

## **PULSED FRESHWATER EFFECTS ON NEKTON COMMUNITIES IN BRETON SOUND, LOUISIANA, USA**

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### **INTRODUCTION**

Freshwater flow defines estuaries. In many estuaries, freshwater flow results from the discharge of large rivers. These rivers carry large amounts of sediments and nutrients which are introduced to the floodplain and downstream habitats through an annual flood pulse (Bayley 1995, Johnson et al. 1995, Power et al. 1995). Overflow events, common during flood pulses, transfer huge amounts of sediment and nutrients to the floodplain and have large physiochemical effects on the receiving basin. These environmental changes have significant effects on phytoplankton and zooplankton (Davidson et al. 1998, Galat et al. 1998), larval fish (Fontenot et al. 2001) and finfish (Galat et al. 1998, Rutherford et al. 2001). Large freshwater flows, characteristic of flood pulse events, may influence the biotic community structure and production in positive (Lonegeran and Bunn 1999, Montagna et al. 2002, Ward et al. 2002) or negative ways (Chan et al. 2002), depending on the timing and magnitude of flows. Nearly all major floodplain rivers in the northern hemisphere and many in the southern hemisphere have been leveed or impounded for human uses – navigation, agriculture, flood control, or power generation (Power et al. 1995), influencing the ecology of both the floodplain habitat and the seaward estuaries. As we continue to engineer these rivers, we need to better understand the link between the timing and magnitude of freshwater flows and biological productivity.

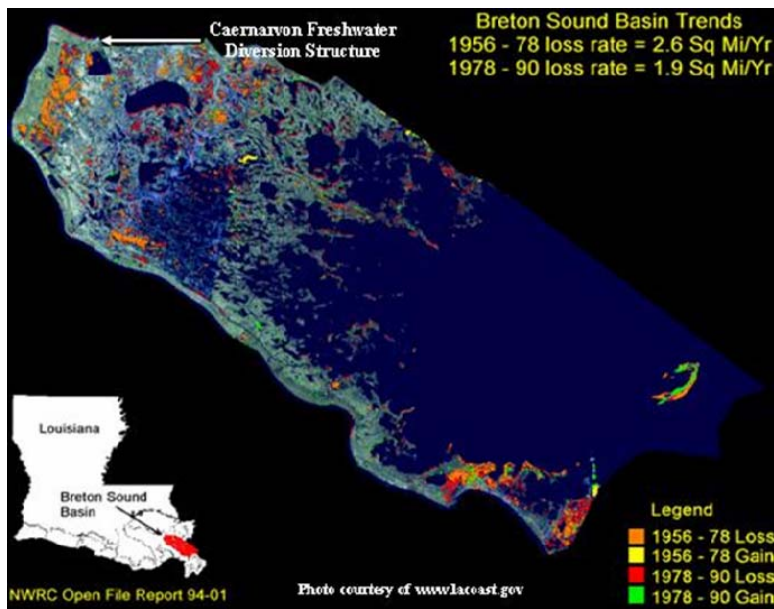
Increasing human demand for freshwater has decreased the amount of freshwater flowing into many of the world's estuaries. Corresponding loss of the natural flood patterns has caused problems in the Mediterranean (Day et al. 1995), South Africa (Gillanders and Kingsford 2002), Egypt (Stanley and Warne 1998), and Australia (Gillanders and Kingsford 2002). In the United States, problems due to lack of freshwater flow have been documented in the San Francisco Bay estuary (Kimmerer 2002), the Florida Everglades (Livingston 1997), the Texas coast (Montagna and Kalke 1992, Gelwick et al. 2001, Powell et al. 2002), and Louisiana's deltaic plain (Day et al. 1995, Twilley and Day 1991, Day et al. 2000). Many regions are now attempting to restore freshwater flow into the estuaries through river diversion projects (Gillanders and Kingsford 2002), and have met with varying levels of success (Lonegeran and Bunn 1999, Kimmerer 2002). The challenge for managers of these projects is to manipulate freshwater inflow to support estuarine functions (Doering et al. 2002): the challenge for estuarine science is to provide knowledge and methods to estimate freshwater needs (Doering et al. 2002). In many places, large scale restoration projects are adapting a systems approach, whereby

the goal is to restore ecological processes and their corresponding fluxes (Odum et al. 1995, Day et al. 1997). Coastal Louisiana is one place where this is occurring, presenting a unique opportunity to examine the effects of variability in the timing and magnitude of freshwater inflow on estuarine fisheries communities.

Coastal wetlands in Louisiana are being lost at a tremendous rate of 64-91 km<sup>2</sup> per year. Land loss has been caused largely by the separation of riverine inputs of the Mississippi River from the floodplains, marshes, and coastal wetlands by flood control levees built and continually fortified in the last 100 years. This, in combination with canal and levee construction for oil and gas exploration and production, has resulted in land subsidence and erosion rates that far outweigh land accretion rates. Massive loss of ecological diversity and productivity of the river delta causes a corresponding huge loss of economic productivity – over \$100 billion estimated by 2050 (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1998). Therefore, effects of this rate of land loss are far-reaching, not only ecologically, but also economically, culturally, and socially.

Louisiana's coastal restoration program has initiated the freshwater-estuary connection process with the construction of five active freshwater diversions, ranging in discharge from 7-297 cm s<sup>-1</sup>. One of the largest, the Caernarvon Freshwater Diversion dramatically influences the supply of fresh water into the Breton Sound estuary (Fig. 1). Caernarvon is operated by the Louisiana Department of Natural Resources for salinity management, fish and wildlife enhancement, and coastal habitat restoration. Caernarvon has been in operation since 1991 and has a direct impact area of 6,475 ha and a 31,160 ha area of influence. The Breton Sound Basin likely plays an important role as a nursery for both marine and freshwater species in this region of the Gulf of Mexico, making the effects of freshwater inflow on productivity critically important to the overall health and productivity of the region. Yearly pulsing of the diversion structure releases periodic large fluxes of river water (184 cms<sup>-1</sup>) into the basin during discrete time periods (14 d), providing optimum conditions for controlled experimentation on the effects of magnitude and timing of freshwater flow on nekton communities.

In spring 2005, we evaluated the response of nekton communities in relation to the magnitude and timing of freshwater flow. This study compared 1) nekton abundance, 2) community assemblage, and 3) nekton diversity in reference and treatment areas downstream from the Caernarvon Freshwater Diversion throughout two experimental high pulse events in Breton Sound estuary, Louisiana.



**Fig. 1. Map of Breton Sound estuary, Louisiana showing the location of the Caernarvon Freshwater Diversion Structure and land loss rates from 1956-1990. Photo courtesy of [www.lacoast.gov](http://www.lacoast.gov).**

## METHODS

Two experimental high-flow pulses (14 d) were conducted in Spring 2005 (February 14-28, March 14-28). Daily nekton samples were taken during each high flow event at multiple sites within the estuary in two treatment areas (treatment and reference). Nekton were sampled at inundated marsh sites with a 1-m<sup>2</sup> hard-sided drop sampler. Continuous hydrologic, discharge, and water quality monitoring data for each pulse event were obtained from the real-time or continuous recorder station nearest each sampling point. In addition to remotely collected data, turbidity was measured at each site with a hand-held turbidity meter and DO, temperature and salinity were measured with a YSI hand held meter.

Common indices of biodiversity (Shannon Weiner, Margalef, Pielou) and community similarity (Sorenson's Community Similarity Index) were applied to field sampling data to assess community dynamics across zones and treatment areas during pulse events (Magurran 1988). Data were analyzed with multivariate statistics to assess (1) differences in nekton density, abundance, diversity and community composition between reference and treatment areas, and (2) identify key environmental variables influencing significant changes in nekton communities, and (3) relate levels of key environmental variables positively or negatively affecting nekton communities to freshwater inflow rates and timing of freshwater pulses.

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