ENVIRONMENTAL IMPACT STATEMENT
WATER ALLOCATION FOR THE APALACHICOLA-CHATTAHOOCHEE-FLINT RIVER BASIN POTENTIAL IMPACTS OF REDUCED FRESHWATER FLOW ON APALACHICOLA BAY, FL OYSTER POPULATIONS: COUPLING HYDROLOGIC AND BIOLOGICAL MODELS

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Abstract. The National Oceanic and Atmospheric Administration (NOAA) participated in the development of a Federal Interagency Plan (IAP) to support the Environmental Impact Statement (EIS) for the Apalachicola-Chattahoochee-Flint (ACF) basin. NOAA's National Ocean Service (NOS) and the National Marine Fisheries Service (NMFS) were consulted to assess the potential impacts on Apalachicola Bay physical and biotic processes due to changes in freshwater inflow. This document is a summary of NOAA's complete report: Potential Impacts of Reduced Freshwater Inflow on Apalachicola Bay, FL Oyster Populations: Coupling Hydrologic and Biological Models. Please refer to the complete NOAA report for details analyses and results.

INTRODUCTION

NOAA was requested to participate as a cooperating agency in the preparation of the EIS for the ACF basin. NOAA responded due to several legislative mandates: develop and review of EISs (National Environmental Policy Act), assess potential impacts on essential fish habitats (Magnuson-Stevens Fishery Conservation & Management Act); determine if any endangered species will be affected (the Endangered Species Act), and assess potential impacts to the Apalachicola Bay National Estuarine Research Reserve (the Marine Sanctuaries Act). This study was conducted jointly by the Apalachicola Bay EIS Assessment Team, NOAA/NOS/NMFS, Silver Springs, Maryland; and the Florida State University Center for Aquatic Research and Resource Management, Tallahassee, Florida.

NOAA received very limited funds to support the draft EIS: Apalachicola Bay component. Therefore as a cooperating agency for the draft EIS, NOAA was unable to address the majority of assessments outlined in the Inter-Agency Plan. The largest void was in the deletion of any study or research on assessing impacts on essential fish habitats (EFH) (e.g., seagrass beds) as defined by NOAA/NMFS and the Gulf of Mexico Fishery Management Council, and defining impacts on the Apalachicola Bay National Estuarine Research Reserve. Therefore, only the potential impacts from changes in freshwater inflow on the Eastern oyster (Crassostrea virginica) mortality, growth, and ecology were studied by NOAA/NOS. The oyster was selected for two reasons: 1) its importance to the ecology and economics of the Apalachicola Bay region and, 2) the availability of a unique database on oyster biological attributes housed at Florida State University (FSU).

STUDY OBJECTIVES

1) Model the variation in estuarine salinity and temperature regimes under various freshwater inflow scenarios.
2) Develop models of potential oyster growth and mortality under various flow scenarios.
3) Integrate the physical and biological models to provide an assessment of the potential impacts of changes in freshwater inflow on the Apalachicola Bay oyster community.
4) Develop digital maps of oyster mortality and growth estimates under the various flow scenarios.

METHODS

Study results were developed by integrating of a suite of biological and physical models using Geographical Information System (GIS) technology to demonstrate how oyster biological responses (mortality and growth) could potentially change with reduced freshwater inflow into Apalachicola Bay. A series of digital maps were produced that showed potential oyster mortality due to predation throughout the Bay under various demands for freshwater under drought, low-moderate, and wetter than normal summer flows. Based on available data, we were able to model a range of potential oyster mortality under various alternative flow conditions.

The integrated biological (mortality) and physical (hydrodynamic) models enabled us to predict potential oyster mortality under two historical flow years, eight simulated alternative operation and demand scenarios, and two existing operations with different demand scenarios. The scenarios bracketed Bay-wide simulated salinity regimes (i.e., oyster habitat) under low to high demands for freshwater. We selected three years to conduct the assessments based on available oyster mortality and growth data. The years of 1985 (low to moderate flow conditions), 1986 (drought flow conditions), and 1991 (wet flow conditions) bracketed flows ranging from drought to high summertime flow. Reductions in freshwater inflow are predicted to indirectly cause oyster mortality primarily due to increased salinities and decreased salinity variability that enables marine predators to colonize oyster beds. The dominant marine predator of oysters in Apalachicola Bay was the oyster drill (snail, Thais haemastoma) (Livingston et al. in review).

RESULTS

Low to Moderate Hydrologic Year (1985)

Surfaces of potential oyster mortality for 1985 under high flow operations with 1995 demands for water were modeled. Under the high flow operations, a peak in potential oyster mortality occurred in the 4-9% category. Over 50% of the Bay would not experience significant potential oyster mortality. Most important, at the largest and most productive eastern oyster beds of Cat Point and East Hole, potential oyster mortality was less than 10%. However, in the far western portions of the Bay (e.g., Scorpion Bar) we predicted this area could experience very high potential oyster mortality (>50%). Under the scenario for 1985 with 2050 demands significant oyster mortality could occur over a greater geographic range when compared to the 1985 with 1995 high flow operations and demands. This was evidenced by 71% (1985 with 2050 low flow operations and demands) of the surface of potential mortality (cells) fell in mortality categories ranging from about 10 to 50%.

Under the "worst case" scenario for 1985 with 2050x demands a peak in potential oyster mortality occurred at 9-16%. However, the largest and most productive bars of Cat Point and East Hole bars could experience an increase in potential oyster mortality from <10% under 1995 demands to 10-25% under 2050x demands. In addition, the commercially important bars of St. Vincent Sound could experience potential oyster mortality ranging from 16-81%; with most of the bars predicted to experience about 25-50% mortality. The mean potential oyster mortality would increase from 11% in 1985 with 95 demands to 16% under 2050x demands.

To better understand and interpret the difference in predicted mortality across the various alternative demand scenarios for 1985, we ran a spatial calculation of percent change in mortality from the base, or best case flow condition--1985 high freshwater inflow operations with 1995 demands, to an extreme condition--1985 with low freshwater inflow with year 2050 demands. The analysis reflects differential mortality as a percentage of the original (base year) condition for the alternative flow analysis of 1985. The analysis indicated that a large portion of the oyster reefs in the eastern portion of the Bay, including East Hole and Cat Point, were characterized by the greatest increases (>25% of base) in mortality from the high flow condition to the low flow condition. The western reefs of St. Vincent Sound would also exhibit large (>5-25% of base) increases in potential mortality. Thus, the most productive oyster beds throughout Apalachicola Bay are predicted to experience the greatest increases in mortality as flow is reduced.

No Action Alternative

Under the "no action" alternative (current reservoir operations), few noticeable changes in the patterns of potential mortality were detected between the 1985 flow conditions with 1995 consumptive demands and the 1985 flows with projected 2050 demands. However, when one compares the cumulative distribution of calculated mortality over the entire bay, the 1985 flow with 1995 demands consistently showed a slightly lower mortality rate. There was an overall greater geographic range of low mortality (0-9%) under the 1995 demand scenario; while the 2050 scenario indicated a 3% greater spatial coverage for the 9-16% mortality range relative to the 1995 demand scenario. Although the differences appear to be slight, implementing the 2050 demands on existing operations would likely result in elevated oyster mortalities baywide. This analysis, when compared to the alternative flow scenarios, indicates that the greatest effects on Apalachicola Bay oysters will result from reservoir operations resulting in low river flows.

DISCUSSION

Optimum oyster habitat in Apalachicola Bay is a function of estuarine circulation, nutrient concentrations, habitats, basin morphometry, and freshwater inflow. At the most productive oyster bars in the eastern Bay, predation, a biological determinant of oyster growth, was due to the indirect effects of salinity limitation of marine predators as well as the actual proximity of these bars to Gulf entry points into the Bay during the summer. In addition, at the western bars where greatest young individual oyster growth rates were observed in relatively high salinity waters, potential oyster mortality increased with decreased riverine freshwater inflow.

The intricate associations of the physical habitat (e.g., salinities) and the biological responses of oysters is part of the complex interplay of the various life stages of the oyster with both physical and biological aspects of the Bay ecosystem. Many of these attributes are either directly (increased salinities) or indirectly (predation) associated with Apalachicola River flows. The Apalachicola Bay accounts for about 90% of Florida's commercial oyster fishery and 10% nationally. Without the nutrient loading from the river, coupled with salinity reductions and variability (i.e., adequate freshwater inflow) that enable continued oyster growth and protection from marine predators, the commercial value of Apalachicola Bay's oyster production would be damaged.

SUMMARY

In summary, the draft EIS Apalachicola Bay component demonstrated that decreases in freshwater inflow, especially during low flow and high demand periods, may significantly increase oyster mortality due to predation. The potential impacts would be greatest at the eastern oyster bars of Cat Point and East Hole where current oyster production is greatest in the Bay. In addition, the western oyster bars which exhibit the fastest growth rates of young oysters, could experience significant predation. The potential increase in Bay-wide cumulative oyster mortality could have major impacts on oyster recruitment and production. Ultimately, decreased oyster production could have significant biological and economical impacts on the Apalachicola Bay region.