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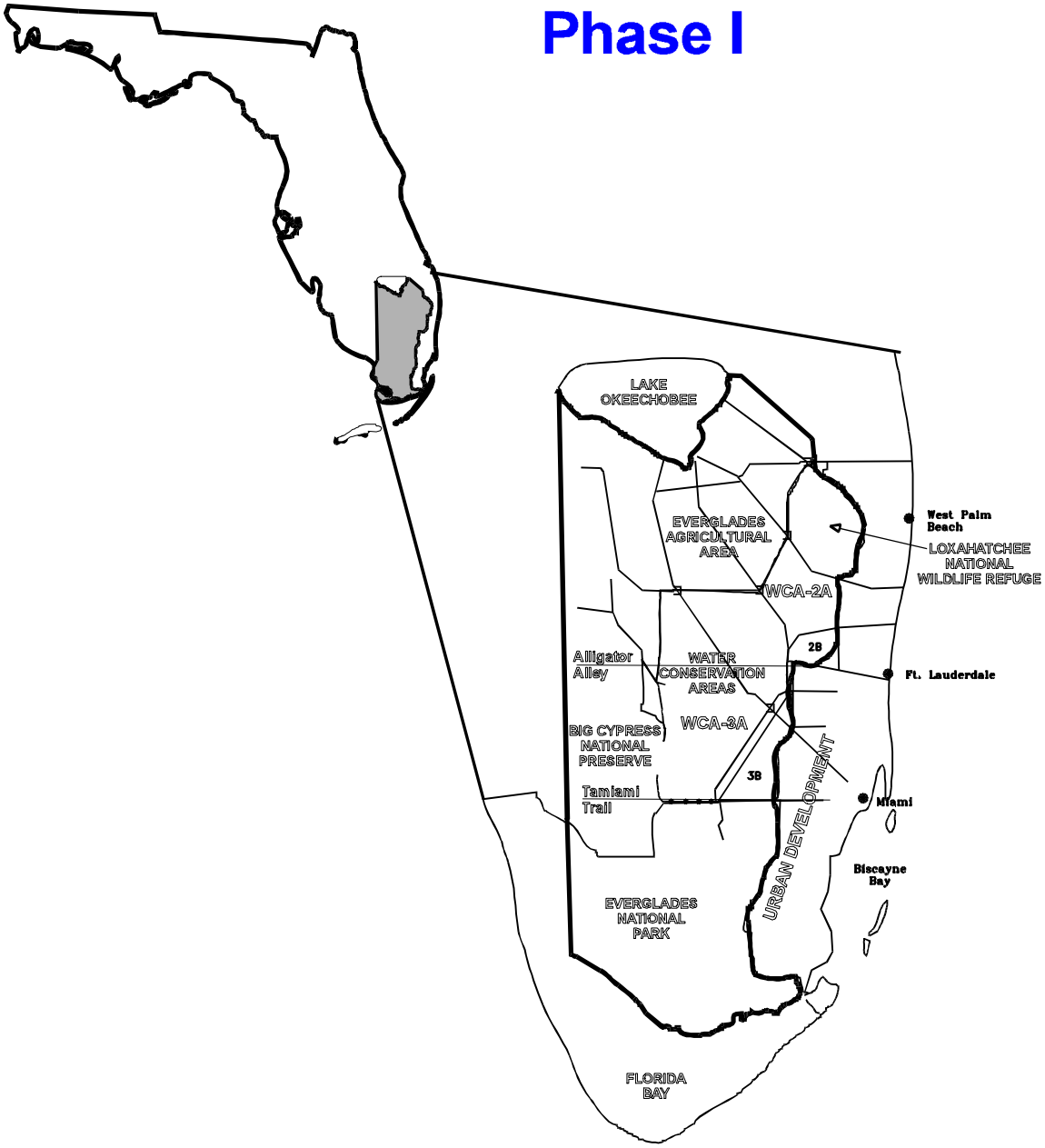

Monitoring for Adaptive Management: Implications for Ecosystem Restoration

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SOUTH FLORIDA ECOSYSTEM ASSESSMENT

MONITORING FOR ADAPTIVE MANAGEMENT: IMPLICATIONS FOR ECOSYSTEM RESTORATION

Final Technical Report - Phase I

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EXECUTIVE SUMMARY

The South Florida Ecosystem Assessment Project is an innovative, large-scale monitoring and assessment program designed to measure current and changing conditions of ecological resources in South Florida using an integrated holistic approach. Using the United States Environmental Protection Agency (EPA 1992) ecological risk assessment framework as the foundation, the ultimate goal of this program is to provide decision makers with sound ecological data needed to improve environmental management decisions for the restoration of the Everglades ecosystem. Furthermore, through an ecological risk assessment approach, the South Florida Ecosystem Assessment Project addresses multiple issues that are thought to be critical to the restoration of the Everglades ecosystem and addresses the interactions among issues. These issues include mercury contamination, eutrophication, marsh habitat alteration and hydroperiod modification. Guided by a set of policy-relevant questions, this project strongly supports the federal and state Everglades restoration efforts and provides a means to evaluate present and future management actions.

A statistical Environmental Monitoring and Assessment Program (EMAP) survey design was used to select 200 canal and 500 marsh sampling stations within the 10,000 km^2 (4000 mi^2) Everglades ecosystem. A quarter of these sampling stations were sampled during successive wet and dry seasons from 1993 to 1996. The data collected at these sampling locations permits quantitative estimates of the relative risk to the ecological resources from the multiple interacting environmental stressors.

Among the key findings: water discharged from Everglades Agricultural Area canals is loading the public Everglades with excess phosphorus, carbon and sulfur; from 1993-1996 about 44% of Everglades canals had total phosphorus concentrations exceeding the Phase I 50 parts per billion control target, as compared to 4% of the marsh area; from 1946 to 1996 portions of the public Everglades lost substantial amounts of peat soil due to drainage and subsidence - northern Water Conservation Area 3A and Northeast Shark Slough may have lost over 50% of soil depth; and about 65% of the marsh had prey fish mercury concentrations that exceed United States Fish

and Wildlife Service 100 parts per billion guideline for protection of predators such as wading birds.

Synoptic monitoring of canal and marsh populations during wet and dry seasons was designed to determine the extent and magnitude of total mercury (THg) and methylmercury (MeHg) in water, sediment/soil, and mosquitofish *(Gambusia holbrooki)* in conjunction with associated water quality and hydrologic parameters. Factor and principal component analyses of canal and marsh data partitioned THg in fish and MeHg in water as two independent components, with total phosphorus (TP), total organic carbon (TOC), and total ionic sulfate (TSO_4) aggregated as a third component accounting for the variance in THg in fish. Statistically significant north to south spatial gradients in these constituents were observed. The interactions among these constituents along this gradient correlated well with the extent and magnitude of Hg contamination in the Everglades.

In order to further synthesize and integrate the interactions of these variables, the central Everglades flowway was parsed by latitude into seven units averaging approximately 27 km in length (north-south) over a total distance of 189 km. Latitudinal parsing of the data aggregated the subtle patterns in plant and floating periphyton responses relative to TP concentrations in the system. These data indicated that TP affects emergent plant communities, floating periphyton presence, aquatic habitat and food web complexity, which in turn affect microbial activity, mercury methylation, biodilution and bioaccumulation of MeHg in the system.

The canal data appear to indicate that mercury interactions with TOC and TSO_4 and biodilution of Hg in mosquitofish where TP concentrations were high resulted in lower mosquitofish Hg concentrations north of Alligator Alley. However, south of Alligator Alley, where TP, TOC and TSO_4 concentrations declined, there was increased bioaccumulation of Hg in mosquitofish and periphyton, until TP declined to a median of 14 ug/L, when both biodilution and bioaccumulation of Hg declined. These data suggest that high MeHg concentrations in water in the northern Everglades did not lead to high THg in mosquitofish (THg in mosquitofish = 95% MeHg) due to interactions with other constituents, biodilution, and associated changes in the food chain.

The marsh data were more definitive in suggesting the interactions between mercury, TOC, TSO_4 and Hg biodilution north of Alligator Alley. As median TP declined from 16 to 12 ug/L progressing north to south, however, the median Hg concentration in mosquitofish nearly doubled to 208 ug/kg and remained high southward through northern Everglades National Park (ENP). However, as TP continued to decline (median = 8.6 ug/L) the Hg concentration in mosquitofish declined to 156 ug/kg in the southern portion of Everglades National Park. Median MeHg concentrations in water declined north to south in both canal (i.e., 0.3 to 0.06 ng/L) and marsh (i.e., 0.54 to 0.15 ng/L) habitats indicating higher methylation occurred in the marsh. The marsh median mosquitofish bioaccumulation factor (BAF) for Hg increased from 0.6×10^5 in the north to 8.5×10^5 in the southern portion of ENP indicating an increasing bioaccumulation efficiency in the food chain from north to south. THg in periphyton, great egrets, and mosquitofish also was spatially correlated with a Hg "hot spot" between Alligator Alley and Tamiami Trail. The stimulatory effects of TP on the plant communities and the methylating microbes appears to be a key component in mercury contamination.

The problems facing the Everglades ecosystem are not independent; they are highly interactive. Management approaches to restore the Everglades ecosystem, therefore, should be coordinated so that a system-wide approach is taken. Without this perspective, approaches that focus on a single problem or problems at a single location might, in fact, correct one problem while exacerbating other problems in the Everglades.

Phase II of the South Florida Ecosystem Assessment Project is scheduled to begin in 1999. Time series monitoring will identify changes occurring since Phase I 1993-1996 data collection. Increased emphasis will be placed on vegetation, phosphorus and mercury assessment, providing data for input to various ecosystem models such as an Everglades mercury cycling model under development by the EPA Office of Research and Development.

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