COP Annual Progress Report

Project Title: SFERPM 2000 Influence of gyres on the transport of pre-settlement stages into Florida Bay

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Award Period: From July 1, 2000 To Jun 30, 2002

Period Covered by this Report: From July 1, 2000 To Mar 31, 2001

Summary of Progress:

1. Work Accomplishments:
   a. Summary of progress:

This research centers on eddy processes in the coastal Florida Keys and their potential effects on the transport of pre-settlement stages into Florida Bay. We compare the densities of pre-settlement fishes, shrimps, and lobsters entering Florida Bay through Long Key and Moser Channels during the presence and absence of an eddy (Figure 1). Remote sensing and ocean models are used to follow the development of the Loop Current and Tortugas gyre upstream for conditions that precede eddy formation (Figure 1). The time that an eddy will arrive in the Middle Keys is estimated. A shore-based Ocean Surface Current Radar (OSCR) system is set up to capture the real-time surface flow structure of the eddy as it passes through the OSCR domain (Figures 1, 2). Concurrently, nets are moored at the channels to sample the influx of pre-settlement stages. The time series of OSCR surface current vectors during the eddy event is used to correlate with catches and to model particles trajectories in the OSCR domain.

The first Eddy Experiment took place in March 2001, when satellite SST imagery clearly showed the cold core signatures of the Tortugas Gyre and an eddy propagating downstream (Figure 1). Channels nets sampled nightly at Long Key and Moser Channels between March 12-19. The OSCR continuously recorded the surface current field from Bahia Honda to Grassy Key to capture the passage of the eddy (Figure 2). However, satellite imagery showed that the eddy weakened and unraveled before reaching the Middle Keys. Only a small-scale spin-off eddy was captured in the OSCR domain at the end of the sampling period on March 22 (Figure 2A). In retrospect, the Tortugas Gyre during this period might have been too small to generate strong eddy events downstream. Simulated surface drifter trajectories using OSCR current vectors showed no onshore transport tendency in the absence of a strong eddy (Figure 2B). This is a stark contrast to the results of an earlier, unrelated OSCR experiment in Key Largo, which had shown simulated drifters definitely directed shoreward when an eddy passed through the domain.

In May 2001, another set of clear satellite images depicted the Tortugas Gyre and a large, well-developed coastal eddy between the Middle and Lower Keys (Figure 3). Sampling was conducted at Long Key and Whale Harbor Channels (Figure 1) between May 18-26. Preliminary analysis showed singular peaks of influx of postlarvae coming in on the 18th and

24th (Figure 4) at both channels, which may have corresponded with the close proximity of the leading and trailing edges of the eddy to the channels. The OSCR was not deployed on this occasion due to lack of funds.

b. Summary of work to be performed:

Through the Eddy Experiment so far we have learned more about the upstream oceanographic conditions culminating in eddy genesis, the temporal and spatial scales of eddy events significant to larval transport, and the lead time necessary for set up to capture these eddies as they progress downstream towards the channels. A major challenge in studying these episodic events lies in capturing sufficient occurrences for understanding and modeling the processes, but it is such events that often hold the key to the variability in marine populations. As continuous deployment of the OSCR system is very costly, the Eddy Experiment necessitates that optimal conditions for maximizing the probability of capturing an eddy event are present.

The second Eddy Experiment is projected to take place between April and May, 2002. Currently, NOAA satellite altimeter and AVHRR MCSST data products are being monitored daily to await the set-up of the Tortugas Gyre and estimate the timing of the subsequent propagation of a coastal eddy downstream towards the Florida Keys. The second experiment will be timed to coincide with the approach of the eddy at the Middle Keys. Channels nets will be deployed at Long Key and Whale Harbor channels with simultaneous OSCR coverage directly offshore. To validate the OSCR surface current data and obtain current data at depth, an ADCP and a current meter will be moored separately inside the OSCR domain, while another ADCP will be mounted on a boat to survey the domain. In addition to channel nets to capture the influx of organisms, artificial habitats will be used on the Bayside of the channels to monitor the settlement of fishes and lobsters during the eddy event.

Results form the experiments are expected to be presented at the ASLO (American Society of Limnology and Oceanography) meeting in June, 2002 and the Larval Fish Conference in July, 2002. A retrospective approach will be taken to examine the correlation between eddy events and recruitment in South Florida. The Florida Department of Environmental Protection owns a monthly time series of spiny lobster settlement abundance in the Florida Keys that dates back to the early 1990's. This time series will be used in a correlation analysis with historical SST/SSH images.

The natural direction of the research is towards connecting coastal processes in the Florida Keys with upstream dynamics at the Dry Tortugas. Exploratory cruises were conducted in conjunction with the Florida Bay Circulation and Exchange Study to the southwest Florida shelf and Dry Tortugas in June and September, 2001. With support from SFP 2002, two offshore multidisciplinary surveys will be conducted in the Dry Tortugas during the summer spawning season (May and August) in 2002. The surveys will map the physical and biological characteristics of the Tortugas Gyre and associated eddy and countercurrent features. There will be coordinated efforts with the offshore surveys to monitor the influx of early stages through nearby channels with concurrent OSCR and field studies of juvenile settlement bayside of the channels. Timing and rate of influx and settlement will be correlated with eddy events. Specimens collected nearshore in channel nets and settlement

habitats will also be correlated with larvae found in the Dry Tortugas through age/stage progression or geochemical signatures (trace element analysis of otoliths in fishes) to verify the link between the Dry Tortugas spawning ground and Florida Bay recruitment.

2. Applications:
   a. Publications, presentations, workshops;

Yeung, C., D. L. Jones, M. M. Criales, T. L. Jackson, and W. J. Richards. 2001. Countercurrent flow and the influx of spiny lobster *Panulirus argus* postlarvae into Florida Bay: influence of eddy transport. *Marine & Freshwater Research* 52:1217-32.

Yeung, C., M. M. Criales, T. N. Lee. 2000. Unusual larval abundance of *Scyllarides nodifer* and *Albunea* sp. during an intrusion of low-salinity Mississippi flood water in the Florida Keys in September 1993: Insight into larval transport from upstream. *J. Geophys. Res.* Vol. 105, No. C12, pp. 28,741-28,758.

Schwamborn, R. and M. M. Criales. 2000. Feeding strategy and daily ration of juvenile pink shrimp (*Farfantepenaeus duorarum*) in a South Florida seagrass bed. *Marine Biology* 137 (1): 139-147

Criales, M. M., C. Yeung, D. Jones, T. L. Jackson, and W. J. Richards. (In review). Variability in size and oceanographic processes affecting the inshore supply of pink shrimp (*Farfantepenaeus duorarum*) postlarvae into Florida Bay. *Est. Coast. and Shelf Sci.*

Yeung, C., D. L. Jones, M. M. Criales, T. L. Jackson and W. J. Richards. 2001. Influence of coastal eddies and countercurrents on the influx of pre-settlement stages into Florida Bay. 2001 Florida Bay Science Conference. April 23-26, 2001. Key Largo, Miami, Florida. (Poster)

Jones, D. L., M. R. Lara, C. Yeung, M. M. Criales, T. L. Jackson and W. J. Richards. 2001. Offshore larval supply of snapper larvae (Pisces: Lutjanidae) into Florida Bay. 2001 Florida Bay Science Conference. April 23-26, 2001. Key Largo, Florida. (Poster).

Criales, M. M., C. Yeung, D. Jones, T. L. Jackson, and W. J. Richards. 2001. Supply of pink shrimp postlarvae through intertidal channels into Florida Bay. 2001 Florida Bay Science Conference. April 23-26, 2001. Key Largo, Florida. (Poster)

Yeung, C., D. L. Jones, M. M. Criales, W. J. Richards and T. L. Townsend. Offshore and upstream transport dynamics influence the recruitment of spiny lobster (*Panulirus argus*) postlarvae to their juvenile habitat in Florida Bay. Sixth International Conference and Workshop on Lobster Biology and Management. Key West, Florida (USA). September 10-15, 2000.

Jones, D. L., M. R. Lara, C. Yeung, M. M. Criales, T. L. Jackson, W. J. Richards. Offshore larval supply of snapper larvae (Pisces: Lutjanidae) into Florida Bay. Annual Meeting of the American Society of Ichthyologists and Herpetologists. La Paz, Baja California Sur, Mexico. June 14-20, 2000.

b. Applications to management or research;

Source-sink dynamics affect the natural variability of an ecosystem. Its influence can be particularly significant in South Florida where many key marine species such as the spiny lobster, pink shrimp, and some snappers and groupers have disjointed larval, juvenile and adult habitats. Mesoscale eddy processes play a potentially pivotal role in source-sink dynamics. Our research focuses on elucidating this role in order to provide information on the sources and causes of variability in marine populations that are vital to resource management. Hydrodynamic and ecosystem models of Florida Bay and adjacent ecosystems that omit eddy processes will not be complete or credible.

c. Data and/or information products;

Continuous records of OSCR surface current vectors will be available for the two-week duration of each Eddy Experiment. ADCP and current meter data will be available for the second Eddy Experiment. These data sets are important to incorporating nearshore, mesoscale processes within a South Florida coastal hydrodynamic model and to validating the model. Biological data from the experiments will be available as catch per unit volume filtered per sample by taxon identified to the lowest possible level. Selected species such as groupers/snappers will also have size, age, and in some cases, otolith chemistry data.

Results of the project will include synoptic dissection of an eddy event, correlation between the offshore passage of eddies and influx of pre-settlement stages into Florida Bay, and the interconnections among Loop Current, Tortugas gyre, and eddy dynamics. These results will be published as peer-reviewed and technical papers. Final data and results will be archived in an internet accessible format, and will contribute to a long-term database for the study of the effects of environmental variability on the fisheries and biodiversity of Florida and the central western Atlantic.

d. Partnerships established with other federal, state, or local agencies, or other research institutions.

Partnerships have been forged with the University of Miami, Harbor Branch Oceanographic Institute, NOAA-AOML and other NOAA fisheries centers to tightly couple pertinent oceanographic and fisheries research with our investigations. We are also in contact with the Florida Department of Environmental Protection and the South Florida Water Management District for information exchange. Old Dominion University and Florida International University are involved in collaborative efforts in various aspects of the project.