

Annual Report

NOAA NMFS Southeast Fisheries Science Center Coral Reef Program

Project Name:

Assessing the potential of the Experimental Oculina Research Reserve to serve as a source of grouper larvae to other reef habitats on the southeast U.S. continental shelf.

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Project Manager:

Jonathan A. Hare
NOAA Beaufort Laboratory
phone: (252) 728-8732
FAX: (252) 728-8784
email: Jon.Hare@noaa.gov

Geographic Area:

Atlantic/Florida East Coast/Experimental Oculina Research Reserve

Project Description:

Background - Many studies have demonstrated that Marine Protected Areas (MPAs) closed to fishing have a higher abundance of fished species than non-protected areas (Mosquera et al. 2000). However, for these MPAs to have a benefit to fisheries, they must act as a source of individuals to non-protected areas (Yoklavich 1998). One way is for excess adults to move out of the MPA. Alternatively, larvae spawned in the MPA may be transported out, thereby contributing to adult populations in non-protected areas. Many studies have concluded that the protection of spawning stock biomass and the provision of recruiting larvae to non-protected areas is the most important mechanism by which MPAs contribute to the sustainability, conservation and preservation of fish stocks (Yoklavich 1998, Parrish 1999, Mosquera et al. 2000).

Most marine fish spawn pelagic eggs, which hatch into larvae in the water column. Planktonic larval durations vary by species from approximately 15-60 days (Lindeman et al.

2000). A combination of physical and biological processes determines the transport of larvae in the water column, with behavioral mechanisms becoming more important as fish reach the end of the larval stage (Cowen 2002, Leis and McCormick 2002). Larval transport can occur over long distances (Hare and Cowen 1996) or may be more restricted to the area of spawning (Cowen et al. 2000). Thus, the fate of larvae spawned in each potential MPA needs to be assessed owing the spatial and temporal specificity of larval transport processes.

The Experimental Oculina Research Reserve (EORR, Figure 1) is one of the few areas on the southeast U. S. continental shelf that is closed to most types of fishing, and as a result the EORR may function as a MPA. Established to protect gag spawning areas and Oculina coral formations, the EORR has value in conserving a variety of fish species and other species associated with the complex Oculina coral habitat. Spawning behavior of gag and scamp has been documented within the Reserve (Gilmore and Jones 1992). However, larval transport processes are not described for the EORR region and thus, the value of the EORR as an MPA to provide larvae to other, non-protected areas is not known.

The goal of this project is to assess the potential contribution of larvae spawned within EORR to populations in other areas of the southeast U. S. continental shelf.

Methods - Satellite tracked drifters were released within the EORR during periods of reported grouper spawning. Drifters were released in February, March and April 2002 coinciding with gag and scamp spawning. Additionally, drifters were released in July and August 2002 to coincide with the spawning period of several deepwater grouper species. Funds obtained in FY01 supported the February-April drifter releases and funds from FY02 supported the July-August drifter releases.

Four drifters were released inside of the four corners of the EORR during each release period (Table 1). Drifters were released approximately along the 20 and 70 m isobaths. Drifter deployments were made from NOAA ships transiting through the area (Feb, Apr, Jul) and from private charters (Mar, Aug). Drifters were tracked by Service ARGOS, and 4-6 positions were obtained per day. The raw series of drifter locations and times were interpolated to an even 6 hour time series.

Formal analysis of the data will begin once the July and August drifters are no longer transmitting from the southeast U. S. continental shelf. Drifter motion will be rotated into along-

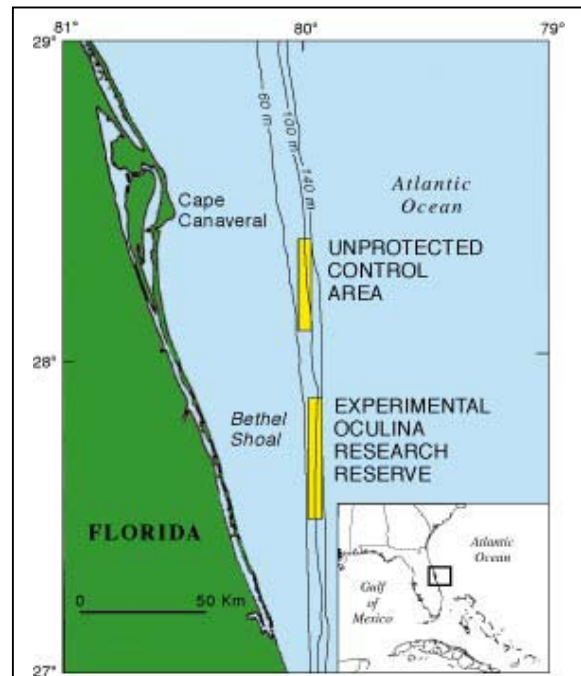


Figure 1. Map of the central east coast of Florida showing location of the Experimental Oculina Research Reserve. Map taken from United States Geological Service Factsheet 108-99 - Oculina Bank - Geology of a Deep-Water Coral Reef Habitat off Florida.

Table 1. Summary of drifter releases. Drifter 23120 was mistakenly released ~ 6 km east of the Experimental Oculina Research Reserve.

Drifter ID	Drogue Depth	Release Date	Release Time (UTC)	Release Latitude (°N)	Release Longitude (°W)
23067	15	15-Feb-02	7:06	27.80	79.98
30374	15	15-Feb-02	7:23	27.80	79.95
23118	15	15-Feb-02	8:57	27.58	79.95
23120	15	15-Feb-02	9:10	27.58	79.87
27364	15	12-Mar-02	14:15	27.58	79.98
27275	15	12-Mar-02	14:32	27.58	79.95
29127	15	12-Mar-02	15:38	27.80	79.95
29134	15	12-Mar-02	15:53	27.80	79.98
29140	15	20-Apr-02	12:29	27.80	79.98
29225	15	20-Apr-02	12:41	27.80	79.95
28514	15	20-Apr-02	14:35	27.58	79.95
28538	15	20-Apr-02	14:47	27.58	79.98
26887	15	22-Jul-02	10:57	27.58	79.98
26857	15	22-Jul-02	11:10	27.58	79.95
30428	15	22-Jul-02	12:07	27.80	79.95

shelf and cross-shelf components using a model of local bathymetry that provides for location specific rotations (Figure 2). Drifter motion will be compared with wind-stress derived from NOAA data buoys. Drifter motions also will be analyzed relative to Gulf Stream flows as determined from sea surface temperature imagery. These formal analyses will determine which physical processes contribute to the transport of larvae spawned within the EORR.

The winter/spring 2002 drifter data was partially processed and examined to provide a preliminary evaluation of the fate of larvae spawned within the EORR (Figure 3). In February, two of the four drifters moved along the western edge of the Gulf Stream and exited the southeast U.S. continental shelf to the north within 30 days. The two other drifters also moved northward along the Gulf Stream front, but moved onshore in the vicinity of Charleston, South Carolina. Both drifters continued to move slowly northwards. At 45 days, which is the average age of settlement for gag (Keener et al. 1988, Hare et al. unpublished data), as well as many other grouper species (Lindeman et al. 2000), one drifter was inside the

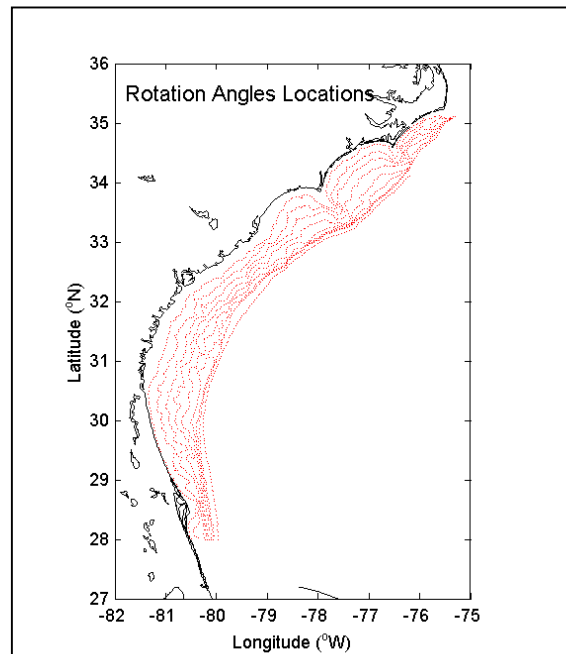


Figure 2. Location of angle of rotation values to be used in rotated drifter motions from north/east coordinates to along-shelf/cross-shelf coordinates. For each point in a drifter time series, an angle of rotation is determined.

Experimental Oculina Research Reserve Drifter Releases

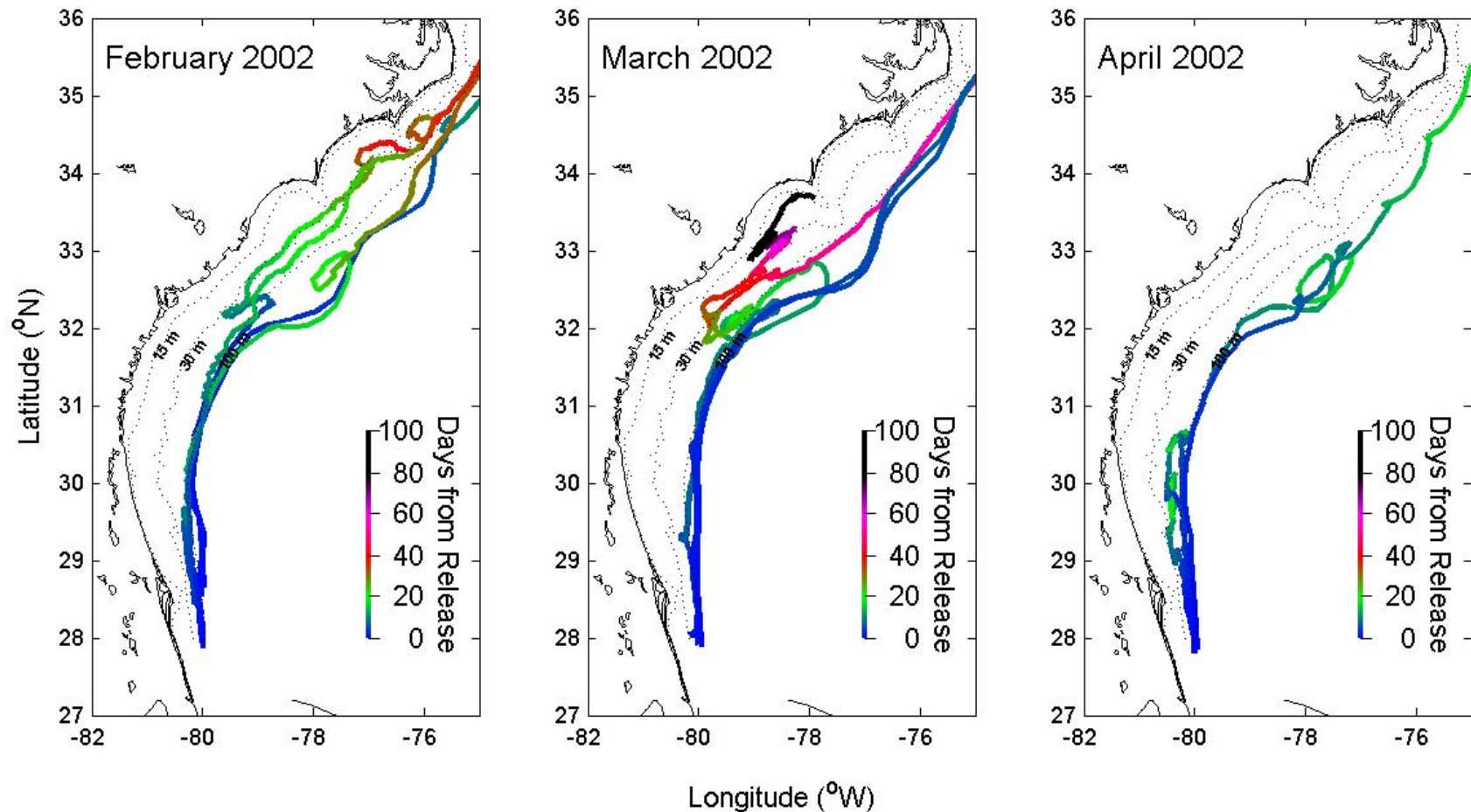


Figure 3. Tracks of drifters released within the Oculina Experimental Research Reserve (EORR) during February, March, and April 2002. Four drifters were released at one time during each month. In each panel, the tracks of four drifters are shown. The tracks of each drifter is color-coded for the time from release. The color scaling in each panel is the same. Gag, one of the grouper species that forms spawning aggregations within the EORR moves into estuarine nurseries habitats between 30 and 50 days from hatching. This time period corresponds to the red portion of the drifter tracks. During this time interval, two drifters were on the shelf off of Cape Lookout, North Carolina (February 2002) and two drifters were on the shelf off of Charleston, South Carolina. Thus, grouper spawning in the EORR could supply larvae to nurseries areas along much of the southeast U.S. continental shelf, and thus protection of the site could contribute to the rebuilding and conservation of grouper stocks in the southeast U. S..

30 m isobath in Onslow Bay and one was between the 30 and 100 m isobath in Raleigh Bay. These drifters indicate that gag larvae could have been transported to reef and estuarine nursery habitats along the North Carolina coast from the EORR.

The movement of drifters released in March were similar to the movement of drifters released in February. Two drifters released in March moved along the western edge of the Gulf Stream and exited the southeast U. S. continental shelf to the north within 30 days. The two other drifters moved northwards along the Gulf Stream front, but then moved onshore in the same region that the drifters moved onshore during February. Both of these drifters were off of Charleston at 45 days. One subsequently was re-entrained into Gulf Stream flows and rapidly moved northwards out of the southeast U. S. continental shelf. The other drifter remained on the shelf.

The drifters released in April also exhibited similar tracks. Two of the drifters moved rapidly northward in association with the Gulf Stream. The other two drifters began to move onto the northeastern Florida shelf. Unfortunately, both these drifters were picked up by fishermen and returned to shore about 25 days after release.

Some caution is required in interpreting the results reported here. The assumption is that drifters move similarly as larvae. However, the drifters are drogued at a fixed depth and larvae move vertically in the water column and thus with depth varying currents, transport could be different. Similarly, the drifter has a small component above the sea surface and there may be small, but direct effects of wind on drifter motion. These caveats acknowledged, the drifter tracks provide a large-scale view of potential transport of larvae spawned with the EORR.

The drifter tracks support the hypothesis that larvae spawned in the EORR would be transported to juvenile habitats along the southeast U. S. continental shelf. Four of the twelve drifters released in the winter/spring of 2002 were on the shelf at times consistent with the larval durations of gag and other grouper species. An additional two of the twelve drifters moved onto the shelf but were recovered after ~25 days. These data combined with the observation of spawning aggregations of gag and scamp within the EORR (Gilmore and Jones 1992) provide strong support for the continued 'protected status' of the OERR. Additionally, these data suggest that other areas of the east coast of Florida and areas off of Charleston would be good candidate sites for the network of MPAs currently under consideration by the South Atlantic Fishery Management Council.

Further the drifter tracks support the hypothesis that larvae spawned in the EORR are not very likely to settle to the OERR, unless the species has a very short larval duration or behavioral mechanisms to retain larvae near the spawning site. All drifters moved to the north following releases. Thus, the source locations for larvae settling to the EORR must be further south along the east coast of Florida, the Bahamas, the Florida Keys or in the Caribbean.

References

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Links to Other NMFS/NOAA Coral Activities:

This project contributes to the assessment of the effectiveness of marine reserves to restore and protect grouper populations along the southeast U. S. continental shelf. The objective is to determine the areas that would be supplied by larvae spawned within the EORR. The project is closely linked with two similar studies that are examining fate of larvae spawned in the within Gray's Reef National Marine Sanctuary and Dry Tortugas Ecological Reserve.

Partners:

NOAA National Ocean Service
NOAA Fleet - NOAA Ship OREGON II, NOAA Ship FERREL

The Project Period: August 2001 to April 2003. All money will be spent by end of FY02 but final report will be completed in April 2003.

Budget:

\$50,000 FY01
\$50,000 FY02

Co-Funding:

\$17,000 FY01 (NOS - Salary of Hare - 2 months and Field Technician - 1 month)
\$17,000 FY02 (NOS - Salary of Hare - 2 months and Field Technician - 1 month)

Proposed Products and Intended Users:Products:

Assessment of Oculina Banks Reserve as source of deepwater grouper larvae to other areas along the southeast U. S. continental shelf

Peer-reviewed publication describing results

Intended Users: NMFS, NOS, SAFMC, NMS, academic community

Status of Proposed FY01 Milestones

May-July 2001: Analyze depth discrete samples to determine appropriate drouge depth for drifters. Purchase drifters.

- Depth distribution of grouper larvae was evaluated using published and unpublished data and a 15 m drogue depth was chosen for the drifters on the basis of available data.
- Hatchdate distributions of gag were evaluated using published and unpublished data. Successful spawning occurs during February, March, April and May and these months were targeted for drifter releases. Successful spawning is defined as hatchdates of individuals surviving to enter estuarine habitats.
- Drifters were purchased and received.

August-December 2001: Develop specific GIS layers for Oculina Banks and adjust drifter processing programs for new releases.

- Modification of drifter processing programs was completed.

January-March 2002: Deploy drifters during late winter/early spring 2002. Track for 80 days.

- Four drifters were released in February, March and April 2002.

April-May 2002: Process drifter tracks and couple with SST images.

- With continuation funding in FY02, this milestone has been postponed so that all drifter tracks and SST images can be combined at same time (see below).

June-July 2002: Prepare assessment of Oculina Banks Reserve as a source of grouper larvae to other reef areas along the southeast U. S. continental shelf.

- With continuation funding in FY02, this milestone has been postponed so that one report will be developed describing the work conducted during FY01 and FY02.

Status of Proposed FY02 Milestones

June - August 2002: Deploy drifters during summer 2002. Track for 80 days

- Additional drifters were purchased and received.
- Four drifters were released in July and August 2002.

December 2002: Complete processing of drifter tracks and coupling with SST images

March 2003: Complete assessment of Oculina Banks Reserve as a source of deepwater grouper larvae to other areas along the southeast U. S. continental shelf

April 2003: Submit manuscript describing results to peer-reviewed journal