SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

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Deepwater Coral Research and Monitoring Needs for the South Atlantic Region
Status Review - May 2009

The **Deepwater Coral Research and Monitoring Plan for the South Atlantic Region** is a regional research plan intended to guide deepwater coral ecosystem research and monitoring efforts conducted by NOAA and partners through grants and contracts in the South Atlantic region. The primary goal of this Research and Monitoring Plan is to support conservation and management of deepwater coral ecosystems in the South Atlantic region while addressing NOAA's strategy to balance long-term uses of the marine ecosystem with maintenance of biodiversity. For purposes of this plan, **Deepwater Coral Ecosystems (DWCE)** are defined as: Deepwater coral, coral reefs, and live/hard bottom habitat in waters extending from 200 m to the seaward boundary of the EEZ.

<u>Goal</u>

To protect deepwater corals by:
A. Refining existing (proposed) and designating new deepwater Coral HAPCs.
B. Increasing our understanding of DWCEs' ecological role and function in the South Atlantic region to guide future management actions.

Phase I: Map and describe known and expected deepwater coral ecosystems in the South Atlantic region.
Phase II: Determine the ecological role of deepwater coral ecosystems in the South Atlantic region, especially the role of deepwater coral habitats as Essential Fish Habitat, and expand the understanding of structure-forming species' biology and ecology.

PHASE I: MAP AND DESCRIBE KNOWN AND EXPECTED DEEPWATER CORAL ECOSYSTEMS IN THE SOUTH ATLANTIC REGION

<u>Objective 1: Map the distribution of DWCEs in the Southeastern U.S. EEZ.</u>
1A. Determine the extent of known DWCEs in the South Atlantic region.
TASK 1: Inventory existing literature and data with a focus on expanding work within existing (proposed) Coral Habitat Areas of Particular Concern (CHAPCs) by:
a. Completing the Southeastern United States Deep Sea Corals (SEADESC) Initiative (Partyka et al. 2007) and integrating data into Council IMS, and

Status: Initial SEADESC reports have not been provided in a spatial format that can be incorporated in to the IMS. Staff to work with SEADESC PIs to obtain this information as it is developed.

b. Completing and integrating data sources identified by deepwater portion of the Southeast Area Monitoring and Assessment Program (SEAMAP) -- Recovery, Interpretation, Integration and Distribution of Bottom Habitat Information for the South Atlantic Bight, 200-2000m.
Status: Interpreted spatial layers available on main IMS.

TASK 2: Rank areas to be mapped within proposed CHAPCs and potential DWCEs outside CHAPCs by:

a. Identifying data gaps based on above inventory,

b. Obtaining SAFMC input to rank priority areas for investigation, and

c. Conducting an *ad hoc* workshop to rank gaps based on proposed CHAPCs as well as outlying areas.
Status: NOAA requested input from the SAFMC to prioritize areas to be mapped in 2009-2010. Priority areas for the SAFMC are the areas adjacent to the proposed Allowable Golden Crab Fishing Areas within the proposed Stetson-Miami Terrace and Pourtales Terrace CHAPCs.

TASK 3: Conduct acoustic seabed mapping, **and ground-truth with visual surveys within proposed CHAPCs and priority areas outside CHAPCs** .

1B. Map human activities that may impact DWCEs.

TASK 1: Obtain Vessel Monitoring System (VMS) access and produce maps showing fishing effort by location.
Status: Maps of potential royal red shrimp fishery location were developed and used to analyze impact of fishing on deepwater corals and propose designation of "Shrimp Fishery Access Areas" through the Comprehensive Ecosystem-based Amendment 1. VMS information will not be available in anything but general processed form to the public or on the IMS. Roger Pugliese will be Council point contact working with NMFS SEFSC.

TASK 2: Assess fishing pressure in and outside CHAPCs through analysis of fisheries-dependent (e.g., NMFS landings) and fisheries-independent data. Produce maps showing fishing effort by location.
Status: EcoGIS project developed base commercial catch layers for incorporation into the FEP presenting non-confidential landing by statistical grid (not standardized effort). These are to be integrated into the IMS.

TASK 3: Map non-fishing activities that may affect DWCE resources (e.g., dredging, cables, outfalls, run-off, shipping routes and energy development and exploration activities).
Status: Layers currently available through IMS as shapefiles.

1C. Assess condition of DWCEs in the South Atlantic.

TASK 1: Identify and quantify natural and anthropogenic stressors (e.g., disease, gear impacts, energy development and exploration, nutrients, sedimentation, ocean disposal of dredge spoil, sewage sludge, paleoclimatic changes, temperature).

TASK 2: Conduct biological and environmental monitoring of indicator species at different scales.

a. Identify potential indicator species for deepwater corals and associated species and

b. Identify monitoring programs for those species.

Status: List of potential indicator fish species provided as part of ESDIM project. Refine?

TASK 3: Monitor impacts of episodic events (e.g., changing currents, temperatures, pH, sediment dynamics, food dynamics).

Objective 2: Describe the physiographic environment of DWCEs.

2A. Describe abiotic features (i.e., hydrographic, chemical) of DWCEs.

TASK 1: Inventory existing deepwater (seafloor) data sources in the South Atlantic region (e.g., Ocean Observing System, OOS).

Status: Very few deepwater OOS. Roger Pugliese is SECOORA member and serving on Board of Directors. He is coordinating with regional OOS to access and integrate additional data layers and data streams.

TASK 2: Identify required data sets and observing technologies (e.g., OOS, benthic landers).

TASK 3: Establish and carry out a deepwater monitoring plan for CHAPCs in partnership with the Southeast Coastal Ocean Observing Regional Association (SECOORA), starting with a pilot observing station at a fairly well-described DWCE.

2B. Investigate the internal structure of DWCEs, particularly in relation to overlying hydrodynamic and physicochemical conditions, and changing climate over time.

TASK 1: Conduct sub-bottom acoustic profiling survey over various DWCE habitats

TASK 2: Based on profile surveys, target specific DWCE types for follow-up coring from surface to base mounds

Objective 3: Describe and inventory biota of DWCEs.

3A. Qualitatively and quantitatively describe the composition, diversity, assemblage organization and distributional patterns of DWCE benthic and water column fauna (invertebrates and vertebrates).

TASK 1: Develop a network of taxonomic experts and support comparative studies (e.g., validation, or inter-regional comparisons).

TASK 2: Assess biodiversity of all groups at different spatial scales (including molecular approaches for phylogeny, phylogeography, genetic connectivity, population dynamics and species boundary assessment).

TASK 3: Make products accessible through appropriate databases (e.g., Council's Internet Mapping Server, Ocean Planning and Information System, OPIS; Southeast Regional Taxonomic Center, SERTC; Coral Reef Information System, CORIS; Census of Marine Life).

3B. Determine relative abundance and occurrence of economically and ecologically important species associated with DWCE.

PHASE II: DETERMINE ECOLOGICAL ROLE OF DWCE, INCLUDING THE ROLE OF DEEPWATER CORAL HABITAT AS ESSENTIAL FISH HABITAT EXPAND UNDERSTANDING OF STRUCTURE-FORMING SPECIES' BIOLOGY AND ECOLOGY

Objective 1: Describe logistic and coordination efforts that could improve the efficiency and effectiveness of deepwater coral biological studies.

TASK 1: To the extent possible, use standardized protocols for data collection so that information may be exchanged among investigators and agencies.

TASK 2: Develop standardized chain-of custody for samples to optimize use of opportunistic or excess samples from deepwater coral habitats.

Status: Done through Etnoyer et al. publication?

Objective 2: Describe the population dynamics, movements and habitat associations of both economically and ecologically important species (including potentially exploitable species) associated with DWCEs.

2A. Determine the habitat relationships between deepwater corals and the species associated with them.

TASK 1: Characterize habitat associations of invertebrate and fish faunas on and surrounding DWCEs. Sampling should include the full geographic and depth ranges of this habitat in the southeastern U.S., as well as all seasons. Direct observation methods (submersible or ROV) coupled with collections of habitat and fauna are the best way to sample these rugged areas for habitat association data. It is important in this task to sample non-reef and non-coral habitats in order to adequately judge degrees of habitat association.

Status: Begun through various research cruises in the region.

2B. Determine the migratory pathways of the economically and ecologically important species associated with DWCEs.

TASK 1: Characterize both the vertical and horizontal movements (at different spatial and temporal scales) of species associated with DWCEs, including all relevant life history stages. To infer vertical movement, sample the water column for species associated with DWCE at various depths over the appropriate time scale. To infer horizontal movement (especially of benthic species), sampling would be required that is logistically difficult (tagging) in the deep-sea, intensive, and expensive. In the near-term, the inference of horizontal movements may not be feasible.

2C. Determine the age structure and growth rates of economically and ecologically important species associated with DWCE as well as the sex ratio within each species.

TASK 1: Collect the full size range (juvenile to adult) of the species available within the study site across seasons.

TASK 2: Determine appropriate aging methods based on taxa examined and age samples.

TASK 3: Construct growth models.

2D. Determine the recruitment processes for the economically and ecologically important species associated with DWCE.

TASK 1: Conduct high-intensity temporal sampling using appropriate methods (e.g., settling plates and traps) to determine larval settlement processes including sites, periodicity, and relevance to oceanography. For traps, samples should be collected by setting multiple settlement traps within the deepwater coral habitat of interest and the adjacent non-reef habitat. Replication and placement of the settlement traps is critical for determining whether settlement is random or based on specific cues. It would be important to record various physical data (e.g., current, temperatures) near these samples.

TASK 2: Determine larval duration, distribution, and vertical migration in the water column. Sample the water column for species associated with DWCE at various depths over the appropriate time scale. For fish species, determine daily ages of fishes from otoliths to determine larval duration. Understanding horizontal and vertical water column physics is important here, and if appropriate models are not available, they should be developed (see next task).

TASK 3: Model the information collected under the two previous tasks with horizontal scale physics (e.g., currents) to improve the understanding of recruitment processes and population connectivity.

2E. Examine the reproductive biology of economically and ecologically important species associated with DWCE.

Characterize the spawning seasonality and reproductive potential of the species of interest by collecting the full size range (juvenile to adult) of the species available within the study site. Adequate sampling will require collection of data on monthly or quarterly intervals and ensuring that there are sexual differences in the population. Samples should be analyzed for sex, reproductive state, and fecundity (for females only). Method details may vary by taxa examined.

2F. Determine the genetic structure of the economically and ecologically important species associated with DWCE.

TASK 1: Sample coral and associated species at a regional scale to make inferences about the mechanisms structuring local assemblages (e.g., community genetics). Using a community genetics approach, patterns of genetic structuring should be compared among taxa and with environmental variables. This study should also include examining the genetic structuring of fauna closely associated with *Lophelia* and other habitat-forming corals and sponges, such as galatheid “crabs”, eunicid polychaetes, urchins and some fishes. If associations between *Lophelia* and co-occurring invertebrates are strong, similar genetic patterns may result, suggesting that similar mechanisms may influence community structure of associated organisms.

<u>Objective 3: Describe food web dynamics of DWCEs.</u>

3A: Characterize the trophodynamics and the benthic-pelagic interactions of organisms associated with deepwater coral habitat using both traditional and novel approaches.

The <u>traditional approach</u> is to capture organisms, determine species, and analyze their stomach contents. A <u>novel approach</u> to couple with the above method is to analyze stable isotopes in the tissues of the captured fauna. Naturally occurring isotopic concentrations in various tissues identify sources of dietary components (e.g., from plankton or benthic sources) provided there is a good understanding of the isotopic signatures of potential food sources. Sampling should be conducted using the appropriate temporal and spatial scales.

Objective 4: Describe relationships among DWCE composition, structure and distribution and abiotic and biotic factors.

4A. Identify relationships between the distribution and development of DWCEs and abiotic and biotic factors.

TASK 1: Collect time-series data of abiotic and other water column factors using a variety of deployed instrument packages (e.g., time-lapse cameras, current meters, CTDs, sediment traps, larval settlement panels).

TASK 2: Conduct multivariate analyses of abiotic factors versus organism distributions and DWCE structure.

4B. Develop models to enable predictions of DWCE status and trends.

TASK 1: Identify suitable models and conduct model-data comparisons to validate models specifically for DWCE application:

a. Ocean circulation (physical, chemical parameters) and
b. Sedimentation.

4C. Determine long-term temporal (decadal to epochal scales) relationships between DWCE structure and distribution relative to overlying hydrodynamic regime.

TASK 1: Examine historical records of pollution, productivity, climate and oceanography across the South Atlantic region.

TASK 2: Determine age, growth and senescence of DWCE (bioherms and lithoherms) by:

a. Radioisotope and amino acid racemization analysis of corals,
b. Cores of coral mounds and
c. Sub-bottom profiling across mounds and hard bottoms.

Objective 5: Describe reproductive strategies (gametogenic cycles, sex ratio, fecundity, larval development modes) of priority structure–forming groups, including scleractinians (*Lophelia pertusa*, *Enallopsammia profunda*, *Madrepora oculata*), octocorals, antipatharians and Stylasterines.

5A: Determine the gametogenic cycles and spawning periods for structure-forming corals.

TASK 1: Collect samples for histological examination. Characterization of these cycles requires repeated sampling at individual sites over time (e.g., monthly). Such sampling can be done opportunistically (i.e. haphazard collections during other cruises) but would be accomplished much more efficiently with targeted sampling effort.

5B: Determine larval development and settlement processes for structure-forming species.

TASK 1: Collect samples of important structure-forming species at the end of the gametogenic cycle to spawn for larval studies.

Objective 6: Describe patterns and processes of colony growth and mortality (e.g., calcification, carbon and energy budgets) of important structure-forming species, and determine how they are affected by environmental factors and stressors.

6A: Determine rates of colony growth (i.e. habitat production).

TASK 1: Conduct *in-situ* tagging or staining and revisit individual colonies for selected coral species. This activity should be in concert with *in-situ* monitoring station such as a benthic lander or other instrumentation to allow correlation of coral growth performance with *in situ* environmental conditions. Radiometric aging and growth estimates should also be conducted for selected corals (e.g., antipatharians)

6B: Determine physiological responses to stress (sediment, temperature, pollutants, CO^2) and how growth rate is affected by environmental factors (i.e., how is habitat production affected by environmental factors?)

TASK 1: Conduct manipulative laboratory dose-response experiments on live coral colonies, where various responses (e.g., molecular biomarkers, growth, and respiration) to stress levels can be documented under controlled conditions. This requires collection of live samples and post cruise maintenance in a temperature-controlled facility.

6C: Determine temporal patterns of coral mortality and bioerosion (habitat loss).

TASK 1: Characterize succession of boring/bioeroding community in coral skeleton. Ideally the degree of bioerosion would be correlated with ageing data to obtain information on bioeroder succession.

TASK 2: Drill cores and age dead skeletons from a range of sites and physiographic features.

TASK 3: Develop techniques for amino acid racemization or other techniques with high temporal resolution.

Objective 7: Describe the genetic characteristics of structure forming coral populations.

7A: Determine the clonal structure of *L. pertusa* across spatial scales.

TASK 1: Conduct targeted sampling on small spatial scales to characterize patterns of genotypic structure at as many geographical locations as possible.

7B: Determine the extent of genetic connectivity among populations of *L. pertusa*.

TASK 1: Conduct combined opportunistic and targeted (to fill in gaps) sampling across the entire geographic and depth range of the species.

Objective 8: Determine the nature, patterns, and processes of communities of microbial coral associates.

8A: Identify the symbiotic microbial community of coral colonies in different places and environmental conditions.

TASK 1: Conduct microbial screening of opportunistic coral (and other species) samples.

TASK 2: Target sampling with “clean” *in-situ* sampler.