Workshop to Determine Optimal Approaches for Surveying the Deep-Water Species Complex off the Southeastern U.S. Atlantic Coast

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SEDAR50-RD04

27 April 2016

NOAA Technical Memorandum NMFS-SEFSC-685

doi:10.7289/V5GB222C

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7-9 April 2015, NOAA Beaufort Laboratory, Beaufort, NC

By

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December 2015

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This report should be cited as follows:
Carmichael, J, M Duval, M Reichert, N Bacheler and T Kellison. 2015. Workshop to determine optimal approaches for surveying the deep-water species complex off the southeastern U.S. Atlantic coast. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SEFSC-685. 24 p. doi:10.7289/V5GB222C

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Executive Summary

In southeastern US Atlantic coast waters (hereafter SEUS), multiple fish species of management importance inhabit continental shelf-break and upper slope habitats, particularly in depths ranging from ~ 50 – 250 m. These demersal, "deep-water" species are managed under the South Atlantic Fishery Management Council's Snapper-Grouper Fishery Management Plan (see http://safmc.net/resource-library/snapper-grouper and focal species list below). Demersal deep-water species in the SEUS tend to be data-poor, with stock assessments relying heavily on fishery-dependent data. Because annual catch limits (ACLs) for many demersal species are low and/or declining, there is essentially a negative feedback loop on the availability and utility of fishery-dependent data: as ACLs are reduced, there are fewer landings data, resulting in greater uncertainty about catch estimates, leading to still-lower ACLs.

This report describes the results from a workshop held April 7-9, 2015 at the NOAA Laboratory in Beaufort, NC devoted to the challenge of monitoring deep-water resources, with emphasis on increasing the role of constituents. The objective of the workshop, attended by fishermen and scientists with relevant experience and expertise across the SEUS, was to identify optimal approaches and associated costs for surveying (for stock assessment and management) the SEUS deep-water species complex.

The workshop participants agreed upon the following focal species:

- Tilefish (*Lopholatilus chamaeleonticeps*) (also often referred to as "golden tilefish")
- Blueline (gray) tilefish (*Caulolatilus microps*)
- Snowy grouper (*Hyporthodus niveatus*)
- Speckled hind (*Epinephelus drummondhayi*)
- Warsaw grouper (*Hyporthodus nigritus*)

Workshop participants generated information on the distribution and life-history characteristics of focal species, including latitudinal ranges, habitat(s) and depths utilized, and optimal seasons for sampling. There was consensus that the focal species inhabited three main habitat types: mud, high relief (reef), and sandy/shell rubble flats. Long bottom longline gear (LBLL) was recommended for sampling in mud and sandy/shell rubble flats habitats. Short-bottom longline (SBLL) and vertical hook and line were recommended for sampling in high-relief habitats. Optimal gear specifications and deployment and retrieval methods were discussed and identified.

Participants discussed collecting both biological and environmental data as well as priority data elements and sampling intensity. There was consensus that all fish captured by the survey should be counted, identified to species, and measured for total length regardless of the platform (i.e. scientific or industry vessel) used. Collecting additional samples (e.g., age and reproductive structures) was considered critical for the focal species and desired for all species, although logistics and funding may be limiting. Bottom temperature was identified as a necessary environmental parameter, with additional information such as current direction and speed, moon phase, weather conditions, etc. also considered useful.

Participants developed recommendations on the survey universe and sampling design. Given the known distribution of the focal species, there was consensus that the survey should extend from the Delmarva Peninsula to the Florida Keys. Two broad depth and habitat-based sampling zones (strata) were recommended, with a series of fixed cells established for each zone. Initially, cells would be distributed equally across latitudes with future adjustments based on habitat information and catch variability. Randomly selected sampling points within the fixed cells were recommended as the basic survey design. There was consensus that fishermen's knowledge was critical to developing the sampling universe due to a lack of sufficient habitat data with which to inform sample site selection.

Use of both industry and scientific vessels as survey platforms was discussed in detail and the advantages and disadvantages of each were noted. While consideration of industry platforms focused primarily on commercial vessels, participants also noted possible roles of for-hire vessels in sampling areas not suitable for standard gears used in previous deep-water survey efforts. Survey approaches using industry vessels, scientific research vessels or a combination thereof could all be successful.

Total cost estimates for the aforementioned survey scenarios could not be calculated due to insufficient information to determine sample sizes. However, daily rates (vessel and crew costs) were provided for both industry and scientific vessels, as well as observer costs for the former. Additional costs to be incorporated include biological sample processing and analysis, as well as data management.

Workshop participants also developed an extensive list of research recommendations and needs, some of which could be accomplished via short-term funding or potentially in conjunction with sampling activities (e.g. impacts of gear configuration).

The recommendations in this report could serve as a guide for establishing a standardized survey for SEUS deep-water species (e.g., to develop abundance indices), or for non-standardized sampling efforts to address other data needs (e.g., providing life-history data).

1. Fishermen Statement of Support

We, the undersigned fishermen, participated in the Deep-water Survey Design Workshop April 7-9, 2015 in Beaufort, NC. We support the collaborative nature of this workshop, which allowed both fishermen and scientists to exchange information in a productive, informal manner. We recommend this approach be used for future survey design efforts as well.

We believe there is great opportunity for fishermen and scientists to work side-by-side to collect the data needed to support future management of deep-water species. We support the workshop recommendations regarding the use of both industry and scientific vessels as a cost-effective means of gathering this information. We all have a common goal of using the best information to make management decisions, and believe that fishermen have a key role to play in this process.

Wiley Coppersmith

Jim Freeman

Robert Freeman

Dewey Hemilright

Robert Johnson

Joe Klostermann

Milton Mathis

Joshua McCoy

James Taylor

2. Introduction

2.1 Workshop Time and Place

The workshop was held April 7-9, 2015 at the NOAA Laboratory in Beaufort, NC.

2.2 Workshop Terms of Reference

Workshop Goal:

Identify optimal approaches and associated costs for surveying the deep-water species complex in the SEUS. Survey goals are expected to include providing abundance information and biological samples to support stock assessments of deep-water species

Workshop Objectives:

1. *Identify focal species*

   Recognizing that, optimally, a survey would collect information on as many species as possible, identify focal species considering catch levels, importance to the fishery and management concern.

   a. Likely focal species:

      i. Blueline (Gray) tilefish (*Caulolatilus microps*)

      ii. Tilefish (*Lopholatilus chamaeleonticeps*) (aka “golden tilefish”)

      iii. Snowy grouper (*Hyporthodus niveatus*)

      iv. Speckled hind (*Epinephelus drummondhayi*)

      v. Warsaw grouper (*Hyporthodus nigritus*)

      vi. Other

2. *Provide species details*

   a. Identify the following for each focal species:

      i. Core depth range

      ii. Habitat(s) utilized

iii. Core and secondary areas utilized, defined by latitude

iv. Preferred season(s) for sampling

v. Effective gears for surveying

3. *Recommend survey gears*

   a. Consider optimal gear for sampling the suite of previously identified focal species.

      Based on methods used by industry targeting the demersal deep-water complex, as well as fishery-independent survey experience, it is highly anticipated, but not pre-determined, that longline gear will be identified as the optimal survey gear (other gears should also be considered - e.g., video and hook and line).

   b. Consider habitats of focal species and the possibility of using a single gear across multiple habitats to increase survey efficiency.

      Species within the SEUS demersal deep-water complex utilize both structured (hardbottom / reef) and unstructured (softbottom / mud) habitats. Determine the possibility of effectively utilizing identical or similar gears in both habitats, so that survey vessels could target both habitat types without making substantial gear changes. Such a capability would enable the incorporation of habitat stratification in the survey design.

   c. Consider gears used in previous survey efforts, and the value of consistent approaches for comparison over time.

   d. Consider each gear's potential for habitat damage, loss, and protected species interactions.

4. *Recommend gear configuration*

   Provide gear configuration details for each gear recommended in #3 above.

   a. Gear #1 configuration.

      Longline criteria example:

      i. Longline material (e.g., mono, Dacron, steel)

      ii. Length of longline

      iii. Hook type, size, number

      iv. Soak time

      v. Deployment time, day/night sampling considerations

vi. Deployment and retrieval methods

vii. Gangion length

viii. Lines/buoys to surface, weak links

ix. Bait type(s)

x. Use of "hooking timers"

xi. Other

b. Gear #2 configuration

If an alternative gear is identified in (a) and (b) above, provide configuration criteria and recommendations.

i. Criteria TBD

5. *Recommend specific data to collect through the survey*

a. Counts and measurements of the catch

b. Biological samples, including sample intensity and selection

i. Consider management and processing, and the fate of samples

c. Environmental and ecosystem

6. *Recommend a survey universe*

a. North/South and East/West Boundaries

b. Depth considerations

c. Consider expansion beyond the SE/SA jurisdictions

d. Methods to develop the survey universe and sample site database for all focal species

7. *Provide survey design recommendations*

a. Sample site selection (fixed, random, combination, other)

b. Need for and methods of stratification (depth, latitude, habitat)

c. Sample allocation across strata

d. Annual effort (sample sizes) and survey frequency (annual, biannual, other)

8. *Compare and Contrast Survey platforms*

Identify advantages and disadvantages of performing the survey from scientific vessels, chartered industry vessels, or some combination thereof.

a. Consider:
    i. Available space (supplies, gear, sampling crew)
    ii. Costs per trip and sample; provide costs estimates for each platform
    iii. Consistency of methods over time and space (especially if multiple vessels used)
    iv. Permits and authorizations
    v. Impacts of catch on ACLs and effects of regulations
b. If a mixed-platform approach were utilized:
    i. How would platform-specific sampling areas be identified (e.g., areas where scientific versus industry vessels surveyed)?
    ii. Who will collect the data (i.e scientific crew, vessel crew, fisheries observer, port sampler…etc.)?

9. *Provide cost estimates for survey options*
    a. Ship time
    b. Personnel
    c. Gear
    d. Biological sample processing and analysis
    e. Data management

10. *Prepare a written report to document workshop recommendations and findings*
    a. At the conclusion (final plenary) session of the workshop, compile in electronic format recommendations from objectives 1-9 above.
    b. Following the workshop, distribute draft recommendations to workshop participants for review and suggested edits.
    c. Refine workshop recommendations based on participant review.
    d. Generate final workshop report. Distribute to workshop participants in electronic format.

- *Additional considerations*
    - Authorization / permitting requirements (e.g., re: protected species takes)
    - Can industry sampling be covered under new BioOp?
    - Development of LOA (or covered under current LOA's)?
    - What do we do with the catch after landing / processing?
        - Who retains the legal catch?
        - Who retains the illegal catch?

2.3 Workshop Participants

Name	Affiliation
INVITED PARTICIPANTS	
Nate Bacheler*	NOAA
Charlie Bergmann	NOAA
Chris Brown	SCDNR
Walter Bubley	SCDNR
John Carlson	NOAA
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Julia Byrd	SEDAR
Tracey McCulloch	NOAA
Amanda Myers	NOAA
Fritz Rohde	NOAA

*****Workshop organizers

2.4 Abbreviations

ACL	Annual Catch Limit
CTD	Conductivity, Temperature, and Depth (Oceanographic Instrument)
EFP	Exempted Fishing Permit
IV	Industry Vessels
LBLL	Long Bottom Longline
MARMAP	Marine Resources Monitoring, Assessment, and Prediction
NCDMF	North Carolina Division of Marine Fisheries
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
SAFMC	South Atlantic Fishery Management Council
SCDNR	South Carolina Department of Natural Resources
SBLL	Short Bottom Longline
SEAMAP	Southeast Area Monitoring and Assessment Program
SEDAR	Southeast Data, Assessment and Review
SEFIS	Southeast Fishery-Independent Survey
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SERFS	Southeast Reef Fish Survey
SERO	Southeast Regional Office, National Marine Fisheries Service
SRP	Scientific Research Permit
SRV	Scientific Research Vessels
VL	Vertical Line

3. Recommendations and Discussions Addressing the Workshop Terms of Reference

3.1 Identify Focal Species

The following focal species were agreed upon:

- Tilefish (*Lopholatilus chamaeleonticeps*)
- Blueline (gray) tilefish (*Caulolatilus microps*)
- Snowy grouper (*Hyporthodus niveatus*)
- Speckled hind (*Epinephelus drummondhayi*)
- Warsaw grouper (*Hyporthodus nigritus*)

Yellowedge grouper (*Hyporthodus flavolimbatus*) and blackbelly rosefish (*Helicolenus dactylopterus*) were identified as secondary species of interest – less frequently encountered but potentially of fisheries importance.

3.2 Provide Species Details

Information on the latitudinal range, habitats and depths utilized, and optimal season for sampling was compiled for each focal species and is listed in Appendix 1. Effective gears for surveying were consistent across the focal and secondary species: bottom longline and vertical hook-and-line. In addition, chevron traps were identified as a potentially effective gear for blueline tilefish. Survey gear recommendations are specified in Section 3.3.

3.3 Recommended Survey Gears

The group identified long bottom longline (LBLL), short bottom longline (SBLL), vertical hook-and-line, trawls, and chevron traps as plausible gear types to discuss (Table 1). Since habitat affinities varied across the focal species, appropriate and preferred gears for each habitat type were considered (Table 2). Next, habitats and depth ranges of focal species were considered with regard to the chosen gear types. The group noted that cameras could be useful in most habitats and with all gear types to improve understanding of gear performance, catchability, and selectivity.

Table 1. Gear types considered. LBLL = long bottom longline; SBLL = short bottom longline; VL = vertical hook and line; Chevron = chevron trap.

Gear	Ease of standardization	Relative area covered	Effect of fisher experience on gear efficiency	Potential impact to habitat structure	Requires current < ~ 2 knots?
LBLL	High	High	Low	Low on unstructured bottoms; high on reef habitat	Preferably
SBLL	High	Moderate	Moderate	Low on unstructured bottoms; moderate on reef habitat	Yes
VL	Low	Minimal	High	Low on unstructured bottoms; low to moderate on reef habitat	Preferably
Trawl	Moderate	High	Low	High (unstructured and live bottoms)	No
Chevron	High	Moderate	Low	Low on unstructured bottoms; moderate on reef habitat	Yes

3.3.1 Gear-Habitat Considerations

Each gear was first considered with regard to its performance in three general habitat types considered prevalent in the deep water areas: mud, high relief, and sandy/shell rubble flats (Table 2). Mud habitats are characterized by large areas of flat, soft bottom, with low relief, and often including holes and burrows used by some species (e.g. tilefish). High-relief areas are characterized by structure reaching into the water column and areas of rapidly changing bottom contour or depth; this describes the typical hard bottom or live bottom areas frequented by structure-oriented species. Sandy/shell rubble flats are characterized by large expanses of sandy or shell rubble bottom with slight (or no) relief.

Other habitat types were considered, such as artificial reefs (including wrecks) and relatively shallow coral areas (e.g. in the Florida Keys). These areas were not considered focal habitat types for survey purposes, due to their localized nature, sensitivity to gear-related habitat damage and/or general difficulty to sample. Because such areas are often magnets for both fish and fishermen the demographics (e.g., abundance, size and age structure) of fish utilizing those habitats may not be representative of the population-level demographics of those species. However, there may be opportunity to sample these areas using non-traditional methods (see Section 3.8.1).

Table 2. Habitat-specific gear considerations. LBLL = long bottom longline; SBLL = short bottom longline; VL = vertical hook and line; Chevron = chevron trap.

Gear	Mud	High Relief	Sandy
LBLL	**Preferred gear.** Efficiently covers large habitat area.	Will snag and damage habitat.	**Preferred gear.** Efficiently covers a large area.
SBLL	Inefficient in large habitat area.	**Preferred gear.** Designed for this habitat. Limited by current	Inefficient coverage over large area.
VL	Very inefficient (low area coverage) and affected by experience.	Appropriate for the habitat; affected by experience.	Very inefficient (low area coverage) and affected by experience.
Trawls	Appropriate for the habitat; likely to under-sample burrowing species.	Habitat damage and gear loss likely.	Appropriate with proper experience and configuration.
Chevron	Low area coverage; could cover burrows.	Habitat damage (minor and small-scale) likely, difficult to set and retrieve properly; increased potential for gear loss.	Possibly advantageous when bait is consumed before longline gear reaches bottom.

3.3.2 Gear-Habitat-Species Considerations

Mud habitat is utilized by tilefish, with most found in depths between ~ 183 and 274 m (600 – 900 ft; Appendix 1), with some out to ~ 305 m (1000 ft). Tilefish are effectively sampled by long bottom longline gear.

Depths of high-relief habitat used by focal species varies by latitude, becoming deeper in the southern areas. This habitat typically begins at ~ 73 m (240 ft), extends to ~ 107 m (350 ft) north of Cape Hatteras, to ~ 183 m (600 ft) from Cape Hatteras to central Florida, and to ~ 244 m (800 ft) in the Florida Keys. Focal species found in high-relief habitat include snowy grouper, Warsaw grouper and speckled hind, as well as yellowedge grouper (secondary focal species). Blueline tilefish also utilize high-relief habitat south of Cape Hatteras and can often be found in conjunction with snowy grouper. Species utilizing high-relief habitat can be effectively sampled with SBLL gear.

Sandy/shell rubble flats habitat, found in depths from ~ 73 to ~ 107 m (240 – 350 ft) from Georgia to Hudson Canyon, is considered most prevalent in the vicinity of, and north of, Cape Hatteras. Blueline tilefish is the primary focal species found in sandy/shelly rubble flats habitat. Blueline tilefish in sandy flats habitat are effectively sampled by LBLL gear and possibly by chevron traps.

3.3.3 Considerations of gears used in previous surveys

The gears recommended here are consistent with those used in ongoing or recently halted surveys (see Section 3.4) and could be used in a manner that would enable continuation of time series from the ongoing or recently halted surveys. The workshop participants recognized the importance of existing time series, and did not recommend any major changes in currently or recently used survey gears. The participants did, however, recommend an expansion of the spatial extent of ongoing or recently halted surveys, on both northern and southern ends of the focal species ranges, and increased sampling in deep-water areas overall.

3.3.4 Recommended survey gears: overall recommendations

- No single gear was recommended as adequate or appropriate to cover the habitats considered in this workshop.
- Long bottom longlines were recommended for mud habitats to sample tilefish.
- SBLLs were recommended for high-relief habitats to sample several of the focal species, as well as other deep-water snapper-grouper species that utilize high-relief habitats.
- Long bottom longlines were recommended for sampling blueline tilefish in sandy habitats in the vicinity and north of Cape Hatteras. It was discussed that chevron traps can be used in this habitat also, but they were considered less effective than longline gear. Chevron traps could have advantages in conditions where bait would be eaten before the longline gear would reach the bottom (affecting efficiency and catchability), and for comparisons of relative abundance between habitats using the same gear.
- The recommended gears were chosen due to their (high) efficiency relative to other potential gears. The workshop participants noted that there may be better methods to catch fish in specific areas or under specific circumstances, and any gear can be configured to maximize efficiency based on site- or time-specific conditions. However, altering gear and sampling methods can affect catch rates. Thus, it is critical that gear specifications and sampling methodology be standardized to enable comparisons of, for example, catch rates and species-specific demographics across sampling areas over time.
- A long-term goal could be to move to spatially configured stock assessment models, so that survey methods could employ greater geographic refinement.

3.4 Recommended Gear Configuration

The South Carolina Department of Natural Resources' (SCDNR) Marine Resources Monitoring, Assessment and Prediction (MARMAP) program uses bottom longline gears to sample deep-water areas, catching numerous snapper grouper species including tilefish, blueline tilefish, and snowy grouper. MARMAP gear configuration has been thoroughly described in other reports (MARMAP 2009, Smart et al. 2015), so it will not be duplicated in detail here. Instead, a general overview of workshop discussions about MARMAP LBLL and SBLL gears is provided with a focus on recommendations by the participating fishermen.

MARMAP's LBLL gear consists of 3 mm (1/8") steel cable mainline, 1219 m (4000 ft) in length, and deployed on mud habitat in sets of two. LBLL gangions are spaced ~ 12 m (40 ft) apart. SBLL gear is deployed in sets of six by MARMAP on high vertical relief habitats. SBLL gear consists of a 27 m (90 ft) mainline of 6 mm (1/4") Dacron rope. SBLL gangions are spaced approximately every 1.2 m (4 ft) apart. MARMAP bottom longlines use 0.6 m (2 ft) gangions of 90 kg (200 lb) test monofilament (1.7 mm) and 14/0 circle hooks baited with premium whole squid (frozen *Illex* or *Loligo*). All MARMAP bottom longline gear is deployed during daylight at least 200 m apart with a 90-min soak time.

A variety of bottom longlines designs are used by the commercial fishing industry. It was agreed that mainline composition should be chosen based on overall longline lengths, the size of the vessel used for deployment, and the level of current typically encountered. For example, longer lines, bigger vessels, and strong currents all increase the strain on the gear and require mainlines made of cable rather than monofilament or rope. The diameter and composition of the mainline is not believed to affect catch rates, so variability in this component of the gear may not be a concern in survey efforts. However, commercially used bottom longlines are generally much longer than those used by MARMAP, with single mainlines commonly ranging from 4.8 to 8.0 km (3 to 5 miles) in length and some reaching 16.1 km (10 miles). There was discussion suggesting that catchability per a given unit of gangions would not change across different mainline lengths, all else remaining equal – an issue that could be assessed through experimental, comparative deployments of longline sets with varying mainline lengths. Standardized effort of 63 gangions per km (100 gangions per mile), spaced evenly, was recommended as a reasonable total effort.

Gangion lengths were not believed to influence catch rates, with fishermen using a wide range of lengths based on preference and deployment approaches. However, participants agreed that longer gangions reduce the chance of hooked fingers when deploying, but have to be managed to avoid tangles. Since strength and diameter ratings of monofilament vary greatly, the fishermen recommended that monofilament specification should be based on diameter rather than breaking strength. Hooks of 14/0 or 15/0 were considered ideal for the LBLL to target the focal species, and it was recommended to use hooks with swivel eyes. The SBLL design is not used in the commercial industry, however its historical success with catch variety and abundance was acknowledged as effective by the workshop. 12/0 circle hooks with swivel eyes were recommended for the SBLL to target the focal species. Another bottom longline issue discussed was gear cleanliness. The general consensus is that "clean" gear catches more fish. Leaders should be replaced if monofilament has been twisted, stretched, kinked, or abraded. Hooks should be replaced if metal has been bent, stretched, or corroded.

Bait quality received considerable discussion. Most fishermen agreed that the highest catches occurred with live bait and fresh cut bait, including squid, Atlantic mackerel, and other bait types available. The fishermen indicated that the next-best and most consistently available bait is high quality frozen squid. Squid sold as premium longline or jig-caught is preferred, and fresher is better. The use of a whole squid for each hook was considered excessive, with use of cut pieces far more common in the commercial industry. A piece of squid enough to cover the hook (e.g. the size of a matchbook) was recommended. Fishermen considered set times of 30-minutes (i.e. deployment to retrieval) adequate, and some participants mentioned studies using hook timers that indicated most bites occurred on deployment and retrieval. As soak times are a critical component of relative abundance estimates, the optimal soak time could be investigated in an experimental setting, possibly by using hook timers. Hook timers provide a means of determining when bait is taken during the soak time. Most participants agreed that the use of hook timers likely affects catch rates, and that they should therefore only be used for research.

It is important to note that while gear changes may alter gear performance, they must be applied with caution. Gear must be standardized if there is a need or desire to compare results over time or space, or with other fishery independent surveys conducted with different methods.

3.5 Recommend specific data to collect through the survey

3.5.1 Counts and measurements of the catch

All fish captured in the survey should be identified to species, counted by species and measured for total length. Individual fish weights, otoliths and gonadal samples are critically important for priority species, and should be collected for non-priority species when possible. Collecting stomachs for diet studies, and tissue samples for genetic or contaminant analysis, is typically possible when using scientific vessels, but may be more challenging on industry vessels, especially when catch rates are relatively high.

3.5.2 Biological samples, including sample intensity and selection

If scientific vessels are used, it may be possible to collect all sample types listed above. If commercial vessels with observers are used, it may be necessary to make a priority list of samples to be taken during times when catch exceeds processing capacity. The highest priority would be otoliths and reproductive tissues of the five focal species, with samples from other species collected if logistics and funding permit (lengths and weights being most easily collected, with otoliths and gonadal samples important to collect if possible). Note that the logistics and costs associated with processing biological samples and analyzing resulting data for use in stock assessments is not addressed in this report. Such logistics and costs would be critical considerations if a survey is implemented.

3.5.3 Environmental and ecosystem considerations

Besides date and time of sampling, the survey group agreed that bottom temperature should be recorded at each site, either via CTD (Conductivity, Temperature and Depth) cast or using a temperature sensor. Participants indicated that other potentially useful site-specific information that could influence fish catch includes weather conditions (sunny versus cloudy), moon phase, sea state, and current direction and speed. It was also suggested that, if possible, other oceanographic information such as oxygen, salinity, pH, and light or turbidity levels should be collected. Participants also indicated that bottom mapping in areas used by focal species would be particularly useful to guide survey developments, and that mesoscale habitat information could be included in catch standardization models, but the group recognized the challenges associated with initiating new, widespread multi-beam mapping in the study area.

3.6 Recommend a survey universe

Some of the priority species such as blueline tilefish and tilefish extend much further north than Cape Hatteras. Therefore, the group recommended that the sampling extend to the Delmarva Peninsula. This recommendation may change if genetic studies show clear breaks in population structure across Cape Hatteras. Sampling north of North Carolina would require coordination with the National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC), and Greater Atlantic Region Fisheries Office. The group also recommended that a survey targeting the focal species should extend southward to the Florida Keys, which would likely result in catches of other data-poor species such as black snapper (*Apsilius dentatus*), queen snapper (*Etelis oculatus*), blackfin snapper (*Lutjanus buccanella*), and misty grouper (*Epinephelus mystacinus*).

Workshop participants recommended two broad zones for sampling: one targeting blueline tilefish and snowy grouper (and Warsaw grouper and speckled hind to a lesser extent) in 69 – 152 m (225 – 500 ft) in structured or gravel habitats as described earlier (see Appendix 1), and another targeting tilefish between 152 – 305 m (500 – 1000 ft) in mud bottom habitats. The group determined that speckled hind and Warsaw grouper shallower than 69 m (225 ft) may be sampled sufficiently by the Southeast Reef Fish Survey (SERFS) chevron trap and video survey. While the SERFS sampling does not currently occur north of Cape Hatteras, the fishermen suggested that the northern limit of these two species, based on their observations, is close to Cape Hatteras. Therefore, the group did not recommend a systematic expansion of the SERFS trap and video survey north of Cape Hatteras. However, there may be merit in future exploration of shallower (< 69 m or 225 ft depth) habitats north of Cape Hatteras using trap and video gears, which could be deployed from fishing vessel platforms. While the group recognized that the purpose of a survey targeting the focal species would be to provide an abundance index for those species, there could be added value in opportunistically extending the sampling universe for currently under-sampled species (e.g., speckled hind, Warsaw grouper).

3.7 Provide survey design recommendations

Participants recommended identifying fixed cells along depth contours, taking into account fishermen's knowledge and scores for focal species. Within the fixed cells a number of specific stations or sites are sampled. Specific stations within each cell can be identified using information from fishermen, MARMAP, multi-beam sonar maps, randomly selected points or a combination of all of these. The group recommended not just sampling "hotspots" (i.e., areas of relatively high focal species densities), which could result in failure to include the full ranges of the focal species, but also some edge or marginal habitats as well.

The two depth zones described above would be considered strata, and fixed cells would initially be allocated equally across latitudes. Reallocation could occur in subsequent years based on new habitat information or variability in catch rates in some areas. Catch data from fishermen could be used to determine the initial allocation of fixed cells, if some areas are known to have highly variable catch rates. Habitat information is lacking in these depth zones, so fishermen knowledge is critical to guide the development of the sampling universe. The determination of optimal sample size would need to be guided by initial survey efforts and additional years of data, and would also be dependent upon the gear being used. Initially, the survey group recommended conducting a survey annually for both depth zones (strata), after which power analyses could be used to determine if survey frequency could be reduced (e.g., performed every other year) while maintaining the value of resulting data for stock assessments and other management needs.

3.8 Compare and contrast survey platforms

Workshop participants divided into commercial and scientific groups to address this Term of Reference. This approach allowed those in each group to focus on their area of expertise. Recommendations and characterizations provided in this section reflect the experience and expertise present at the workshop.

3.8.1 Fishermen Group

Commercial vessels fishing for deep-water species with longline gear typically range from 12 to 18 m (40 to 60 ft) in length, and operate with a crew including a captain and two deckhands. They have ample space for longline gear since it is commonly used, and can likely accommodate three to five SERFS-style chevron traps for combined deployments. One limitation for the total number of crew members may be life boat size, as most are rated for 4 individuals. This issue could be addressed, if necessary, through supplemental lifeboats provided by NMFS or the vessel captain if larger scientific or observer crews are needed on a vessel. Sampling trips of up to three days are feasible, based on capacities for sampled fish, water, fuel and other supplies, with a sampling intensity of four to five LBLL sets per day. Total effort within a three-day trip depends on factors such as the distance between home port and sampling area, and the distance between each sampling site. Costs are expected to be ~ $3,500 per day to cover use of a vessel, crew and gear.

Commercial vessels are considered able to deploy bottom longline gear in a consistent manner, as the gear is widely used in the industry and past MARMAP deployments do not differ greatly from industry practices. Similarly, chevron trap gear is not believed to pose a challenge to consistent deployment approaches across a range of commercial vessels.

SBLL is not used in the industry and therefore poses the largest challenge to ensuring the consistency necessary for a standardized research survey. Industry participants may need time to learn the gear and how to deploy it successfully across high-relief habitats, and may lose some gear in the process, but none of those involved in the workshop felt that learning to use the gear was a major impediment. While the present SBLL configuration limits its use to waters in which current speeds are less than ~ 3.7 km/h (2 knots), those with experience fishing areas where such favorable conditions are rarely experienced suggested that they could likely develop methods to deploy the gear in those areas, resulting in an expanded sampling of high-relief habitats.

There was discussion of both EFPs (Exempted Fishing Permits) and SRPs (Scientific Research Permits) to allow fishermen to participate in survey efforts. SRPs were recommended, as they were determined to provide the greatest flexibility to conduct survey operations. A disadvantage of SRP acquisition is that the permitting process is more rigorous and time-consuming. The group noted that captains and industry vessels must be free of fishery violations to be approved to sample under an SRP. Regardless of the type of permit, it is noted that (1) a goal of any resulting survey would be to generate indices of abundance (changes in abundance over time) for focal species, and (2) generation of such indices would require use of standardized methodologies (consistent gear specifications and methods of deployment and retrieval) over space and time. The long-term commitment and participation of cooperating fishermen would help to ensure that gears are fished consistently over space and time.

How survey catches would affect Annual Catch Limits (ACLs) for focal species would depend on how a cooperative survey program was structured (assuming sampling would occur from industry vessels) and the ultimate disposition of fish caught for survey purposes. In the case of some deep-water species with very low ACLs, research catch levels could prove significant and may need to be considered within a management context. However, the fishermen recognized a value-added opportunity if survey effort could be combined with regular fishing effort and the fish sold after being scientifically processed. Proceeds from selling fish caught in such circumstances could help offset survey costs, which could help preserve survey funding for sampling in areas and at times that are otherwise closed to normal operations. The fishermen recommended that final catch disposition should be dictated by survey and scientific needs, with some bounds expected from management and permitting requirements. Options considered included retention for commercial sale after sampling, retention by an agency for research, released alive for tag studies and returned to the sea either dead or alive. However, some of these decisions will need to be discussed in the management framework.

Since fishermen are highly experienced with general fish handling, but less so with the scientific sampling tasks such as recording data and removing life history and aging structures, an observer or scientist will need to be onboard to work up samples and record the necessary data. With training, fishing crew members can likely assist in the basics such as counts and length measurements, particularly when catches are relatively abundant. Care will be required in developing contracts for sample work to specify what is expected and required of the vessel and its crew.

While most of the gear and sampling issues considered revolved around commercial vessels and some type of longline gear, participants also discussed possible roles of for-hire vessels. These vessels are not suitable for longline or trap gear deployments. However, they do offer a large sample of potential vertical line gear operators likely representing a wide range of fishing experience. Thus, they may be able to overcome some of the concerns expressed with hook and line gear when fished by highly experienced individuals, and thereby provide insight into areas that cannot be safely or effectively sampled by other gears. Examples include the highest relief areas, wrecks, artificial reefs and locations with persistent extreme currents. In addition, for-hire vessels could focus on major data gaps such as the size and age of discarded fish or species composition inside and outside of artificial reef or protected areas.

One way this approach could work would be to design a program where for-hire vessels “fish for science”, using their patrons for the day to fish in areas or at times that are currently missed by other sampling programs. This could be done with observers onboard, or by allowing full retention of the catch and having it provided for scientific sampling by port-samplers.

3.8.2 Scientist Group

The Scientists Group first identified advantages and potential disadvantages of using industry vessels (IVs) and scientific research vessels (SRVs).

Industry Vessels (IV): the scientists identified multiple potential advantages of using IVs. There was consensus that the daily rate (defined as vessel and vessel crew costs) for IVs would be considerably less than the daily rate for relatively large (> 27 m or 90 ft in length) SRVs used for fishery-independent sampling, but similar to rates for similarly sized SRVs (e.g., the SCDNR R/V Silver Crescent). Additionally, the scientists noted that IVs could be chosen for sampling in areas near their home port, thus reducing transit times (which could be extensive for a SRV sampling across the region). With multiple IVs, sampling across the region could occur within a relatively short time period, decreasing the potential effect of temporal variability. In contrast, sampling across the region using a SRV will require sampling across a more extended time period, increasing the potential effect of temporal variability. Sampling with IVs could also be advantageous because IV captains and crew likely possess valuable expertise with gear deployment and recovery. Finally, sampling from IVs with industry participation will promote greater trust in resulting data, encourage the development of positive and cooperative relationships between industry members and scientists and facilitate cooperative research.

In terms of potential disadvantages of using IVs, the federal contracting process can be cumbersome and slow, which could potentially result in delays in sampling due to delays in award of contracts. Industry participants cannot be pre-selected or sole-sourced through the federal contracting system – instead, contracts are awarded through a competitive bid process. Such a process could hinder participation by the most qualified and interested industry participants. Due to the complexity of the funding process, a long-term commitment may be required of industry participants. In addition, IV are generally smaller platforms than SRV (see below), possibly limiting crew size and sample processing capabilities.

Scientific Research Vessels (SRVs): Advantages of using SRVs include greater capacity for data collection and longer trip capability. Increased capacity is generally due to greater deck and laboratory space which adds the ability to have multiple scientific personnel and gears on board. This increases capability for collecting and processing biological samples, allows carrying more equipment for data collection such as still or video cameras, acoustics (e.g., split-beam and multi-beam gears), and environmental instruments such as CTDs. Larger SRVs would also be capable of longer trips, allowing for reaching areas further away from home ports.

The scientists concluded that survey approaches using industry vessels (IVs), scientific research vessels (SRVs) or some combination thereof could all be successful, with each approach having advantages and limitations. An important caveat is that increasing the number of participating vessels and crew over time and space (which might occur to a greater degree if IVs were used) will increase variability due to vessel effects. If a combination of IVs and SRVs are used, the scientists recommended a potential approach in which MARMAP, supplemented with funds from the Southeast Area Monitoring and Assessment Program – South Atlantic (SEAMAP-SA), conducts sampling centered off SC and GA via a SRV, while the northern and southern areas of the region are sampled from IVs. Overlapping the regions covered by IVs and the SRVs will enable evaluating potential vessel effects.

3.9 Provide cost estimates for survey options

Workshop participants concluded that there was insufficient information to guide estimates of survey sample sizes (number of samples per year; e.g., minimum or optimal) for either survey approach (i.e. using IVs versus SRVs). Without sample size estimates, it was not possible to scale-up cost estimates for different survey scenarios. The following information was generated for potential use in cost scale-ups once target sample sizes have been identified and a specific sampling area defined:

- Daily rates (vessel and vessel crew costs) for IVs (all costs included) were estimated at $3,500. There was consensus that use of IVs for sampling would require participation by a scientific observer, adding a daily cost of $1,500 (which includes all expenses associated with the observer, including data entry.
- For SRVs, daily rates (vessel and vessel crew costs) ranged from
    - $1,800 for the R/V *Silver Crescent* (SCDNR, 15.8 m)
    - $3,400 for the R/V *Lady Lisa* (SCDNR, 22.9 m)
    - $8,500 to $10,000 for vessels such as the R/V *Palmetto* (SCDNR, 33.5 m), R/V *Savannah* (University System of GA; 29.3 m), and the NOAA Ship *Oregon II* (51.8 m)
- When possible, industry participants indicated they prefer to use their own gear.
- Costs for biological sample processing and analysis are likely similar for IVs and SRVs, although greater amounts of biological samples could likely be collected from SRVs.
- Costs for data management are similar for IVs and SRVs, although much of the data management costs for IVs using observers are covered via the observer funds.
- Regardless of whether IVs, SRVs, or a combination of both are used, a survey coordinator is needed.

3.10 Research recommendations

- Use industry vessels for pilot studies, particularly when exploring new areas, to test sampling methods and gear configurations
- Conduct tilefish tagging studies to address questions on their movements and habits
- Increase use of video during deployments to understand gear behavior and interactions, and help address questions about catchability and selectivity
- Conduct gear development and deployment studies directed toward deploying SBLL gear in higher current areas in the southern portion of the SEUS (i.e., south of Cape Canaveral)
- Conduct exploratory studies north of Cape Hatteras given evidence of expanding species ranges
- Evaluate catchability impact of one 3-mile bottom longline vs three 1-mile bottom longlines

- Evaluate the impact of gear configuration on longline catch rates, considering factors such as gangion length and spacing, hook style and size, bait size and type, mainline composition, and set times
- Conduct a tilefish age composition study targeting the full age range, providing unbiased samples for updating reproductive models
- Perform a fishery-independent study to characterize the age composition and reproductive biology of blueline tilefish
- Assess discards in fisheries targeting the focal species
- Explore means of developing total abundance estimates, such as depletion and occupancy approaches, to reduce reliance on relative survey values
- Evaluate the effectiveness and performance of MPAs
- Increase coverage of bottom mapping

4. Literature Cited

MARMAP. 2009. Overview of sampling gear and vessels used by MARMAP. Charleston, SC.

Smart, T. I., M. J. Reichert, J. C. Ballenger, W. J. Bubley, and D. Wyanski. 2015. Overview of sampling gears and standard protocols used by the Southeast Reef Fish Survey and its partners. Charleston, SC. 15pp.

Appendix 1. Focal species details.

Species	Latitudinal range	Dominant area(s)	Adult habitat	Juvenile habitat	Mean depth caught (meters / feet)	Minimum depth caught (meters / feet)	Maximum depth caught (meters / feet)	Best season for sampling
Tilefish	Atlantic coast (to Hudson Canyon; separate Mid-Atlantic and SEUS stocks)	Throughout range where habitat occurs	Mud	Mud; also caught on hardbottom	183-274 / 600-900	61 / 200	274 / 900 in the SEUS; up to 610 / 2000 FL Keys	Year-round
Blueline tilefish	FL Keys to Hudson Canyon	Unknown	Mud and interspersed rock / mud; unconsolidated "flats" north of Cape Hatteras	Rocks	91 / 300 north of Hatteras, 152-183 / 500-600 south of Hatteras	73 / 240 (industry); 30 / 100 (survey)	213 / 700	April - November
Snowy grouper	SEUS north to Baltimore Canyon	Not likely - distributed throughout range	Rock, ledge, wreck	Inshore of adult (<70m)	122-213 / 400-700	38 / 125 (21 / 70 juveniles)	274 / 900	Year-round
Speckled hind	FL Keys to Cape Hatteras	Unknown - Potentially decreasing abundance in southern SA	Ledges, rock	Ledges, rock	46-73 / 150-239	30 / 100	114 / 370	Year-round
Warsaw grouper	FL Keys to Cape Hatteras	Unknown - Potentially increasing abundance in southern SA	Live-bottom, rock, ledges, pinnacles, ARs / wrecks	Live, rock, artificial reefs, pinnacles	46-122 / 150-400	21 / 70	183 / 600	Year-round
Yellowedge grouper	FL Keys to Oregon Inlet	Coast-wide	Rock and ledges; mud	Unknown	91-183 / 300-600	30 / 100	213 / 700	Year-round