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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
Center for Coastal Fisheries and Habitat Research
101 Pivers Island Road
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***Comparative analysis of the functioning of disturbed and undisturbed
coral reef and seagrass ecosystems in the Tortugas:
Phase I- Establishing a baseline***

Progress Report # 2

October 1, 2000

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Significant progress has been made in processing information obtained from the July-August cruise aboard the NOAA Ship Ferrel. Progress has been made in the sorting and identification of samples, transcription of electronic positioning data and video files, and even addition of new resources. Based on what we have learned during this first effort, we have altered the initial project description and dropped one task (old Item #4 regarding nutrient cycling) - and replaced it with added emphasis on food web analysis. Therefore, the project now consists of 5 tasks designed to meet information gaps in the assessment of the effectiveness of the ecological reserve. Below we report on the progress made in regard to each task.

Task 1. CCFHR shall conduct a preliminary investigation into the technical and logistic difficulties in preparing a numerically accurate and spatially precise characterization and inventory of the fish and benthic communities of the Tortugas South reserve component, focusing on the Riley's Hump area. While the area boundaries have been delineated, the structure of the benthos has not been tightly linked with its function as fishery habitat. Therefore, bathymetric delineation alone is not sufficient - a direct examination is required to determine the amount of living sessile and motile resources, their kind (taxonomy) and spatial organization and distribution. However, the depth ranges involved in this examination exceed NOAA diving safety standards and remote means or piloted submersibles are needed to conduct the study correctly. CCFHR will utilize its videographic technology within the depth ranges of its equipment (< 200') to conduct random point-grid surveys, stratified by depth of portions of the reserve where NOAA ships can maneuver. We will also utilize NURC ROV technology to expand this search on a as-available basis. From the interpretation of these videographic images, correlated with their geographic position, we will build GIS data layers of species distributions and conduct statistical analyses to project and plan further characterization efforts. We will also attempt to utilize historical videography of this site from other programs and recruit other programs utilizing technology with greater deep ranges into the delineation process.

Product: At the end of year 1, CCFHR will provide a characterization report describing challenges in performing an accurate benthic and fish communities characterization with taxonomic lists for fish, stony corals, soft corals, sponges, and algae. CCFHR will also provide a preliminary assessment of these communities in the form of GIS data layers within the depth ranges addressable with current technology.

Progress to Date: We conducted georeferenced mapping of this area by ~100 ft depth increments using the NURC ROV S-2. This was accomplished by drifting the vessel or lightly powered tows to the operational depth of the equipment (~ 800 feet). Day and night surveys were conducted - daytime for resource distribution and nights for nighttime observations of faunal behavior and their utilization of the resource. These tapes have been secured at Beaufort and are awaiting analysis.

However, as part of our effort to work with other programs (see above) we have been able to add to the data base for this site. At the request of John McDonough who was working with the Sustainable Seas Expedition, we sent a georectified, underwater video of the Riley's Hump area for the SSE pilots to choose sites and familiarize themselves with the terrain. In return, the SSE team conducted preliminary, sub surveys down to 1600', doubling the range of the survey effort with georeferenced video in early September 2000. We are awaiting delivery of those tapes for analysis.

We are also working with NCCOS HQ to integrate this work with the "Islands in the Stream" initiative so as to further avail ourselves of the deep mapping technology needed for this site.

Task 2. CCFHR shall characterize the mutton snapper spawning aggregations on Riley's Hump by documenting the approx. size of the aggregation, its timing and duration, and other species involved. Aggregations of four other species of snappers also occur on Riley's Hump. Management strategies have not sufficiently limited fishing pressure at this site, nor decreased the potential damage to coral reefs through fishing activities. There remains real concern about

the viability of the population of mutton snapper that uses this site for spawning, and more generally, about the viability of large spawning aggregations of groupers and snappers once spawning aggregations are found. To better protect spawning aggregations, research into the special characteristics of the specific spawning sites is needed. In addition, knowledge of the fate of larvae spawned from these sites is crucial to evaluate a site's larger importance to populations throughout the southeastern United States. We will attempt to identify specific spawning sites of mutton snapper via SCUBA surveys during the spawning months of May and June, with limited work in July. Characteristics of specific spawning sites (e.g. benthic cover, bathymetry) will be recorded. During spawning site characterization, satellite tracks drifters will be released to estimate the potential fate of larvae spawned at the site. These drifter tracks will be used in the development of a probabilistic model to assess the regional importance of mutton snapper spawning at Riley's Hump.

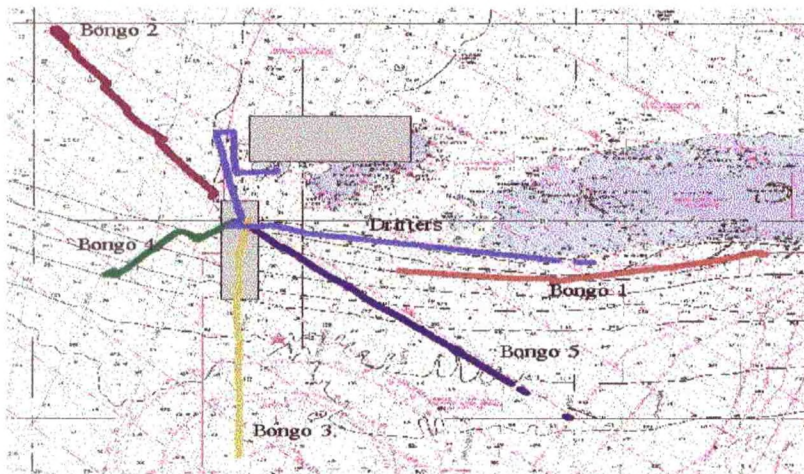


Figure 8. Tracks for bongo net tows and the track taken for drifter deployment are shown overlain on the local chart and proposed reserve locations.

Product: A spawning characterization chapter shall be produced as part of the overall site characterization document for Tortugas South. (Interim report in each of years 1-2; final in 3-5 years).

Progress to Date: Drifters were released in late June, mid July, late July and early August. These drifters are still being tracked via Service ARGOS. Drifters released early were caught in cyclonic gyre and transported east-northeastward

along the Florida coast. Drifters released later remained in the vicinity of the Tortugas and then moved northward along the West Florida shelf. Once data transmission is ended, drifter tracks will be processed and summarized. During the fourth leg, ROV transects were made across the Tortugas South Ecological Reserves. Transects were made at depth from 100 to 700 feet. Video tapes will be analyzed this winter for indications of fish spawning aggregations. Also during the fourth leg, four radial transects were made from the Tortugas heading northwest, west, southwest and southeast. CTD and bongo tows were made at each station along the radial transects. CTD data has been processed and ichthyoplankton samples will be sorted by the Polish Plankton Sorting Center.

Task 3. CCFHR shall begin to characterize the deepwater seagrass and other non-reef benthic communities and its contribution to sustaining the fishery resources in the proposed ecological reserve and compare this contribution to a disturbed site (e.g., nearby site not within the reserve designation). This work is an examination of the geographic extent and offshore depth limit of the various seagrasses within the reserve, including the deeper *H. decipiens* bed and a study of how these seagrasses and other habitats (macroalgae, live bottom) sustain the fishery resources of the TER. We would attempt to locate the offshore limit of forage areas of hard bottom/coral reef resident fishes of the TER proper within the ranges of our divers and remote technology. We will measure the flux of fishes between hard bottom and seagrass habitats in both disturbed and undisturbed representative habitats by documenting their movement, particularly during crepuscular hours. The offshore limit of the distribution of resident reef fishes would delineate the areal extent of their habitat utilization in both areas. This area would also define that required to support the current reef fish population - the functional area of the reef ecosystem which is critical in order to evaluate effectiveness of the reserve, both in a disturbed and undisturbed state. We

would accomplish this by creating a georectified sampling grid encompassing the TER and sampling (in partnership with NURC and other investigators) using ROVs to locate the habitat extent. Within this grid, habitat structure and function will be examined within replicate, representative one km² study areas using a variety of remote and direct sampling techniques that have proven successful in our work on the west Florida shelf. As in our ongoing work, stable isotope analyses (C, N, S) will be taken of plants and animals comprising these communities to more precisely define food webs and linkage among habitats.

Product: Preliminary comparative analysis of the structure of faunal-habitat linkages among disturbed and undisturbed portions of the reserve as an indicator of reserve effectiveness. (Interim report in each of years 1-2; final in 3-5 years).

Progress to Date: *Fauna:* Juvenile and adult fish data from point counts and band transects has been coded in Excel and will be analyzed in the near future. Beam trawl samples are being sorted and fishes and invertebrates identified and measured. Coded fish census data has also been sent to CCMA for comparative analysis with our joint, ongoing work in La Parguera, Puerto Rico. These comparisons are being made to determine the strengths/weaknesses of the various census protocols for the various habitat types we are sampling.

We have begun processing samples for isotopic analysis and comparison with our findings from the west Florida shelf. The seafloor on the West Florida Shelf is a habitat mosaic composed of open sand areas, *Halophila decipiens* beds, and live bottom. Given the sparse, but persistent presence of *H. decipiens* in the low relief areas adjacent to reef habitat in the Tortugas, we posit that once fishing gear impacts are relaxed, a significant spread of this seagrass and associated alga may ensue. On the West Florida Shelf, microalgal biomass in the top 2 cm of the sediment exceeded depth-integrated phytoplankton biomass at each station and sampling time. Seagrass and macroalgal biomass were patchily distributed, with peaks in biomass occurring at shallower stations and late summer. Benthic invertebrates, particularly shrimp, had isotopic signatures indicating utilization of *Halophila* production. Fishes also demonstrated a reliance on benthic production, including benthic species (flatfish, catfish) which had isotopic signatures indicating a benthic algal-based food web, but also pelagic planktivores (sardines) and predators (jacks and scombrids). Our results support the hypothesis that benthic primary production provides the base for the food web on this portion of the West Florida Shelf, and that high levels of fishery production associated with the live bottom habitats are in fact directly supported by the surrounding open sand, algae and *Halophila* communities. This kind of shift in trophic structure may occur in the Tortugas as the reserve is implemented.

Flora: Destructive sampling was conducted during the first leg of the West Florida Shelf/Dry Tortugas cruise. Samples were collected from each of three 10 m x 10 m plots within each of the three 1 km x 1 km stations. Samples included 90 plant biomass samples (20 cm x 20 cm quadrats), 90 video quadrat samples of the collected plant biomass samples (400 cm²), and 90 seed cores collected from sediment adjacent to the plant biomass samples (4.5 cm diam x 6 cm deep). Video quadrat samples have been archived for further processing, including visual Braun-Blanquet estimates of abundance and counts of leaf pairs. Training is underway to prepare an undergraduate intern for both video quadrat and biomass sample processing. We are in the final stages of developing a protocol for seed core processing. Temperature data loggers deployed in January 2000 were retrieved, downloaded, and redeployed to collect bottom water temperatures on the West Florida shelf. These data have been archived at the Beaufort Lab and plotted to look for trends in bottom water temperature fluctuation. Light profiles were collected to estimate light penetration to the sediment surface. Profile data have been entered into a spreadsheet and extinction coefficients calculated.

During the second leg of the West Florida Shelf/Dry Tortugas cruise, no destructive sampling was conducted. Visual Braun-Blanquet estimates of vegetative abundance were recorded for four randomly selected distances at four compass points from each of the randomly selected stations in the Dry Tortugas. These data are currently being organized and entered into a spreadsheet for further analysis. Light profiles were collected and data are being entered into a spreadsheet for calculation of extinction coefficients.

Task 4. The CCFHR will initiate a comparative analysis of the delineation of habitats based on depth will be performed by conducting a georectified towed video transects the seafloor within and outside of the reserve at various depths and within previously delineated habitat boundaries. Statistical analyses will be performed after interpretation of the video as to the probability of habitat type occurrence by depth using the existing delineations vs. those of the towed video. Data will be compiled in [ArcVIEW] GIS.

Product: Preliminary report on comparative analysis of error in habitat delineation within and outside of the reserve as a function of water depth. (Interim report in each of years 1-2; final in 3-5 years).

Progress to Date: Data collected using the MiniBat towed vehicle and associated MiniBat Control software were exported into Microsoft Excel for ease of data manipulation and subsequent addition of video interpretation data. Data fields of interest obtained from the MiniBat included year, day, time, latitude, longitude, north and east components of the vehicle's velocities, water depth, and depth of MiniBat. Data fields were updated every second throughout the duration of the tow. For any given data set, the MiniBat velocity was calculated using the known north and east component velocities and the following equation: $velocity = (\text{north component}^2 + \text{east component}^2)^{1/2}$. Once computed as an instantaneous velocity for each observation, the average velocity over the entire tow was then computed. Using this average velocity, we calculated that making a video interpretation every 10 seconds would yield data points every 15.9-17.6 meters, and this frequency of visual assessment of the video tape was adopted.

Video transects obtained from the camera attached to the MiniBat were recorded onto Super VHS videocassettes. Local time, Greenwich Mean Time, and GPS co-ordinates were stamped onto the video every second of the tow via Horita. As a given video transect was displayed onto a color TV screen, observations of bottom type were made every 10 seconds (local time) and such observations were entered into the corresponding Excel file using the following numeric codes:

- 0 Video not interpretable
- 1 Bare sand
- 0.5 Sand with blue-green algae film or any other algae species present (>50% cover)
- 1 Rock/coral rubble
- 1.1 Rock/coral rubble with blue-green algae film or any other algae species present (>50% cover)
- 2 Seagrass (not discernable to species level)
- 3.5 Mixed seagrass species (typically *T. testudinum* & *S. filiforme*)
- 3 *Thalassia testudinum*
- 3.1 *T. testudinum* with macroalgae present (>50% cover)
- 4 *Syringodium filiforme*
- 4.1 *S. filiforme* with macroalgae present (>50% cover)
- 5 *Halodule wrightii*
- 5.1 *Halodule wrightii* with macroalgae present (>50% cover)
- 6 *Halophila decipiens*
- 6.1 *Halophila decipiens* with macroalgae present (>50% cover)
- 7 algal pavement
- 8 free macroalgae over sand bottom
- 9 coral reef (includes hard and soft corals, sponges, algae)
- 10 hard coral community
- 11 soft coral community
- 12 bioturbation (mounds)
- 13 bioturbation (pits)
- 14 bioturbation (urchins)

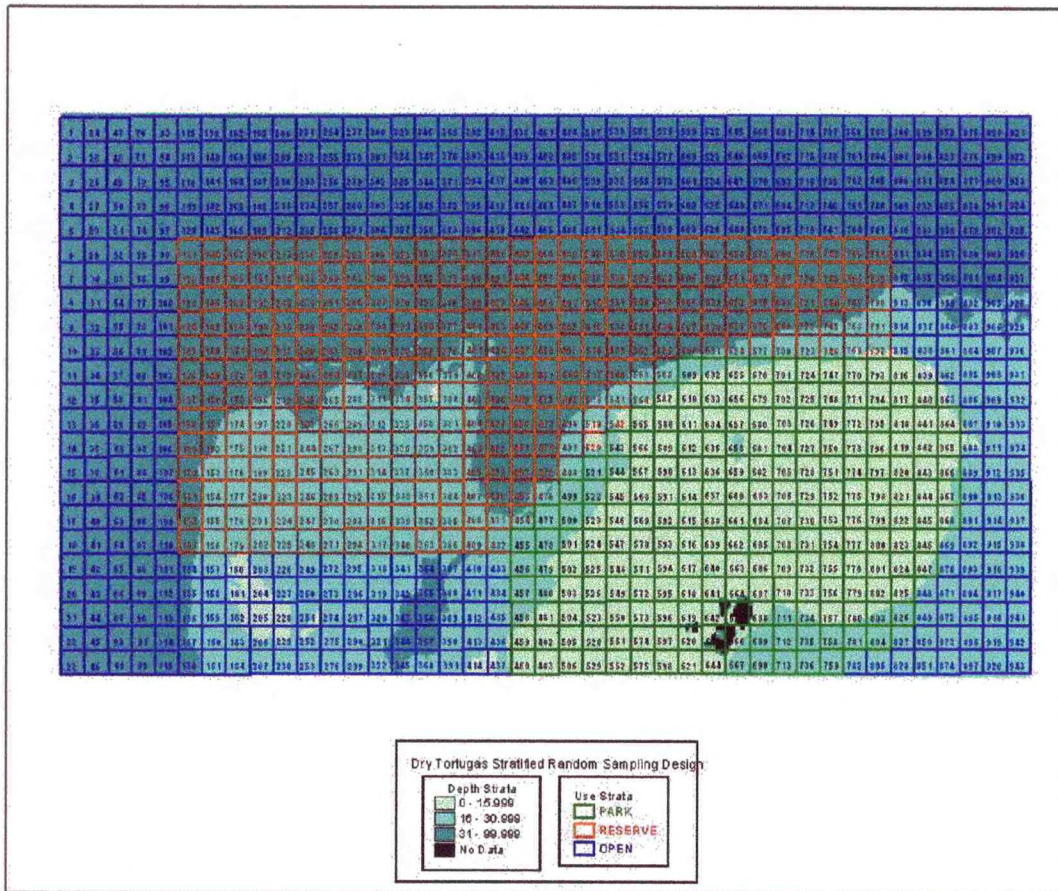


Figure 2. Stratified random sampling design for Tortugas North - by depth and Use Zone.

After complete interpretation of a video transect, rows in the Excel file that did not contain a habitat code were deleted. Likewise, rows that contained obscure values in the data field of MiniBat depth were deleted. Below is an example of the resulting spreadsheet:

Year	Julian Day	Time	Bat Depth	Lat	Long	Use Strata	Water Depth	Habitat Code	Bat Depth
2000	201	9:56:25	10.5	24.70450	-82.90717	Reserv	14	10	3.5
2000	201	9:56:35	10.5	24.70467	-82.90700	Reserv	13.6	10	3.1
2000	201	9:56:45	10.9	24.70483	-82.90700	Reserv	14.4	10	3.5
2000	201	9:56:55	10.9	24.70500	-82.90683	Reserv	14.4	10	3.5
2000	201	9:57:15	10.9	24.70517	-82.90650	Reserv	14	10	3.1
2000	201	9:57:25	11.0	24.70533	-82.90633	Reserv	14.5	10	3.5
2000	201	9:57:45	11.3	24.70567	-82.90617	Reserv	14.3	10	3.0
2000	201	9:57:55	11.3	24.70567	-82.90600	Reserv	14.1	10	2.8
2000	201	9:58:05	11.3	24.70583	-82.90600	Reserv	14.1	10	2.8
2000	201	9:58:15	11.0	24.70600	-82.90583	Reserv	14.6	10	3.6

The column entitled "Use Strata" indicates in which area of the Dry Tortugas the observation was made in (i.e. park, reserve, open) (Figure 2). To date, two video transect interpretations with their corresponding spreadsheets have been completed.

We have also converted the QTC sonar data to SAS files - these will be united with the aforementioned Excel files so that Eigenvalues can be ascribed to various habitat types under Principle Components Analysis using Varimax rotation.

Task 5. Examine how well ecological data collected at high resolution can be scaled to the larger spatial extent of a given habitat type within the proposed ecological reserve. Georectified videographic records of habitat distribution and bathymetric data will be examined using geostatistical methods to determine the scale dependency of the benthic structure.

Product: A statistical analysis of the minimum spatial scales that should be utilized to conduct unbiased parametric assessments of habitat-linked resources in and out of the reserve. (Interim report in years 1; final in 2 years)

Progress to Date: This work has not been initiated as it requires the interpretation of the full video census (Task #4) which is not yet complete.