Loxahatchee River Oyster Reef Restoration Monitoring Summary - 2011

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This report provides a summary of the oyster reef restoration monitoring results from two oyster reef restoration projects in the Loxahatchee River, Florida. This includes oyster recruitment and size monitoring data collected by the Loxahatchee River District's Wildpine Laboratory. Our partners from Dr. Craig Layman's laboratory at Florida International University (FIU) are also performing research on macro-fauna (shrimp, crabs, and small fish) at these restoration sites. FIU's forthcoming report will be available from the Loxahatchee River District's website at www.loxahatcheeriver.org/reports.php.

Oyster Reef Restoration Projects

In 2008 and 2009, the Loxahatchee River District, in partnership with FIU, The Nature Conservancy, NOAA, the Loxahatchee River Preservation Initiative (LRPI), and community volunteers, completed oyster reef restoration and conducted detailed monitoring on the usage of the oyster habitat by fish and other fauna. Volunteers from school groups, scouts, and the community assembled over 1,300 bags of oyster and fossilized shell and deployed them beneath nine residential docks in the Northwest Fork of the Loxahatchee River, downstream of River Mile 4 (Figure 1).

During the summer of 2010, the Loxahatchee River District partnered with Martin County to win a grant from NOAA that was funded through the American Recovery and Reinvestment Act of 2009. Contractors used small barges and a long-arm excavator to deploy the rock and shell by-product from Palm Beach County's Juno Beach Shore Protection Project. A total of 5.84 acres of oyster habitat was created in the Northwest Fork of the Loxahatchee. The majority of the restoration area is in the vicinity of the mangrove island above River Mile 4 (Sites 13 and 14), and a small experimental area (Site N8) was placed downstream near channel marker 17 (Figure 1). When mature, this oyster reef will filter over 100 million gallons of water per day, and provide habitat for countless numbers of organisms.

Figure 1. Locations of oyster reef restoration sites, Loxahatchee River, Florida.

Oyster Recruitment & Growth Monitoring

To assess the success of the oyster reef restoration projects, the Loxahatchee River District (LRD) has conducted bi-annual (summer and winter) monitoring at each of the residential dock and NOAA restoration sites since August 2009. Summer samples were collected during August/September, and winter samples were collected during January/February. Monitoring of both the residential dock and NOAA restoration sites commenced following project completion. Quantifying the trajectory of restoration success, i.e., the change in oyster density and size over time, and the relative functionality of various restoration materials (clutch) were the primary objectives of these monitoring efforts.

LRD initially monitored the residential dock restoration sites by collecting and evaluating new oyster settlement from shells collected from the shell bags used in the restoration. However, due to extensive recruitment and growth of new oysters, LRD began quantifying oyster density using a quarter meter quadrat sampling method in Summer 2010. This quadrat method was less invasive and has been applied consistently at all of the oyster restoration sites within the Loxahatchee River.

Quarter-Meter Quadrat Sampling

Each Summer and Winter since 2010 LRD scientists collected and evaluated new oyster settlement occurring within 0.25 x 0.25 meter quadrats. Within each quadrat shells were excavated to a depth of 6 inches deep, or until no additional live oysters were present. All live and dead oysters were counted and measured within each quadrat. Two quadrat samples were collected at each dock site, with one sample haphazardly collected from the near-shore half of the dock and one sample collected from the off-shore half of the dock. At the NOAA restoration sites, multiple sites were randomly sampled throughout the restoration areas, with the number of samples varying by the size of the restoration size (i.e., 10 samples were collected at site N8, 16 samples were evaluated at Site 13, and 21 samples evaluated at Site 14). For all new spat/oysters within each quadrat (sample), LRD staff quantified the following parameters:

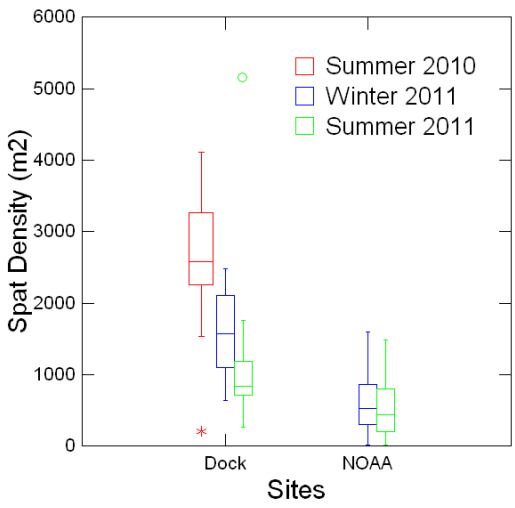
1 The number of live (post-settlement) oysters;
2 The number of dead oysters;
3 Oyster size (i.e., shell height) in millimeters
4 Restoration substrate (e.g., shell, rock, fossil shell; if identifiable)
5 Water depth
6 Location (GPS coordinates)

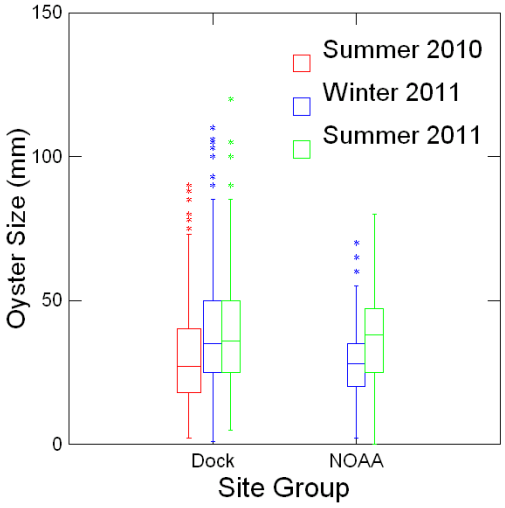
Oyster Monitoring Results & Discussion

Both oyster reef restoration projects (Dock and NOAA) have showed rapid and dense oyster settlement. At the dock sites, approximately 12-24 months after construction, median densities ranged from 1,000 to 2,500 post-settlement spat/oysters per square meter (Figure 2). For the NOAA sites, 6 and 12 months after construction, median densities were roughly 500 oyster spat per square. The range of oyster spat densities at the older dock sites reached over 4,000 spat/m^2. The ranges of spat densities were generally lower at the newer NOAA sites than the dock sites, but several samples exceeded 1,000 spat/m^2 on the NOAA sites. It is likely that the construction methodology used under the docks (i.e., placing bags of oyster shell) contributed to the significantly higher oyster spat densities observed under the docks, because placement of bagged oyster shell creates a larger amount of vertical habitat space. And, it seems the higher spat densities may simply be more larval oysters settling on a larger amount of available space. Nonetheless, the age and size of the restoration sites also may contribute to the varying oyster densities observed among the restoration projects.

Median size of live, post-settlement oysters at the restoration sites gradually increase over time (Figure 3). At dock sites median oyster size was 25 mm, though some oysters exceeded 75 mm only 12 months after construction. Several oysters exceeded 100 mm within 24 months following construction. At the NOAA restoration sites, median oyster size was over 25 mm, with several oysters over 60 mm just 6 months after construction. As the restored oyster reefs mature, we have observed oyster densities decline while oyster size has increased (Figures 2 and 3). Our monitoring data clearly show several oyster recruitment events over time. Based on the Winter and Summer 2011 monitoring (12 and 18 mo. after construction) of the Dock sites, perhaps the restored reefs in the Loxahatchee quickly mature with median oyster size of approximately 40 mm (Figure 3). This median size is comprised of juvenile oysters settling on and growing over older oysters with only a few oysters able to grow larger than 75 mm. It will

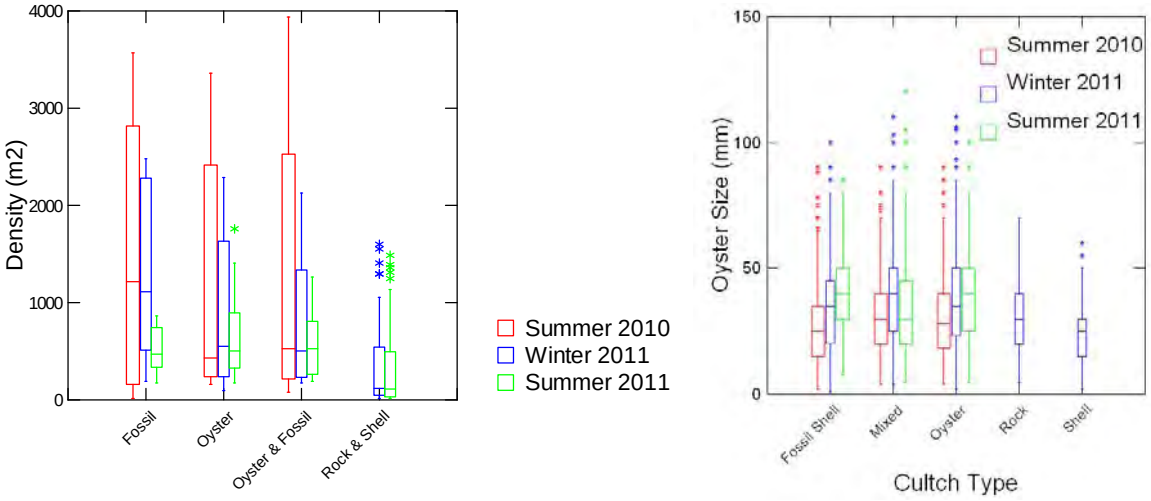
be valuable to continue to monitor these restored oyster reefs to better understand the relative health of the restored oyster reefs relative to existing, mature, natural oyster reefs.





Figures 2 (Left) and 3 (Right). Plot of oyster density (left) and size (right) over time at both the dock and NOAA restoration sites. The trend for both projects show a decrease in oyster density and increase in oyster size as the reef matures.

Another key question for these restoration projects was the performance of the various cultch materials used for restoration. The restoration materials for the Dock sites included oyster shell from area restaurants, or fossilized shell, or a combination of both. The cultch material for the NOAA project was limestone rock and shell, the byproduct from Palm Beach County's Juno Beach Renourishment Project. All available data appear to show no statistically significant differences in substrate quality (Figures 4 and 5). Summer 2010 monitoring was approximately 12 months after construction of the dock sites, and the Winter 2011 monitoring 6 months after construction of the NOAA sites. The groupings for the density and size computations vary because density is computed from multiple shell counts, and the assumption that the base cultch material could be identified for the spat size measurements. At the NOAA sites, the delineation of the mixed base material ("Rock" or "Shell") became impractical and was discontinued following the Winter 2011 sampling because of the extensive growth of new oysters had obscured the original cultch. These preliminary results suggest that all of these calcium carbonate materials provide good cultch for restoration work in the Loxahatchee River, as widely documented in literature for other water bodies. Moreover, these data suggest oyster restoration using fossilized shell, fresh oyster shell from restaurants, or limestone rock and shell from beach renourishment projects all equally provided high quality substrate (cultch) that was rapidly colonized by oyster larvae.



Figures 4 (Left) 5 (Right). Plot showing oyster density (left) and size (size) over time for each type of substrate used for the oyster dock and NOAA restoration projects. "Fossil Shell", "Mixed", and "Oyster" describes material used for the dock restoration. "Rock" and "Shell" describes the material the material used for the NOAA restoration sites. Segregation of material was discontinued after Winter 2011 monitoring at the NOAA sites due to consolidation new oyster growth.

Summary

In summary, after 12-36 months following construction, the restored oyster reefs in the Loxahatchee are flourishing. Monitoring of the restoration sites indicates high oyster recruitment with 250 to 3500 oysters and spat per square meter, and remarkable utilization by more than 22 species fish, shrimp, crabs and other macro fauna.

PHOTOS

"Oyster bags" used for oyster restoration at residential docks immediately after installation(left), and two years later (right).

Fossilized shell used for oyster reef restoration at residential docks.

New oysters and mussels on fossilized shell from the residential dock oyster reef restoration project, 2 years after installation.

New oysters and mussels on fossilized shell from the residential dock oyster reef restoration project, 2 years after installation.

New oysters and mussels on fossilized shell from the residential dock oyster reef restoration project, 2 years after installation.

Rocks and shell used for the large-scale NOAA oyster reef restoration project. This material was the byproduct of Palm Beach County's Juno Beach Renourishment Project.

New oyster growth on a rock from the NOAA project, 12 months after installation.

New oyster growth on a rock from the NOAA project, 12 months after installation.

Additional Figures: