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BEYOND THE ESTUARY:
The Importance of Upstream Wetlands in Estuarine Processes

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BEYOND THE ESTUARY: THE IMPORTANCE OF UPSTREAM WETLANDS IN ESTUARINE PROCESSES

WHICH WETLANDS ARE IMPORTANT TO THE ESTUARY?

Coastal, brackish, and freshwater wetlands all perform important functions affecting estuarine processes. In addition to their aesthetic appeal, coastal wetlands have well-known functions including habitat for wildlife, spawning and feeding grounds for fish and shellfish, flood protection, pollution removal, shoreline erosion control, and recreation.

The relative importance of the networks of wetlands located above estuaries has not been as widely recognized. These wetlands include bottomland hardwoods, riparian forests, bogs, vernal pools, and emergent marshes. These networks are often extensive and can have a significant impact on the quality and functions of the downstream estuary.

The cumulative effects of all of these areas should be considered in discussions of estuarine processes and impacts. The benefits these inland wetlands provide should be factored into estuary management decisions. In addition, restoration of previously altered wetlands along the network of streams and tributaries may provide a solution to many of the problems in the estuary itself.

WHAT FUNCTIONS DO THESE AREAS PERFORM?

Upstream wetlands perform various functions within a given watershed:

- greatly influence the water quality of adjacent river or stream by removing pollutants such as sediments, nutrients, and organics/inorganics
- increase detention time of floodwaters thereby reducing flow velocity, erosion, and flood peaks in downstream areas
- provide habitat for wildlife including waterfowl, mammals, and unique vegetation
- serve as spawning and nursery grounds for many estuarine and marine species of fish
- contribute to the aquatic food chain by providing detritus (decaying organic matter) to the biota of the adjoining waters
- prevent excessive water temperatures during summer months which could be lethal to invertebrates or fish

HOW DO THESE FUNCTIONS TRANSLATE TO ESTUARINE PROCESSES?

Water Quality

The estuarine system is complex and highly dependent on the balance of its many components. The organically rich water and sediments within the estuary, in their proper proportions, support a myriad of aquatic plant and animal life. During periods of minimal rainfall in the estuarine zone, the quality and quantity of inflowing freshwater from upstream tributaries becomes even more crucial. Without the pollution removal function of upstream wetlands, the estuary could be adversely affected in several ways:

- High levels of nitrogen and phosphorus (plant nutrients) could be transported from upstream areas to the estuary. This often results in high algal standing crops (algal blooms) which greatly reduce the level of available oxygen which can cause massive fish kills

- Transported pollutants such as pathogens and toxics could impact the estuary unless upstream areas trap and absorb these substances

- Beneficial levels of nutrients and sediments would not be available for estuarine systems if stream flow is decreased or stopped altogether, or if stream flow is channelized sending nutrients to deeper, offshore waters.

Riparian forests, in particular, act as nitrogen sinks and reduce the load of nutrients from agricultural lands (Peterjohn and Correll, 1986). Conversion of forested areas to agriculture has resulted in decreased surface water salinity, increased turbidity, and increased phosphorus, nitrogen, and ammonia concentrations in the adjacent tributary (Kirby-Smith and Barber, 1979). Within the normally saturated soils of riparian forests, the process of denitrification permanently removes excess nitrogen in surface runoff and shallow groundwater. Although storage of nitrogen and phosphorus by riparian vegetation is mostly temporary, these nutrients are transformed in a way that makes them less likely to support nuisance algae in downstream estuaries (Elder, 1985).

How can water quality be altered?

In discussions of water quality, it is important to remember that some factors have the potential to be both favorable and detrimental. There are levels of certain nutrients, sediments, or biota that are tolerable or essential to the overall productivity of the estuary or other waterbody, yet, when these levels are surpassed, these same materials may prove toxic or detrimental. Generally, water quality can be affected in several ways:

- Addition of artificial materials
- Alteration (increase or decrease) of the "normal" levels of naturally occuring materials
- Addition of natural materials which prove toxic or detrimental when combined with naturally occurring materials

The first 19 - 20 meters of the wetland, immediately below the source of contaminated nonpoint runoff, may be the most effective filter, both in riparian systems (Peterjohn and Correll, 1984; Correll and Weller, in press) and in salt marshes (Hook and Brinson, 1989). Similarly, studies of bottomland hardwood wetlands have indicated that when a significant proportion

of the watershed is converted to agriculture, stream concentrations of phosphorus tend to increase (Gosselink and Lee, 1987).

Water Regime

The ability of wetlands to temporarily store floodwater plays an integral role in the flow of freshwater to the estuary. These natural functions are commonly hindered by structures, such as dams and levees, which are designed to do just the opposite—manage flow and define direction. Constructed levees result in the increased height of the inflow downstream because flood waters are not able to overflow the natural banks of the river or stream. Such alterations may cause essential constituents to be deposited into deeper offshore waters where they will not be available for estuary processes. Along the Mississippi River, early modifications to upstream areas to control flooding increased flow velocity making it necessary to construct similar structures downstream closer to the estuary.

The Charles River Basin, on the other hand, still remains a prime example of controlling flooding using the natural process of watershed wetlands. This flood control project was developed by the U.S. Army Corps of Engineers and involved setting aside upstream wetlands for floodwater detention along the Charles River in eastern Massachusetts. These wetlands allowed the river to overflow in upstream areas, thus, decreasing the velocity and height of the floodwaters in the more highly populated areas downstream. This method was found to be not only the most effective means of flood control, but also the most economical.

Habitat

The importance of freshwater wetlands in providing habitat for numerous species of waterfowl, fish, and invertebrates, including many rare and endangered species, is well known and well documented (Niering, 1988).

Many species are dependent upon both estuarine and freshwater wetlands during different stages of their life cycles. Waterfowl, for example, adapt to seasonal food supplies during their migration patterns by exploiting a variety of habitats, using freshwater inland marshes during breeding and coastal marshes during wintering (Bellrose and Trudeau, 1988). Prevett et al. (1985) found that Canada geese (*Branta canadensis*) in James Bay made daily trips between the coastal marshes where they fed and the adjacent muskeg areas where they nested. Further, Fredrickson and Drobney (1977) found a definite tendency for waterfowl to shift from unstable freshwater areas utilized during breeding to more stable, permanent wetlands and marine areas in the winter. In their review of tidal freshwater marshes, Odum et al. (1988) reported that in many cases a large number of freshwater, estuarine, marine, and anadromous fish and invertebrates utilized these areas as nursery sites before moving downstream to the estuary.

In recent years, movement among habitats has become increasingly difficult due to various habitat modifications including reservoirs, hydroelectric dams, and stream alterations, as well as loss of wetland habitat to development and agriculture. Habitat enhancement measures, such as fish ladders, are a component that increasingly needs to be addressed when viewing estuarine processes on a watershed level.

Sediment Load

The role of wetlands as sediment sinks has been well documented (Gosselink and Lee, 1987; Tiner, 1984). Due to their low slope and position downslope from uplands, wetlands such as bottomland hardwood

forests can remove moderate amounts of sediment from turbid runoff without ecological damage. As upstream areas are altered, sediments are often left exposed. This makes them highly susceptible to the effects of erosion which result in increased loads of sediment to adjacent streams or rivers and, ultimately, to the estuary. Upstream vegetated wetlands also stabilize soils along the banks of rivers and streams which helps control the volumes of sediment transported downstream (Mahoney and Erman, 1981).

The turbidity caused by suspended sediments affects estuarine waters in several ways. High turbidity can interfere with the recreational aspects of the watershed making water contact sports or fishing undesirable. The amount of light available for aquatic plants is significantly reduced which is detrimental to many species. As excess sediments settle, bottom dwelling organisms may be adversely affected. Finally, high turbidity can adversely affect fish spawning. In larger quantities, loads of sediment can change the pattern of stream flow, fill a channel, or raise the level of the channel bed which increases the chance of flooding.

Furthermore, upstream wetlands reduce the amount of toxic laden sediment particles that might otherwise be transported to the estuary as well as produce organic substances which reduce the toxicity of heavy metals to estuarine life (Sugai and Burrell, 1984). Even though sediment transport is an important factor in building and maintaining some coastal wetland areas, as with nutrients, there exists a delicate balance which is ideally regulated by the upstream wetlands.

HOW ARE UPSTREAM WETLANDS THREATENED?

There are many threats to these wetland resources due to physical, chemical, and biological impacts. As more and more people occupy the watersheds of the nation, these areas become more susceptible to alterations.

- The practices of clearing, draining, and filling wetlands for agriculture continue. When an agricultural area is cultivated right to the edge of a river or stream, runoff of agricultural chemicals or pesticides increases. As these chemicals are deposited into the tributaries, the chances of transport to the estuary are greatly increased. In addition, some timber harvesting practices, such as clear cutting, may significantly degrade wetlands.

- Development and other activities in urban areas continue to pose threats to wetlands. The most obvious impacts are filling or draining wetlands for development. Urbanization of these areas has introduced high levels of nutrients, toxics, and sediments into upland runoff. Toxic input has also been traced to industrial plants, domestic sewage, hazardous waste sites, illegal dumping, pesticides, oils, and heavy metals from urban runoff, petroleum hydrocarbons from oil exploration and production, and spraying of herbicides for aquatic weed and insect control. Even though wetlands have been identified as a potential filter for pollutants, the long term effects of

the indiscriminate introduction of substances to these ecosystems have not been determined.

- Levees for flood control and water supply may completely eliminate some wetlands and may substantially change water flow patterns. In some instances, the presence of these structures has completely eliminated freshwater inflow thus upsetting the delicate balance of the brackish environment which is characteristic of the estuarine ecosystem.

- Other channel alterations such as dams, channel diversion structures, and linear canals all contribute to the limitations placed on wetlands in the natural functions they perform.

WHAT CAN WE DO?

The wave of awareness is growing. Increasingly, estuarine and wetland environments are receiving recognition as delicate ecosystems deserving our protection and restoration. By promoting this awareness we can coordinate our efforts in the comprehensive management, protection, and enhancement of the upstream wetlands and the estuaries.

Estuary resource advocates have already begun developing a network to address the problems and concerns relating to these areas. One recently established mechanism is EPA's National Estuary Program (NEP) which goes through a process of identifying problems, setting goals, selecting options, and developing action plans. Through the expansion of this network, awareness of the role of upstream wetlands to estuarine systems can be increased. Since many of these areas are privately owned, we must also increase citizen involvement and seek support on a watershed basis, not just at the site specific level.

Limitations in our current understanding obviously exist. However, we must join together to improve our understanding of the complexities of the systems—both ecologically and politically—to effect change. Here are some steps to improve protection of these vital resources:

Resource Assessment

- Locate the wetlands along rivers and streams which eventually feed into the estuary of concern

- Identify the wetland types

- Map out the wetlands to allow a landscape understanding of how they work within the watershed

- Use historical data (if available) to determine the extent and location of wetland losses and associated problems

- Assess the value of remaining wetlands

Planning

1. Incorporate wetland protection into the NEP estuary planning conference or through other federal, state, regional, and local planning processes such as:

   - Special Area Management Plans (authorized under the Coastal Zone Management Program)

- Multi-Objective River Corridor Management Plans (supported by the National Park Service)

- Advance Identification (conducted by EPA and the Corps of Engineers)

- Critical Habitat Plans (authorized by the Endangered Species Act)

- Statewide Comprehensive Outdoor Recreation Plans (state acquisition plans prepared for Fish and Wildlife Service)

- Regional or local zoning and land use plans

2. Use such planning approaches to coordinate wetlands protection tools on the local, state, and federal levels within the watershed

Regulation

- Enhance the wetland protection afforded by the Section 404 Clean Water Act federal regulatory program

- Develop state regulatory programs designed explicitly to protect wetland areas as they relate to the entire watershed

- Improve the wetlands protection potential of states' existing authority under Section 401 of the Clean Water Act to certify that a federal permit or license will comply with state water quality standards

- Incorporate wetland protection measures into local and regional zoning provisions

Restoration and Acquisition

- Develop restoration and acquisition strategies, including funding mechanisms, and incorporate these components into local comprehensive plans

- Identify opportunities for restoration of wetland sites or upstream embankments as one solution to problems in the estuary downstream

- Encourage farmers in the watershed to enroll their cropped wetlands into the Conservation Reserve Program. Also encourage farmers to participate in exchanges of debt, or grant conservation easements, where allowable, to permanently protect wetland resources

Public Education / Awareness

- Promote values of wetlands through the community including local schools

- Start an "Adopt A Wetland" program for citizen monitoring of key wetland areas

Additional information on these wetland and estuary protection measures can be obtained from the EPA regional offices or from other agencies and organizations listed in the back of this brochure.

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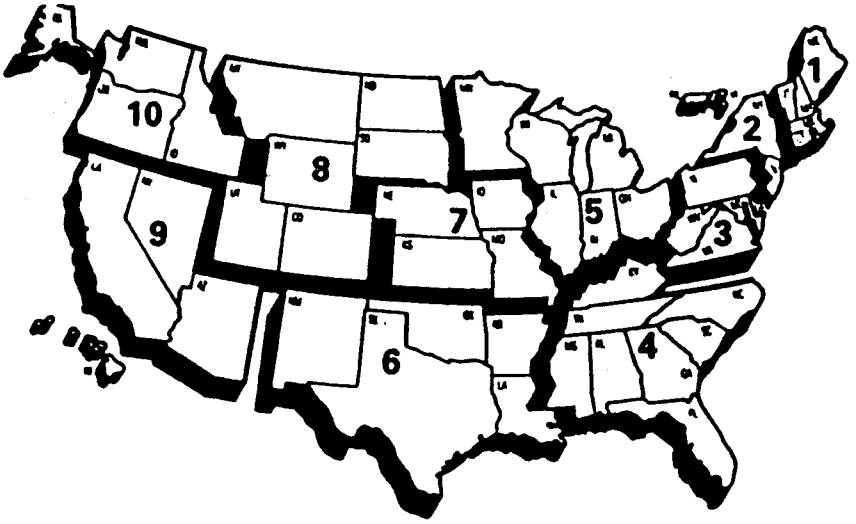

For more information, ask for the Wetlands Coordinator or the Estuarine in any of these EPA regions:

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Additional information can also be obtained from:

U.S. Fish & Wildlife Service
U.S. Army Corps of Engineers
Soil Conservation Service
National Marine Fisheries Service
Association of State Wetland Managers
American Planning Association
Society of Wetland Scientists
State Resource Agencies and State Departments of Environmental Protection