Isotopic Evidence for Anthropogenic Impacts on Aquatic Food Web Dynamics and Mercury Cycling in the Florida Everglades

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Introduction

The Everglades in south Florida is a large, complex subtropical wetland ecosystem that has experienced unprecedented anthropogenic modification over the last century. More than half of the original Everglades wetland has been drained for agricultural and urban use, resulting in significant habitat degradation and deterioration of water quality. Although the effects of hydrological modification and nutrient loading on plant communities have been well documented, little is known about how these changes have affected the energy base that supports the aquatic food web in this unique, subtropical wetland ecosystem. Furthermore, increased global atmospheric mercury (Hg) deposition due to human activities (e.g., burning coals in power plants and incineration of municipal and medical wastes) in recent decades has resulted in high levels of Hg in fish and other organisms in the Everglades (e.g., Renner, 2001). After deposition, a portion of the inorganic Hg is converted to methylmercury (MeHg) by anaerobic bacteria in aquatic systems. Although surface waters contain low levels of MeHg, after entering the food chain MeHg biomagnifies to toxic levels in organisms occupying higher trophic positions and poses significant health risks to human consumers. Thus, food web structure plays a critical role in controlling Hg levels in fish. Elucidating the complex structures of food webs can help to understand processes and factors controlling Hg contamination of aquatic ecosystems. In this study, we determined the radiocarbon and stable carbon and nitrogen isotopic signatures of fish samples from both relatively pristine (reference) and impacted (eutrophic) wetlands in the Everglades. These data, along with total Hg concentrations, reveal significant food web consequences of land-use change and hydrological modification in this important subtropical wetland ecosystem.

Results

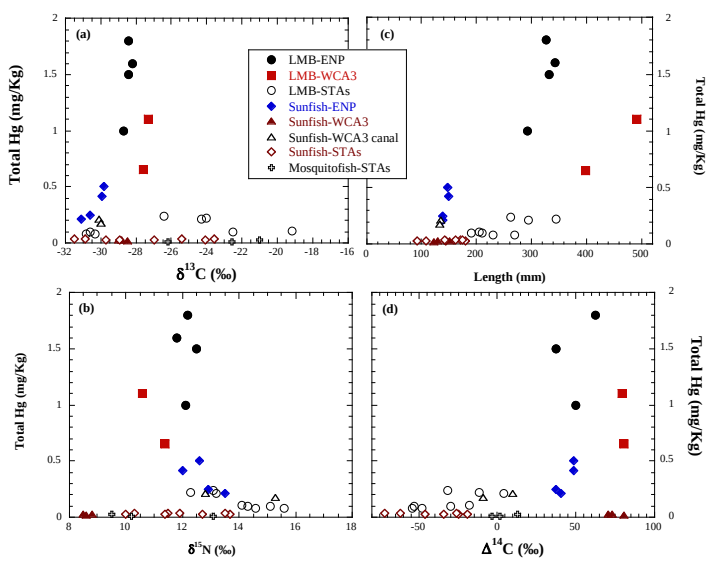

Fig. 1. Comparison of (a) $\delta^{13}C$, (b) $\delta^{15}N$, (c) length, and (d) $\Delta^{14}C$ values with total mercury contents of largemouth bass (LMB), sunfish and mosquitofish from reference (ENP & WCA3) and impacted (STAs) wetlands in the Everglades.

Conclusions

The isotopic signatures of largemouth bass and sunfish in reference wetlands indicate their reliance on the food supply of modern primary production within the wetland. In contrast, in areas impacted by agricultural runoff, both fishes had old radiocarbon ages and a larger isotopic variability than their counterparts in reference wetlands, reflecting differences in the food web between impacted and reference wetlands. Significant radiocarbon deficiencies in largemouth bass and sunfish, relative to mosquitofish, in impacted areas most likely indicate a reduced dependence on small fish. Furthermore, largemouth bass and sunfish from impacted areas had much lower mercury contents than those from reference wetlands. Taken together, these data suggest a shift toward lower trophic levels and a possible reduction in mercury methylation in impacted wetlands.

References

Renner, R., 2001. Everglades mercury debate. Environ Sci Technol 35, 59A-60A.