USA Restoration Briefs

•University of South Alabama Oyster Reef and Fisheries Habitat Enhancement Program•

Volume Three: Oyster larval transport in Mobile Bay **Summer 2010**

Highlights

• Oysters larvae are transported through the water by currents, tides, wind, and river discharge until they settle to hard bottom habitat becoming spat and eventually adult oysters.

• This study combined a field monitoring of oyster settlement and development of 3-dimensional computer model to better understand factors influencing oyster larvae transport and settlement.

• Computer model and field study results show:
  o Oyster larval supply and spat settlement follow a decreasing gradient from west to east and this is likely due to local recruitment of oyster larvae released at Cedar Point Reef.
  o Bon Secour Bay shows good potential for retention of locally-spawned larvae due to a well-protected environment.
  o Consistent flushing through the main pass of Mobile Bay prevents larval exchange between the west and east side of the Bay.

• This study produced one Ph.D. Dissertation for Dr. Choong-Ki Kim (a former student of Dr. Park) and three papers in scientific journals.

Research Objectives

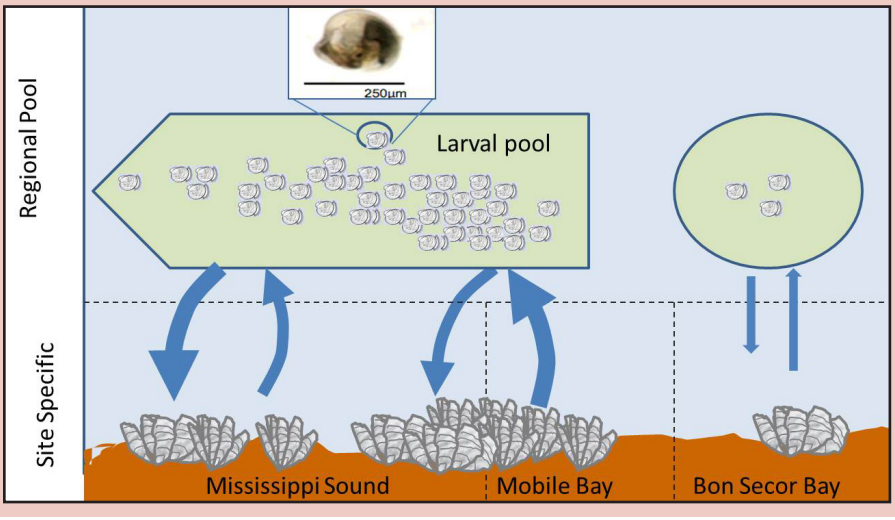
The objectives of this study were: (1) to develop a three-dimensional larval transport model for the eastern oyster (Crassostrea virginica), (2) to validate the model using field observations, and (3) to use the model to study the characteristics of oyster larval transport in Mobile Bay and eastern Mississippi Sound, Alabama.

Background

Oysters spawn by releasing eggs and sperm into the water. Fertilized eggs develop into larvae and are moved through the water based on currents, tides, wind and river discharge until conditions are suitable for settlement. When oysters settle they are called spat. The supply of larvae and their transport through the water are critical factors in regulating oyster populations. Understanding the factors that influence how oyster larvae are transported and ultimately supplied to reefs is critical for restoration planning and developing effective management strategies.

Higher oyster production has been observed in the southwest side of Mobile Bay and eastern Mississippi Sound for the past 90 years, particularly in Cedar Point Reef that has contributed over 90% of oyster harvest in Alabama (Figure 1). Whereas oyster reefs in the middle and east side of Mobile Bay are largely unproductive. Observations of oyster spat settlement intensity have also shown the same gradient decreasing from west to east: significant settlement in the southwest side of the system and negligible settlement in the middle and east side of the Bay. Some previous studies suggested that low larval supply might be responsible for the poor oyster recruitment in the east side of the Bay, but no direct studies had been conducted for oyster larval transport in the Mobile Bay system.

Figure 1. Schematic illustration of larval transport in Mobile Bay. Hydrodynamically the bay is often separated into eastern and western section. In the eastern section low population levels lead to low larval supply with high retention in the region. Larval supply and hence recruitment of oyster increases towards the west into Mississippi Sound.



Methods

This study included field surveys and computer model development and application. Field studies consisted of deploying and retrieving 18 moorings with settlement plates. Settlement plates are a hard surface that oysters will attach to and then can be counted to compare densities among different regions of the bay. The larval transport computer model was developed accounting for: (1) physical factors such as tides, currents, wind, river discharge, (2) biological movement of larvae (i.e. swimming and sinking behavior of oyster larvae), (3) and site-specific and larvae-specific conditions (i.e. spawning location, spawning stock size, spawning time, and larval period). The computer model was validated by using field data and then the model was used to study the characteristics of oyster larval transport under various conditions of tide, river discharge, and wind.

Findings

The results of the computer model and field data showed the following:

West-East Gradient

- Both oyster spat settlement and bivalve larval concentration show a persistent gradient decreasing from west to east, which was validated by the computer model (Figure 2).
- Local recruitment of larvae released at Cedar Point Reef, contributing over 90% of oyster harvest in Alabama, is likely responsible for the persistent gradient.

Larval Transport, Retention and Connectivity

- Local recruitment of larvae at Cedar Point Reef may provide maximum larval supply, which however may be influenced by variations in river discharge and winds.
- Bon Secour Bay is a well-protected area due to shallow depth and surrounding shoreline configuration. These factors indicate that it has good potential for retention of locally spawned larvae if substrate is available.
- Efficient flushing through Mobile Bay's main pass prevents larval exchange between the west and east side of the Bay, resulting in little or no connectivity between the two basins.
- Overall, patterns of larval transport are determined by physical transport (i.e. currents, wind or river discharge).

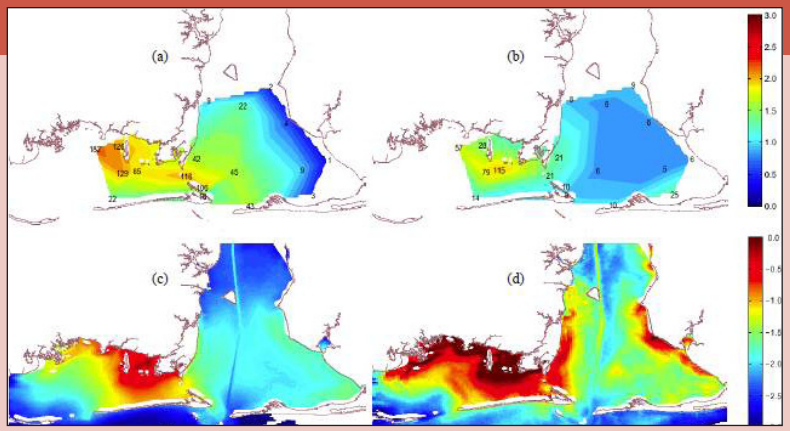


Figure 2. Maps produced by the computer model that show the persistent decreasing gradient from west to east under different scenarios of wind, tides, and river discharge.

Publications

Kim, C.K., K. Park, S.P. Powers, W.M. Graham, and K.M. Bayha. 2010. Oyster larval transport in coastal Alabama: dominance of physical transport over biological behavior in a shallow estuary. Journal of Geophysical Research, doi:10.1029/2010JC006115 (In Press).

Kim, C.K. and K. Park. (In Prep) Modeling of the water exchange into and out of Mobile Bay, Alabama, USA.

Kim, C.K., K. Park, and S.P. Powers. (In Prep) Population connectivity of eastern oyster in coastal Alabama: a larval transport modeling study.

Application

- For the Cedar Point Reef area, addition of hard substrate (e.g., shell planting) and efforts to reduce post-settlement mortality would be beneneficial.

- For the Bon Secour Bay, providing seed oysters (e.g., spawning sanctuaries) could increase larval production in the area. Other factors that reduce post-settlement death of oysters such as low-oxygen water and siltation also need to be addressed in this region.

Contact Information

Sean Powers, Ph.D.
Restoration Program Manager
Associate Professor of Marine Sciences
University of South Alabama
& Senior Marine Scientist II, DISL
Dauphin Island, AL 36528
251.861.2141 ext.2265
spowers@usouthal.edu

Steven Scyphers
Restoration Briefs Editor
Ph.D. Student
University of South Alabama &
Dauphin Island Sea Lab
Dauphin Island, AL 36528
251.861.2141 ext.2384
sscyphers@disl.org