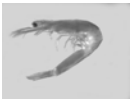
Modeling Transport as a Function of Tide and Behavior of Pink Shrimp Postlarvae



J. A. BROWDER[1], M. M. CRIALES[2], L. CHERUBIN[2], C. PARIS[2], AND S. GREMES-CORDERO[2]

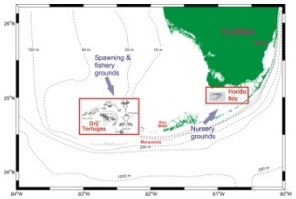
[1]NOAA Fisheries, Southeast Fisheries Science Center,

[2]Rosenstiel School of Marine and Atmospheric Science (RSMAS), University of Miami

Objectives

The goal of this NOAA-FATE (Fisheries and the Environment) project is to develop physical and biological indicators of recruitment for the pink shrimp (*Farfantepenaeus duorarum*) in south Florida to help assess the stock status in relation to climatic and other environmental variation.

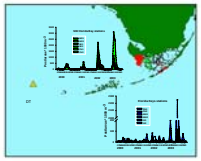
A coupled biophysical model is under development for the species to help determine the main migration pathways, spawning grounds and environmental factors that affect the journey and successful recruitment.



Background

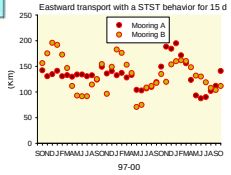
Pink shrimp spawn NE of the Dry Tortugas and larvae migrate to the nursery grounds of Florida Bay (FB) ~ 150 km eastward. Development from egg to postlarvae to settle takes ~ 30 d.

Several pathways of larval migration have been hypothesized. Integrated field and modeling work suggests a flexible path across the SWF shelf involving larval behavior, tidal currents and winds (Criales et al. 2006, 2007).

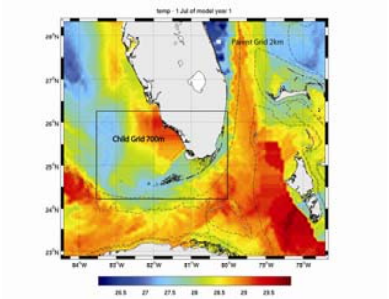


During a 4-yr sampling study the highest concentrations of postlarvae were found at the NW border of FB

A simple Lagrangian model suggested that postlarvae with STST behavior may migrate up to 200 km in 30 d across the SWF shelf



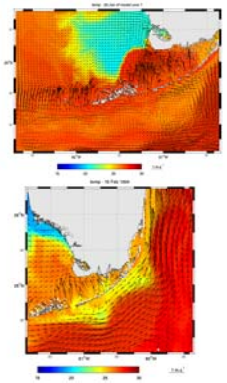
The Regional Ocean Modeling System (ROMS)



ROMS, a coastal hydrodynamic model with ***tidal flux***, is the foundation of the biophysical model. ROMS operates on two grids, the parent, 2 km resolution, and the embedded child, 700 m resolution.

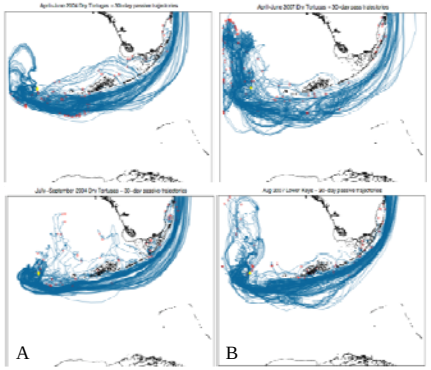
The circulation model is based on data from the National Center for Environmental Predictions (NCEP). The model's lateral boundaries are provided by the HYCOM TOPAZ Atlantic Ocean 1989-to present reanalysis.

Freshwater inflows from rivers, channels and creeks are important components of the model.



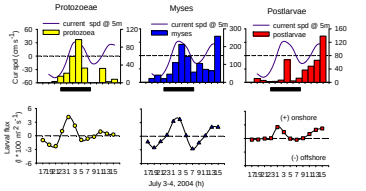
Model results show the highly dynamic circulation on the SWF shelf with spinoff eddies traveling along the edge of the Florida Current and a strong northward flow on the inner shelf.

The Biophysical Individual-Based Model (IBM)

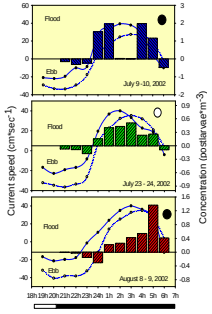


Temporal Variability in transport along the FLorida Keys: 30-d passive Lagrangian-particle trajectories during April-June, and July-September of 2004 A) and 2007 B); 500 particles were released weekly. There are periods with more retention near the spawning grounds that coincide with the presence of a mesoscale eddy in the Dry Tortugas.

Larval and Postlarval Behavior

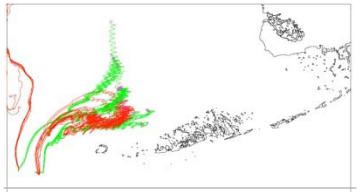


Over 90% postlarvae collected in FB were located at the subsurface layer during nocturnal flood tides.



Data collected near Marquesas (SWF shelf) indicate that young protozoea migrate with the day-night cycle (DVM) but advanced myses and postlarvae synchronize their vertical migrations with the tides. This mechanism known as ***Selective Tidal Stream Transport (STST)*** allows organisms to move horizontally in the direction of migration, in this case toward the nursery grounds.

Active vs. Passive Transport



Trajectories represent 7 days of transport for passive particles (green) and STST larval behavior linked with tides (red).

Simulations of the IBM model conducted with a 1-wk input from ***ROMS with tides*** indicate that transport patterns with behavior varied in direction and distance, even when starting from nearby locations, in comparison with passive particles.

Ongoing Research

Simulations with a DVM during the first ten days of development and a STST during the remaining 15 days of development will verify pathways of migration.

Decadal ROMS simulations coupled with the IBM model over the 1995-2005 period will be used to assess the effect of environmental factors on pink shrimp stock variability.

References

Criales MM, Wang J, Browder JA, Robblee MB, Jackson TL, Hittle C (2006) Variability in supply and cross-shelf transport of pink shrimp postlarvae into western Florida Bay. Fish Bull US 104:60–74.

Criales, MM, Browder JA, Mooers CKN, Robblee MB, Cardenas H, Jackson. TL (2007) Implications of tidal transport and internal tides on transport of pink shrimp larvae across the SW Florida shelf. Mar Ecol Prog Ser 345:167-184.