, totaling $380,000 per year. Total estimated personnel costs for post-collection processing and management is $1.91 million.

Annual cost of stomach content analyses per stratum (does not include analyst)

Geographic Strata	**Shelf (10-70 m)**	**Shelf-break (70-140 m)**
North of Cape Hatteras	-	$30,333
Cape Hatteras - St. Lucie, FL	$91,000	$30,333
South of St. Lucie, FL	$15,166	$15,166

Annual cost of video analyses per stratum

Geographic Strata	**Shelf (10-70 m)**	**Shelf-break (70-140 m)**
North of Cape Hatteras	-	-
Cape Hatteras - St. Lucie, FL	$335,250	-
South of St. Lucie, FL	$111,750	-

Annual cost of life history sample processing per stratum

Geographic Strata	**Shelf (10-70 m)**	**Shelf-break (70-140 m)**
North of Cape Hatteras	-	$70,166
Cape Hatteras - St. Lucie, FL	$210,500	$70,166
South of St. Lucie, FL	$35,083	$35,083

Annual cost of project management per geographic stratum

Geographic Strata	
North of Cape Hatteras	$260,000
Cape Hatteras - St. Lucie, FL	$260,000
South of St. Lucie, FL	$260,000

Equipment and Supplies

Necessary equipment and supplies can be broken down into sampling gear, other equipment, and supplies. The sampling gear needed for this survey design includes video arrays, traps, longlines, CTD units, fish measuring boards, and wave compensating scales, shown below:

Sampling Gear	Number	Cost per unit	Total cost
Video array	12	$100,000	$1,200,000
Fish trap	24	$1,500	$36,000
Longline	48	$1,000	$48,000
CTD unit	6	$25,000	$150,000
Fish measuring board	24	$5,000	$120,000
Wave compensating scale	6	$5,000	$30,000

The other equipment includes items such as computers, miscellaneous electronics, image processing software, and microscopes. The total estimated cost for this equipment is estimated to be about $450,000 per year. Lastly, general supplies were estimated to be approximately $110,000 per year.

Annual cost of equipment and supplies per stratum

Geographic Strata	Shelf (10-70 m)	Shelf-break (70-140 m)
North of Cape Hatteras	-	$84,533
Cape Hatteras - St. Lucie, FL	$1,131,000	$84,533
South of St. Lucie, FL	$377,933	

Total Annual Costs

The estimated annual costs in millions of dollars are listed below, assuming a 5% per annum increase in costs:

Category	Year 1	Year 2	Year 3	Year 4
Vessels	$5.76	$6.05	$6.35	$6.67
Field Personnel	$1.65	$1.73	$1.82	$1.91
Shore Personnel	$1.91	$2.01	$2.11	$2.22
Sampling Gear	$1.58	$0.39	$0.41	$0.43
Equipment and Supplies	$0.56	$0.59	$0.62	$0.65
Total	$11.46	$10.77	$11.31	$11.88

Decreases in total annual costs in year 2 are the result of one time equipment costs, most notably the video array units.

Items Not Included in Costs

The rough costs sketched out above do not include some potentially important components to a long term fishery independent sampling program. A major assumption is that there are six 70-100 ft vessels, properly equipped and ready to commit to this survey. What is more likely is that there may be one or two vessels that fit the survey needs and then some others that would require some modifications (e.g. improved hydraulics, crane, hull modifications, etc.). This would result in considerable additional start-up costs.

Another potentially large cost not included in this estimate is facilities for housing (in terms of office space) staff and conducting the laboratory work. If the full survey, as outlined in the report, were implemented, it could require significant office and laboratory space. This need has not been accounted for in the cost estimates.

One of the limitations of the proposed sampling design is its reliance on known habitat locations. The workshop participants discussed the need for an additional mapping component to the fishery independent survey. This component should involve at least one vessel whose full time activity would be acoustic mapping of the U.S. South Atlantic. With this activity the number of possible sampling locations would be increased for the fishery independent sampling program. The costs for this would involve one vessel, probably in the 100+ ft size range, equipped with state-of-the-art acoustic gear operating year round up and down the U.S. South Atlantic EEZ, as well as personnel and software / licensing costs associated with post-processing and interpretation / analysis of the acoustic data. Habitat mapping would require high-resolution multibeam and side-scan (interferometric) sonar sensors on the vessel for bathymetry and bottom backscatter (an indicator of bottom hardness and roughness). Geological and biological features such as reef and hardbottom would require direct observation using a drop camera or remotely operated vehicle. Approximately 30 km^2 could be surveyed and mapped in a day for the shelf depth strata (10-70m) at an estimated cost of $15,000 per day, and approximately 75 km^2 could be covered in a day in the shelf-break depth strata (>70 m) at a cost of $20,000 per day. These cost estimates includes vessel (assuming they are outfitted with hydrographic sonars) and personnel required to conduct hydrographic and ground truth of the survey as well as costs for analysis and production of the habitat maps.

Other gear and areas discussed for this survey included the use of bongo nets, neuston samplers, channel nets, bridge nets, and Witham traps for use in the estuarine (5 m) and inshore (5-30 m) habitats. Costs for these were not discussed in detail. In general, the costs to operate vessels and deploy sampling gear in these areas can be much less expensive than offshore operations. However, the level of sampling required for useful data for stock assessments, and in particular year-class strength determination remains unknown. The workshop participants did recommend that some level of funding be put toward ongoing research into other sampling methods, which would include an examination of the gear and areas mentioned above.

On that same note, other areas of research which could be considered part of a fishery-independent sampling program includes bycatch, tagging and hooking mortality studies. These are critical pieces of information in stock assessments. Due to time constraints, the workshop did not address funding levels required to support these add-on research activities.

Appendix 1. Workshop announcement.

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

4055 Faber Place Drive, Suite 201
North Charleston, SC 29405
TEL 843/571-4366 FAX 843/769-4520
Toll Free: 1-866-SAFMC-10
email: safmc@safmc.net Web site: www.safmc.net

Duane Harris, Chairman
David Cupka, Vice Chairman

Robert K. Mahood, Executive Direct
Gregg Waugh, Deputy Executive Direct

South Atlantic Fishery Independent Monitoring Development Workshop

November 17-20, 2009

The South Atlantic Fishery Management Council and the Southeast Fisheries Science Center are convening a workshop to develop a fishery independent monitoring program for the fisheries resources of the South Atlantic. Topics to be considered include:

- Sampling Intensity and Design Considerations
- Temporal and Spatial Allocation of Effort
- Target Species and their habits and habitats
- Gear Selection and Configuration
- Needs addressed through current programs
- Necessary personnel, time, and expenses

This will be a ground-up approach as no comprehensive independent survey covering the full region exists. The intent is to build on the experience of existing programs such as MARMAP and SEAMAP, and to incorporate knowledge of effective and practical sampling methods developed for similar habitats and species in other areas. The organizers are seeking participants from agencies and Universities in the Southeast and beyond who have experience designing monitoring programs and sampling the reef fish and pelagic species managed by the South Atlantic Council.

Time and Place: November 17-20 at the SEFSC Beaufort Laboratory, Beaufort NC

How to get Involved: If you are interested in participating, please contact John Carmichael at the South Atlantic Council (john.carmichael@safmc.net) or Erik Williams at the Beaufort Lab (erik.williams@noaa.gov) for further details. We also encourage recipients of this notice to forward any relevant documents related to monitoring efforts that may provide useful background and design information.

Appendix 2. Workshop agenda

South Atlantic Fishery Independent Monitoring Program Development Workshop

November 17-20, 2009
NMFS Beaufort Lab, Beaufort, NC

Steering Committee:

Erik Williams, Co-chair (NMFS Beaufort Lab) and John Carmichael, Co-chair (SAFMC), Chris Gledhill (NMFS Pascagoula Lab), Doug DeVries (NMFS Panama City Lab), Marcel Reichert (SCDNR and MARMAP), Todd Kellison (NMFS Beaufort Lab)

Day 1 8:30 a.m. – 6:00 p.m.

1. Welcoming remarks, introductions, why are we here? (Erik Williams)

2. Review Terms of Reference and goals for workshop (John Carmichael)

3. Presentations\overviews of background information, concentrating on
    a. Assessment needs from SEDAR Index Workshop (Chris Gledhill)
    b. Pascagoula Lab sampling program overview (Chris Gledhill)
    c. MARMAP survey and habitat distribution overview (Marcel Reichert)
    d. Panama City Lab sampling program overview (Doug DeVries)
    e. FWRI sampling program overview (Bob McMichael)
    f. Acoustic possibilities (Chris Taylor)

LUNCH BREAK

4. Discuss boundaries for the scope of the survey (Moderator: Todd Kellison)
    a. What species can we expect to cover?
    b. Geographic/depth limitations?
    c. Do we consider sample processing?

5. Discuss group break outs, missions, and goals for the day (Erik Williams)

6. Break into groups:
    Gear Group (Leader: Marcel Reichert)

Appendix 2. (continued).

Statistical Sampling Design Considerations (Leader: Kyle Shertzer)
Life History Group (Leader: Jack McGovern)

Day 2 8:30 a.m. – 6:00 p.m.

1. Plenary: Discuss the day's mission and goals (15 minutes)

2. Break into groups:
   Gear Group (Leader: Marcel Reichert)
   Statistical Sampling Design Considerations (Leader: Kyle Shertzer)
   Life History Group (Leader: Jack McGovern)

LUNCH BREAK

3. Return to Plenary:
   Reports and discussion on progress in break out groups
   Gear Group (30 minutes)
   Stat Design Group (30 minutes)
   Life History Group (30 minutes)

4. Break into groups to **finalize decisions**:
   Gear Group (Leader: Marcel Reichert)
   Statistical Sampling Design Considerations (Leader: Kyle Shertzer)
   Life History Group (Leader: Jack McGovern)

Appendix 2. (continued).

Day 3 8:30 a.m. – 6:00 p.m.

1. Plenary: Discuss the day's mission and goals (15 minutes)

2. Final reports from groups:

   Gear Group – present final recommendations & draft report

   Stat Design Group – present final recommendations & draft Report

   Life History Group – present final recommendations & draft report

3. Discuss implementation details (Moderator: Marcel Reichert)
   a. type and number of ships
   b. how much sampling gear needed
   c. pilot studies needed to work out methods
   d. number of technicians and scientists needed to run cruises
   e. number of days-at-sea needed
   f. integrate MARMAP?
   g. processing of biosamples (who, how many samples, data type being collected)
   h. cost considerations

Day 4 8:30 a.m. – 12:00 p.m.

1. Plenary: Discuss the day's mission and goals (15 minutes)

2. Wrap-up discussions (if needed)

3. Overview presentation of final recommendations from all groups and topics

   a. Final Q&A

4. Assign follow-up work and writing assignments

5. Discuss final steps and due date for final report

Appendix 3. Workshop terms of reference.

US South Atlantic Fishery Independent Monitoring Program Development Workshop

Terms of Reference

Objective of workshop

The overall objective of the workshop is to develop recommendations for the design of a multi-species, fishery-independent survey(s), focused on the snapper-grouper complex within the South Atlantic Bight, designed to:

- Enable evaluation of response(s) of fish populations to management actions, including pending actions under Amendments 16 and 17 to the South Atlantic Fishery Management Council Snapper Grouper Fishery Management Plan; and

- Provide useful (e.g., characterized by annual coefficients of variation < 20%) spatiotemporal indices of abundance, length-frequency and age distributions, including information on variance, for as many species as possible within the snapper-grouper complex for incorporation into population assessments.

Additionally, if possible given funding and logistical constraints, the survey(s) should:

- Provide data (e.g., species composition, including non-targeted species, and identification of trophic linkages) that can be utilized in ecosystem approaches to fisheries management (EAFM) as they are developed and utilized for US South Atlantic waters.

To accomplish the overall objective, workshop participants will develop survey recommendations under three categories: (1) survey gear, (2) statistical sampling design, and (3) life-history data collection. Objectives for each category are as follows:

1. **Survey gear**
    a. Develop a list of potential survey gears
    b. For each gear, determine, asses or consider:
        i. Gear effectiveness / efficiency under varying field conditions and habitat types (i.e., are there conditions or habitats in which the gear is less effective?)
        ii. Species- and life-stage-specific capture efficiency and variability
        iii. Required vessel support (type of vessel and on-vessel specifications)
        iv. Required personnel support
        v. Required sampling / soak time
        vi. Specific advantages (e.g., "maintains long-term time series") and disadvantages (e.g., "personnel-intensive")

Appendix 3. (continued).

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Terms of Reference

vii. Costs

c. Make final recommendations, with justifications, on recommended gear(s), potentially by strata

2. Statistical sampling design

a. Discuss and consider potential sampling frameworks (e.g. simple random sampling, stratified random sampling, adaptive random sampling, double sampling, etc.)

b. Develop a list of pros\cons for each sampling framework

c. Discuss and consider potential survey strata, including but not limited to:

i. Temporal (annual and potentially intra-annual)

ii. Spatial (e.g., by latitude, depth or habitat)

d. Develop recommendations for a stratified survey design

e. Develop recommendations for sample sizes, including minimal useful sample size, or for sample size determination

3. Life-history data collection

a. For focal species, discuss species- and life-stage-specific considerations pertinent to life-history data collection (e.g., "species x predominantly collected in waters deeper than 40m")

b. Develop recommendations for stratifications that should be considered / implemented in sampling design (e.g., pertaining to depth, latitude, artificial / natural reefs, species associations, inshore / offshore, timing / season of collection)

The workshop participants will integrate recommendations from the three categories above to generate a recommended detailed survey design, coupled with an itemized projected cost breakdown. In addition, a matrix should be created containing (1) survey approaches / gear(s) utilized, (2) type of data collected (e.g., species composition, proxy for abundance, length-frequency, age-growth/reproduction, diet composition), and (3) projected costs. This matrix should be used to indicate surveys that should be immediately initiated, and those (in priority order) that should be initiated should subsequent funding become available.

Appendix 4. List of participants.

Steve Amick.. Snapper-Grouper AP, GA for-hire Captain
Joseph Ballenger .... SC DNR
Charlie Barans...SC DNR, retired
David Berrane ....SEFSC
Ken Brennan ....SEFSC
Chris Brown .... SC DNR
Mike Burton ....SEFSC
Bobby Cardin .... Snapper Grouper AP, FL Commercial Captain
John Carmichael...SAFMC
Dan Carr...SEFSC
Rob Cheshire..SEFSC
Brian Cheuvront...SAFMC Member, NC
Chip Collier... NC DMF
Paul Conn...SEFSC
Scott Crosson .... NC DMF
Leslie Davis .... NC for-hire Captain
Maurice Davis.. NC for-hire Captain
Doug DeVries ....SEFSC
Kenneth Fex .... Snapper-Grouper AP, NC Commercial Captain
Robert Freeman.. NC for-hire Captain
Gary Fitzhugh ....SEFSC
Pat Geer.. GA DNR
Chris Gledhill...SEFSC
David Gloeckner ....SEFSC
Terrell Gould...Snapper-Grouper AP/NC
Robert Johnson... FL for-hire Captain
Sean Keenan...FL FWCC
Todd Kellison...SEFSC
Kathy Knowlton.. GA DNR
Josh Loefer... SC DNR
Gretchen Bath-Martin ....SEFSC
Jack McGovern .... SERO
Stephanie McInerny .... NC DMF
Bob McMichael ....FL FWCC
Paulette Mikell .... SC DNR
Warren Mitchell ....NCSU
Julie Neer .... SEDAR
Roldan Munoz...SEFSC
Jennifer Potts...SEFSC
Marcel Reichert.. SC DNR
Fritz Rhode.. SERO
Paul Rudershausen ....NCSU
Zeb Schobernd ....SEFSC
Amy Schueller ....SEFSC

Kyle Shertzer .... SEFSC
Jessica Stephens .... SC DNR
Chris Taylor .... NOS
Doug Vaughan .... SEFSC
Jim Waters .... SEFSC
Byron White .... SC DNR
Erik Williams .... SEFSC
Lisa Wood .... SEFSC
David Wyanski .... SC DNR

Affiliation abbreviations: South Atlantic Fishery Management Council (SAFMC), Southeast Fisheries Science Center (SEFSC), South Carolina Department of Natural Resources (SC DNR), Southeast Regional Office (SERO), North Carolina State University (NCSU), Southeast Data Assessment and Review (SEDAR), North Carolina Division of Marine Fisheries (NC DMF), Georgia Department of Natural Resources (GA DNR), Florida Fish and Wildlife Conservation Commission (FL FWCC), Advisory Panel (AP), National Ocean Service (NOS).