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Underwater Visual Census Provides "Snapshot" Assessment of Tidal Connectivity (Bahamas)

Craig A. Layman, Dept. of Wildlife and Fisheries Sciences, Texas A&M University, College Station, TX 77843-2258, CAL1634@yahoo.com; D. Albrey Arrington, Dept. of Biological Sciences, The University of Alabama, Tuscaloosa, AL 35487; and Brian Reed Silliman, Dept. of Ecology and Evolutionary Biology, Brown University, Providence, RI 02912

Road construction projects in many areas throughout the Bahamas have blocked tidal connections that are necessary to maintain exchanges of water, organisms, and organic matter between estuarine and marine waters. As a result, many estuaries are fragmented, which has led to degraded habitats, declines in available nursery area for Nassau grouper (*Epinephalus striatus*) and other commercially and recreationally important species, and lower fishery yields. Recently, culverts have been installed in some Bahamian estuarine systems to restore connectivity. Because the effectiveness of these culverts has not been evaluated, we compared fish assemblages at sites with culverts to those at sites that were either blocked or had more natural hydrologic flows.

In August 2001 and 2002, we surveyed the presence and absence of fish species in 26 estuarine creeks on Andros Island, Bahamas. We divided the creeks into four categories according to their hydrologic (or tidal) connectivity: completely blocked, blocked by culverts, blocked by a bridge, and unblocked with natural flow. Six of the creeks were completely blocked by roads, resulting in fragmentation of aquatic habitat and total loss of tidal connectivity. Seven had culverts that were constructed in an effort to restore tidal exchange following years of complete tidal blockage. These culverts ranged from less than 1.5 ft to 8 ft (0.5 m to 2.5 m) in diameter. All culverts allowed less tidal exchange than bridges. Of the remaining creeks, three had bridges and ten were unblocked.

The highly transparent waters enabled us to conduct underwater visual census (UVC), a standard, non-destructive technique for characterizing faunal assemblages in sensitive estuarine and marine habitats (Brock 1954). These data were then used to assess the degree of estuarine degradation and the effects of restoring tidal connectivity.

In each of the estuaries, we delineated 100-m^2 areas in each of four habitat types: sand- or mudflat, seagrass, rocky, and mangrove. For each survey, we recorded all fish species observed within the area for 30 minutes. We conducted each survey within two hours of high tide. The observer wore snorkeling gear and moved slowly throughout to closely examine the entire survey area. We recorded only presence/absence of species, and did not estimate abundances of individual species. This provided a "snapshot" of fishes at a given site, although it did not fully incorporate diel, tidal, and seasonal changes known to occur in estuarine habitats (Nagelkerken and others 2000).

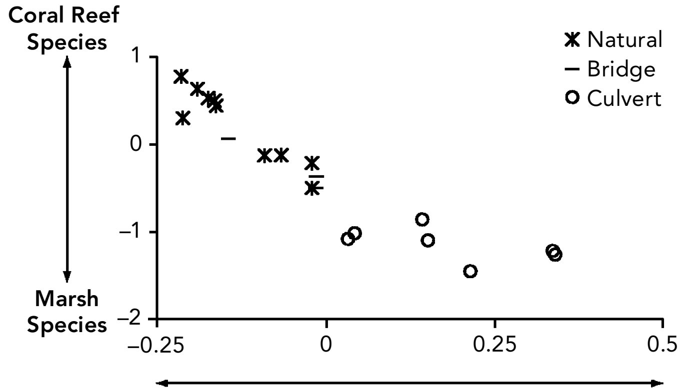

Figure 1. Fish species assemblages diverge according to the amount of tidal flow. The figure depicts data from rocky sites only.

We analyzed our data using correspondence analysis (CA), an indirect gradient analysis technique using CANOCO version 4.5 (ter Braak and Šmilauer 2002), and demonstrated significant turnover in assemblage composition among creeks with different degrees of tidal connectivity. Bridge and natural sites had very similar species assemblages, while culvert sites were characterized by dissimilar assemblages. Figure 1 shows sample scores generated using CA (for simplicity, data is shown from rocky survey sites only), and indicates that assemblages at bridge and natural sites were more species rich than assemblages at sites with culverts. In addition, sites with more natural flows contained a larger fraction of reef-associated species, such as bluehead wrasse (*Thalassoma bifasciatum*) and foureye butterflyfish (*Chaetodon capistratus*). Culvert sites were more species rich than completely blocked sites, but less than bridge and natural sites. Blocked sites (not represented in the figure) had distinct and depauperate fish assemblages, characterized by tolerant marsh species, such as mosquitofish (*Gambusia hubbsi*).

Our work demonstrates the usefulness of UVC as a tool for assessing restoration success in tropical estuarine systems. Restorationists should be aware, however, that UVC is known to bias against cryptic and mobile species. Moreover, difficulty in identifying some individuals (for example, gobies) necessitated grouping some taxa at the genus or family level, rather than by species. While UVC may not have allowed us to detect subtle differences, it was useful in assessing patterns of species composition across a large number of samples.

Our data suggest that bridges allow fish assemblages to be most similar to that of a natural estuary. However, bridge construction is often not feasible. Consequently, we suggest that culverts, particularly when arranged along an entire creek blockage, can provide substantial ecological benefit to estuaries with obstructed tidal flow. Installation of multiple large culverts (see *ER* 20(4):270-277) allows more natural "sheet" flooding and a greater number of access points to isolated upstream areas, which are likely to increase overall recruitment of organisms. Even a few, small culverts enable fish to immigrate into otherwise isolated upstream habitats, suggesting faunal use of estuaries can be substantially increased without complete habitat restoration.

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Saltmarsh Plantings Accelerate Vegetative Colonization of Hurricane Deposits on Barrier Island (Louisiana)

Philip V. McCarty, Coastal Research Laboratory, Dept. of Geology and Geophysics, University of New Orleans, New Orleans, LA 70148, 504/280 6325, Fax: 504/280-7396, pmccarty@uno.edu; Gregory Grandy, Dept. of Natural Resources, Coastal Restoration Div., P.O. Box 94396, Baton Rouge, LA 70804; Rachel Sweeney, NMFS, c/o Louisiana State University, Baton Rouge, LA 70803-7535; Melissa Kay Hymel and John P. Troutman, Dept. of Natural Resources, Coastal Restoration Div., CERM Building, Suite 309, 2045 Lakeshore Dr., New Orleans, LA 70122

The 45-mile-long (72-km) Chandeleur barrier island chain, located in the Gulf of Mexico about 72 miles (116 km) east of New Orleans, is the remnant of an ancient delta that was abandoned as the Mississippi River shifted westward approximately 1,500 years ago (Suter and others 1988). These islands are subject to cycles of land loss from storms followed by phases of rebuilding, which contribute to the westward migration of the islands. In 1998, a significant land-loss and migration event occurred when the storm surge from Hurricane Georges cut numerous breaches through the previously continuous main northern island. The storm deposited sands behind the breaches, forming intertidal lobes and washover flats. Since then, erosion on the eastern side of this 22-mile-long (35-km) island has caused shoreface sediments to fill the breaches, thereby restoring continuity to the island. Stabilization of these intertidal lobes and washover flats is important because they will eventually serve as the foundation of the island as it migrates westward.

In this note, we describe the Chandeleur Island Restoration Project and summarize our initial monitoring efforts during the first two growing seasons. The state of Louisiana and the National Marine Fisheries Service are sponsoring this project, which is funded under the Coastal Wetlands Planning, Protection and Restoration Act. Our main objective is to stabilize 364 acres (146 ha) of unvegetated hurricane deposits by planting smooth cordgrass (*Spartina alterniflora*), a native saltmarsh species. This planting should complement the natural colonization that often occurs on such deposits (Debusschere and others 1990), and thus increase the percent cover of emergent vegetation. We also expect that the presence of vegetation on these lobes will trap additional sediment during future washover events, which should maintain or increase the intertidal area of the planting sites.

In a test planting during summer 2000, we determined that the optimal planting design would consist of a combination of plugs and 4-inch containers planted at mean tide elevation (0.46 ft NAVD88). In summer 2001, ten sites were planted with two rows of smooth cordgrass below mean tide, plus additional rows to reach the mean high tide line (1.06 ft NAVD88). Rows were spaced 10 feet (3 m) apart, and plants were planted on 5-foot (1.5-m) centers. Mitch's Landscaping of Cut Off, Louisiana, grew and planted 66,598 vegetative plugs and 14,132 4-inch containers, for a total of 35,100 linear feet (10,698 m) of plants installed. Each plant was fertilized with a 19-gram Agriform 19-19-19 tablet. At the time of the planting, the plants were approximately five months old. Most were 24 to 36 inches (61-91 cm) tall, exceeding our minimum height specifications for both the 4-inch containers and the plugs. The total planting cost was $388,743, which included cost to acquire, deliver, and install the plants.

Following the smooth cordgrass installation, we surveyed baseline elevation data along 18 transects at five selected planting sites. Results of this survey showed that the mean elevation of the planting sites was 0.72 ± 0.3 ft (0.22 ± 0.1 m) NAVD88. We measured plant percent cover within 72 randomly placed, 4-m^2 plots along the 18 transects. These were sampled again after the 2001 and 2002 growing seasons.

Our surveys indicate that vegetative cover increased at all planting sites from 2001 to 2002 (Table 1). Although approximately half of the plots remained unvegetated, the distribution of unvegetated sites changed from 2001 to 2002. The number of unvegetated plots decreased at the northern sites and increased at the southern sites (Table 1). This was most likely due to severe storm activity in fall 2002 that caused beach erosion, breaching and overwash, especially at the southern end of the island, which is narrower and more vulnerable to storms. However, plants in the remaining plots generally thrived, and it