Wetlands of Washington: A Resource Characterization and Risk Assessment

January 1990

Douglas J. Canning

Shorelands and Water Resources Program
Washington Department of Ecology
Olympia, Washington 98504-7600

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This volume contains reprints of two Washington Environment 2010 project reports:

Wetlands of Washington: A Resource Characterization
Washington's Wetlands at Risk: Loss and Degradation

The information contained in these reports regarding wetlands loss and degradation was the best available information at the time it was developed in the late 1980s. Still, the values derived to represent net annual loss were speculative even if they were conservative. The principal problem was a paucity of information on the status of wetlands then or earlier under baseline conditions before the agricultural, timbering, and urban development of Washington had begun.

Little has changed regarding our comprehensive knowledge of the status of wetlands. The cost of monitoring and measuring the status of wetlands is high and few such programs are carried out.

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Douglas J. Canning
Shorelands and Water Resources Program
Washington Department of Ecology
Post Office Box 47600
Olympia, WA 98504-7600

360.407.6781
dcanning@igc.apc.org

WETLANDS OF WASHINGTON: A RESOURCE CHARACTERIZATION

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January, 1990

Douglas J. Canning and Michelle Stevens

Land and Wetland Resources Subcommittee
Washington Environment 2010 Technical Advisory Committee

Shorelands and Coastal Zone Management Program
WASHINGTON DEPARTMENT OF ECOLOGY
Olympia, WA 98504-7600

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About the authors:
Douglas J. Canning (BA, MS, Environmental Science), is a special area management planner with the Planning Section, Shorelands and Coastal Zone Management Program, Washington Department of Ecology. Michelle Stevens (BA, MS, Wetlands Ecology) is a wetlands ecologist with the Wetlands Section, Shorelands and Coastal Zone Management Program.

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SUMMARY

Current Status of Washington's Wetlands

Washington is a rapidly growing state with a finite wetland resource. The best information available at this writing indicates that there are approximately 938,000 acres of wetlands in Washington (US Fish and Wildlife Service estimates, 1989). Estimates of pre-settlement acreage vary widely depending on what historical information and research assumptions are used. Estimates vary from 33 to 50 percent of the wetlands have been lost. Localized areas have experienced much higher losses; 70 percent of the tidally influenced emergent wetlands in the Puget Sound have been lost due to diking, dredging, and filling activities. Urbanized wetlands in the Puget Sound have suffered losses ranging from 90 to 98 percent (Bortelson, 1980).

In both western and eastern Washington, many of the remaining wetlands have experienced some degree of degradation to vegetation, soils, or hydrology. All areas inventoried have been degraded to some extent; it is difficult to determine the condition of the land prior to European settlement (Kunze, 1989; Evans, 1989). Mitigation has had a very poor track record for adequately compensating for lost wetland values and function (Kunz et al., 1988).

With increasing populations and a decreasing developable land base, wetland losses are continuing and are expected to increase in the absence of regulatory and preservation/acquisition programs. This will result in continued loss of wetland functions and values. For example, loss of fish and wildlife habitat may lead to declines in populations and less opportunities for hunting, fishing, and passive observation. Continued loss of hydrologic functions of wetlands for flood control and water quality improvement will lead to greater municipal costs to provide these benefits through engineered structures.

Comprehensive planning is a key component to protecting the remaining wetland resource base and providing opportunities for continued human growth and development. Advanced planning for development through such activities as the Special Area Management Plans developed by the US Army Corps of Engineers, Advanced Identification by the US Environmental Protection Agency, watershed management plans, and sensitive area planning by state and local governments assist in maintaining wetland areas for all the functions and values which they serve.

Principal Threats to Washington's Wetlands

Human Threats

Direct

1. Drainage for crop production, timber production, and mosquito control.
2. Dredging and stream channelization for navigation channels, flood protection, coastal housing developments, and reservoir maintenance.
3. Filling for dredged spoil and other solid waste disposal, road and highway construction, and commercial, residential, and industrial development.

4. Construction of dikes, dams, levees, and sea walls for agriculture, hydroelectric energy, flood control, water supply, irrigation, and storm protection.

5. Discharges of materials (e.g. pesticides, herbicides, other pollutants, nutrients from domestic sewage and agricultural runoff, and sediments from dredging and filling, logging, and agriculture, and bacteria from septic and other sources).

6. Mining of wetland soils for peat, coal, sand, gravel, phosphate, and other materials.

7. Vegetation removal, particularly through forestry and other land clearing activities.

Indirect

1. Sediment production from erosion through road construction, land clearing activities through agriculture, forestry and urbanization, and bank destabilization.

2. Introduction of exotic plant species, reduced wildlife habitat values, and reduced species diversity and food chain support from disturbance adjacent to and within wetlands.

3. Hydrologic impacts due to extraction of ground water, oil, gas, sulphur, and other minerals.

4. Stormwater impacts from increased peak flows; and pollutants, sediment and nutrients accumulating in wetland areas.

5. Reduced groundwater exchange capacity from filling springs, and reducing points of groundwater discharge and recharge.

6. Subsidence, including natural rise of sea level.

7. Soil compaction, erosion, and bank destabilization from livestock grazing.

Natural Threats

1. Flooding, particularly rain or snow events, hurricanes and other storms.

2. Droughts.

3. Fire.

4. Ice scour.

5. Erosion.

6. Biotic effects, e.g. muskrat, nutria, and goose "eat outs."

Trends in Recent Years

Several estimates of wetland loss have been attempted in recent years. All differ from each other, but review of them offers some general understanding of the state of Washington's wetlands. It should be noted that all projections of loss are conservative estimates; whatever numbers are given, significant loss of Washington's wetland base is indicated.

According to the US Fish and Wildlife Service discussion paper on Wetlands and Deepwater Habitats in the state of Washington (July, 1989), all wetlands and deepwater habitats comprised about 5.5 percent of the state of Washington in the early 1980s. Wetlands made up about 2 percent and deepwater habitats about 3.5 percent of the state. Within the state of Washington only about 67 percent of the estimated wetland acres at pre-settlement remained in the early 1980s. Deepwater habitats decreased by only about 4 percent. These estimates of loss are very conservative; actual wetland losses are expected to be higher than these estimates. In addition, losses do not account for conversion from forested riparian types to deepwater habitat for reservoir construction; they also do not account for degradation. In summary, Washington has lost over 33 percent of the state's wetlands.

Other loss projections for Washington include the following losses for freshwater wetlands in the following selected areas of western Washington (Boule et al., 1983):

Tenino and Yelm (south Thurston County): 55%
Tacoma South (Pierce County): 82%
Lake Washington (King County): 70%

A detailed analyses by the US Geological Survey of historical wetland acreage of eleven estuaries in Puget Sound estimates that 100 percent of the Puyallup River, 99 percent of the Duwamish River, and 96 percent of the Samish River wetlands have been lost (Bortleson et. al., 1980). In the remaining nine estuaries studied, acreage losses ranged between +0.2 % to -89.7 %.

Some local indicators of recent trends are available in Washington. Based on field inventory observations, Snohomish County estimates losses of 15 wetland acres per month, or 180 acres per year. Based on this figure, statewide losses for the eight counties with similar growth projections plus King and Pierce counties would be 1,800 acres per year for urbanized counties.

A Department of Ecology study of SEPA documents for rural and suburban wetland losses throughout Washington found that a conservative estimate of wetlands loss is 530 acres per year (Hull and MacIvor, 1987). This study found that well over twice the number of acres of wetland were drained as were filled. This is a concern because the Clean Water Act 404 permitting process covers filling but not draining of wetlands. Over 74 percent of the wetlands observed as impacted on the project sites were between one-half and five acres in size; of the wetlands extending off-site, 46 percent were found to be under five acres in size. Small, isolated wetland fills are also not covered under the 404 permitting process.

A review of the annual loss of wetlands through issuance of permits under Section 404 of the Clean Water Act indicates 185 acres are lost per year in Washington. This estimate is extremely conservative and does not reflect the acreage losses of isolated wetlands issued under Nationwide 26 of the Clean Water Act, nor do they reflect losses from activities other than placement of fill in wetlands.

Besides outright wetland loss, wetland and riparian systems in the state have been so degraded that it is difficult to piece together what these systems looked like prior to European settlement. All wetland sites have been adversely impacted to some degree by upslope or upstream activities. Virtually all sites inventoried in Washington have been disturbed to varying degrees by human or livestock activities. The best sites are recovering from these impacts and are no longer in a pristine state.

Mitigation through creation and restoration has proved to be largely unsuccessful in compensating for wetland losses. Between 1980 and 1986, mitigation negotiations resulted in the exchange of 152 acres of natural wetlands for 100 acres of created/restored wetlands, a proposed replacement rate of 67 percent (Kunz et al., 1988). This includes only those wetlands under the jurisdiction of and regulated by Section 404 of the Clean Water Act. It does not include areas unregulated, which make up the bulk of the wetland losses (Hull and MacIvor, 1987). In addition, it does not account for the poor success rate on the ground of a created wetland's ability to provide values and functions within the context of the landscape. A net loss in wetland diversity has occurred in wetland mitigation design, with little attempt at replication of forested or peat wetlands.

The Likely Future

One case example is the Green River Valley of King County where growth information is based on estimates from the Puget Sound Council of Governments. The Green River Valley contains the largest supply of vacant, zoned commercial and industrial land in the Seattle metropolitan area. The supply of zoned land is virtually exhausted in Seattle and is running low in the communities east of Seattle. A large portion of the vacant, industrially-zoned land in the Kent portion of the Green River Valley contains wetland areas. The supply of land in the valley is expected to last only until the mid-1990s; therefore, only a two- to four-year supply is available. The market is extremely tight, land prices continue to escalate, and development pressure in this area is extremely high.

This example demonstrates that wetland losses are likely to continue or increase in the absence of comprehensive legislation and/or funding to carry out acquisition and protection programs. Population densities continue to increase, particularly in Thurston, Mason, Island, Snohomish and Kitsap, Clark, Douglas, Franklin, King, and Pierce counties. Increases in population by the year 2000 are as high as 30 percent for some Puget Sound counties, and average 17 percent statewide (1987 Office of Financial Management population trends). In many areas such as the Green River Valley and Mill Creek, most buildable upland sites have already been developed. Increased population growth and reduced available upland alternatives can only translate into increased wetland loss. In addition, development pressure often results in isolation and truncation of wetland/upland ecosystems, reducing the value of the wetland for wildlife. Urbanization results in increased run-off with oils, gasoline, nutrients from fertilizers and pesticides, sediment and increased stormwater from impermeable surfaces degrading remaining wetlands. Degradation due to pollution, introduction of exotic plant species, habitat loss, and other factors is likely to continue also.

Mitigation replacement rates of acreage only to compensate for lost wetlands is only 67 percent for activities permitted under Section 404 of the Clean Water Act. Many wetland losses occur without mitigation. Without stronger wetland regulations, increased mitigation monitoring and reliability, and better enforcement wetland losses will increase exponentially in the next decade.

Benefits Derived from Washington's Wetlands

Groundwater recharge and discharge.
Flood storage and desynchronization.
Shoreline anchoring and dissipation of erosion forces.
Sediment trapping.
Nutrient retention and removal.
Food chain support.
Habitat for fisheries.
Habitat for wildlife.
Active recreation.
Passive recreation, aesthetics, and heritage value.
Native plant reserves.
Biological diversity.

Successful Methods for Protecting Washington's Wetlands

There has been no known systematic evaluation of successes in protecting Washington's wetlands, however, the following methods have been shown to be useful:

- Expanded regulatory authority, particularly over isolated wetlands and over activities other than placement of fill. This can be implemented at the federal, state, or local level.
- Preservation through acquisition in fee, conservation easements, or other securing methods.
- Inclusion in buffer strips, greenbelts, or open space required of development projects.
- Tax incentive programs, such as the Washington State Open Space Act.

1. RESOURCE DESCRIPTION

Wetlands inventory and evaluation in Washington State is in progress, and as yet is incomplete. On May 9, 1988, Governor Booth Gardner signed Executive Order 88-03 directing the Department of Ecology to undertake a study of Washington's wetlands. The Executive Order consists of the following three sections:

Section 1. *A study report shall be submitted to the Governor by November 30, 1988.* The report, *1988 Washington Wetlands Study Report* (Ecology, 1988a), was completed on schedule; copies are available from Wetlands Section, Shorelands and Coastal Zone Management Program, Washington Department of Ecology. Much of this present report is adapted from the executive order report.

Section 2. *The Executive Order encouraged the formation of an advisory committee to assist Ecology in carrying out its charge.* A broad-based advisory committee was created by Ecology in July, 1988. The committee met eight times between August and November, 1988, providing Ecology with advice on technical and policy matters.

Section 3. *Ecology was directed to assess the extent, types, and sizes of Washington's wetlands, and to evaluate the extent and causes of wetlands alteration and loss.* To accomplish this task, Ecology contracted with the US Fish and Wildlife Service (US FWS) to produce digitized National Wetlands Inventory maps for the entire state, plus a report comparing the extent of wetlands in the mid-1980s to historical wetlands information. Maps, tabular data summaries, and the wetlands trends report was submitted to Ecology in June, 1989. Portions of the US FWS report were available in draft form during the preparation of this report, and have been incorporated where appropriate.

1.1 Introduction

Washington State is divided by the Cascade Mountains into two distinct physiographic regions, providing a wide range of climatic conditions and a considerable diversity of geology, soils, vegetation, and water regimes. This physiographic diversity has produced a great variety of wetlands in Washington, ranging from alpine and subalpine meadows in the higher elevations of the Cascade and Olympic mountain ranges, to salt marshes along the Pacific Coast; river mouth estuaries within the greater estuary of Puget Sound; and vast areas of freshwater marshes in the Columbia Basin, which result from both natural interior drainage and from irrigation activities.

Washington has over 2,400 miles of shoreline, most of which is found west of the Cascades. This includes the Pacific Ocean, large estuarine areas such as Grays Harbor and Willapa Bay, Puget Sound itself, and many large river systems which drain into both Puget Sound and the Pacific Ocean. The Skagit River, for instance, is the largest West Coast river system north of San Francisco Bay—with the obvious exception of the Columbia River—and the estuarine wetlands at the mouth of the Skagit are both extensive and biologically rich.

While many of the freshwater wetlands of western Washington are associated with ponds, lakes, rivers, and other shorelines, many more are isolated from open water and owe their existence to saturated soil conditions. The water source for isolated wetlands is from rainwater or snowmelt, and usually is associated with the groundwater through springs or seeps.

The wetlands of eastern Washington are more localized in their distribution but even more varied than their western counterparts in terms of seasonality, chemistry, and plant species composition. The climatic regimes of eastern Washington give rise to a variety of permanent and intermittent streams and wetlands. Flowing water wetlands along rivers and streams are very dynamic ecosystems, with flashy hydrology resulting in very rapid high water events in the spring and drier conditions in summer and fall. Bogs and fens are generally very acidic, nutrient poor and form over a period of thousands of years. Vernal ponds and playas form in the spring, provide important habitat for waterfowl and migratory birds, then dry up by summer. These intermittent wetland systems are often saline, and contain some of the same plants found in tidal areas.

Many existing wetlands in eastern Washington, particularly in the Columbia Basin, have been rearranged by human activities. Large hydroelectric projects in the Columbia River produced large expanses of open water habitat, converting hundreds of miles of riparian habitat adjacent to rivers. Subsequent irrigation projects created wetlands through water redistribution and high water tables, though many valuable riparian wetlands have been eliminated by irrigation projects and farming and livestock activities.

Washington is a rapidly-growing state, and it is estimated that half the state's wetlands have been directly or indirectly lost to various types of development since the turn of the century. Many of those which remain have been degraded through altered hydrologic conditions; compaction of soil through livestock grazing or use of heavy equipment while soils are wet; attempted draining; introduction of exotic species such as reed-canary grass, smooth cordgrass, Russian olive, and purple loosestrife displacing native plant communities; and using wetlands for dumping of garbage, tires, and sometimes hazardous materials. The two principle causes of direct wetland alteration in Washington in the past have been the establishment of agriculture and the siting of ports and industrial facilities. Wetland alteration is currently occurring through urban expansion, forestry and grazing.

In many areas of western Washington, including the Skagit and Nisqually River deltas, the original loss of wetlands can be attributed to the creation of farmland through the construction of dikes—a practice that was encouraged by federal policy beginning with the Swampland Acts of 1849 through 1860.

In the case of estuaries, the conversion of wetlands to industrial land took place as ports and cities were established—including Olympia, Tacoma, Seattle, and Everett on Puget Sound, and Hoquiam, Aberdeen, and Raymond—at the mouths of major western Washington rivers. Large river surge plain forests entering the Puget Sound, Grays Harbor and coastal areas were cleared for forestry, and large log booms floated down river to ports or railroads where logs could be shipped. Only half of the surge plain rivers still have forests, and vast expanses of those that remain have been channeled, diked, and converted to agriculture or residential uses.

Filling of wetlands in these major port areas was originally done because they were the most convenient and seen as the least valuable places to dump ballast. The practice later became a major focus of port activities in western Washington to create more land for water-related industrial and commercial activities. It is estimated that more than 90 percent of the original saltwater wetlands in urban estuaries of Puget Sound have been filled or otherwise eliminated.

It was not until the late 1960s and early 1970s that the public started to understand and appreciate the functions and values associated with wetlands and, with this increased awareness, public policy began to be changed through the passage of federal and state laws to protect wetlands. Some nonregulatory

programs, dating as far back as the early 1940s, were established to protect wetlands. The 1929 Migratory Bird Conservation Act, 1934 Duck Stamp Act, 1961 Wetlands Loan Act and 1986 Emergency Wetlands Resources Act establish funding to acquire habitat for migratory waterfowl. Private groups such as Ducks Unlimited have continued donating private funds for acquisition of private property.

The federal Clean Water Act was passed in 1972 and is still the primary tool with which the federal government protects wetlands—although the Act only regulates the discharge of dredged or fill material into wetlands. Presidential Executive Order 11990 ended most federal assistance for wetland conversion through requiring federal agencies to consider the effect of any proposed activity on federal lands.

The Washington Legislature passed the Shoreline Management Act in 1971 and this Act is the only state law which specifically addresses the regulation of activities in wetlands—although 75 percent of the state's wetlands are left out of the Act's definition of shoreline "associated wetlands." Many local governments in the state have passed local ordinances restricting or regulating adverse impacts to wetland areas. Work in wetlands below ordinary high water in waters of the state can be regulated under the Hydraulics Code.

1.2 Wetlands Definitions

Wetlands are transitional areas between open water and upland. While the line between upland and wetland is generally indistinct in nature, for planning and regulatory purposes a line must be drawn. To determine the wetland edge, wetland definitions are based on three parameters: water (hydrology), soils, and vegetation. The US Fish and Wildlife Service wetland definition is the most comprehensive. While all wetland areas must have water (thus the hydrology definition component), either soils or vegetation may be included to meet the wetland definition. The Clean Water Act definition is a more rigorous definition, and all three parameters must be present on a site.

However, the new Federal Wetland Delineation Methodology, approved this year (1989) by the Army Corps of Engineers, Environmental Protection Agency, Fish and Wildlife Service and Soil Conservation Service, provides one consistent regulatory approach for delineating wetlands. The differences between the two definitions for vegetated wetlands is reduced by use of the new methodology.

In Washington State, three definitions have generally been applied to implement various federal, state, and local regulations and wetland management programs:

1.2.1 US Fish and Wildlife Service

The following definition, developed by Lewis M. Cowardin et al. in 1979, has been adopted by the Fish and Wildlife Service for inventorying and mapping the nation's wetlands through the National Wetland Inventory. It is also the basis for all local inventories in Washington, as well as some state and local regulations:

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water... Wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

1.2.2 Clean Water Act

This definition applies to all waters of the United States regulated under the federal Clean Water Act, including dredge and fill permits under Section 404 (33 CFR 323.2). Although this definition is also based on conditions of soil, water regime, and vegetation, it requires that a positive indicator of all three features be present—as opposed to one or more positive indicators with the Cowardin method. This definition is also used in several local wetland ordinances:

> The term wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

1.2.3 Shoreline Management Act

In 1971, the Washington Legislature adopted a definition of wetlands for purposes of implementing the Shoreline Management Act (Chapter 90.58 RCW). This definition relies largely on a measurement of 200 feet from the ordinary high water mark of certain streams, lakes, and tidal waters plus associated marshes, bogs and swamps to establish the landward limit of the Act's jurisdiction. The definition of associated marshes, bogs and swamps uses the US Fish and Wildlife Service definition. Because the scope of the Shoreline Management Act is limited to lakes at least 20 acres in size and streams with flows of at least 20 cubic feet per second (cfs), the following definition under the Act includes only a fraction of the state's wetlands:

> Wetlands or wetland areas means those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all marshes, bogs, swamps, and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter; the same to be designated as to location by the department of ecology; Provided, That any county or city may determine that portion of a 100-year floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom.

1.2.4 Discussion

The official definition of the term "wetlands" is of great concern to farmers, developers, state agency staff, local government officials, and members of the public concerned about the protection of wetlands because the definition will determine the overall scope of any new state-mandated or state-funded program to identify, protect, and/or acquire wetlands.

The advantages and disadvantages of the two primary federal definitions were discussed with the Governors Wetlands Executive Order Advisory Committee. No consensus was reached by the Advisory Committee on the topic of wetlands definition. The Committee was almost evenly split between favoring the US Fish & Wildlife Service and Clean Water Act definitions.

This report uses the US Fish & Wildlife Service definition (Cowardin, et al., 1979) where there is a choice. As a practical matter, wetlands inventories conducted in the past may have used any of a number of definitions, often undefined. Prior to 1979, the most common definition used by researchers was that of *Circular 39* (Shaw & Fredine, 1956), also a US Fish & Wildlife Service sponsored definition.

1.3 Wetlands Types

The following description of wetland plant communities generally follows the current classification system of the US Fish and Wildlife Service (Cowardin, et al., 1979). Information from the draft report being prepared by the US Fish and Wildlife Service (US FWS) for Ecology to be titled *Wetlands of Washington* has been summarized and adapted for this report. These descriptions are keyed to the ecoregions of Washington state: Coast Range Ecoregion; Puget Lowland Ecoregion; Cascade Ecoregion; Eastern Cascades Slopes and Foothills Ecoregion; Columbia Basin Ecoregion; Northern Rockies Ecoregion.

Many factors influence wetland plant community structure. Like all plant communities, climate, soils, elevation, aspect, fire history, human activities, and animal activities such as herbivory and pollination mechanisms play important roles in plant species abundance and composition. In wetland plant communities, water source, frequency and duration significantly influence soil chemistry and pH, the stability or dynamics of the plant community over time, and plant species composition. The presence and abundance of a wetland plant species depends upon its life history and adaptation to its local environment (Van der Valk, 1981).

In addition, the distribution of vegetation in wetlands has been strongly influenced by disturbance such as logging, plowing, burning, mowing or grazing by livestock; invasion of exotic species such as purple loosestrife, reed canary grass and Russian Olive; and alteration of water quality and quantity influencing the wetland.

Wetland ecosystems vary within the landscape and watershed in which they occur. The dynamics and relative stability of wetland systems vary widely. Peat systems generally include bogs, which are separated from surface and groundwater sources, and fens, which are hydrologically connected to surface or groundwater. Bog systems form very slowly, at a rate of one inch in 40 years in western Washington and one inch in 100 years in eastern Washington. This slow rate of peat accumulation is due to the lack of decomposition in permanently saturated systems. Peat systems have very low pH, as low as 4.0, and low nutrient availability. These systems are very stable for long periods of time; since the last glacial period, peat formation has been relatively constant. Small changes in water quality or quantity can significantly impact bog systems. Nutrient input of fertilizer, wastewater or stormwater can significantly adversely impact these peat systems.

Riparian systems are dynamic systems. They rely on extreme "10-" or "100-year" events to maintain ecological dynamics. The accretion and deposition of river sediments, rechannelization, and hydrologic configuration of rivers, is altered on an annual basis. Successional sequences in rivers is in a fluctuating equilibrium, with river bars, old oxbows, deposition, and accretion areas constantly changing over time. In riparian systems, up to 80 percent of the water moving through the system can be subsurface. These systems depend on rapid and extreme hydrologic changes to maintain the successional equilibrium.

Surge plain wetlands form near the mouths of rivers flowing into tidal waters. High tide causes a backwater effect in these systems, with fresh river flowing into high tidal waters, and backing up into the wetlands. Dendritic tidal channels form convoluted micro-topography; flooding and tidal changes are constants in these systems. Most of the area is below the ordinary high water mark; tree and shrub reproduction occurs on down logs and stumps. Cutting in these areas can eliminate successful forest reproduction.

Wetland succession is referred to as "hydrosere succession." This refers to a fluctuating equilibrium of plant communities driven by the constant hydrologic and climactic changes associated with wetland systems. Succession from open water to emergent vegetation to shrub and forested woody vegetation is not usually linear. Instead, floods, fire and other natural disturbances cause constant fluctuations in the vegetation. Extreme events such as a hundred year flood generally cause the system to develop more open water habitat; periods of relative stability cause forested system development. Dry periods cause trees to pioneer a site; wet periods cause them to die, creating habitat for cavity nesters.

The mosaic of open water, different vegetation seral stages, and the edge created through the interface of these structurally diverse types, represents a high quality wetland ecosystem with high habitat value.

Wetlands of Washington occur in all five National Wetland Inventory systems. Marine wetlands are mainly restricted to Pacific Ocean intertidal beaches and rocky shores. The majority of estuarine wetlands are found within Puget Sound, Grays Harbor, Willapa Bay, and the mouth of the Columbia River. Palustrine wetlands are the predominant wetland type throughout the state. Lacustrine and riverine wetlands mainly consist of lake shores, river bars, and aquatic beds.

The following sections will describe common wetlands types and wetland communities for each ecological wetland system within Washington's ecoregions. These community descriptions are based upon a literature review specific to Washington wetlands and data collected during the National Wetland Inventory mapping process. Data has also been provided from plant associations developed on national forest lands and an inventory done for the Columbia Plateau region of Washington.

1.3.1 Marine

The Marine System includes the open ocean overlying the continental shelf and associated coast line. Important vegetated deepwater habitats include kelp beds and surfgrass beds. These areas are classified as marine, subtidal, aquatic beds. Kelps persist on rocky reefs near the intertidal shores.

Marine wetlands consist of beaches (unconsolidated shores) and rocky shores. Wetlands within this zone dominated by macrophytic plants are classified as estuarine habitats (Cowardin, et al., 1979). These marine wetlands front the Pacific Ocean, occur along the strait of Juan de Fuca, on San Juan Islands coast lines, and off shore rocky islands. Macroalgae are the most visible rocky shore inhabitants. Extensive beaches occur only along the southern Washington coast, and spits at the mouth of Grays Harbor and Willapa Bay. The high energy environment keeps these habitats unvegetated.

1.3.2 Estuarine

The estuarine system is characterized by semi-enclosed coastal areas where sea water brought in by tides and wind mixes with freshwater supplied either from coastal or interior watersheds. Adjacent vegetation is inundated with brackish waters at least occasionally. Estuarine water extends upstream in coastal rivers to where the salinity of ocean derived salts is less than 0.5 parts per thousand (ppt; ‰). A variety of estuarine wetlands exist due to the variations in estuarine water salinities and the duration and frequency of flooding. These include estuarine subtidal and intertidal aquatic beds, estuarine intertidal shores, estuarine emergent wetlands and estuarine scrub-shrub and forested wetlands. Major estuarine habitats are found at the mouth of the Columbia River, Willapa Bay, and Grays Harbor in the Coast Range ecoregion. The waters of Puget Sound and adjacent lands are the other major estuarine habitats located in the Puget Sound ecoregion.

Estuarine: Subtidal and Intertidal, Aquatic Beds Vegetated sandy and muddy substrates adjacent to intertidal zones are often dominated by eelgrass (*Zostera marina, Z. japonica*). Green algae (*Ulva* spp.) are common co-dominants. Rocky substrates are commonly dominated by the kelps *Nereocystis* and *Laminaria*. Padilla Bay is famous for it expansive eelgrass beds. Other major stands of eel grass occur throughout Puget Sound. Portions of intertidal channels dewatered at low tide are commonly dominated by eelgrass and *Lilaeopsis occidentalis*.

Estuarine: Intertidal, Shores Estuarine, intertidal, unconsolidated shores consist of gravels, sand and mud exposed by tides. Commonly known as "tidal mud flats" drastic water fluctuations discourage most plant communities from colonizing these sites. However, during summer months, wide extensive mats of green and blue green algae may develop. The macroalgaes are commonly found on estuarine, intertidal, rocky shores. The estuarine, intertidal shores of Willapa Bay, Grays Harbor, and the Columbia River are Washington's largest areas of this habitat type and famous for their values as migratory bird feeding areas.

Estuarine: Intertidal, Emergent Wetlands Plant communities within estuarine, intertidal, emergent wetlands are a result of tidal salinities, flooding duration, inland freshwater mixing, and disturbance. These areas are commonly referred to as salt marshes. Broad expanses of these wetlands are common in Grays Harbor, Willapa Bay, and the mouth of the Columbia River. Estuarine, intertidal, emergent plant community distribution at the mouth of the Columbia River are somewhat different than those found in Grays Harbor and Willapa Bay. The large volumes of Columbia River freshwater mixing with marine waters results in plants more commonly associated with freshwater systems growing adjacent to plants commonly associated with saline waters.

Regularly flooded estuarine plant communities (low salt marshes) typically occur from about six feet above mean lower low water to mean higher high water. Salinities can be variable, from saline (30 to 35 ppt) to brackish (5 to 7 ppt). Sites regularly flooded with highly saline waters areas are dominated by pickleweed (*Salicornia virginica*), salt grass (*Distichlis spicata*), seaside arrowgrass (*Triglochin maritimum*), Jaumea (*Jaumea carnosa*), and saltmarsh sandspurry (*Spergularia marina*).

More brackish regularly flooded sites commonly contain the above mentioned species in addition to Olney's Three Square (*Scirpus americanus*), Lyngby's sedge (*Carex lyngbyei*), redtop (*Agrostis alba*), hard stem bulrush (*Scirpus acutus*) and cattail (*Typha latifolia*). Smooth cordgrass (*Spartina alterniflora*), a species common to Atlantic coast low salt marshes, has become established in Willapa Bay and Padilla Bay (Puget Sound) and appears to be expanding its range.

Intertidal emergent wetlands irregularly flooded by estuarine waters normally occur above mean higher high water. These "high salt marshes" also may have a wide range in flood water salinities and very often have a more varied plant community than low salt marshes.

Estuarine: Scrub Shrub and Forested Wetlands Estuarine scrub shrub and forested wetlands are characterized by woody species typically found as a boundary condition between freshwater woody wetlands and estuarine emergent wetlands and along channel levees and dikes. Flood waters normally are very brackish and these habitats more closely resemble freshwater wetlands. Woody species less than 6 meters tall are considered scrub shrub and those greater than 6 meters tall considered forest (Cowardin, et al., 1979). Common species include western crabapple (*Pyrus fusca*), Hooker's willow (*Salix hookeriana*), Sitka willow (*Salix sitchensis*), red osier dogwood (*Cornus cernua*), Pacific ninebark (*Physocarpus capitatus*), black twinberry (*Lonicera involucrata*), red alder (*Alnus rubra*), western redcedar (*Thuja plicata*) and Sitka spruce (*Picea sitchensis*).

1.3.3 Riverine

The riverine system is mainly a deepwater habitat system. Riverine wetlands consist of exposed portions of the river bed, aquatics within the river channel and non-persistent emergents within the river channel.

By far, the most common Riverine wetland class is the Riverine, Unconsolidated Shore, commonly know as the river bar or gravel bar. Many of these bars become vegetated with pioneering species such as dandelions, fireweeds, etc., during low flows, but disappear when the annual high flows scour the vegetation from the bar.

It is common in many tidal lower perennial, and slower portions of upper perennial reaches for rivers bottoms to be dominated by various algae, aquatic mosses and rooted vascular aquatics. True watercress (*Nasturtium offininale*) and yellow-cress (*Rorippa* spp.) are probably the most conspicuous riverine aquatics. Riverine non-persistent emergents, other than the cresses, are not common. Occasionally species such as yellow water lily (*Nuphar polysepalum*), arrow-head (*Sagittaria cuneata*, *S. latifolia*), water-plaintain (*Alisma plantago-aquatica*), or smartweed (*Polygonum* spp.) may occupy river channels with slow flows, but these areas are not extensive. Most often persistent vegetation is found in or adjacent to river channels.

1.3.4 Lacustrine

The Lacustrine system is mainly a deepwater habitat system consisting of lakes, reservoirs and deep ponds. Wetlands are restricted to shallow water (less than 2 meters at low water or the maximum extent of non-persistent emergents (Cowardin, et al., 1979) and exposed shorelines. Vegetated wetland classes consist of aquatic beds and non-persistent emergents. Lacustrine aquatic bed species are the same as those noted for Palustrine aquatic bed. Lacustrine emergent wetlands usually border lake shores. Persistent vegetation is also common along the margins of lakes, but is considered to be in the Palustrine system (Cowardin et al., 1979). Common non-persistent emergent species include arrowhead, water-plaintain, smartweed, yellow water lily, common mare's-tail (*Hippuris vulgaris*), and pondweed (*Potomogeton* spp).

1.3.5 Palustrine

The majority of Washington's wetlands are freshwater wetlands, classified as Palustrine wetlands. Palustrine wetlands include most of the vegetated freshwater wetlands, and form marshes, swamps, bogs, wet meadows, shallow ponds and many riparian habitats. Wetlands are transition zones between open water and upland. Some wetland plant species, known as obligate wetland plants, are found only in permanently flooded or saturated conditions. Other wetland plants, known as facultative, grow in both wetland and upland conditions. Palustrine wetland plant communities will be discussed by class in the following subsections, with some discussion of dominant plant species and plant community dynamics.

Palustrine forested wetlands, commonly referred to as swamps, are dominated by woody vegetation greater than 6 meters (20 feet). They are the most structurally diverse wetlands found in Washington. Most forested wetlands occur along rivers or in river floodplains, but are also common in upland depressions, seepage areas and adjacent to estuarine systems. These wetlands occur in tidal and nontidal freshwater situations. Common species occurring in wetlands include: red alder, thin-leafed alder, black cottonwood, western red cedar, Sitka spruce and hemlock.

Palustrine scrub-shrub wetlands are characterized by woody vegetation less than 6 meters tall. Such wetlands have been referred to as swamps and bogs. These wetlands are most commonly found along rivers or in valley bottoms, but as with forested wetlands, may be locally abundant in upland depressions, seepage areas and adjacent to estuaries. Scrub-shrub wetlands occur in tidal and nontidal freshwater areas. Common species occurring in wetlands include willows, red osier dogwood, Douglas spiraea, snowberry, hawthorn, wild rose, and gooseberry.

Palustrine emergent wetlands are the most common wetland type inventoried in Washington. They are dominated by persistent and non-persistent grasses, sedges, rushes, cattails, forbs and ferns. Such wetlands have commonly been referred to as marshes, wet meadows, fens, bogs and prairies. There are over 350 species of grasses and grasslike (sedges, rushes, etc.) plants and over 850 species of forbs which occur in Washington wetlands. Many are found in association with other classes of wetlands (scrub-shrub and forested).

Palustrine aquatic beds occur throughout Washington's ecoregions usually where water is semipermanent or permanent. Most often shallow ponds or the littoral zone of lakes support this vegetation type. Some aquatics float through the water column, while others float on the surface like duckweed. There are many rooted vascular plants which float on the water surface, such as water lilies and water buttercup.

1.3.5.1 Coast Range and Puget Lowland Ecoregion

Forested Wetlands Several types of forested wetlands occur within Washington's Coast Range and Puget Lowland Ecoregions. Within the coastal sand dune systems, forested communities occupy some deflation plain wetlands. These sand dune forested wetlands are found along the sand spits of Grays Harbor and Willapa Bay.

Forested wetlands occupying lowlands adjacent to estuaries are commonly known as coastal swamps. These surge plain wetlands are formed through freshwater tidal action formed when the river backs up during high tide. These areas are characterized by high water tables throughout the growing season, with daily water level fluctuations based on tidal action. Plant communities are nearly identical under tidal and nontidal freshwater flooding regimes. Large tracts of freshwater tidally flooded forested wetlands are found along the lower Chehalis River, Willapa River, Black River (Thurston County), Skagit River delta, and Nisqually River delta. Nontidal coastal swamps are also found at the above mentioned areas and in lowlands bordering the major estuaries of Washington.

Inland from the coast within the Coastal Range and Puget Lowland Ecoregions, forested wetlands are found primarily in river valleys and occupying depressional areas particularly in the glacial drift portions of the Puget Lowland. Examples of these wetlands are found along the lowland valleys of the Chehalis, Willapa, Newaukum, Cowlitz, Lewis, and Columbia rivers as well as the lower reaches of the Skykomish, Skagit, Stillaguamish, and Nooksack rivers.

Scrub-Shrub Wetlands Many deflation plain wetlands within the coastal dunes are dominated by shrubs. The stabilized dunes at the southern end of the Long Beach Peninsula often contain circumboreal sphagnum bogs, with a compliment of ericacious shrubs such as Labrador tea (*Ledum groenlandicum*), bog laurel (*Kalmia occidentalis*) and small cranberry (*Vaccinium oxycoccus*). These areas are characterized by saturated sphagnum based peat soils with no external drainage. These extremely acid, nutrient deficient conditions favor a specialized plant community.

Commercial cranberry bogs are sometimes created in upland sites, and other times are wetland bogs which have been manipulated to favor growth and reproduction of small cranberry. Normally small cranberry would be just one component of a natural bog.

Scrub-shrub wetlands are common along the Columbia River, particularly freshwater tidal portions of the lower Columbia. Dominant species include willows (particularly *Salix hookeriana* and *S. sitchensis*), red osier dogwood (*Cornus cernua*), salmonberry (*Rubus spectabilis*), Indian plum (*Oemleria cerasiformis*), Douglas spirea (*Spiraea douglasii*), black twinberry (*Lonicera involucrata*) and Pacific ninebark (*Physocarpus capitatus*). Thirty species of willow are found in Washington wetlands. Five species may grow to tree size, but the majority remain shrubs. All but three species are found nearly exclusively in wetlands. Most species are wide spread though the state, however, some species such as River Willow (*Salix fluviatilis*) have very restricted ranges. River willow is found only along the lower Columbia River.

Scrub-shrub wetlands inland from the coast are common and extensive in some areas of the Coast

Range and Puget Lowland Ecoregions. Extensive tracts of these wetlands may be found in the Willapa and Chehalis River valleys and in the lowland valleys between Longview and Olympia. Isolated depressional scrub-shrub wetlands are very numerous in the glacial drift portions of the Puget Sound and Olympic Peninsula. Some species such as Douglas spirea and willow may form nearly monotypic stands while most other species usually are intermixed with other shrub species or are components of forested stands. Herbaceous species associated with scrub-shrub wetlands depend upon duration of flooding, saturation and degree of disturbance. Common understory species in both shrub and forested wetlands include skunk cabbage (*Lystichitum americanum*), slough sedge (*Carex obnupta*), water parsley (*Oenanthe sarmentosa*) and water buttercup (*Ranunculus* spp.)

Emergent Wetlands In the Coastal Range ecoregion, Palustrine emergent wetlands are found above high tide, in dunes, along water courses and adjacent to water bodies. Within Washington's coastal dune systems, emergent dominated wetlands are found in deflation plains, dune swales, adjacent to dune lakes, and lake edges throughout the ecoregion. Common wetland indicators include slough sedge, tufted hairgrass (*Deschampsia caspitosa*), Pacific silverweed (*Potentilla pacifica*), redtop (*Agrostis alba*), soft rush (*Juncus effusus*), baltic rush (*Juncus balticus*), skunk cabbage, water parsley and water buttercup.

Seepage wetlands on the coastal bluffs are scattered but not uncommon.

Diked former tide lands are a common Palustrine emergent wetland type adjacent to Estuarine emergent wetlands. These former salt marshes have been diked off from estuarine tidal influence and are typically used as pasture or converted to agricultural uses. They are found adjacent to all the major estuaries along the Pacific coast and Puget Sound. The Nisqually National Wildlife Refuge contains excellent examples of this type or wetland as well as estuarine wetlands. These areas hold major potential for restoration and enhancement and if acquired and monitored could increase the estuarine and palustrine emergent base in Washington state resulting in a net increase in estuarine wetland acreage (Bob Ziegler, Washington Department of Wildlife, personal communication, 1989).

Large areas of former estuarine marshes and coastal forest swamps (particularly in the Snohomish, Skagit, and Nooksack river deltas) have been diked, cleared and converted to agriculture. Many of these areas would establish wetland plant communities if normal farming practices were ceased. These "farmed wetlands" occur not only in coastal areas, but are also common in river valleys and other bottom lands throughout the state. This would provide a major opportunity by 2010 to increase very valuable wetland resources through restoration.

Inland from the coast, emergent wetlands in the Coastal Range are found mainly in river valley bottoms, adjacent to water bodies or in meadow complexes. Extensive emergent wetlands are found throughout the valley bottoms of the Puget lowlands and as isolated depressions in the glacial drift of the northern Puget lowlands. Extensive tracts of valley bottom wetlands are found in the Chehalis River lowlands in the vicinity of Centralia and the Napavine and Grand Prairie in the Winlock vicinity.

There are many plant species found in emergent wetlands depending upon degree of wetness, water chemistry, climate, disturbance, etc. Many are closely associated with wetlands dominated by woody species. Sedges, rushes and grasses are usually the first types of plants to come to mind when considering emergent wetlands, however many species of forbs are equally common.

1.3.5.2 Cascade Ecoregion

Forested Wetlands Forested wetlands in the Cascade Mountains are common but not as extensive as in lower elevations. They are found along rivers and streams, in depressions, adjacent to wet meadows and water bodies and on slopes with abundant seepage. Forested wetland tree species do not differ from forested wetlands of the Puget Lowland Ecoregion within the western hemlock and Douglas-fir dominated forests.

Black cottonwood and red alder are common along stream courses. Cedar/hemlock and alder swamp understory species may differ in higher elevation wetlands. Alder swamps tend to be quite wet, with salmonberry, slough sedge, skunk cabbage, lady fern, and deer fern as understory dominants. Cedar/hemlock swamps are more varied. Dense shrub components of these systems include snowberry, Indian plum, wild rose, ninebark, bitter cherry, red-stem ceanothus and red-osier dogwood.

As elevation increases, silver fir and mountain hemlock become the predominate forest types. Forested wetlands in these high elevations become less common and less diverse. At this altitude forested wetlands are found at ground water seepage areas and along narrow stream corridors.

Scrub-Shrub Wetlands Scrub-shrub wetland species differ little from Puget Lowland scrub-shrub wetland species in the Douglas-fir/western hemlock forests of the Cascade Ecoregion. They occur along rivers and streams, adjacent to wet meadows and water bodies and less often in isolated depressions. With increases in elevation, scrub-shrub understory species differ somewhat, but shrub overstory species are the mostly the same. In the high elevation silver fir/mountain hemlock forests, several shrub other species become more common. Sitka alder forms dense, monotypic stands in sites of heavy snow accumulation and abundant water seepage.

Above tree line, scrub-shrub wetlands are mostly restricted to narrow stream corridors or seepage areas.

Emergent Wetlands Palustrine emergent wetlands are abundant in the Washington Cascades, particularly as wet meadow complexes in mountain basins and at the edges of lakes and ponds. Sedges, rushes and grasses compose the bulk of these emergent wetland plants, however, many forbs occur throughout wet meadow complexes. At high elevations, subalpine emergent wetlands contain some different dominant species. The alpine zone in the Cascade mountain is not well developed. Above timberline is mostly rock, glaciers, snow fields, and rubble.

1.3.5.3 Eastern Cascades Ecoregion

Forested Wetlands The Eastern Cascades Ecoregion is a transitional zone between the very moist forests of western Washington and the arid high desert of eastern Washington. Ponderosa pine is the predominate upland forest tree with lodgepole pine occurring in either drier or wetter sites than Douglas-fir. Forested wetlands are restricted to stream corridors, edges of wet meadows and lakes, and occasionally in isolated depressions. Dominant forest species include thin-leaved alder, aspen, water birch, and black cottonwood. Good examples of this type of wetland occur in the vicinity of Conboy Lake National Wildlife Refuge and Trout Lake.

Scrub-Shrub Wetlands Scrub-Shrub wetlands in the Eastern Cascades Ecoregion are mainly restricted to river and stream corridors and adjacent to wet meadows. River bank species most commonly are willows (*Salix lasiandra, S. exigua, S. amygdaloides*), red osier dogwood, Douglas hawthorn (*Crataegus douglasii*), wood rose (*Rosa woodsii*), Nootka rose (*R. nutkana*), current (*Ribes aureum, R. sanguineum*, and *R. cireum*), serviceberry (*Amelanchier alnifolia*), Douglas hawthorn (*Crataegus douglasii*), water birch. Species such as snowberry and Douglas spirea are more commonly found adjacent to wet meadows. Bogs are very uncommon in the eastern Cascades area; species common in bog systems include bog blueberry (*Vaccinium uliginosum*), bog willow (*Salix pedicellaris*), Labrador tea, bog laurel, and bog cranberry. Scrub-shrub wetlands dominated by saplings of quaking aspen and lodgepole pine may occur where disturbance by logging or fire has recently occurred.

Emergent Wetlands Palustrine emergent wetlands in this ecoregion are not extensive. Most emergent wetlands in this area are dominated by reed canary grass, hardstem bulrush (*Scirpus acutus*), softstem bulrush (*Scirpus validus*), three-square bulrush (*Scirpus americanus*), and cattail. In smaller wet meadows such as those in the vicinity of Trout Lake, sedges such as beaked sedge (*Carex rostrata*), inflated sedge (*Carex vesicaria*), Nebraska sedge (*Carex nebrascensis*), clustered field sedge (*Carex praegraciis*), tufted hair grass, and giant wildrye (*Elymnus cinereus*).

1.3.5.4 Columbia Basin Ecoregion

Forested Wetlands The arid Columbia Basin Ecoregion supports few forested wetlands except along major water courses and adjacent to springs. The largest tracts of forested wetlands occur along the Yakima and Methow rivers, Satus Creek, and in the Yakima Valley, and to a lesser extent along the Okanogan and Similkameen rivers. These riparian forests are composed of black cottonwood, aspen, and water birch. In some areas, white alder is locally prominent.

Scrub-shrub Wetlands Scrub-shrub wetlands are more common than forested wetlands in the Columbia Basin; dominant species include those listed for the east Cascades region. They are mainly restricted to river floodplains, intermittent stream banks, backwaters of reservoirs and irrigation wasteways. Scrub-shrub dominated seeps and springs are common. Occasionally, scrub-shrub vegetation will dominate isolated pothole depressions. Extensive tracts of scrub-shrub wetlands occur along the Yakima River, Toppenish Creek, the Similkameen River floodplain north of Palmer Lake and the Okanogan River floodplain immediately south of Lake Osoyoos. The Winchester and French Hill irrigation water wasteways are a complex mix of scrub-shrub and emergent wetlands as are backwater areas of Potholes Reservoir. Willows (*Salix exigua, S. amygdaloides, S. lasiandra* var. *caudata*), hawthorn and water birch are important components, similar to the east cascades region. Hackberry (*Celtis reticulata*) occurs in localized areas along the Palouse and Snake Rivers.

Russian olive is a major problem in scrub-shrub forested areas where it eliminates cottonwood which provides a higher habitat value for multiple wildlife species. It is expected to dominate riparian systems in eastern Washington within the next 90 years, the life span of cottonwood (US FWS, Ft. Collins). This species spreads rapidly, is extremely difficult to eradicate, and has limited value for wildlife in dense monotypic stands. Reed canary grass and purple loosestrife are also problems in eastern Washington. Some of the wasteway areas in Grant County are 10-12 foot high dense jungles of purple loosestrife; it can invade and completely take over an area in one growing season. This species is detrimental to wildlife and agriculture.

Very distinct wetland scrub-shrub communities develop on saline and alkaline soils. Salt tolerant shrub species such as black greasewood (*Sarcobatus vermiculatus*), and alkali seepweed (*Suaeda intermedia*) are most common with inland salt grass (*Distichlis spicata* var. *stricta*) as understory. *Elynus cinereus* occurs in less alkaline areas.

Emergent Wetlands Palustrine emergent wetlands are locally abundant in certain areas of this dry ecoregion. Many of these emergent wetlands are formed from elevated groundwater levels from irrigation, and are used for grazing. Common species are reed canary grass, hardstem bulrush, softstem bulrush, alkali bulrush, and cattail. The floodplain of Toppenish Creek (Toppenish National Wildlife Refuge) contains broad floodplain emergent wetlands as does the floodplain of Cow Creek in the Moses Lake area. The Winchester and French Hills irrigation water waste ways have developed a complex of emergent and scrub-shrub wetlands. Pothole wetlands have developed in the Moses Lake and Grand Coulee areas as a result of water development projects. Vernal pools fed by precipitation are locally common in the "channeled scablands" between Ritzville and Cheney, northeast Douglas County and south central Okanogan County in the Omak Lake area.

Common herbs found in the emergent wetlands of eastern Washington include fowl mannagrass (*Glyceria striata*) around seeps, blue vervain (*Verbena hastata*), spearmint (*Mentha spicata*), monkey-flower (*Mimulus guttatus*), rough bugleweed (*Lycopus asper*), water speedwell (*Veronica angalus-aquatica*), and Watson's willowherb (*Epilobium watsonii*). Prairie cordgrass (*Spartina pectinata*) is thought to have occurred along the Columbia in historic times (Shelley Evans).

Most of the Columbia River area is heavily disturbed through intensive grazing and agricultural practices. Very little is known about undisturbed, pre-settlement plant communities. At one time, season-long, year-round grazing was accompanied by removal of vegetation along riparian areas. Many stream channels became very unstable, with headcutting and widening of the channel. Shallow channel configurations resulted in less temperature moderation, causing more icing in winter and hotter summer water temperatures; this is detrimental for fish habitat. With fencing and revegetation of some of these areas, sediment begins to accrete around the vegetation. Stream channels become deeper and narrower, and intermittent streams often become perennial. Forage value increases outside of the riparian area, as water tables rise (pers. comm. Wayne Elmore, BLM).

1.3.5.5 Northern Rockies Ecoregion

Forested Wetlands Forested wetlands occur along water courses and in poorly drained sites in the lower elevations of this ecoregion. Low elevation forested wetlands adjacent to marshes and wet meadows are usually dominated by quaking aspen with snowberry being the most common understory shrub and red osier dogwood and willow more common on wetter sites. At higher elevations, forested wetlands in depressional areas and seepage slopes are dominated by Engelman spruce and quaking aspen and sometimes lodgepole pine. Common understory shrubs are Sitka alder, red osier dogwood, and prickly current. Forested wetlands dominated by western red cedar and western hemlock also occur on seepage slopes and wet bottomlands. In the subalpine forested wetlands, subalpine fir and Engelmann spruce are the dominant tree species. Lodgepole pine also commonly occurs. Forested sites saturated by late melting heavy snow packs have an understory dominated by Sitka alder and sedges.

Scrub-shrub Wetlands Palustrine scrub-shrub wetlands within the Rocky Mountain Ecoregion are very similar in species composition to those found in the lower elevations of the Eastern Cascades Ecoregion and at high elevations, similar to high elevation scrub-shrub wetlands found in the Cascades Ecoregion.

Emergent Wetlands The major river valleys, lake margins and meadows along and near the head waters of streams are where most of the emergent wetlands occur within this ecoregion. Large areas of emergent wetlands and farmed wetlands are in the Colville River floodplain and Pend Oreille River floodplain in the vicinity of Cusick and Calispell Lake. Moses Meadows in Okanogan County is a good example of a headwater emergent wetland. The wettest sites are dominated by cattail and hard stem bulrush. Wetland plants typical of seasonally and temporarily flooded emergent wetlands are essentially the same as those listed for Columbia Basin wet meadows. As in the Columbia Basin, plant species composition may vary greatly with the degree of wetness and disturbance.

1.4 Major Functions and Values of Wetlands

The information contained in this section has been edited from the *1988 Washington Wetlands Study Report* (Ecology, 1988a).

Wetlands have many important ecological functions and values that have only begun to be understood and appreciated by the public in recent years. Because wetlands were traditionally regarded as places to be drained and filled when necessary to accommodate development, almost half the nation's wetlands were deliberately eliminated since colonial times for various, and often beneficial, purposes. The use of wetlands has become a major public policy issue in recent years due to open conflicts between those who want to preserve them and those who wish to convert them to other uses. Only recently has public policy been changed to reflect an appreciation of wetlands as resources having important ecological functions and values.

Wetlands provide essential escape cover and feeding, nesting, and breeding habitat for many species of fish and wildlife; in fact, wetlands are generally considered to be the most productive ecosystems in the world. Some species, including furbearers such as beaver, mink, and muskrat, spend their entire lives within a particular wetland while others, including deer and anadromous fish such as salmon, depend on wetlands during part of the year or part of their life cycle. During times of drought, wetlands play an especially critical role in providing food and water for wildlife.

Waterfowl and migratory shorebirds are particularly dependent on wetlands for their survival. Major north-south migration routes for ducks, geese, and swans roughly correspond to the regions of greatest wetland concentration. Washington, with thousands of acres of natural and human-created wetlands, plays a major role in both production and wintering of waterfowl in the Pacific Waterfowl Flyway. Several million waterfowl use Washington's wetlands during their annual spring and fall migrations and over half a million "resident" ducks and geese are produced in the ponds and potholes of central and eastern Washington each year. In addition to waterfowl, millions of shorebirds concentrate in Washington's wetlands each year.

Coastal wetlands provide critical habitat for many species of game fish and commercially-important food fish and shellfish. Because wetlands are important sources of nutrients, they play an important role in the food web, and because wetland plants also provide escape cover for juvenile fish, they serve as important rearing habitat for both marine and anadromous fish. In a 1980 study, the dockside value of estuarine-dependent fish and shellfish caught by US fisheries was estimated at over $1.1 billion.

The Washington Department of Wildlife has identified the loss of wetland habitat as the number one problem affecting both waterfowl and furbearer populations in this state. Since wetland areas also provide critical rearing and feeding areas for salmon, sea-run cutthroat trout, steelhead trout, and other anadromous fish, continued loss of this habitat could become a major limiting factor in maintaining wild stocks of these fish.

1.4.1 Flood Control

Wetlands play an important role in slowing and storing flood waters. Riverine wetlands and floodplains provide flat expanses where flood waters are able to spread out and slow down, thereby reducing the height and velocity of floods. Once the velocity of floodwaters is stemmed, the water may then drain slowly out of these wetland areas, reducing streambank erosion and flood peaks downstream. If the soil in a wetland area is not fully saturated, the soil itself will provide some storage capacity during periods of flooding. Shallow depressions where these wetlands usually form will also hold standing water for weeks or months, slowly recharging groundwater.

Building structures or filling within floodway areas confines flood flows to narrower channels and causes increased flood heights and rates. Studies have shown that flood peaks may be as much as 80 percent higher in watersheds without wetlands than in similar basins with large wetland areas. For example, a US Army Corps of Engineers study on the Charles River in Massachusetts predicted that a 40 percent reduction in wetland areas along the river would increase flood damages by at least $3 million annually.

1.4.2 Erosion Control

Wetlands effectively reduce erosion of shorelines from tides, waves, wind, and river currents by slowing down and dissipating much of the water's energy and by stabilizing shorelines with their root systems. Replacing wetlands with bulkheads, riprap, and other shore-hardening structures often causes

the erosive forces to be transferred to other areas and other properties downstream or downcurrent. In many coastal areas of Washington, shoreline erosion is a major problem and the ability of wetlands to reduce erosion can result in substantial economic benefits.

1.4.3 Sedimentation and Pollution Control

Wetlands improve water quality by filtering out sediments, nutrients, and toxic chemicals. Moving water carries sediments and other materials in suspension and, as this water enters a wetland, its flow decreases so that soil and other suspended material settles out. The sediment is then trapped by the wetland vegetation and held in place by the root system. This trapping and storing of sediment contributes greatly to the reduction of siltation in lakes, and reservoirs.

Many pollutants, including nutrients, disease organisms, and toxic chemicals, have a tendency to adhere to suspended matter and the ability of wetlands to trap and temporarily retain this matter can reduce the level of both organic and inorganic pollution in water supplies. Some dissolved nutrients such as nitrogen and phosphorus may be taken up directly by plants during the growing season and by chemical absorption and precipitation at the wetland soil surface. As organic and inorganic suspended material settles out in a wetland, some pollutants associated with this trapped material may be converted by biochemical processes to less harmful forms, some may be taken up by the wetland plants and either recycled or transported away, and some may simply remain buried in the bottom sediments. While the trapping and storing of pollutants certainly results in improved water quality, questions have been raised about the long-term environmental effects of this function on the food chain. Bacteria found in wetland soils may also break down or transform chemical compounds into less harmful forms.

1.4.4 Water Supply

In many parts of Washington, wetlands are important as areas where water can soak into the soil, adding to the supply of ground water, or as areas where springs and seeps can collect in small pools or ponds, increasing the available supply of surface water. For example, irrigation has caused ground water levels to rise in parts of the Columbia Basin in eastern Washington, creating many wetlands, including the Potholes, which now provide important waterfowl and shorebird habitat. In other parts of eastern Washington, temporary or seasonal wetlands serve a valuable role in the spring by recharging ground water from snowmelt runoff.

1.4.5 Agriculture

While many wetlands have been converted to crop production, others left in their natural state provide benefits to the agricultural economy. Wetlands serve as catch basins to hold surface water and they recharge ground water for agricultural uses. They also trap sediment and runoff from cultivated land, thereby reducing soil loss and the pollution of water supplies. Some berry crops such as cranberries and blueberries are also produced in farmed wetlands.

1.4.6 Education and Research

Because wetlands contain a variety of flora and fauna not found in other environments, they provide unique educational and scientific research opportunities. The diversity of wetland plant life (over 5,000 species nationwide) creates habitats for every form of animal life, including insects, amphibians, reptiles, mammals, and birds.

Ecological relationships are easily observed in wetlands, making them excellent locations for teaching the environmental sciences at every level from elementary school through graduate education. The tremendous diversity of plant and animal life and the unique interactions of the land and water interface also present biological research opportunities not found in other ecosystems. Research, particularly in botany and ornithology, is often conducted in the coastal and inland wetlands of Washington.

1.4.7 Open Space and Recreation

The scenic and recreational qualities of wetlands are highly valued in Washington. Many of our most popular scenic attractions and recreational areas feature wetlands. Included here would be the Nisqually and Skagit River deltas, Padilla Bay, and the Potholes area of central Washington. The economic contribution of wetland-related outdoor recreation to the state's economy—including hunting, fishing, hiking, boating, and birdwatching—runs into millions of dollars annually.

1.4.8 Other Values and Functions

In addition to the values and functions discussed above, there may be other less obvious but important intrinsic reasons for preserving wetlands and other natural areas. Natural systems can provide baseline conditions that help determine the extent to which the environment has been affected by human activity and pollution. They may provide models for restoring or replacing significantly altered habitats. Or they may be valuable in and of themselves, as part of the natural order of things, regardless of any tangible benefits or ecological services society may receive from them.

2. CURRENT STATUS OF WETLANDS

This section summarizes information about the current status of wetlands in Washington State. As noted in the findings of the *1988 Washington Wetlands Study Report* (Ecology, 1988a), documentation of the current status of Washington's wetlands is incomplete.

2.1 Key Indicators of Wetlands Status

According to the US Fish and Wildlife Service discussion paper on *Wetlands and Deepwater Habitats in the State of Washington* (July, 1989), all wetlands and deepwater habitats comprised about 5.5 percent of the state of Washington in the early-1980s. Wetlands made up about 2 percent and deepwater habitats about 3.5 percent of the State. Within the state of Washington only about 67 percent of the estimated wetland acres at pre-settlement remained in the early 1980s. Deepwater habitats decreased by only about 4 percent. These estimates for loss are based on assumptions about pre-settlement condition which are very conservative; actual wetland losses are expected to be higher than these estimates. In addition, losses do not account for conversion from forested riparian types to deepwater habitat for reservoir construction; they also do not account for degradation. In summary, Washington has lost over 33 percent of the state's wetland, based on very conservative estimates.

This section is intended to identify the "major stress agents" upon Washington's wetlands, thereby linking the resource characterization (Section 1) and the Risks to Wetlands (Section 2.2).

The Environment 2010 Technical Advisory Committee developed the following threat definition for the loss or degradation of wetlands:

Definition:

> Loss or degradation of wetlands is a conversion or alteration which results in a net reduction to total wetland area and/or impairment of the physical functions and ecological values of the affected wetland. Examples include draining and filling of wetlands.

Major stressors:

- Alteration of hydrology - increased flows, higher peak events
- Alteration of hydrology - decreased flows, loss of water, draining
- Decreased water quality - increased sediment, nutrient or pollutants
- Compaction of soils, oxidation of peat
- Introduction of exotic plant species
- Isolation of wetland in the context of the landscape

Major sources:

- Draining
- Filling
- Diking (e.g railroad berms, road building, etc.)
- Urbanization
- Agricultural operations
- Forestry operations

Major damage pathways:

Human Health

None

Ecological

- Decreased floral & faunal species diversity
- Loss of food chain support
- Loss of feeding, nesting, and breeding habitat for waterfowl
- Loss of habitat for furbearers (e.g. beaver, mink, etc.)
- Loss of habitat for anadromous and game fish during early phases of their life cycle
- Loss or deterioration of aquifer recharge functions
- Loss or deterioration of capacity for biofiltration of contaminants, sediment and nutrients
- Loss or deterioration of ability to desynchronize flood events

Economic Damages

- Loss of aesthetic values
- Cost of alternative forms of flood control
- Loss of fish and wildlife for fishing and hunting
- Loss of passive recreation opportunities
- Reduced water quality

Additionally, Environment 2010 reviewers have noted the following issues:

Agricultural operations are a threat to wetlands loss and/or degradation, citing grazing as a specific example of an uncontrolled activity. Jurisdictions which have adopted wetland ordinances typically exempt grazing due to the financial and other problems associated with protective fencing.

Another general problem resulting from all activities is the loss of vegetated wetland edges and vegetated and aquatic connectors (corridors). For many wildlife species a wetland without a vegetated edge is an incomplete habitat. One hundred and twenty one western Washington species depend on wetlands and wetland edges for some or all of their life cycle requirements (Zeigler, 1988; Brown, 1985; Guenther & Kucera, 1978).

Peat mining is destructive of a special kind of wetland, mostly in western Washington. Peat forms at the rate of 1 inch in 40 years in western Washington, 1 inch in 100 years in eastern Washington (Rigg, 1958) Once mined, it cannot be replaced.

Palustrine forested wetlands take a minimum of 20 years to reestablish, and usually 40 to 200 years to reach maturity. In wetlands, trees are usually stressed by flooding, and grow very slowly. Replacing of forested wetland systems takes a long period of time; if compaction of the soil, altered hydrology or invasion by weedy plants occurs, the area may never be restored to its original characteristics, values or functions. A review of Department of the Army (Section 404) permits in Washington state indicates that forested systems were not being mitigated for or replaced (Kunz et. al., 1986).

Vegetation removal in shallow water wetlands for purposes of lake management is destructive of habitat used by fish and waterfowl. Lake management is conducted for aesthetic purposes, for enhancement of recreational activities such as swimming, boating, and water skiing, and for the control of exotic and invasive weed species.

2.2 Risks to Wetlands

The major causes of wetland loss and degradation are summarized in Table 2.1. The Environment 2010 Technical Advisory Committee identified the major threats to wetlands as (1) wetlands loss and degradation, and (2) hydrologic disruption; minor threats were identified as (1) global warming, (2) point source discharge, (3) nonpoint source discharge, and (4) inactive hazardous waste sites.

Other major threats to wetlands were identified as: (1) impacts on wetlands from nonchemical impacts on forest land; (2) impacts on wetlands from nonchemical impacts on recreation lands; (3) impacts on wetlands from nonchemical impacts on rangelands; and (4) impacts on wetlands from nonchemical impacts on agricultural lands.

Table 2.1 Major causes of wetlands loss and degradation.

Human Threats

Direct

1. Drainage for crop production, timber production, and mosquito control.
2. Dredging and stream channelization for navigation channels, flood protection, coastal housing developments, and reservoir maintenance.
3. Filling for dredged spoil and other solid waste disposal, road and highways, and commercial, residential, and industrial development.
4. Construction of dikes, dams, levees, and sea walls for flood control, water supply, irrigation, and storm protection.
5. Discharges of materials (e.g. pesticides, herbicides, other pollutants, nutrient loading from domestic sewage and agricultural runoff, and sediments from dredging and filling, agricultural and other land development) into waters and wetlands.
6. Mining of wetland soils for peat, coal, sand, gravel, phosphate, and other materials.

Indirect

1. Sediment diversion by dams, deep channels, and other structures.
2. Hydrologic alterations by canals, spoil banks, roads, and other structures.
3. Subsidence due to extraction of ground water, oil, gas, sulphur, and other minerals.

Natural Threats

1. Subsidence, including natural rise of sea level.
2. Droughts.
3. Hurricanes and other storms.
4. Erosion.
5. Biotic effects, e.g. muskrat, nutria, and goose "eat outs."

Source: Zinn & Copeland, 1982 and Gosselink & Bauman, 1980, in: Tiner, 1984.

2.2.1 Wetlands Loss

The following discussion is summarized from the wetlands loss and degradation analysis except as noted.

1. According to a report completed by the US Fish and Wildlife Service (1989), wetlands made up about 2 percent of the land area of the state of Washington in the early 1980s. Conservative estimates from this study indicate that only about 67 percent of the original acres remain, a reduction from 1.4 million to 938,000 acres. Deepwater habitat decreased by only 4 percent. These estimates for loss are based on assumptions about pre-settlement condition which are very conservative; actual wetland losses are expected to be higher than these estimates. In addition, losses do not account for conversion from forested riparian types to deepwater habitat for reservoir construction; they also do not account for degradation. Forested systems are very difficult to accurately estimate by aerial photography. In summary, Washington has lost over 33 percent of the state's wetlands, based on very conservative estimates.

2. Other indicators of recent trends are available in Washington. Based on field inventory observations, Snohomish County estimates losses of 15 wetland acres per month, or 180 acres per year. Statewide losses for the eight counties with similar growth projections plus King and Pierce counties would be 1,800 acres per year in urbanized counties.

3. State Environmental Policy Act Wetlands Evaluation Project (Draft) (Hull & MacIvor, 1987). The unpublished study done by Department of Ecology of selected environmental impact statements estimates that roughly half of Washington's original 800,000 acres of wetlands have been lost due to development, a figure that mirrors national wetland loss estimates. This study also indicated that freshwater marshes and forested wetlands experienced the greatest losses from development and that most of the wetlands lost were small, between 0.5 and 5 acres in size. This report also identified draining as a greater cause of wetlands loss than filling in those sites visited for the study. A conservative estimate of wetlands loss—wetlands outside the jurisdiction of the Shoreline Management Act and considered under the State Environmental Policy Act—is 530 acres per year.

4. Wetlands of the United States: Current Status and Recent Trends (Tiner, et al., 1984). Tiner et al., estimated original wetlands acreage in the contiguous United States at 215 million acres. This acreage estimate had decreased by about 50% to 108.1 million acres by the mid-1950s. Of 99 million acres remaining in the mid-1970s, 94 million acres were estimated to be fresh water or palustrine wetlands and 5.2 million acres estuarine wetlands. Of the estimated 11 million acres of wetlands lost during a 25-year period between the mid-1950s and mid-1970s, 96 percent were estimated to be palustrine or freshwater wetlands; agricultural development was estimated to be responsible for 87 percent of these losses. Estuarine wetlands only account for about 5 percent of remaining wetlands but are generally better protected by state laws. It is estimated that 90 percent of the estuarine wetlands loss in California and four other coastal states is due to residential home construction.

5. Inventory of Wetland Resources and Evaluation of Wetland Management in Western Washington (Boule et al., 1983). Boule, et al. included acreage loss estimates that are very consistent with Tiner, et al. The 458,000 acre annual loss figure cited by Tiner has been reduced since the mid-1970s largely due to a decline in the rate of agricultural draining activities as well as better state and federal wetland protection laws. Boule et al. includes three

case studies in Washington showing the following losses of freshwater wetland acreages in the following USGS quadrants:

Tenino and Yelm (south Thurston County): 55%
Tacoma South (Pierce County): 82%
Lake Washington (King County): 70%

6. Historical changes of shoreline and wetland at eleven major deltas in the Puget Sound Region, Washington. (Bortleson, Chrzastowske & Helgerson, 1980). Bortleson, et al. evaluated wetland loss at the major river deltas of the Puget Sound and found a loss of 28 to 100 percent of wetlands (Table 2.4).

7. US Environmental Protection Agency, Region 10. EPA evaluated records of 2,300 US Army Corps of Engineers Public Notices in Washington for activities requiring permits under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act, and determined a loss rate of 186 acres per year for Washington (Table 2.3). This represents a small portion of wetland losses in Region 10 since activities which damage or destroy wetlands but do not require a permit are not included. Examples of non-404 permitted activities which may cause physical degradation of wetlands include logging activities, drainage, water impoundment, activities markedly changing runoff or recharge, major water withdrawals, and activities which result in changes to watersheds or the hydraulic regime.

8. Wetlands of the United States (Shaw & Fredine, 1956). Shaw and Fredine estimated an average national wetlands loss rate of 0.40 percent per year, or 2,034 acres per year for Washington (Table 2.2). Estimated annual loss for Idaho and Oregon are also shown for comparison.

Table 2.2. Estimated[1] Annual Loss of Wetlands in Washington[2], Oregon, and Idaho.

State	Acres of Wetlands Remaining	Approximate Yearly Loss (acres)
Idaho	95,140	380
Oregon	412,120	1,650
Washington	938,000	2,034

[1] Based on an estimate of the number of acres of wetlands in each state (Shaw and Fredine, 1956) and a 0.4 percent per year loss rate (Shaw and Fredine, 1956) for Idaho, Oregon and Washington. The loss rate for Alaska is based on only a review of 404 permitted projects (Faris et al, 1987).

[2] Based on USFWS report, 1989.

Table 2.3. Annual Loss of Wetlands in Washington, Oregon, and Idaho Based on Review of Section 404 Permit Activities.

State	Palustrine	Estuarine	Marine	Lacustrine	Riverine	TOTAL
Idaho	21.20	0	0	0.38	3.33	24.91
Oregon	112.22	6.35	0.11	0.11	56.51	175.30
Washington	32.22	144.38	0.19	0.73	7.10	185.62

Palustrine: nontidal wetlands dominated by trees, shrubs, and persistent emergent vegetation (i.e., wet meadows, freshwater marshes).

Estuarine: deepwater tidal habitats and adjacent tidal wetlands, including emergent saltwater marshes.

Marine: open ocean and the high energy coastline.

Lacustrine: wetlands and deepwater habitats contained within a depression (i.e., lakes).

Riverine: all wetland and deepwater habitats within a channel.

Table 2.4. Estimated historical changes in natural habitat of principle estuaries of Washington State.

Estuary	Estimated (km^2) sub-aerial wetland		
	Historical	Present	% change
Nooksack	4.5	4.6	+0.2
Lummi	5.8	0.3	-89.7
Samish	11.0	0.4	-96.4
Skagit	29.0	12.0	-58.6
Stillaguamish	10.0	3.6	-64.0
Snohomish	39.0	10.0	-74.4
Duwamish	2.6	0.1	-99.2
Puyallup	10.0	0	-100.0
Nisqually	5.7	4.1	-28.1
Skokomish	2.1	1.4	-33.3
Dungeness	0.5	0.5	0

Source: Bortelson et al., 1980.

Other Environment 2010 risk analysts identified the following impacts leading to wetlands loss.

In the past, dam construction, particularly on the Columbia River system, was the cause of riparian wetlands loss. The amount of loss is not known to have been documented. Presently the loss rate due to dam construction is presumed to be low to none, however the threat is considered to remain.

Flood control actions, e.g. diking and bank protection, can lead to secondary effects of increased stream bank erosion downstream and the loss or degradation of riparian wetlands.

Urbanization sets in motion a chain of events such that building construction, paving, and soils compaction lead to large percent increases in impervious surface coverage which leads to chronic hydrologic shifts (increased winter and flood flows, and decreased summer flows); the increased winter and flood flows cause chronic bank erosion and loss of riparian wetlands.

Existing sea level rise is known to cause shoreline erosion and loss of coastal (Pacific Ocean and Puget Sound) wetlands; the loss rate is unknown. Accelerated sea level rise due to global warming will aggravate this loss to an as yet uncertain degree. Losses caused by accelerated sea level rise will be directly attributable to erosion, inundation, and transformation of fresh water wetlands to saline wetlands.

2.2.2 Wetlands Degradation

Losses due to degradation are based upon estimates by statewide inventories conducted by the Washington Natural Heritage Program of the Department of Natural Resources. Estimates of degradation are based upon deviance from pre-settlement condition; this is measured by how closely the plant community species composition, soils, and hydrology approximates pre-settlement condition. According to these criteria, all wetlands inventoried in the state of Washington have some adverse impact from degradation (Kunze, 1989). The purpose of these inventories is to identify pristine wetlands for potential preservation by The Nature Conservancy or some other state, federal, local, or private group. There are many wetlands which still have high quality even though they do not meet the stringent requirements of the Natural Heritage Program.

Methodologies to assess wetland values and functions have not been developed which provide consistency, reliability, accuracy, and replicability for the Pacific Northwest region. Due to the fact that a methodology is not in place, inventory evaluations of wetland values and functions tend to be general and relatively simplistic. The only information on wetland degradation through loss of functions and values is inferred from lowered fish numbers (particularly coho salmon), lowered waterfowl numbers, or increased flooding and water quality problems.

This should not imply that wetland managers are not concerned about degradation of wetlands—quite the contrary, the level of concern regarding degradation equals the concern regarding direct loss. Degradation is occurring due, but not limited to, the following factors: vegetation removal; introduction of exotic plant species; hydrologic disruption, e.g. diversion of surface water, lowering of water tables caused by ground water withdrawals, and alteration of the timing and quantity of seasonal surface water flows; compaction of soils or oxidation of organic soils; isolation of the wetland so the area has less upland habitat edge and more disturbance so that it is no longer used by wildlife. Additionally, wetlands managers are also concerned about degradation due to nonpoint pollution (principally urban, agricultural, and forestry runoff) and point source pollution (principally industrial discharges and accidental spills).

Other Environment 2010 risk analysts identified the following impacts leading to wetlands loss. Typically, they were unable to quantify their conclusions due to a lack of quantitative data.

Surface water diversions can change the character of wetlands. By altering the hydrologic regime—the timing and abundance of water—the plant species composition will be shifted towards a community with greater or lesser predominance of hydrophytes.

Livestock grazing can lead to the loss of wetlands vegetation and the alteration of the plant species composition. Stressed habitats such as this are more susceptible to invasion by exotic plant species.

Urbanization causes, in addition to the hydrologic shifts described above, adverse changes in the quality of runoff water. The load of pollutants finds its temporary or permanent resting place in the sediments of lakes, wetlands, and estuaries. Contaminated sediments have been associated with changes in the species composition and abundance of aquatic and estuarine habitats. Additionally, inactive hazardous waste sites have been associated with similar effects.

2.3 Impacts on Wetlands from Nonchemical Impacts

2.3.1 Impacts on wetlands from nonchemical impacts on forest land

Nonchemical impacts on forest lands include physical modifications (e.g. road building) and other impacts that affect Washington's forests. These impacts often result from changes in the use of the forest that alter the mix of commodities produced; they influence the profitability of current and future economic activities and diminish or alter ecological values, constrain recreational opportunities, and preclude future use.

Specific examples include compaction of wetland soils; drainage of wetlands to increase merchantable timber production; habitat loss through short-term removal of habitat; habitat loss through long-term impacts to pristine and old-growth wetlands. In addition, hydrologic functions of wetlands such as stormwater retention are reduced by canopy removal. Increased sediment input from slopes can cause sediment deposition in wetlands beyond the threshold capacity; resulting vegetation die-off and species changes reduce habitat value.

Conversion of forest land to non-forest uses, for example, causes increased loading of wildlife into remaining wetland and forest land. When the carrying capacity of the remaining land is exceeded, the excess wildlife population dies.

Conversion of forest land also causes a reduction in the diversity of fauna supported in forest and wetland ecosystems. In particular, loss of the wetland/upland "edge" causes reduction in plant and wildlife species diversity, and reduces the quality of the habitat.

As a generalization, it can be said that forest harvesting causes a reduction in the functional and structural diversity of forest and wetland ecosystems. Often pathways or corridors for wildlife movement and genetic exchange of native plant material are truncated. Opening the canopy around wetland and aquatic sites can cause a reduction in the temperature buffering canopy of vegetation, which reduces both high summer temperatures and winter icing problems.

Conversion of old-growth to second-growth, for example, causes a loss of ecosystem structure and diversity which manifests itself as a reduction in the number and diversity of species supported in forest land.

Conversion of old-growth causes fragmentation of wildlife habitat and the phenomenon of island biogeography. Island biogeography dictates that some post harvest forest stands will be too small to support wildlife populations, particularly range and habitat necessary for reproduction.

Markets for species found in wetlands such as alder and cottonwood create impacts through compaction of soil; reduced reproductive ability in trees in wetland areas, due to the stress of flooding and predominantly vegetative (asexual) reproductive strategies; and invasion of exotic plant species such as reed canary grass, blackberry, and purple loosestrife.

Bog systems are particularly vulnerable to impacts from changing water quality or quantity. Changes of a few centimeters of water, or increases in nutrient of pH, can permanently and irretrievably adversely impact bog systems.

2.3.2 Impacts on wetlands from nonchemical impacts on recreation lands

Nonchemical impacts on recreation lands include physical modifications to those lands caused by such things as road building, concentrated use, misuse, and urbanization. These impacts can result in reductions in overall recreational opportunities, as well as ecological damages such as loss or degradation of wildlife habitat and damage to vegetation.

The most serious threat to wetlands from nonchemical degradation of recreation land is habitat loss and disruption from concentrated use of recreation land.

Road building in urban/rural, roaded, and semi primitive recreation lands causes loss and degradation of wildlife habitat. Increased impermeable surfaces causes increased runoff, with an increase in pollutants such as oil and gasoline adversely impacting water quality. Road building is a key element in the conversion of semi primitive recreation land. Once road building occurs, wildlife is continuously disrupted from vehicle noise and increased access.

Resource extraction activities on roaded and semi primitive recreation lands causes loss and degradation of wetland habitat. The loss may be only temporary, if the environment is allowed to recover.

Urbanization/development and misuse of urban/rural, roaded, semi primitive and primitive recreation land causes degradation of wetlands.

2.3.3 Impacts on wetlands from nonchemical impacts on rangelands

At the time of European settlement, many streambanks were lined with woody vegetation, such as willow, aspen, alder, and cottonwood. Year-round, season-long livestock use allowed heavy animal concentrations along wetland areas, rather than on adjacent hillslopes. As a result, many of the wetland and riparian areas in eastern Washington are in a state of disrepair and degradation. Streams that were a perennial water source may no longer flow in late summer. Channels that once handled spring runoff and summer freshets easily are now unstable and eroding. Where channel gully erosion proceeded unabated, extensive deep gullies now remain as monuments to a lack of appreciation of how riparian wetlands function and maintain themselves (Elmore and Beschla, 1987).

Removal of vegetation through both grazing pressure and agricultural activities had several impacts on stream systems. Wetland plants such as willows, sedges, and rushes have strong root systems to hold banks. Their stems provide roughness and resistance to flow. This wetland vegetation maintains bank stability and filters sediment before reaching surface waters. Sediment accretion maintains the deep, narrow bank morphology which provides excellent fish habitat.

As a stream channels aggrade (i.e. channel elevation increases as sediment is deposited within and along the banks of the channel), water tables rise. Species composition and community structure of vegetation becomes dominated by typical riparian wetland species. An aggrading channel and a rising water table have many benefits. More water is stored during wet seasons, and slow release of this water may allow a stream to flow throughout the summer. The vegetation along the streambank provides valuable fish and wildlife habitat. In addition, increased forage production is provided for livestock.

Unregulated grazing before 1900 initiated streambank deterioration by wiping out vegetation and encouraging erosion. These conditions led to passage, in 1934, of the Taylor Grazing Act, which regulates grazing on the public domain. Since then, cover has returned to the range, usually as cheatgrass or crested wheatgrass. While they stabilize soil, these plants are not good wildlife food or habitat, and do not maintain streambank stability.

Dr. William Platts and his co-workers at the Forest Service Intermountain Forest and Range Experiment Station in Boise, Idaho have studies livestock/ riparian problems for many years (Platts, 1987). After season-long grazing experiments, these changes were documented:

- Riparian vegetation was changed, reduced, or eliminated;
- Stream channels widened and eroded, and water table dropped;
- Fish habitat was lost as shade and cover disappeared and water temperature and sediment increased, reducing pool depth, aquatic invertebrates, and spawning gravel;
- Stream banks were degraded, water flows became inconsistent, and eroded soil was deposited away from the initial site; and
- Populations, types and numbers of fish, wildlife, aquatic invertebrates, and plants were altered or eliminated.

Grazing on federal lands is improving through improved grazing practices and rangeland recovery projects (Thomas, 1988). Range restoration projects include water gaps for livestock, pass-throughs for anglers, gap fences, and barriers built to keep livestock out of some riparian and wetland areas; conifers and junipers cut and cabled along badly-eroded streambanks to catch and deposit sediment for woody vegetation to grow in, and to reduce the effects of cattle trampling. Fish habitat has been improved in demonstration areas with instream structures, artificial shade, and cover and boulder replacement. Streamside vegetation has been planted. Check dams have been built and beaver been introduced.

Riparian wetlands have been severely degraded in Washington. In some areas, the stream has been plowed to the edge, and banks erode and headcut, costing the property owner loss of land. Most of the landscape in the eastern portion of the state has been so degraded, an assessment of pristine condition is a best professional guess (Evans, 1989). Impacts of grazing include decreased fish and wildlife habitat; decreased water quality through increased stream temperatures, siltation, erosion, and nutrient; increased flooding impacts; and decreased low flow augmentation of streams during dry periods of the year.

2.3.4 Impacts on wetlands from nonchemical impacts on agricultural lands

National estimates of wetland loss indicate that 87 percent of wetlands were lost due to drainage for agricultural conversion. Many wetlands have been drained and converted to agriculture. Many of the remaining wetlands have been degraded through off-site activities.

Soil erosion from farmland and other lands increases sediment, nutrient, and pesticide loadings in wetlands prior to entering surface waters. Sediment, nutrient, and pesticide loadings cause sedimentation problems on stream bottoms, affects aquatic plant and animal life, affects the quality of wetland and riparian habitats, reduces recreation opportunities, and may be related to human health affects.

2.4 Conclusions

The reports cited in the wetlands risk and degradation study identify two values for an existing wetland base: 938,000 acres (USFWS, 1989), and 400,000 acres (Hull & MacIvor, 1987). These do not represent upper and lower bounds, but rather the results of defining wetlands differently for different purposes. As currently defined, the remaining wetland base for Washington is presumed to be approximately 938,000 acres.

An interpolation of national loss rates of 0.40 percent per year (Shaw and Fredine, 1956), times the wetland base of 938,000 acres, indicates a yearly loss rate of 2,034 acres of wetlands per year. This national loss rate is based on 1956 data, and has not been field checked in Washington. Other estimates of yearly loss rates include the following:

Clean Water Act	186 acres/year (Table 2.3)
Unregulated	530 acres/year (Hull & MacIvor, 1987)
Total	716 acres/year

Another method for estimating wetland loss might be:

Rural/Suburban areas	530 acres/year (Hull & MacIvor, 1987)
Urban areas	1800 acres/year (Snohomish County, 1989)
Total	1530 acres/year

Estimates of wetland loss vary from 716 acres per year, to 1530 acres/year to the national estimate of 2,034 acres per year. These numbers are highly variable and are based on very rough estimates. Clearly, the numbers are not as significant as the message. Wetland loss is occurring, and documentation of the loss is unavailable.

Without knowing what types of wetlands are lost, how they are lost, and where they are being lost, it is extremely difficult to prevent or manage the state's wetland resource. Many wetland losses occur due to agriculture, small-scale farming, silviculture, small scale development, highway construction, or other activities which have been exempted from the regulatory process. More than twice the acreage of wetlands have been lost to draining rather than filling, and small, isolated wetlands contributed to a high percentage of wetland loss (Hull and MacIvor, 1987). Both small wetlands and impacts to wetlands other than fill are not covered under the Clean Water Act, the only legislation which specifically addresses wetland protection.

National and state estimates strongly indicate that wetlands are continuing to be lost at a rapid rate. While reliable trend analyses are difficult to develop, it is clear that a definite reduction of wetland acreage, values, and functions has occurred statewide. In addition, wetland loss is continuing to occur, with limited regulatory protection and increasing demand for development of remaining resources.

3. WETLANDS MANAGEMENT PROGRAMS

A variety of federal, state, and local laws and regulations affect construction and other activities in wetlands and adjacent areas in Washington. With the exception of the Wetlands Protection element of the Puget Sound Water Quality Management Plan, none of these laws focus on the protection of wetlands as their primary purpose. In addition, the types, sizes, and locations of wetlands included in the regulations vary from law to law. The Department of Ecology's Wetland Regulations Guidebook, published in July 1988, gives a complete description and analysis of the existing matrix of federal and state laws and regulations that protect wetlands in Washington. Section 3, Wetlands Management Programs, is quoted or closely paraphrased from the 1988 Washington Wetlands Study Report (Ecology, 1988a) except as noted. Additional information may be found in the Wetland Regulations Guidebook (Ecology, 1988b) and The Path Between Habitat and Development (Wildlife, 1987).

3.1 Federal and Washington State Management Programs

The primary laws currently used by federal, state, and local agencies to protect wetlands are summarized below:

3.1.1 Federal Clean Water Act

Wetlands management provisions of the Clean Water Act (CWA; 33 USC 1251-1376) are contained in Section 404 (33 USC 1344). The Clean Water Act is a broad based law covering water pollution control in general; wetlands management is not the primary focus of the Act. Section 404 is enforced by the US Army Corps of Engineers through its Department of the Army Permit which combines the provisions of Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899.

Intent "... restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

Jurisdiction All wetlands meeting the Clean Water Act definition (see Section 1.2.2) are covered.

Regulated activities The placement of fill in waters of the United States, including wetlands, as defined in the Act is covered.

Gaps in regulatory coverage Section 404 only regulates filling, not dredging, draining, or land clearing. It exempts normal farming, ranching, and forestry practices. Corps regulations allow fills of less than one acre in isolated wetlands and may allow fills of 1 to 10 acres in isolated wetlands and headwaters streams of less than 5 cfs.

3.1.2 State Shoreline Management Act

The Washington Shoreline Management Act (SMA; Chapter 90.58 RCW) was adopted in 1971 primarily to manage development on the state's shorelines. The Act is administered through Shoreline Master Programs adopted and enforced by local governments. The Department of Ecology has

oversight authority over the local government actions. Locally developed master programs must be approved by the Department of Ecology.

Intent To manage appropriate uses of the state's shorelines, as defined by the Act.

Jurisdiction Shorelines of the State, including marine waters, lakes 20 acres or greater in size, streams with flows over 20 cfs, and all lands within 200 feet of Shorelines of the State (ordinary high water mark), plus associated marshes, bogs, and swamps are covered.

Regulated activities Most wetland alterations are covered, but exact coverage depends on individual local Shoreline Master Programs.

Gaps in regulatory coverage The Act excludes wetlands not "associated" with waters of the State, including isolated wetlands and riparian wetlands associated with lakes less than 20 acres and streams with flows less than 20 cfs. It exempts most agricultural and forest practices from permit requirements. Wetland protection is highly variable and is dependent upon the local Shoreline Master Program.

3.1.3 State Hydraulics Code

The Hydraulics Code (RCW 75.20.100) is jointly administered by the Washington departments of Fisheries and Wildlife through the Hydraulic Project Approval (HPA) permit process. In general, the Department of Fisheries assumes responsibility for marine shorelines and anadromous fish streams; the Department of Wildlife assumes responsibility for all other streams.

Intent The intent of the Code is to protect fish and fish habitat.

Jurisdiction All waters of the state, including marine waters, lakes, ponds, rivers, and sloughs, and wetlands are covered.

Regulated Activities Most activities within the Ordinary High Water Mark are covered; exceptions are defined by Rule.

Gaps in regulatory coverage Wetlands outside the Ordinary High Water Mark are excluded, as are isolated wetlands without fish life. The Code does not address impacts to wetland values and functions other than fish and fish habitat.

3.1.4 Forest Practices Act

The Forest Practices Act (FPA; Chapter 79.09 RCW) is enforced by the state Department of Natural Resources.

Intent The Act is intended to protect public resources while promoting and maintaining a sound forest products industry.

Jurisdiction Wetlands are considered Type 2 waters, as defined by the Act, when they have one acre or more of open water at low water. Wetlands are considered Type 3 waters, as defined by the Act, when they have less than one acre of open water at low water and an outlet to a stream containing anadromous fish, or if they have between 0.5 and 1 acre of open water at low water. Wetlands without open water are generally considered to be Type 5 waters.

Regulated activities All forest practices including road construction are covered.

Gaps in regulatory coverage The Act only regulates forest practices. It provides little or no protection for wetlands without open water (Type 4 or 5). It allows logging to the edge of wetlands classified as Type 2 or 3 waters. It is important to note that the Forest Practices Act was amended in 1987 to include certain provisions agreed to in the Timber, Fish and Wildlife (TFW) negotiations. As a result of the TFW agreement, a process is now in place that provides for detailed review of proposed forest practices and may result in greater protection of wetlands than is provided for in the forest practices regulations.

3.1.5 State Environmental Policy Act

The State Environmental Policy Act (SEPA; Chapter 43.21C RCW) is implemented mostly at the local government level. There is no central oversight or review authority for SEPA decisions.

Intent SEPA requires full disclosure and consideration of possible adverse environmental impacts of a project, and identification of ways to mitigate or reduce adverse impacts.

Jurisdiction SEPA review is required for any proposed action not categorically exempt by the Act; SEPA review must be completed before issuance of Shoreline Substantial Development Permits, Hydraulic Project Approvals, and many other state and local permits.

Gaps in regulatory coverage SEPA is not a regulatory Act except when it is used to deny or condition a state or local permit based on significant adverse environmental impacts. SEPA includes no language specifically protecting wetlands.

3.1.6 Aquatic Lands Management Act

The Aquatic Lands Management Act (Chapter 79.90 RCW) provides for the management of state owned aquatic lands for a variety of uses. The Act is administered by the Department of Natural Resources.

Intent The Act provides for the management of state owned lands for a variety of uses including encouragement of direct public use and access, fostering water dependent uses, ensuring environmental protection, and utilizing renewable resources.

Jurisdiction Many uses of state owned aquatic lands, generally those requiring structures or other restrictions on public use, must receive a use authorization from the Department.

Gaps in regulatory coverage The ALMA applies only to the state owned aquatic lands. Private lands are not affected.

3.2 Program Evaluation Summary

Cities and counties have other options available to them besides state and federal laws to protect wetlands. Included among these options are comprehensive plans and zoning ordinances; environmentally sensitive area ordinances; clearing, grading, and filling ordinances; and SEPA policies; and preservation program. Some cities, including Bellevue, Kirkland, and Olympia, and counties, including Island, King, Pierce, Snohomish, and Thurston, have adopted their own wetland protection programs. Grant County in eastern Washington is working on adoption of an ordinance.

Under the provisions of the Puget Sound Water Quality Management Plan, the Department of Ecology is developing wetland protection standards which will be used as guidance by local governments who are developing wetland protection programs. At some point in the future, these standards may be adopted as state rules for the Puget Sound basin. Hopefully, these standards will be used by local governments to provide improved wetland protection at the local level.

In summary, the current matrix of federal, state, and local laws and regulations, when taken together, do not provide adequate statewide protection for wetlands in Washington, even though the Puget Sound Water Quality Management Plan will offer a high degree of protection in the 12 counties included in the Puget Sound region. The principle gaps in statewide coverage include:

> Jurisdiction over isolated wetlands—that is, wetlands not associated with Shorelines of the State or within the Ordinary High Water Mark of streams, lakes, and other waters of the state;
>
> Regulation of agricultural and forest practices;
>
> Regulation of activities in wetlands other than filling; and
>
> Lack of monitoring and enforcement of mitigation proposals.

3.3 Opportunities

There was no documentation found on opportunities created by successful application of wetlands management although such opportunities clearly exist.

4. EFFECT OF POPULATION GROWTH ON WETLANDS

Conventional wisdom indicates that an increase in population will lead to increased pressures on open space, including wetlands. Population is projected to continue to increase, with a 25 percent increase projected statewide in the decade of the 1990s. Because of regulatory restrictions and time delays in developing wetland areas, upland alternatives are usually exhausted first. In rapidly growing areas, only wetlands or steep slope remain undeveloped. Because there is usually no protection offered for upland buffers, these wetlands are often isolated habitat islands in a developed landscape. As land becomes more scarce and population continues to grow, the pressure to develop remaining wetlands will become even more intense.

One case example is the Green River Valley of King County. The following growth information is based on estimates from the Puget Sound Council of Governments. The Green River Valley contains the largest supply of vacant, zoned commercial and industrial land in the Seattle metropolitan area. The supply of zoned land is virtually exhausted in Seattle and is running low in the communities east of Seattle. A large portion of the vacant, industrially-zoned land in the Kent portion of the Green River Valley contains wetland areas. The supply of land in the valley is expected to last only until the mid-1990s; therefore, only a two- to four-year supply is available. The market is extremely tight, land prices continue to escalate, and development pressure in this area is extremely high.

There are many problems with estimates of wetland losses by comparing data from past wetland resource base to the present. In the past wetland inventories were conducted for relatively narrow purposes, e.g. the early 1950s *Circular 39* (Shaw and Fredine, 1956) inventory which was focused on waterfowl habitat. The early Soils Conservation Service maps were based on aerial photos and spot checked at a very large scale; forested wetlands were often missed in the data base, and no information was gathered for higher elevation areas. Thus, wetlands loss at that time was measured against a smaller base than are current wetland analyses. Any estimates based on wetland loss are extremely conservative.

Additionally, one must consider the factors regulating the rate of loss. In the past, particularly prior to the 1970s, there were few or no regulations controlling wetlands fill or drainage—in fact, federal policy often encouraged such activity. Major wetland losses occurred through drainage for agriculture, grazing, mining, and forestry activities. Current losses occur through urbanization; industrial, residential and commercial development; and timber harvesting at a landscape scale to create significant cumulative adverse impacts. The differences in types of wetland loss also make quantification of changes over time or correlation with population very difficult. As the base area of wetland resources diminish, there are fewer wetlands to be lost in the future; this would tend to lower the rate of present and future loss.

The point is: lacking a stable baseline for comparison, it is difficult to compute meaningful loss rates for wetlands. The importance of conducting a statewide inventory and monitoring loss rates closely is a critical component of building an adequate data base for long-term wetland planning decisions. In addition, advanced planning for development through such activities as the Special Area Management Plans developed by the US Army Corps of Engineers, Advanced Identification by the Environmental Protection Agency, and watershed management plans by state and local governments assist in maintaining wetland areas for wildlife and other wetland values and functions.

5. WETLANDS STATUS IN 2010

There are two clear trends in operation regarding wetlands: (1) a continued loss of wetlands of all kinds, and (2) a growing concern over their loss which is being reflected in tentative government action, e.g. the 1988 Washington Wetlands Study Report, and the proposed Wetlands Management Act of 1989.

If no regulatory action takes place, clearly then there will be a continued loss of wetlands at rates similar to or higher than now occurring. The secondary effects of this will principally be continued loss of fish and wildlife habitat leading to declines in populations and fewer opportunities for hunting, fishing, and passive observation; and continued loss of the hydrologic amenity values of wetlands in flood control and water quality improvement, leading to greater municipal costs for providing these benefits through engineered structures.

If a regulatory program similar to the proposed Wetlands Management Act of 1989 is adopted, then some reduction in the loss rate can be expected. There may also be revisions to the Clean Water Act to reduce the impacts of filling isolated wetlands. Local government may adopt wetland protection ordinances.

Assuming an existing (1989) wetlands base of 938,000 acres and a sustained annual loss rate of 800 acres (page 27), during the 21 years to 2010 an additional 16,800 acres of wetlands would be lost.

This is a minimal estimate of loss rate. Population growth and development pressures for both wastewater and storm water treatment; placement of fill for residential, commercial, and industrial projects; and silvicultural, agricultural, and roadbuilding activities will all continue or increase while the resource base remains finite.

Without regulatory protection or increased acquisition/presentation programs, loss and degradation of fish and wildlife habitat, water quality, and water quantity is expected to accelerate to 2010 in the state of Washington.

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WASHINGTON'S WETLANDS AT RISK: LOSS AND DEGRADATION

V 1.1.1
January 1990

Douglas J. Canning, Editor

Land and Wetland Resources Subcommittee
Washington Environment 2010 Technical Advisory Committee

Shorelands and Coastal Zone Management Program
WASHINGTON DEPARTMENT OF ECOLOGY
Olympia, WA 98504-7600

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About the authors:
Douglas J. Canning (BA, MS, Environmental Science), is a special area management planner with the Planning Section, Shorelands and Coastal Zone Management Program, Washington Department of Ecology. Joe La Tourrette, Wetlands Section, Shorelands and Coastal Zone Management Program, provided editorial and analytical support.

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EXECUTIVE SUMMARY

Introduction

At the time this report was initially prepared, there was no accurate, comprehensive inventory of the nature or extent of Washington's wetlands, nor was there enough quantitative information available to adequately document the precise nature of the threat to Washington's wetlands or the rate of loss or degradation. To address these shortcomings, and as a requirement of Governor Booth Gardner's Executive Order 88-03, the Department of Ecology contracted with the US Fish and Wildlife Service (FWS) in 1988 to complete the digitization of National Wetlands Inventory (NWI) data for Washington, and to produce a narrative report on wetland trends including quantitative information on the local and types of wetlands. This information began to be available to the Department of Ecology in June 1989.

As an interim measure, this report is based partly on a draft risk assessment of non-chemical alteration of wetlands done in 1987 by Region 10, US Environmental Protection Agency (EPA) for Alaska, Idaho, Oregon, and Washington; the information for Washington was extracted and edited. Additional sources were used. As the US Fish & Wildlife Service data became available, it was added to subsequent drafts of this report.

Threat Definition

The Environment 2010 Technical Advisory Committee developed the following threat definition for the loss or degradation of wetlands:

> Loss or degradation of wetlands is non-chemical conversion or alteration which results in a net reduction to total wetland and/or impairment of the physical functions and ecological values of the affected wetland. Examples include draining and filling of wetlands.

Only direct loss of wetlands due to urbanization was analyzed; no quantitative information was available on wetlands loss due to other human activities was available. No quantitative information on wetlands degradation was available.

General Analytic Approach

The EPA analysts focused on alteration of wetland habitats, particularly from filling activities, in their ecological risk assessment. While this focus does not represent all activities or ecological effects associated with non-chemical degradation of aquatic ecosystems, EPA believes it represents the greatest potential concern for Region 10.

Findings

The draft FWS report, now considered the definitive Washington wetlands inventory, estimates that 938,000 acres of wetlands remain in the state, and that they are being lost at the rate of 2,034 acres per year. Earlier reports consulted identify two values for an existing wetland base: 200,000 acres (US Environmental Protection Agency, Region 10, 1987), and 400,000 acres (Hull & McIvor, 1987). These do not represent upper and lower bounds, but rather the results of defining wetlands differently for different purposes.

These figures do not include losses due to agriculture, hobby farming, forestry, small scale development, highway construction, or other activities.

Wetlands loss is extremely severe or fatal to both resident wildlife and migratory animals, such as waterfowl and shorebirds, which rely on wetlands for part of their annual life cycle.

Wetland fills are rarely reversible, especially after secondary development has occurred on the site. Diking is often reversible by merely removing the dike, except in instances where development has occurred behind the dike—in which case it is highly unlikely the dike would be removed. Although there is presently little impetus for landowners to breach existing dikes, positive tax incentives and an active federal program to encourage removing or breaching dikes could result in many wetlands being "re-created" or enhanced. Draining can be reversed if the source of water is again provided to the drained wetland and if other factors disturbing the wetland (i.e. plowing) are removed or stopped.

Wetlands degradation and destruction is no longer primarily an agricultural problem, although agricultural activities continue to have a significant effect on wetland changes, both positive and negative. Wetlands loss is now largely a result of industrial, commercial, and residential development. Although the problem of wetlands loss is statewide in scope, the areas of greatest loss are those areas, such as Snohomish, King, and Pierce counties, which are experiencing the most rapid growth.

Trends
No wetlands analysts have developed trends analyses for wetlands loss. To do so is made difficult by the fact that wetlands definitions have changed frequently through time due to changing values associated with wetlands. For example, the earliest wetlands inventories were concerned only with wetlands as they served as waterfowl habitat. More recently, wetlands concerns have extended to broader habitat values as well as hydrologic values.

1. BACKGROUND

In the past, insufficient quantitative data to adequately document the state's wetland resources hampered efforts to identify loss and degradation trends affecting the state's wetlands. Existing estimates of total wetlands and wetlands loss rates, some of which are cited here, differed substantially.

In response, and as a requirement of Governor Booth Gardner's Executive Order 88-03, the Department of Ecology contracted with the US Fish and Wildlife Service (FWS) in 1988 to complete digitalization of National Wetlands Inventory (NWI) data for Washington, and to produce a narrative report on wetlands types and locations. The draft FWS report, now considered the definitive Washington wetlands inventory, estimates that 938,000 acres of wetlands remain in the state, and that they are being lost at the rate of 2,034 acres per year.

This report is also based partly on a draft risk assessment of non-chemical alteration of wetlands done in 1987 by Region 10, US Environmental Protection Agency (EPA) for Alaska, Idaho, Oregon, and Washington; the information for Washington was extracted and edited. Since this risk assessment done by EPA only addressed activities permitted under Section 404 of the federal Clean Water Act, essentially, non-agricultural filling of wetlands, it documents only part of the problem of non-chemical alteration of wetlands. Four other sources of information regarding national and statewide wetland losses were also used in developing this preliminary risk assessment; these other information sources are identified in Section 2.1.4.

There is not yet any reliable means of quantifying wetlands degradation, thus this issue was not addressed in the Washington Environment 2010 study.

1.1 Characterization of Threat

For purposes of the EPA risk assessment, non-chemical alteration of aquatic habitats included direct and indirect physical stresses on these habitats. Physical impacts on aquatic habitats result from a variety of human activities, including dredging and filling, channelization, drainage, impoundments, mining, shoreline stabilization, and silvicultural and agricultural activities. Emerging and rapidly expanding projects associated with physical impacts include use of wetlands for stormwater filtration and the hydrologic alteration of streams and groundwater as our population and agricultural needs increase. These physical impacts affect marine, estuarine, and freshwater systems by causing direct loss or alteration of habitat, adding suspended matter to the water column, modifying hydrology, and changing ambient water parameters.

The Washington Environment 2010 Technical Advisory Committee developed the following threat definition for the loss or degradation of wetlands:

Definition:
Loss or degradation of wetlands is non-chemical conversion or alteration which results in a net reduction to total wetland and/or impairment of the physical functions and ecological values of the affected wetland. Examples include draining and filling of wetlands.

Major stressors:
Loss of water
Inundation
Siltation

Major sources:
Draining
Filling
Diking (e.g. railroad berms, road building, etc.)
Urbanization
Agricultural operations

Major damage pathways:
Human Health
- None

Ecological
- Loss of feeding, nesting, and breeding habitat for waterfowl
- Loss of habitat for furbearers (e.g. beaver, mink, etc.)
- Loss of habitat for anadromous and game fish during early phases of their life cycle
- Loss or deterioration of aquifer recharge functions
- Loss or deterioration of capacity for biofiltration of contaminants

Economic Damages
- Loss of aesthetic values
- Cost of alternative forms of flood control

Additionally, Washington Environment 2010 reviewers have noted the following issues:

Agricultural operations are a threat to wetlands loss and/or degradation; grazing is cited as a specific example of an uncontrolled activity. Jurisdictions which have adopted wetland ordinances typically exempt grazing due to the financial and other problems associated with protective fencing.

Loss of vegetated wetland edges and vegetated and aquatic connectors (corridors) is also a major problem. For many wildlife species a wetland without a vegetated edge is an incomplete habitat. One hundred and twenty one western Washington species depend on wetlands and wetland edges for some or all of their life cycle requirements (Zeigler, 1988; Brown, 1985; Guenther & Kucera, 1978).

Peat mining is destructive of a special kind of wetland, mostly in western Washington.

Vegetation removal in shallow water wetlands for purposes of "lake management" is destructive of fish and wildlife habitat. Lake management is conducted primarily for aesthetic purposes and enhancement of recreational activities such as swimming, boating, and water skiing.

Sea level rise has recently come to be appreciated as a significant factor in coastal change. Existing sea level rise of about 1.2 mm/yr combined with subsidence throughout much of Puget Sound combine to produce a net sea level change of up to 1.1 ft/century in the South Sound. In some areas sedimentation will be great enough to offset relative sea level rise and maintain coastal wetland

elevations at a constant relative tidal elevation; in other areas, sedimentation may be inadequate, leading to gradual drowning of wetlands and transformation to subtidal habitat. For example, the shoreline erosion of coastal wetlands at the mouth of the Nisqually River might be attributable to relative sea level rise combined with a decrease in sedimentation due to impoundments in the upper watershed.

Future loss of wetlands due to accelerated sea level rise caused by the global greenhouse effect is anticipated to be significant for wetlands unable to migrate inland. An inability migrate could be natural, due to topographic gradient, or cultural, caused by the protection of property. As saline water is pushed further up river deltas, some freshwater wetlands will be transformed to estuarine wetlands. The net effect is not yet known.

1.2 Types of Risks Analyzed

Only direct loss of wetlands due to urbanization was analyzed; no quantitative information was available on wetlands loss due to other human activities was available. No quantitative information on wetlands degradation was available.

This should not imply that wetlands managers are not concerned about degradation of wetlands—quite the contrary, the level of concern regarding degradation equals the concern regarding direct loss. The analytical problem lies in the lack of a generally agreed upon measure of degradation. Degradation is presumed to be occurring due, but not limited to, the following nonchemical factors: vegetation removal; introduction of exotic plant species; and hydrologic disruption, e.g. diversion of surface water, lowering of water tables caused by ground water withdrawals, and alteration of the timing and quantity of seasonal surface water flows. Additionally, but beyond the scope of this analysis, wetlands managers also concerned about chemical degradation due to nonpoint pollution (principally urban and agricultural runoff) and point source pollution (principally industrial discharges and accidental spills).

2. ECOLOGICAL RISKS

2.1 Analytic Approach

2.1.1 General Approach
This report relies on summaries of analyses previously conducted for other purposes. No original analyses were prepared.

The EPA analysts focused on alteration of wetland habitats, particularly from filling activities, in their ecological risk assessment. While this focus does not represent all activities or ecological effects associated with non-chemical degradation of aquatic ecosystems, EPA believes it represents the greatest potential concern for Region 10. This concern was also expressed in EPA's Comparative assessment of environmental problems (EPA, 1987b, Appendix III) which stated "Physical habitat alteration is the stress that has the greatest adverse impact on ecosystems."

Other wetlands loss studies relied on the interpretation of secondary evidence, e.g. a review of a sampling of SEPA environmental impact statements.

For the purpose of this risk assessment, wetlands include: habitats where the influence of surface or ground water has resulted in development of plant or animal communities adapted to such an aquatic or intermittently wet condition. Examples include tidal flats, shallow or subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas. General functions and values of wetlands are discussed in the characterization report and summarized in Table 2.1.

Table 2.1. Functions Served and Values Provided by Wetlands

Groundwater recharge and discharge.
Flood storage and desynchronization.
Shoreline anchoring and dissipation of erosive forces.
Sediment trapping.
Nutrient retention and removal.
Food chain support.
Habitat for fisheries.
Habitat for wildlife.
Active recreation.
Passive recreation, aesthetics, and heritage value.

2.1.2 Effects Examined
Ecological risks associated with non-chemical alteration of aquatic habitats were evaluated by most analysts as alteration or destruction of wetlands and the functions and values they serve. The wetland losses were itemized by major wetland type (palustrine, lacustrine, riverine, estuarine, and marine) in the US EPA Region 10 study.

2.1.3 Data Sources Used
1. *Wetlands of the United States* (Shaw and Fredine, 1956).
2. *Environmental indicators of effectiveness* (US Environmental Protection Agency, Region 10, 1987).
3. *Wetlands of the United States: Current Status and Recent Trends* (Tiner, et al., 1984).
4. *Inventory of Wetland Resources and Evaluation of Wetland Management in Western Washington* (Boule et al., 1983).
5. *State Environmental Policy Act Wetlands Evaluation Project (Draft)* (Hull & MacIvor, 1987).
6. *Historical changes of shoreline and wetland at eleven major deltas in the Puget Sound Region, Washington* (Bortleson, Chrzastowske & Helgerson, 1980).
7. *National Wetlands Inventory Data for Washington Department of Ecology (Draft)* (US Fish and Wildlife Service, 1989).

2.1.4 Critical Assumptions
The following assumptions were used by EPA in their review of Section 404 and 10 permits in Region 10:

1. A drained, diked or filled wetland is completely destroyed and has a complete loss of value.

2. All wetlands have a uniform, high value. (In a more thorough review, one wouldn't merely evaluate gains and losses of "average" wetlands but would consider the functions and values of specific wetlands).

3. In using Shaw and Fredine (1956), the estimated upper bound of wetlands lost per year in Region 10 is a conservative or low estimate of the upper bound.

4. Many wetland-destroying activities are never reported or observed for many reasons, including: 1) wetland activities covered by nationwide permits requiring no public notification; 2) the remoteness of many areas with wetland damaging activities reduces the chances that these wetland alterations will be observed; and 3) limited resource agency staff are available to search for violations of wetlands policies and regulations.

2.2 Description of Findings

2.2.1 Summary

A recently completed comprehensive study of wetlands loss for Washington indicates that wetlands are continuing to be lost at the rate of 2,034 acres per year. Reliable long term trend analyses are difficult if not impossible to develop because wetlands studies conducted at different times were based on different definitions of wetlands. Although agricultural development has traditionally been responsible for most wetland losses, both nationally and statewide, it appears to have been replaced, in Washington, by industrial, commercial, and residential development, particularly in the Puget Sound trough. When discussing agricultural impacts to wetlands, it should be noted that thousands of acres of wetlands have been created due to irrigation runoff in eastern Washington, particularly in the Columbia Basin. Following is a summary of trend information from each of the data sources cited in Section 2.1.3.

1. *Wetlands of the United States* (Shaw and Fredine, 1956). This study applied an estimated national average wetlands loss rate of 0.40 percent per year to the estimated Washington state wetlands inventory. The Washington loss rate was estimated to be 815 acres per year.

2. *Environment indicators of effectiveness* (US Environmental Protection Agency, Region 10, 1987). EPA evaluated records of 2,300 Corps of Engineers Public Notices in Washington for activities requiring permits under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act, and determined a loss rate of 186 acres per year for Washington (Table 2.3). This represents a portion of wetland losses in Region 10 since activities which damage or destroy wetlands but do not require a permit are not included. Section 404 of the Clean Water Act only regulates the discharge of dredged material or upland derived fill into waters of the United States, including wetlands. These permits have little control over drainage, silviculture, logging, or agricultural activities, except where there is an associated discharge of dredged or fill material. The estimated loss rates for Washington include losses resulting from non-404 projects (i.e., agricultural conversions of wetlands to pasture or cropland). The EPA analysts regarded Table 2.2 to represent an upper bound for direct physical wetland loss for all states but Alaska. However, they noted that this loss rate does not include the degradation of wetlands from secondary impacts (chemical leaching from in-place sediments from a fill for example) or cumulative impacts from numerous small stresses or incremental losses to wetlands. Examples of non-404 permitted activities which may cause physical degradation of wetlands include logging activities, drainage, water impoundment, activities markedly changing runoff or recharge, major water withdrawals, and activities which result in changes to watersheds or the hydraulic regime.

3. Wetlands of the United States: Current Status and Recent Trends (Tiner, et al., 1984). Tiner et al. estimated original wetlands acreage in the contiguous United States at 215 million acres. This acreage estimate had decreased by about 50% to 108.1 million acres by the mid-1950s. Of 99 million acres remaining in the mid-1970s, 94 million acres were estimated to be fresh water or palustrine wetlands and 5.2 million acres estuarine wetlands. Of the estimated 11 million acres of wetlands lost during a 25-year period between the mid-1950's and mid-1970's, 96% were estimated to be palustrine or freshwater wetlands; agricultural development was estimated to be responsible for 87% of these losses. Estuarine wetlands only account for about 5% of remaining wetlands but are generally better protected by state laws. It is estimated that 90% of the estuarine wetlands loss in California and four other coastal states is due to residential home construction.

Table 2.2. Estimated[1] Annual Loss of Wetlands in Washington, Oregon, and Idaho.

State	Acres of Wetlands Remaining	Approximate Yearly Loss (acres)
Idaho	95,140	380
Oregon	412,120	1,650
Washington	938,000	2,034

1. Based on an estimate of the number of acres of wetlands in each state (Shaw and Fredine, 1956) and a 0.4 % per year loss rate (Shaw and Fredine, 1956) for Idaho, Oregon and Washington. The loss rate for Alaska is based on only a review of 404 permitted projects (Faris et al, 1987), Washington based on USFWS 1989.

Table 2.3. Loss of Wetlands in Washington, Oregon, and Idaho Based on Review of Section 404 Permit Activities.

State	Palustrine	Estuarine	Marine	Lacustrine	Riverine	TOTAL
Idaho	21.20	0	0	0.38	3.33	24.91
Oregon	112.22	6.35	0.11	0.11	56.51	175.30
Washington	32.22	144.38	0.19	0.73	7.10	185.62

Palustrine: non-tidal wetlands dominated by trees, shrubs, and persistent emergent vegetation (i.e., wet meadows, freshwater marshes).

Estuarine: deepwater tidal habitats and adjacent tidal wetlands, including emergent saltwater marshes.

Marine: open ocean and the high energy coastline.

Lacustrine: wetlands and deepwater habitats contained within a depression (i.e., lakes).

Riverine: all wetland and deepwater habitats within a channel.

4. *Inventory of Wetland Resources and Evaluation of Wetland Management in Western Washington* (Boule et al., 1983). Boule, et al. included acreage loss estimates that are very consistent with those of Tiner, et al. The 458,000 acre annual loss figure cited by Tiner has been reduced since the mid-1970s largely due to a decline in the rate of agricultural draining activities as well as better state and federal wetland protection laws. Boule et al. includes three case studies in Washington showing the following losses of freshwater wetland acreages in the following USGS quadrants:

Tenino and Yelm (south Thurston County): 55%
Tacoma South (Pierce County): 82%
Lake Washington (King County): 70%

5. *State Environmental Policy Act Wetlands Evaluation Project* (Draft) (Hull & MacIvor, 1987). This unpublished study by Department of Ecology staff of selected environmental impact statements estimates that roughly half of Washington's presumed original 800,000 acres of wetlands had been lost due to development, a figure that mirrors national wetland loss estimates. This study also indicated that freshwater marshes and forested wetlands experienced the greatest losses from development and that most of the wetlands lost were small, between 0.5 and 5 acres in size. This report also identified draining as a greater cause of wetlands loss than filling in those sites visited for the study. A conservative estimate of wetlands loss—wetlands outside the jurisdiction of the Shoreline Management Act and considered under SEPA—is 530 acres per year.

6. *Historical changes of shoreline and wetland at eleven major deltas in the Puget Sound Region, Washington.* (Bortleson, Chrzastowske & Helgerson, 1980). Bortleson, et al. evaluated wetland loss at the major river deltas of the Puget Sound and found a loss of 28 to 100 percent of wetlands (Table 2.4).

7. *National Wetlands Inventory Data for Washington Department of Ecology* (US Fish and Wildlife Service, 1989). The Department of Ecology contracted with the US Fish and Wildlife Service (FWS) in 1988 to complete digitalization of National Wetlands Inventory (NWI) data for Washington, and to produce a narrative report on wetlands types and locations. The FWS report is now considered the definitive Washington wetlands inventory and loss analysis. The US FWS estimates that 938,000 acres of wetlands remain in the state and that loss rate is 2,034 acre per year.

An interpolation of national loss rates to Washington state (Table 2.2) indicates an annual loss rate of 815 acres. Two studies of wetlands loss in Washington of different classes of wetlands, (1) those regulated by the Clean Water Act, and (2) those unregulated, give incomplete estimates of wetlands loss:

Clean Water Act	186 acres/year (Table 2.3)
Unregulated	530 acres/year (Hull & McIvor, 1987)
Total	716 acres/year

These figures do not include losses due to agriculture, hobby farming, forestry, small scale development, highway construction, or other activities. The definitive 1989 US FWS work, however, concluded that loss is occurring at a rate of 2,034 acres per year.

Table 2.4. Estimated historical changes in natural habitat of principle estuaries of Washington State.

Estuary	Estimated (km2) subaerial wetland areas: Historical	Present	% change
Nooksack	4.5	4.6	+0.2
Lummi	5.8	0.3	-89.7
Samish	11.0	0.4	-96.4
Skagit	29.0	12.0	-58.6
Stillaguamish	10.0	3.6	-64.0
Snohomish	39.0	10.0	-74.4
Duwamish	2.6	0.1	-99.2
Puyallup	10.0	0.0	-100.0
Nisqually	5.7	4.1	-28.1
Skokomish	2.1	1.4	-33.3
Dungeness	0.5	0.5	0.0

Source: Bortelson et al., 1980.

2.2.2 Severity

Wetlands loss is extremely severe or fatal to both resident wildlife and migratory animals, such as waterfowl and shorebirds, which rely on wetlands for part of their annual life cycle. As individual wetlands are reduced in size, diversity, and complexity, their functions and values are also reduced or lost; for example, specific wetlands may become too small to provide habitat for certain species or contribute in a measurable way to flood control).

2.2.3 Reversibility

Wetland fills are rarely reversible, especially after secondary development has occurred on the site. Diking is often reversible by merely removing the dike, except in instances where development has occurred behind the dike—in which case it is highly unlikely the dike would be removed. Although there is presently little impetus for landowners to breach existing dikes, positive tax incentives and an active federal program to encourage removing or breaching dikes could result in many wetlands being "re-created" or enhanced. Draining can be reversed if the source of water is again provided to the drained wetland and if other factors disturbing the wetland (i.e. plowing) are removed or stopped.

Diking and draining of some wetlands is reversible under an acquisition and restoration program being considered by various resource agencies and private nonprofit organizations. This technique could also be used for project mitigation or establishment of mitigation banks.

2.2.4 Scale

Wetlands degradation and destruction is no longer primarily an agricultural problem, although agricultural activities continue to have a significant effect on wetland changes, both positive and negative. Wetlands loss is now largely a result of industrial, commercial, and residential development. Although the problem of wetlands loss is statewide in scope, the areas of greatest loss are those areas, such as Snohomish, King, and Pierce counties, which are experiencing the most rapid growth.

EPA looked at three areas of western Washington experiencing wetland losses due to commercial development pressures: the Silverdale area of Kitsap County, the suburbs east of Seattle, and Pierce County:

In the Silverdale area, an unincorporated portion of central Kitsap County, 66 wetlands totalling 650 acres are potentially affected. The threat is from developmental pressure and lack of specific wetland planning and protection other than that afforded by the Kitsap County Subarea Plan and the State Environmental Policy Act.

Wetlands losses are also occurring in the Soos Creek Planning Area of King County. The Soos Creek Planning Area shares boundaries with Renton, Auburn, Kent and Tukwila and contains 87 wetlands totalling 1,563 acres. These wetlands are threatened by strong development pressure and the potential for annexation into these cities—which are judged to have a lesser degree of wetland protection than the county.

Pierce County wetlands are threatened primarily by residential development and are located in Spanaway (433 acres), South Hill (155 acres), Bonney Lake (252 acres), Gig Harbor (152 acres), and south Pierce County (142 acres).

It is important to remember that these are simply examples of urban wetlands losses. Similar wetlands losses are reported by report reviewers in other areas of western Washington, including the Issaquah, Federal Way, Bothell, Snoqualmie, and Redmond areas of King County.

2.2.5 Sensitivity

Wetlands are also potentially affected by degradation due to conversion of adjacent uplands habitat and to chemical pollution by urban and agricultural runoff (NRC, 1982). No analyses are known to have been conducted to quantify this impact in Washington state.

2.2.6 Trend

No wetlands analysts have developed trends analyses for wetlands loss. To do so is made difficult by the fact that wetlands definitions have changed frequently through time due to changing values associated with wetlands. For example, the earliest wetlands inventories were concerned only with wetlands as they served as waterfowl habitat. More recently, wetlands concerns have extended to broader habitat values as well as hydrologic values.

2.2.7 Productivity/Uniqueness

Despite the assumptions used by EPA in their risk assessment, it is a fact that the values and functions of all wetlands are not equal. While some level of protection should be given to all wetlands, certain wetlands, because of their uniqueness or high productivity, have been targeted for preservation through

acquisition by public agencies at the local, state, and federal levels. The Puget Sound Water Quality Management Plan, for instance, makes the identification and preservation of high quality wetlands in the Puget Sound region a high priority.

EPA recognized certain wetlands in King County as unique and threatened areas, including: Bear Creek in Redmond with 83 wooded or shrub wetlands (1,055 acres) associated with the Bear Creek floodplain; East Lake Sammamish with 86 riverine and lacustrine wetlands (1,325 acres); and Snoqualmie Planning Area with 167 riverine wetlands (3,553 acres). Other King County wetlands threatened by development are located in the following planning areas: Northshore area (262 acres), Federal Way area (1,432 acres), the Newcastle area (373 acres), the Green River Valley (6 acres), and the City of Kent (127 acres).

2.3 Discussion of Uncertainty

This review makes no distinction between the quality or value of individual wetlands. Because most attention is focused on large, visible wetlands, the cumulative impacts of small wetland destruction are severely underestimated. Indirect adverse impacts to wetlands are also largely undocumented and underestimated. Threshold impacts to wetland-dependent fish and wildlife species are poorly understood and often exceeded. Additionally, no evaluation of wetlands degradation was attempted.

2.4 Nature of the Risk

2.4.1 Geographic Area

Refer to Section 2.2.4.

2.4.2 Stressors and Sources

Stressors and sources considered by EPA analysts to affect wetlands are summarized in Table 2.5. Some report reviewers question the reversibility of many of the sources cited by EPA as reversible.

Table 2.5. Stresses and Sources Affecting Wetlands.

Stressor	Source	Endpoint[1]	Reversible[2]
Filling	Agriculture	HA/HD	No
	Silviculture	"	No
	Misc Dredging & Disposal	"	No
	Urban Development	"	No
	Rural Development	"	No
	Highway/Causeway Construction	"	No
	Mining	"	No
	Stream Impoundment/ Dam Construction	"	No
	Shoreline Construction Stabilization	"	Yes
Diking	Agriculture	HA/HD	Yes
	Silviculture	"	Yes
	Misc. Dredging and Disposal	"	No
	Highway/Causeway Construction	"	No
	Shoreline Construction/ Stabilization	"	Yes
	Urban Development	"	No
	Rural Development	"	No
	Stream Impoundment/ Dam Construction	"	No
Draining	Agriculture	HA/HD	Yes
	Silviculture	"	Yes
	Urban Development	"	No
	Rural Development	"	No
	Highway/Causeway Construction	"	No
	Stream Improvement/ Dam Construction	"	No

1. HA/HD = Habitat Alteration/Habitat Destruction.
2. The practicality of reversing wetland destruction must realistically be addressed on a site specific level.

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