

Procedures For Evaluating Wetlands Non-Market Values and Functions

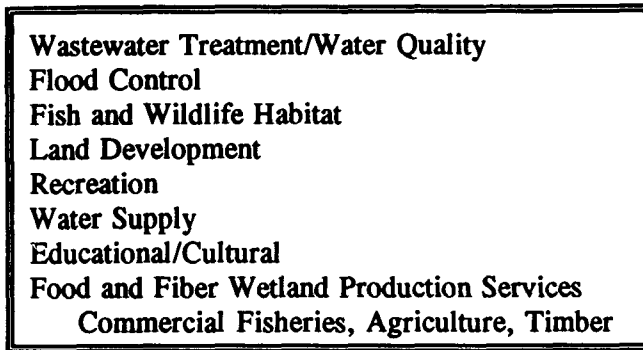
PURPOSE: This technical note provides a procedural framework for evaluating the economic values of wetlands. Important economic concepts on supply/demand and valuation are presented as they relate to the economic values supported or provided by wetlands. The framework presented here can be used to evaluate economic values within the Section 404 process, while recognizing the difficulties of wetland valuation. Economic values of wetlands have been difficult to evaluate due to uncertainties in the relationship between wetland functions and the production of goods and services. Production of some wetland goods and services is better understood than others. Just as there are changes over time in wetland habitat and other functions, economic values of wetlands change over time and should be accounted in the Section 404 evaluation process.

BACKGROUND: Wetlands perform many functions that provide goods and services to society and have economic value (Shabman and Batie 1988). To be of economic value, there must be a demand for the good or services. However, providing the good or service alone does not result in economic value if there is no demand. Goods or services may be in over-supply or available at no cost. Consequently, only those goods or services for which there is demand have economic value.

The focus of wetland assessment within the context of the Section 404 Program is the determination of the effects of a proposed action on a wetland site. For economic considerations, this focus must be expanded because the economic values associated with a single site are determined, in part, by the affected area's relationship to local, regional or larger economic conditions. To assess the potential for economic value, the relationship and significance of the wetland site's economic services within the larger economic context must be established. Information in this technical note provides the basis for establishing the potential relationship between an affected wetland and the market and other economic conditions that determine its economic value, as previously outlined in an internal working document. Henderson, J.E. 1991. "A Conceptual Plan for Addressing Wetland Economic Values," U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

EVALUATION FRAMEWORK: A quantitative dollar and cents evaluation is not possible with, nor the intent of, this framework. Depending on the particular wetland and functions being assessed and other available information, a determination of economic value can be made in some situations. In most cases, this information then will form the basis for more in-depth data collection and analysis. Goods and services provided by wetlands are shown in Figure 1. The relationship between functions and economic goods and services is summarized in Table 1.

Those wetland functions possessing high functional capacities can be related to economic goods and services by examining the relationships in Table 1. Wetland functions are listed in column 1. The value of the function to society, that is, the importance and significance of the function, is briefly described in column 2. After the assessment, those functions with high functional capacities (col. 1) should be examined to determine potential economic value by relating them to the goods and services (col. 3, Table 1). Information on the goods and services as described below can assist in determining



whether economic values exist. "Supply/demand" information describes how goods and services are provided to society and their relation to local, regional, or larger contexts. Information on "valuation considerations" explain the technical basis for determining economic value. Information about markets and other data that is not a part of the functional assessment will be needed to complete the economic evaluation. Table 2 summarizes the information needs and additional sources.

Figure 1. Economic Goods and Services

- **Wastewater Treatment/Water Quality.** Evaluating the economic benefits for water quality requires determining the value of improved water conditions. These benefits can be determined by establishing relationships between inflow sediment and pollutant characteristics, storage capacity, sediment retention and nutrient transformation capacity. The construction and other costs associated with providing alternative water quality treatment can be used to value the water quality improvement attributable to the wetland.

Key Considerations are areal scale of changes in water quality services; i.e., assessment of whether the changes in water quality at the wetland is significant to the overall water quality of the watershed or basin, or whether the loss of water quality is a localized effect; structural and non-structural water quality measures; and appropriate water quality standards.

Demand/Supply Considerations are magnitude and areal extent of effects on downstream water quality; changes in sediment, nutrient, and other water quality parameters for downstream reaches; contribution and significance of affected wetland to localized water quality.

Valuation Considerations where $\text{Value} = (\text{Cost of using alternative}) - (\text{Costs of using wetland})$. Value of wetland water quality services requires identifying the alternative means (e.g. structures, treatment) and costs to provide the same level of water quality improvement provided by the wetland. Costs of continued use of an unaltered wetland may be negligible, but there may be opportunity costs for not using the wetland for other benefits, e.g. habitat, which may be incompatible with wastewater treatment/water quality services.

- **Flood Control.** Evaluation of flood control benefits requires estimating flood damages with and without the wetland's flood control capacity. These benefits can be determined by establishing the relationships between wetland flood storage capacity and flood damages downstream, and the costs of providing alternative flood control structures or provisions for flood control.

Key Considerations: Existing structures, floodplain measures, and plans for flood control may provide adequate level of flood control; i.e. wetland storage may not be needed (demanded) for flood protection, and may therefore not be of economic value. Wetland storage may be a localized effect, not significant on a watershed or regional scale.

Table 1. Relationship of Wetlands Functions to Economic Goods and Services		
Functions	Value of Functions	Economic Goods and Services
Detain, remove, and transform contaminants	Maintain surface and groundwater quality	Wastewater treatment/water quality
Detain and remove sediments	Maintain surface water quality	Wastewater treatment/water quality
Provide ecosystem, landscape and global integrity	Maintain ecosystem, landscape, and global processes	Educational/Cultural Habitat
Provide wetland ecosystem structure	Maintain populations of wetland dependent plants and animals species, preserve endangered species, maintain biodiversity, provide dispersal corridors	Fish and wildlife habitat
Provide a setting for cultural activities	Produce food and fiber, provide recreational opportunities, provide education and research opportunities, provide aesthetic enjoyment, preserve archaeological/historic sites	Commercial fisheries; agriculture, timber, peat production Education/Cultural
Store surface water	Reduce flood-related damage	Flood control
Reduce the energy level of surface water	Reduce erosion from storms and floodwater	Land development
Recharge groundwater	Maintain pumpable supplies of groundwater	Water supply
Discharge groundwater	Maintain stream and lake water levels	Water supply
Stabilize soils	Reduce erosion of shorelines and streambanks from storms and floods	Land development
Detain, remove, and transform nutrients	Maintain surface and groundwater quality	Wastewater treatment/water quality

Table 2. Information Needs	
Available from Wetland Functional Assessment	Not Available from Wetland Functional Assessment
<p><u>Wastewater Treatment/Water Quality</u> Sediment and contaminant retention and transformation capacity Water storage capacity</p> <p><u>Flood Control</u> Storage Capacity Downstream land uses and floodplain</p> <p><u>Habitat</u> Habitat types affected Threatened and endangered species habitat affected</p> <p><u>Land Development</u> Size, configuration of affected wetland Proximity to roads, infrastructure</p> <p><u>Recreation</u> Areal extent of recreation resource Habitat quality to support consumption, i.e. hunting and fishing Indication of types of possible recreation activities possible</p> <p><u>Water Supply</u> Potential of wetland to discharge and recharge groundwater Hydrology and groundwater relationships</p> <p><u>Educational/Cultural</u> Screening for Red Flags Access to the affected wetland Scarcity/Abundance of affected wetland type Vegetation, landform, water components and other factors important for visual quality assessment Public review comments on issues of proposed action</p> <p><u>Food and Fiber Wetland Production</u> Land uses and patterns Habitat, vegetation, soils and information important for evaluation of production potential</p>	<p><u>Wastewater Treatment/Water Quality</u> Regional water quality, wastewater treatment plans Costs of structural alternatives</p> <p><u>Flood Control</u> Areal extent of flood protection provided by wetland Flood damage estimates</p> <p><u>Habitat</u> Plans and costs for replacement of wetland</p> <p><u>Land Development</u> Land market (real estate) transaction data Plans and costs for replacement of wetland</p> <p><u>Recreation</u> Supply of regional recreation resources and significance of affected wetland (quantity and quality) for regional resources Recreation user characteristics: Distance traveled and travel costs Age, income, and other demographic distributions Mix of types of recreation use Institutional considerations on demand, e.g. bag and catch limits, hunting and fishing seasons Willingness to pay values</p> <p><u>Water Supply</u> Existing infrastructure for providing water supply Engineering or other alternatives and costs for water supply</p> <p><u>Educational/Cultural</u> Public concerns regarding local and regional wetlands, historic values and aesthetics State and local laws and policies regarding Red Flag issues</p> <p><u>Food and Fiber Wetland Production</u> Regional production patterns Market specific information, e.g. market prices, production costs</p>

Supply/Demand Considerations are areal extent of flood protection provided; importance and value of downstream land uses, e.g. agriculture, residential or urban development; existing flood control or storm surge projects providing flood protection to the same area; existing comprehensive flood control/floodplain protection plans or programs; and possible induced private or public development actions (construction, regulation) if flood storage were reduced.

Valuation Considerations where $\text{Value} = (\text{Value of flood damages without wetland storage}) - (\text{Value of flood damages with wetland storage})$, require determination of aerial extent of flooding with and without the wetland storage and valuation of flood losses under the above with and without conditions.

- **Fish and Wildlife Habitat.** A number of wetland functions support wetland fish and wildlife habitat services that may have economic value as existence, preservation and bequest--the nonuse values; and habitat as input to other economic values of recreation, educational/cultural, and production services--use values considered elsewhere in the text. Little work has been done to estimate the economic benefits of the nonuse values, with most of the effort on quantifying habitat quality.

Key Considerations are scarcity of habitat types and importance/significance of habitat on a landscape, ecosystem, or regional basis; the ability to effectively create substitute wetlands through construction or restoration; and altered wetlands may also provide (or be managed to provide) habitat.

Supply/Demand Considerations are areal extent and significance of affected wetland habitat in local, regional or ecosystem context; habitat quality of affected wetland; importance of affected habitat for species life stages or migration; habitat for threatened or endangered species; availability of replacement habitat; and feasibility, in terms of available technology, and success associated with replacement of the particular habitat type.

Valuation Considerations where $\text{Value} = \text{Costs of a substitute for the habitat services}$. Costs associated with monitoring and maintenance should be included with the engineering and other construction costs. Although there is increasing information on costs of substitutes (necessary for valuation) through creating, constructing, or replacing wetlands, there is uncertainty in the ability of substitute wetlands to successfully or effectively replace the affected functions or habitat. Evaluation should include ability to ensure substitute will actually provide the same habitat.

- **Land Development.** Pressures for changes in land use often result in the conversion of wetlands to agricultural, forestry, urban, and water based residential uses. Agricultural and forestry uses (considered elsewhere in this text) are often a transitional stage in the conversion to urban uses. The aesthetic and waterfront location amenities of wetlands result in extensive pressure to convert wetlands to residential development. Valuation of residential land development is possible because markets exist for residences.

Key Considerations are residential land sale transactions or real estate appraisals can be used to value land development; the services provided by unaltered wetlands, e.g. habitat, educational / cultural, should be considered as well as the services that could be provided by modified development to minimize impacts or losses; and value of wetland characteristics must be isolated from the value of any existing improvements.

Supply/Demand Considerations are availability of non-wetland sites, with similar amenities, for development (in some areas, wetlands may indeed offer the only site for waterfront and other amenities); existence and stability of a functioning local land market; and historic change in prices, i.e. whether or not any dramatic changes in land market has occurred in recent time period indicating increased demand.

Valuation Considerations. Both approaches depend on identifying feasible alternative development plans that reduce the need for wetland conversion. If a non-wetland alternative for development exists, $\text{Value} = (\text{Value of wetland development site}) - (\text{Value of next best alternative})$ and if no development alternative exists, $\text{Value} = (\text{Sale price of developed lot}) - (\text{Cost of developing the lot})$.

Two approaches, hedonic valuation or appraisal methods, may be used. Both are based on the market value of wetland residential development sites; hedonic approach requires enough market transactions to develop a statistical model.

Hedonic valuation studies identify and value different characteristics of wetland development sites and quantify the importance of development site characteristics to the market value of wetland residential sites. Site characteristics important to development are categorized as site amenities, location factors, and historical factors; examples are site amenities, lot size; level of waterfront amenities, such as linear fee of water frontage, whether the lot isolated on a natural bay or a man-made channel; proximity to unaltered wetlands; market value of improvements; location factors, location advantage provided to residence by proximity to shopping centers and other public services; and historical factors, change in general price levels in local or regional real estate markets.

In comparing the value of substitutes, comparability of identified alternatives should ensure the lots are really comparable in terms of the wetland based amenities and are not actually alternative development sites with different types or levels of amenities; consideration of value of improvements to development sites should include only site development and improvement for a building site. Modifications of a land parcel beyond that required to prepare the site to a minimum standard necessary to provide residential housing services should not be included. Extensive wetland site modifications do not contribute to the net development value of a wetland area as they provide services that are not unique to the wetland development.

Appraisal methods use the expected sale price for residential parcels to estimate the value of wetland development. The market comparison appraisal approach uses data from comparable parcels to infer the market value of a lot. Land market sales records, tax records, and local real estate experts can be used to support this method. Establishing comparable sales requires that adequate market data be available. An alternative appraisal method is the replacement cost method which establishes market value for replacement of the physical aspects of the site; that is the cost of building on another equivalent wetland site.

- **Recreation.** Wetland areas support recreation for consumptive, i.e. hunting and fishing, and non-consumptive purposes, e.g. wildlife viewing (considered under Educational/Cultural). Recreation use is determined in part by the biological productivity of the wetland in producing game species, and by available access and size of the recreation area, both of which are available from a regulatory application. Additional determinants of demand are demographic characteristics, e.g. age, income, travel time; experiential aspects, e.g. years of recreation experience, importance of bag or catch to the user, congestion at the recreation site; and institutional constraints on bag or catch limits and season length.

Valuation of recreation for regulatory actions should include identification of types and extent of recreation occurring in the larger region; assessment of the quantity and quality of the recreation resources at the site; identification of possible alternative sites for activities; and estimation of future recreation both with and without the proposed development, with consideration being given to recommending modified development, that is, incorporation of recreation opportunities, e.g. access, in development plans.

Key Considerations. Evaluation requires certain assumptions about the relationship between recreation use and wetland habitat and other resources. These relationships are required to predict changes in recreation use in response to development.

Demand/Supply Considerations. The assessment procedure should determine the magnitude and significance of changes in available recreation resources due to development of the wetland area. There may be substitutes for the range of wetland recreation activities at different sites. Displaced recreation may move to other under-used areas or cause overuse at already congested areas; these conditions should be considered in the evaluation. Supply can be assessed in terms of quantity of recreation resources, e.g. number of acres; quality of the resources, including quality of access. Demand is usually approximated by the complex interactions of wetland resource attributes; user characteristics which act as demand shifters are such things as taste, preferences, income, hunting or fishing success; institutional constraints; and the availability of appropriate substitutes or alternatives. General information on existing recreation use may be available from state or local fisheries and wildlife management agencies.

Valuation Considerations where Value for wetland recreation at a site = (willingness to pay (WTP) to recreate at the wetland site) - (WTP for same activities at next best alternative). This formula requires identifying alternative recreation sites and evaluating WTP values for both the affected wetland and for the substitute.

Accepted valuation methods for WTP are the travel costs method that uses costs of travel and time as proxies for WTP; the contingent valuation method in which users respond to proposed wetland recreation conditions; and the Unit Day Value Method which assigns a standardized value to the quality and other characteristics of recreation resources.

- **Water Supply.** The ability of wetlands to recharge and discharge groundwater can provide water supply services. There are few documented uses of wetlands for water supply due to uncertainty in interactions between wetlands and groundwater and in the capacity to use wetland water supplies without damaging the wetland itself. Better understanding of wetland hydrology and wetland-aquifer interactions may change demand for wetland water supply services. Engineering costs for providing water supply are generally available and can be used to value the costs of alternatives for wetland water supplies.

Key Considerations. Valuation of wetland water supply is dependent on establishing demand or need for the water; relationship between affected wetland area and the local groundwater supply; and valuation of the alternatives or substitutes for the wetland water supply.

Supply/Demand Considerations. In many areas, wetlands serve as secondary, rather than primary, water supply sources. Evaluation requires establishing the extent of potential local or regional demand for the wetland water. Groundwater recharge and discharge capacity and areal and hydrologic measurements can be used to determine potential water supplies, but these must be

compared to the demand for additional water. Local or municipal water supply agencies provide information on existing supply and costs.

Valuation Considerations. Valuation is determined by the availability of alternative water supply. If no alternative exists for the wetland water supply services, Value = value of the water supply to the consumer. If alternatives exist, Value = (costs of development of wetland water supply) - (costs of development of alternative water supply sources).

Evaluating differences in costs between the wetland and an alternative water source entails determining the costs of alternative sources and then comparing those costs to those of the wetland source. Identification of the least cost alternative is not straightforward since little use and costs data for wetland water supplies exist. Engineering and hydraulics personnel can provide development costs for alternative water supply, and public utility records can be used for unit costs of water.

- **Educational/Cultural.** Educational/cultural goods and services provided by wetlands are based on the significance of wetlands for human uses and preservation. Educational/cultural services are composed of natural, scenic, or aesthetic values; historic, archaeologic, or public use values; and non-consumptive recreation values, e.g. bird watching (consumptive recreation is covered in recreation). Monetary valuation is not normally attempted or appropriate. Rather, significance or technical ratings of quality are determined for the components.

Key Considerations. It is often difficult to separate educational/cultural services from the provision of other goods and services, e.g. flood control. These values derive from the existence of the wetland in a natural or undisturbed state, rather than the value derived from some use of the wetland.

Supply/Demand Considerations. Visual quality characteristics and potential for recreation in the affected wetland are evaluated in terms of regional scarcity and quality. The question is "Are the visual and recreational resources unique or scarce, and will there be a significant loss with development?" The visual quality is determined by the relative uniqueness of vegetation, water, landform, etc, and whether these visual characteristics are unique or abundant in the region. For recreation, wetland size, public access and use, and availability of substitutes in the region must be considered. Historic and cultural resources must be identified and their significance determined, if present. The wetland may be of cultural significance because of its role in providing food, fiber and other necessities for groups engaged in subsistence economies.

Valuation considerations consist primarily of visual quality applications. Wetlands provide visual diversity in upland and especially urban environments. Wetland aesthetics have been evaluated and show variation between regions. Studies have related wetland characteristics to overall visual quality with varying levels of success. Other things being equal, people prefer open water/marshy wetland areas to thickly vegetated shrub/woody swamps where visual access is impaired. Visual quality is related primarily to the shape of the upland wetland edge, the vegetation/water interspersion pattern, and pattern or relation of types of vegetation or vegetation classes. Shape of wetland/upland edge: Irregular, non-straight line edges have higher visual quality. Vegetation/water interspersion pattern: Mosaic patterns of vegetation interspersed among channels, pools, and flat water areas are of higher visual quality than intermediate conditions or well defined vegetation areas with little or no interspersion. Vegetation class interspersion: Mosaics of vegetation types or classes of similar heights are of higher visual quality than well defined areas of single vegetation types with little or no interspersion.

Historic Values: Screening for Red Flags during the evaluation process determines whether or not the affected wetland is protected under Federal policy; applicable State and local screening criteria should be identified. Potential impacts to protected historic or archaeological resources should be evaluated by District personnel.

Non-consumptive Recreation: Non-consumptive recreation potential is determined by physical access to the wetland areas and the abundance and diversity of wetland vegetation, wildlife and other resources necessary for recreation.

- **Food and Fiber Wetland Production Services.** Habitat functions support agriculture, forestry, and commercial fishery production. Economic valuation is determined by market conditions, and production functions that incorporate production factors and supply and demand considerations.

Key Considerations. For commercial fisheries, linkage must be established between habitat availability, habitat productivity; production costs, e.g. harvest; and changes in the wetland. Little data is available on valuation of wetland forest management of conversion to intensive silviculture. Decisions on agricultural production, on the other hand, are complicated by provisions of the Food Security Act (Swampbuster).

Supply/Demand Considerations. Alternatives or substitutes for production services should be identified to determine in value in the differences between wetland production and the next best alternative. Commercial fishery market prices and costs of production are obtainable. Timber production in a wetland or wetland conversion for timber is responsive to the local and regional timber market and future changes in those markets.

Valuation Considerations. Commercial fisheries, agriculture, and forestry are market based so valuation of a wetland is dependent on regional markets. Valuation must consider whether the service can be produced elsewhere, i.e., whether there is a production alternative. The value of the wetland production services is measured as the change to the economic surplus, i.e, return of the wetland to private owner. Value of wetland for production: (Net returns from production from wetland harvest) - (Net returns from production from next best alternative).

Fisheries. Valuation of wetland fisheries is determined by production models relating changes in catch to changes in production factors, e.g., habitat size, water quality, level of harvest effort. Changes in catch can then be multiplied by the market price of the fish. Difficulties in this approach, known as marginal value product method, are in formulating a production function.

Agriculture. Decisions to convert wetlands to agricultural production must account for the profitability of different crops given the market for respective crops; government price supports and targets; availability of suitable non-wetland rental lands; and the Swampbuster provisions of the Food Security Act (making farmers ineligible for government supports if crops are grown on converted wetlands). Value is measured by the projected change in return to the farmer.

Forestry. Value for timber production is the stumpage value, i.e. the value of the timber that can be cut off the site, if there is no alternative for timber production. If alternative sites exist, then value is the difference between the returns to development and returns to development of the next best alternative.

CONCLUSIONS: The economic evaluation framework presented in this technical note uses and builds on information obtained when assessing wetland functions and their relationships to economic

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goods and services. For those wetland functions assessed as having a high functional capacity, a method is to determine whether or not there is potential for economic value is outlined.

REFERENCES:

Shabman, L. A., and Batie, S. S. 1988. "Socioeconomic Values of Wetlands: Literature Review, 1970-1985," Draft Technical Report, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

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