WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Wetland Buffers:

Use and Effectiveness

February 1992
Publication #92-10
printed on recycled paper

This paper was funded in part through a cooperative agreement with the National Oceanic and Atmospheric Administration pursuant to Award No. NA170Z0230-01. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

Wetland Buffers: Use and Effectiveness

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for

Washington State Department of Ecology
Shorelands and Coastal Zone Management Program
Olympia, Washington

February 1992

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the critical review, written contributions, and technical expertise provided by Mark Bentley, Scott Boettcher, Peggy Clifford, Jaime Kooser, Perry Lund, and Stewart Toshach of the Washington State Department of Ecology; Hal Beecher and Bob Zeigler of the Washington State Department of Wildlife; and Dyanne Sheldon and Deborah Dole of Sheldon and Associates.

CITATION

This report should be cited as:

Castelle, A.J., C. Conolly, M. Emers, E.D. Metz, S. Meyer, M. Witter, S. Mauermann, T. Erickson, S.S. Cooke. 1992. Wetland Buffers: Use and Effectiveness. Adolfson Associates, Inc., Shorelands and Coastal Zone Management Program, Washington Department of Ecology, Olympia, Pub. No. 92-10.

EXECUTIVE SUMMARY

This report was developed to assist efforts by Washington State agencies and local governments developing policies and standards for wetlands protection. The report summarizes and evaluates scientific literature, an agency survey, and a recent field study on wetland buffer use and effectiveness. Published literature was obtained from several sources and contains information from throughout the country on the concept of wetland buffers, their important functions, effective buffer widths, and buffer determination models. The agency survey reviewed buffer requirements of several states throughout the U.S. and for counties and cities in Washington. The field study reviewed the current state of buffers at several sites in King and Snohomish counties.

Scientific Literature Review

Wetland buffers are areas that surround a wetland and reduce adverse impacts to wetland functions and values from adjacent development. The literature indicates that buffers reduce wetland impacts by moderating the effects of stormwater runoff including stabilizing soil to prevent erosion; filtering suspended solids, nutrients, and harmful or toxic substances; and moderating water level fluctuations. Buffers also provide essential habitat for wetland-associated species for use in feeding, roosting, breeding and rearing of young, and cover for safety, mobility, and thermal protection. Finally, buffers reduce the adverse impacts of human disturbance on wetland habitats including blocking noise and glare; reducing sedimentation and nutrient input; reducing direct human disturbance from dumped debris, cut vegetation, and trampling; and providing visual separation. Wetland buffers are essential for wetlands protection.

Scientists generally agree that appropriate buffer widths are based on several variables, including:

- existing wetland functions, values, and sensitivity to disturbance;
- buffer characteristics;
- land use impacts; and
- desired buffer functions.

Wetland functions, values, and sensitivity are attributes that will influence the necessary level of protection for a wetland. Those systems which are extremely sensitive or have important functions will require larger buffers to protect them from disturbances that may be of lesser threat to a different site. Where wetland systems are rare, or irreplaceable (e.g., high quality estuarine wetlands, mature swamps, bogs), greater buffer widths will ensure a lower risk of disturbance.

Buffer characteristics influence their ability to reduce adverse effects of development, most importantly in relationship to slope and vegetative cover. Buffers with dense vegetative cover on slopes less than 15% are most effective for water quality functions. Dense shrub or forested vegetation with steep slopes provide the greatest protection from direct human disturbance. Appropriate vegetation for wildlife habitat depends on wildlife species present in the wetland and buffer. Effectiveness is also influenced by ownership of the buffer.

Land uses with significant construction and post-construction impacts need larger buffers. Construction impacts include erosion and sedimentation, debris disposal, vegetation removal, and noise. Post-construction impacts are variable depending on the land use, but residential land use, in particular, can have significant impacts. Residential land use is associated with yard maintenance debris, domestic animal predation, removal of vegetation, and trampling. Wetland areas and their buffers should not be included in residential lots.

Appropriate buffer widths vary according to the desired buffer function(s). Temperature moderation, for example, will require smaller buffer widths than some wildlife habitat or water quality functions. Buffer widths for wildlife may be generalized, but specific habitat needs of wildlife species depend on individual habitat requirements.

Buffer effectiveness increases with buffer width. As buffer width increases, the effectiveness of removing sediments, nutrients, bacteria, and other pollutants from surface water runoff increases. One study found that for incrementally greater sediment removal efficiency (e.g., from 90 to 95%), disproportionately larger buffer width increases are required (e.g., from 100 to 200 feet). As buffer width increases, direct human impacts, such as dumped debris, cut or burned vegetation, fill areas, and trampled vegetation will decrease. As buffer width increases, the numbers and types of wetland-dependent and wetland-related wildlife, that can depend on the wetland and buffer for essential life needs, increases.

In western Washington, wetlands with important wildlife functions should have 200 to 300-foot buffers depending on adjacent land use. In eastern Washington, wetlands with important wildlife functions should have 100 to 200-foot buffers depending on adjacent land use. To retain wetland-dependent wildlife in important wildlife areas, buffers need to retain plant structure for a minimum of 200 to 300 feet beyond the wetland. This is especially important where open water is a component of the wetland or where the wetland has heavy use by migratory birds or provides feeding for heron. The size needed would depend upon disturbance from adjacent land use and wetland resources involved. Priority species may need even larger buffers to prevent their loss due to disturbance or isolation of subpopulations.

Buffer widths effective in preventing significant water quality impacts to wetlands are generally 100 feet or greater. Sensitive wetland systems will require greater distances and degraded systems with low habitat value will require less. The literature indicates effective buffers for water quality range from 12 to 860 feet depending on the type of disturbance (e.g., feedlot, silviculture) and the measure of effectiveness utilized by the author. For those studies that measured effectiveness according to removal efficiency, findings ranged from 50 to 92% removal in ranges of 62 to 288 feet. Studies that measured effectiveness according to environmental indicators such as levels of benthic invertebrates and salmonid egg development in the receiving water generally found that 98-foot buffers adjacent to streams were effective. These latter buffer distances may be conservative for wetlands, where lower water velocities and presence of vegetation result in increased sediment deposition and accumulation.

Studies indicate that buffers from 50 to 150 feet are necessary to protect a wetland from direct human disturbance in the form of human encroachment (e.g., trampling, debris). The appropriate width to prevent direct human disturbance depends on the type of vegetation, the slope, and the adjacent land use. Some wetlands are more sensitive to direct disturbance than others.

Various methods are used for determining buffer widths in a regulatory context. Regulatory agencies often establish a rating system, commonly of three or four categories, assessing a given wetland's functional value, sensitivity, rarity, or other attributes. Accordingly, the amount of protection afforded to each type differs.

Agency Survey

A survey conducted of regulatory requirements for wetland buffers indicated that of 16 states surveyed, ten require wetland buffers and eight incorporate wetlands rating, either adopted or proposed. Of five Washington counties with adopted wetlands protection ordinances, all five require buffers and four utilize wetlands rating systems (the fifth is currently proposing an amendment that incorporates rating). Of 28 identified cities with wetlands protection ordinances, 27 contain specific buffer standards and 20 utilize wetlands rating systems. The one city without specific standards has adopted an interim policy statement for wetlands protection.

Specific buffer requirements vary widely at the state and local level. State buffer requirements range from 0 to 300 feet; Washington county buffer requirements range from 0 to 200 feet; and Washington city buffer requirements range from 0 to 300 feet.

Field Study

A field analysis of the current state of buffers in King and Snohomish counties found that effectiveness of the buffer was determined by the type of buffer in place, the type of alteration to the buffer and surrounding area, the width of the buffer, the time elapsed from development, and the ownership of the buffer and adjacent wetland.

Buffer function was found to be directly related to the width of the buffer. Ninety-five percent of buffers smaller than 50 feet suffered a direct human impact within the buffer, while only 35% of buffers wider than 50 feet suffered direct human impact. Human impacts to the buffer zone resulted in increased impact on the wetland by noise, physical disturbance of foraging and nesting areas, and dumping refuse and yard waste. Overall, large buffers reduced the degree of changes in water quality, sediment load, and the quantity of water entering the adjacent wetland. As a rule, buffers were subjected to a reduction in size over time. Of 21 sites examined, 18 were found to have reduced buffer zones within one to eight years following establishment.

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Preface

Three significant developments relating to wetlands protection in Washington State occurred in 1990 and 1991. The first was the state legislature's adoption of the 1990 Growth Management Act that requires local governments to protect critical areas including wetlands. The second was Governor Booth Gardner's issuance of an Executive Order for wetlands protection. The third was a revision to the 1991 Puget Sound Water Quality Management Plan which recommends that local governments in the Puget Sound Basin adopt comprehensive wetlands protection programs to achieve a goal of no-net-loss of wetlands functions and values and a long term increase in wetland quantity and quality.

Washington's Growth Management Act was adopted by the state legislature in the final days of the 1990 legislative session. The provisions of the 1990 statute, as well as amendments adopted in 1991, require local governments throughout the state to identify and protect critical areas including wetlands. Interim development regulations are to be adopted by all jurisdictions no later than March 1992. Final development regulations are to be completed by 1994. Those local governments who have not already adopted regulations for critical area protection are now in various stages of developing their ordinances assisted by the Department of Community Development.

On April 21, 1990, Washington's Governor Booth Gardner issued Executive Order (EO) 90-04, Protection of Wetlands. The EO is directed at both state and local governments with specific requirements for state agencies and recommendations for local governments. All state agencies are required to protect wetlands under existing authorities to the extent legally permissible. Following a task in the EO, the Department of Ecology developed a model wetlands protection ordinance to provide guidance to local governments. The model ordinance was released in September 1990 and will be amended in the future to incorporate new information.

In the summer of 1991, the Puget Sound Water Quality Authority modified the wetlands protection element (W-4.1) of the 1991 Puget Sound Water Quality Management Plan. The modified element recommends local adoption of a comprehensive approach to wetlands protection using both regulatory and non-regulatory tools. The comprehensive approach is intended to complement the provisions of the Growth Management Act. The Plan amendments recommend that local development regulations address several elements, including wetland buffers. The amendments refer to Ecology's model ordinance for technical guidance on wetlands protection standards.

Each of these three actions has brought into focus the need for technical information upon which to base wetlands protection policies and standards. During the development of wetlands protection policies and regulations, including the accompanying public deliberation, information is sought on both the scientific basis for wetlands protection standards and on the actions of other regulatory decision-makers.

I. Introduction

This report was developed to assist efforts by the Washington State Department of Ecology (Ecology), other Washington State agencies, and local governments to develop policies and standards for wetlands protection within existing authorities. Specifically, the report summarizes and assesses information related to wetland buffer use and effectiveness.

The report is organized into four sections accompanied by an executive summary, references, and appendices. The sections include:

- introductory information;
- a review of the existing literature;
- an agency survey of existing regulatory requirements for buffers; and
- conclusions drawn from the literature review and agency survey.

Appendix A presents the results of a field study that provides a post-construction evaluation of the effectiveness of required wetland buffers in protecting wetlands from adverse impacts. Several local projects in King and Snohomish counties were assessed to determine the effectiveness of buffers that were required for development projects adjacent to wetlands.

A companion document entitled Wetland Buffers: An Annotated Bibliography is also available.

II. Scientific literature review

The scientific literature review is a compilation of the findings of a literature search for information on wetland buffers. A general discussion of the concept of buffers is followed by background information on wetlands buffers and their important functions. Research on recommended buffer widths and buffer determination models is presented.

Information was obtained from a review of published literature as well as from oral and written personal communications. Sources of information included computer search programs, on-line library collections, existing bibliographies, research centers, federal and state agencies, county and city planning departments, professional organizations, environmental organizations, and individuals. A specific list of information sources for this section is listed in Appendix B.

Buffers and Setbacks in Land Use Planning

Our present landscape is a mosaic of developed lands and natural areas, forests and fields, wetlands, and uplands. Expanding human use within the landscape presents a difficult problem to the community and to decision makers: how best to fit the pieces of this mosaic together. Such long-range planning is further complicated by the knowledge that some land uses are incompatible in close proximity to one another.

Designating buffer areas between zones of incompatible land uses has been a common regulatory mechanism for minimizing environmental as well as other physical impacts. In diverse situations ranging from buffer zones around power plants, to tree-lined streets, buffers are employed to lessen the impact of one activity on another. In general, as the level of activity or potential for conflict increases, the width of the buffer needed to minimize conflict between the two land uses will increase proportionally (Brown and Schaefer, 1987). For example, the level of noise, light, temperature, and activity are dramatically higher in developed areas than in natural areas, and the border between developed and natural areas is frequently characterized by "overflows" of these disturbances from the developed land to the undeveloped. These "overflows" may take many forms: subsurface and surface water flow; increased sedimentation; atmospheric pollution; increases in noise and temperature; the introduction of toxins, bacteria, and viruses; more frequent, extensive, and intensive physical disturbances; and the introduction of non-native plant and animal species. Buffer zones are used to protect natural areas such as streams, shorelines, steep slopes, and wetlands from these impacts.

Wetland Buffers

Wetlands are among the most valuable and complex ecosystems on earth. They provide many functions and values to society, including flood control, ground water recharge and discharge, water quality improvement, shoreline stabilization, fish and wildlife habitat, recreational and educational opportunities, and aesthetic values (Smardon, 1978; Williams and Dodd, 1978; Adamus and Stockwell, 1983; Roman and Good, 1983; Brown, 1985).

Until recently, the complexity and importance of wetlands were not widely known, and accordingly, wetlands protection was non-existent or ineffective. Land use strategies in the past frequently encouraged the filling of wetlands, calling it "reclamation," and granted title to anyone who would fill the land. More recently, however, wetlands have been recognized as ecologically and economically valuable. Federal, state, and local governments have responded by enacting laws and developing programs to protect the important values of wetlands recognized by society.

Many wetlands managers believe that the most effective means of stemming the loss of wetlands is avoiding and minimizing adverse impacts of development from the outset (Shisler, 1987). This includes both impacts originating within the wetland perimeter as well as impacts originating adjacent to the wetlands. Uses and development adjacent to wetlands can negatively affect wetland systems through increased runoff (Harris and Marshall, 1963); sedimentation (Darnell, 1976); introduction of chemical and thermal pollutants (Ehrenfeld, 1983); diversion of water supply; introduction of invasive and exotic species; and reduced populations of wetland-dependent species (Zeigler, 1990). The area immediately upland of the wetland boundary is important as a seed reservoir, as habitat for aquatic and wetland-dependent wildlife species, and as a refuge to wildlife during periods of high water (Brown and Schaefer, 1987).

One method of reducing the impacts of development upon adjacent wetlands is to provide a buffer around the wetland. Wetland buffers are those areas that surround a wetland and reduce adverse impacts to the wetland functions and values from adjacent development. Wetland buffers can include both upland and aquatic areas contiguous with a wetland edge, however, the focus of this study is on vegetated upland buffers.

Wetland Buffer Functions

Wetland health can be measured in terms of water quality, hydrology, and fish, wildlife and plant species diversity and abundance. The protective functions provided by wetland buffers can be described under these same parameters.

Water Quality

Wetlands are generally located in low areas of the landscape, causing them to be particularly susceptible to sediment loading from upland sources and to erosional scouring that results from increased water velocities from mismanaged upland surface waters (Brown and Schaefer, 1987). Vegetated wetland buffers function to reduce adverse impacts to water quality by controlling the severity of soil erosion and removing a variety of pollutants from stormwater runoff (Shisler et al., 1987).

Soil erosion is reduced within buffers as vegetation and organic debris shields the soil from the impact of rain and binds soil particles with root materials. Vegetation acts as an obstruction to water flow thereby decreasing water velocities, allowing infiltration, and reducing the erosion potential of stormwater runoff. As a physical barrier to flowing water, vegetation also traps sediments and other insoluble pollutants. The proper functioning of a buffer zone depends in great part on its ability to resist channelization (Broderson, 1973). If the majority of stormwater moving through the buffer does so as sheet flow, the rate of flow is significantly slower, and the residence time of the water in the buffer is increased, allowing more time for settling of water-borne sediments and infiltration. In addition, the root systems of the buffer vegetation aid in the maintenance of soil structure and bank stability (Broderson, 1973).

Soluble nutrients and pollutants are also removed or transformed by the soils, bacteria, and plants in wetland buffers (EPA, 1988). The uptake of dissolved heavy metals and large amounts of nutrients by plants has been well-documented (Murdoch and Capobianco, 1979; Shisler et al., 1987; Gallagher and Kibby, 1980). For example, Murdoch and Capobianco (1979) found that *Glyceria grandis*, a wetland grass, took up 80% of the available phosphorus, and also took up significant quantities of lead, zinc, and chromium. Gallagher and Kibby (1980) found that salt marsh species such as *Carex lyngbyei* (Lyngbi's sedge), *Salicornia virginiana* (pickleweed), *Juncus balticus* (Baltic rush), and *Potentilla pacifica* (Pacific silverweed) accumulated copper, chromium, iron, manganese, strontium, lead, and zinc.

Vegetation scatters sunlight and provides shade, reducing water temperature in the summer, limiting nuisance algae growth, and reducing the release of nutrients from the sediment (Karr, 1978).

Hydrology

Large, sudden fluctuations in wetland water levels often destroy wetland vegetation, particularly along the wetland edge (Clark, 1977). Where wetland vegetation is weakened or destroyed by periods of drought or flooding, native plants give way to weedy, invasive species, invertebrate communities are altered, and wildlife species dependent on these food sources disappear. Increased water level fluctuations caused by increased urbanization have been found to be a major threat to remaining wetlands in the Puget Sound Region, with potential effects on plant succession, habitat, and breeding conditions (Stockdale, 1991).

Wetland buffers play a role in moderating water level fluctuations. Vegetation impedes the flow of runoff and allows it to percolate into the ground. The soil then yields this water to the wetland over an extended period of time, resulting in stable, natural ecosystems. Vegetation also produces litter which increases the humus content of the soil and increase adsorption and infiltration. It also protects other soil properties that are important to infiltration capacity. By intercepting intense rainfall, vegetation preserves soil composition so that infiltration is not impaired (Dunne, 1978).

Bertulli (1981) concluded from his study of a southern Ontario, Canada watershed that adjacent forest vegetation and litter lowered stream flow from 388 to 207 inches in a 100-year flood event. It should be noted, however, that when a catchment area for a wetland has been urbanized and the natural infiltration system has been disrupted, the role of buffers in reducing abnormal water level fluctuations is less significant.

Fish and Wildlife Habitat

The vegetated uplands adjacent to wetlands are considered to be one of the richest zones for aquatic organisms, mammals, and birds (Clark, 1977; Williams and Dodd, 1978). Wetland buffers provide essential habitat for wetland-associated species. In Washington State, 85% of the terrestrial vertebrate species use wetlands and/or their buffers; 359 of 414 species in western Washington (Brown, 1985), and 320 of 378 species in eastern Washington (Thomas, 1979). In Washington, stream buffers and riparian areas provide essential habitat for 68 species of mammals, birds, amphibians, and reptiles. One hundred and three species are more numerous in riparian ecosystems or use them more heavily than upland habitat (Riparian Habitat Technical Committee, 1985). In western Washington and

Oregon, 236 animal species are reported to use coastal, riparian, or wetland communities as their primary breeding or feeding habitats. One hundred and twenty-one species of animals use both aquatic systems and associated uplands for primary breeding or feeding habitat. One hundred and six species use upland edges associated with aquatic systems as primary breeding and feeding habitats (Brown, 1985). This increased use of riparian and other transitional areas demonstrates the concept of "edge effect," a term first coined by Leopold (1933), who proposed that species numbers of both plants and animals increase at edges, due to overlap from adjacent habitats and to creation of unique edge-habitat niches. Such edges are the location of increased wildlife use including feeding, roosting, breeding and rearing of young, and cover for safety, mobility, and thermal protection (Ranney et al., 1981). Naturally vegetated wetland buffers frequently provide vertical as well as horizontal edges that provide ground, shrub, and tree canopy cover (Zeigler, pers. comm., February, 1992).

Often birds and animals that are considered to be wetland-dependent species have essential life needs that can only be met in the adjacent upland buffer (Naiman, 1988, WDW [Appendix C, this report]). These life needs include food, water, shelter from climatic extremes and predators, and structure and cover for reproduction and rearing of young. Waterfowl feed primarily in wetlands but most species nest on dry ground to avoid flooding their nest (WDW, [Appendix C, this report]). Species such as wood ducks, great blue herons, pileated woodpeckers, and ospreys require large trees for nesting. While amphibians, such as the Pacific chorus frog, spend only a short portion of their life span actually in a wetland, they cannot complete their life cycle without one. Many wetland-associated mammals, such as mink and river otters, feed in wetlands, but breed and raise their young in the buffer (Zeigler, 1990). These animals must burrow above the high water mark to avoid inundation of their burrows, which means that they spend significant portions of their lives in the buffer.

Wetland buffers are also important for wetland-related wildlife: animals that concentrate near wetlands but are not necessarily wetland-dependent. The Department of Wildlife (Appendix C, this report) notes that "lush and divergent vegetation in wetland buffers provide food and cover for many species ranging from large mammals, such as deer and elk, to small ones, such as voles and shrews. These areas are used for rearing of young."

Wildlife species have varying spatial requirements to maintain viable populations for survival. Buffers provide an area where animals have needed separation and interspersion to reduce competition and maintain populations (WDW [Appendix C, this report]). Habitat alterations and land use changes adjacent to wetlands can affect wetland-dependent wildlife populations by fragmenting habitat to non-functional sizes and shapes and by introducing disturbance factors above the tolerance levels of some species (Brown and Schaefer, 1987). In 1916, Dice reported that along the Touchet River in southeastern Washington, the natural vegetated buffer was about a quarter mile from the stream. He noted that where the tall cottonwood and shrubby understory had not been disturbed by man, it provided excellent refuges for birds and mammals. Today, the average width of the riparian vegetation is about 50 feet and species that have been totally eliminated or greatly reduced in number since Dice's time include sandhill crane, bobwhite quail (bobwhite), sparrow hawk (American kestrel), Lewis' woodpecker, chipping sparrow, black-headed grosbeak, warbling vireo, Macgillivray warbler, redstart, and long-tailed chickadee (black-capped chickadee) (Mudd, 1975). Washington Department of Wildlife (Appendix C, this report) cited Foster et al., 1984, who found that grazing next to wetlands in the Columbia Basin removed buffer vegetation and reduced waterfowl production by 50%.

Particularly in urban environments where isolated wetlands and riparian wetlands often afford much of the greenspace and wildlife habitat, the use of buffer zones as travel corridors is critical. The vegetated buffer allows animals and birds to move through the urban landscape with some protection from humans and domestic animals. These wildlife corridors have become increasingly important to wildlife with the continuing development of the natural landscape into smaller and smaller isolated units. Corridors effectively increase the size of the habitat area and its ability to maintain viable wildlife populations.

Riparian buffers maintain fish habitat by providing shade, keeping water temperature low enough in the summer to retain dissolved oxygen to support fish and to prevent lethal low temperatures in winter. Streamside vegetation provides a food source through leaf litter and insect drop and provides cover through deposition of large organic debris. By decreasing sediment loads, buffers reduce siltation of essential spawning ground and the destruction of aquatic invertebrates that are important fish food sources. Buffers provide bank cover for fish and provide bank stability though the soil binding capacity of root systems and energy dissipation during flood periods (Riparian Habitat Technical Committee, 1985; Young, 1989).

Direct Human Disturbance

Vegetated buffers provide visual separation between wetlands and developed environments, blocking glare and human movement from sensitive wildlife (Young, 1989). Buffers also discourage direct human disturbance within a wetland in the form of dumping debris, cutting vegetation, or trampling. Direct human disturbance affects both the habitat provided by wetlands vegetation and the wildlife species that are dependent on the wetland. Plant loss can result from either direct crushing or the compaction of soil. Plants in wet soils are especially vulnerable to trampling. Compaction of the soil damages roots, decreases soil water retention, lessens seed germination and seedling survival, and promotes the survival of more aggressive weedy species. As cover is reduced by trampling, for example, wildlife species that depend on the cover or food provided by the vegetation decrease. All wildlife respond to human activities but the intensity and duration of the response varies with life-cycle stage and the affected species. Disturbance at breeding and nesting time can lead to reduced populations caused by loss of eggs and/or young to predation or injury following abandonment by the parents. Repeated disturbance during feeding or resting can result in depletion of vital energy stores during flight or other avoidance responses to humans (Josselyn et al., 1989).

Size of Wetland Buffers

The literature review found a number of approaches used to assess the adverse impacts on wetlands from adjacent land uses and to determine what buffer width will be effective in reducing adverse impacts. Some researchers focused on the use of buffers to reduce impacts of specific land uses such as silviculture, agriculture and recreation. These studies and others have examined buffer requirements and effectiveness either holistically or have isolated one or two specific functions in their studies. Researchers have measured buffer effectiveness by using various biological, chemical, and physical components to assess wetland impacts. These studies include monitoring water quality and quantity; examining plant and animal species distribution; monitoring habitat quality and composition; and measuring levels of human use. Each of these approaches gives a portion of the information necessary to make informed decisions about buffer widths.

The width of buffer considered appropriate to protect a wetland from degradation is related to the wetland functions being protected and the buffer functions being provided (Rogers, et al., 1988). Because buffer function is an important factor in determining buffer widths, information from the literature is summarized according to the following functions:

- sediment removal;
- nutrient removal;
- fecal coliform removal;
- temperature moderation;
- human impact deterrence; and
- wetland species distribution and diversity.

Sediment Removal

Sediment removal is recognized as an important function of wetland buffers, not only to protect the wetland from the adverse impacts of increased sediments loads, but because most nutrients are attached (adsorbed) to sediment. Several investigators have researched the width of buffer necessary to reduce sediments. These studies measure effectiveness based on percentage of sediments removed rather than other measures of ecosystem health.

Wong and McCuen (1982) analyzed the ability of vegetated buffers to trap sediment. They found that average particle size, slope, roughness of vegetated cover, and runoff characteristics must be taken into account in determining buffer widths effective to trap a given percentage of sediment in stormwater flow. Using these parameters, they derived an equation to determine effective buffer widths. While small buffers were found to remove small amounts of sediments, these investigators found that the direct relationship between buffer width and percent sediment removal was non-linear and that disproportionately large buffer width increases were required for incrementally greater sediment removal. For example, effective buffer widths approximately doubled (from 100 to 200 feet at 2% slope) when the design criteria increased from 90 to 95% sediment removal. The authors did not address the removal of the soluble components in stormwater. Young et al. (1980) looked at sediment trapping from livestock feedlots and found that an 80-foot vegetated buffer reduced the suspended sediment in the runoff by 92%. Gilliam and Skaggs (1988) found that 50% of the sediment from agricultural fields was deposited in the first 288 feet adjacent to the exit location of the fields. Horner and Mar (1982) found that a 200-foot grassy swale removed 80% of the suspended solids and total recoverable lead.

The effectiveness of buffers at improving water quality adjacent to logging operations was examined by Broderson (1973), Darling et al. (1982), Lynch et al. (1985), and Corbett and Lynch (1985). Broderson studied three watersheds in western Washington (Green River, North Fork Snoqualmie River, and South Fork Tolt River). He noted that buffers will have little or no effect on sediment removal if the sediment-laden waterflows cross the buffers as channelized flow; buffers can only be effective if they resist channelization and maintain overland flow as sheetflow. Broderson found that 50-foot buffers were sufficient for controlling most sedimentation on less than 50% slopes, while steeper slopes required wider buffers. A maximum buffer width of 200 feet was found to be effective even on extremely steep slopes. Furthermore, Broderson recommended that buffer widths be measured not from the top of the streambank, but rather from "visual signs of high water."

Corbett and Lynch (1985), citing research for an earlier paper by Corbett et al. (1978), concluded that a 40-foot buffer may be adequate to protect streams from excessive temperature elevation following logging, but that a zone of 66 to 100 feet may be necessary to buffer the entire ecosystem, especially when steep slopes are encountered and increased runoff with heavy sediment loads are generated.

Darling et al. (1982) assessed an Oregon State University (OSU) formula for protecting streams and wetlands from tree blow-downs and subsequent large debris and sediment incursions into streams and wetlands. This formula included factors, such as slope and horizontal and elevational distances, from the midpoint of the buffer to the top of the nearest major ridge in the direction of the prevailing winds. Additionally, soil stability and antecedent soil moisture were considered. These investigators were primarily interested in buffer stability over time, and concluded that the OSU formula could be successfully applied in Olympic National Forest, Washington. Further, they found that the best-functioning buffers were the most stable, and that buffer stability was in turn enhanced by high percent vegetative cover and dense stands of trees, rather than by sparse vegetation or individual trees protruding above an understory. They did not, however, directly address buffer widths.

Lynch et al. (1985) assessed the success of 98-foot buffer strips between logging activity and wetlands and streams in Pennsylvania. They found that these buffers removed an annual average of approximately 75 to 80% of the suspended sediment in stormwater. Greater sedimentation resulted from forested areas which had been commercially clear-cut and then denuded with an herbicide. Surface flow in these areas tended to be channelized rather than sheetflow, although Lynch et al. (1985) made no recommendations for larger buffers in such areas.

Moring (1982) assessed the effect of sedimentation following logging with and without buffer strips of 30 meters (98 feet). The author found that increased sedimentation from logged, unbuffered, stream banks clogged gravel streambeds and interfered with salmonid egg development. With buffer strips of 98 feet or greater, the salmonid eggs and alevins developed normally.

Both Erman et al. (1977) and Newbold (1980) found that a 98-foot buffer zone was successful in maintaining background levels of benthic invertebrates in streams adjacent to logging activity in a study of California streams.

<u>Nutrient Removal</u>

A number of studies have assessed the use of buffers to control nutrient inputs into wetland and stream surface waters. Vanderholm and Dickey (1978) monitored feedlots exposed to natural levels of rainfall and found buffer widths ranging from 300 (at 0.5% slope) to 860 feet (at 4.0% slope) to be effective in removing 80% of the nutrients, solids, and oxygen-demanding substances from surface runoff through sediment removal and nutrient uptake. Doyle et al. (1977) assessed the effect of forest and grass buffer strips at improving the quality of runoff from manure application. These investigators found that both forested and grass buffers were effective at reducing nitrogen, phosphorus, potassium, and fecal bacteria in 12.5 and 13.1 feet respectively. In addition, grass buffer strips were effective in reducing nitrate and sodium levels. The percentage reduction of these nutrients was not discussed. Lynch et al. (1985) evaluated the utility of vegetated buffers in reducing soluble nutrient levels in runoff from logging operations. They found that a 98-foot buffer reduced nutrient levels in the water to "far below drinking water standards." Wooded riparian buffers in the Maryland coastal region were found to remove as much as 80% of phosphorus and 89% of nitrogen from agricultural runoff, most of it in the first 62.3 feet (Shisler et al., 1987).

Phillips (1989) studied non-point source pollution in North Carolina, and found that the current 75-foot regulatory requirement for estuarine shorelines was inadequate for filtering polluted runoff from typical residential development. Phillips used a hydrologic model that measures the ability of a buffer to detain polluted stormwater. Pollutant removal efficiencies were estimated for biochemical oxygen demand, total nitrogen, and total phosphorus.

A slightly different approach was used by Bingham et al. (1980), who studied pollutant runoff from caged poultry manure. Rather than recommending specific buffer widths, the authors reported that a 1:1 buffer area to waste area ratio was successful in reducing nutrient runoff to background levels for animal waste applications. Overcash et al. (1981) analyzed grass buffer strips as vegetative filters for non-point source pollution from animal waste with a one dimensional model, and also concluded that a 1:1 ratio of buffer area to waste area was sufficient to reduce animal waste concentrations by 90% to 100%.

Lowrance et al. (1984) evaluated the ability of riparian forest vegetation to remove sediment and nutrient discharges from surrounding agroecosystems. They found that nutrient uptake and removal by the soil and vegetation in the upland forested buffer was high and prevented outputs from adjacent disturbances from reaching the stream channels. However, they did not recommend any specific buffer widths.

Fecal Coliform Removal

A fecal coliform reduction model for dairy waste management was developed by Grismer in 1981 and applied to the Tillamook basin in northwestern Oregon. The model considered the effects of precipitation, season, method of waste storage and application, die-off of the bacteria in storage, die-off of the bacteria on the land surface, infiltration of bacteria in the soil profile, soil characteristics, overland transport of bacteria through runoff, and buffer zones. Grismer's model suggested that a 98-foot "clean grass" strip would reduce the concentration of fecal coliform by 60%. Bufferstrips of 118 feet were found to be sufficient in reducing the concentration of nutrients and microorganisms to acceptable levels in feed lot runoff from summer storms (Young et al., 1980).

Temperature Moderation

Forested buffers adjacent to wetlands function to provide cover, thereby helping to maintain lower water temperatures in summer and lessen temperature decreases in winter. The ability of forested buffer strips to maintain lower water temperatures in the summer months has been investigated by several researchers.

Broderson (1973) found that 50-foot buffers provided 85% of the maximum shade for small streams (defined as streams with mean annual discharges of less than five cubic feet per second). Broderson also found that buffer widths along slopes could decrease with increasing tree height. For instance, a stand 200 feet tall on level ground provides shade approximately 90 feet from the trunk during mid-July when temperature problems often occur. If this stand of trees were on a 60% slope, the effective shade width would increase to 150 feet. Shadow length also increases in the summer months with increasing latitude.

Lynch et al. (1985) found that a 98-foot buffer from logging operations maintained water temperatures within 1^{o}C of their former average temperature. Barton et al. (1985) found a strong correlation between maximum water temperatures and buffer length and width for trout streams in southern Ontario, Canada. They derived a regression equation in which buffer dimensions accounted for 90% of the observed temperature variation.

In their study, Brazier and Brown (1973) sought to define the characteristics of buffer strips that were important in shading small streams adjacent to logging. They found that 73 feet was often ample buffer to shade these streams, maintaining pre-logging temperature ranges. They advocated establishing a buffer range that would apply to different situations of slope, exposure, and canopy cover on a case-by-case basis.

Human Impact Deterrence

Buffer zones function to protect wetlands from direct human impact through limiting easy access to the wetland and by blocking the transmittal of human and mechanical noise to the wetland. Direct human impact to wetlands most often consists of refuse dumping, the trampling of vegetation, and noise. Shisler et al. (1987) analyzed 100 sites in coastal New Jersey to evaluate the relationship between buffer width and direct human disturbance to wetlands. The investigators completed a post construction analysis to demonstrate the effectiveness, or lack thereof, of different buffer widths for different land uses. Disturbance came in the form of abandoned or dumped constructions materials, dumped debris, cut or burned vegetation, fill areas, excavation, trampled paths, bulldozed areas, and adjacent residents expanding their property illegally into the wetlands. Shisler found that the adjacent land use type accounted for much of the variation found in the level of human disturbance. In all cases, human disturbance was higher in wetlands adjacent to dense residential or commercial/industrial uses. As a result of their investigation, Shisler et al. recommended that low intensity land uses (agriculture, low density residential, and recreation) maintain buffers of 50, 50, and 100 feet, respectively, for salt marshes, hardwood swamps, and tidal freshwater marshes. For high intensity land uses (high density residential and industrial/commercial), buffers of 100, 100 and 150 feet were recommended. As buffer width increased, direct human disturbance decreased. Disturbance levels were double at sites with narrow buffers (less than 50 feet). Buffers of 100 feet and greater provided significantly more protection and reflected in lower disturbance to the wetlands than did buffers less than 50 feet. Steeply sloping buffers with dense shrub understories provided the greatest protection.

Cooke (Appendix A, this report) studied 21 wetlands in King and Snohomish counties in a post-project evaluation to assess the effectiveness of buffers in protecting wetlands from human disturbances. Efficiency was measured qualitatively, using observations of human caused disturbance to the wetland and buffer to indicate loss of buffer effectiveness. Cooke felt that the effectiveness of a buffer in protecting adjacent wetlands was dependent on:

- intensity of adjacent land use;
- buffer width;
- buffer vegetative cover type; and
- buffer area ownership.

Buffers functioned most effectively when adjacent development was of low intensity; when buffer areas were 50 feet wide or greater and were planted with shrub and/or forested plant communities; and when the buffers were located on land owned by individuals who understood the rationale for establishing buffers, or were on land outside of residential lots. Projects that incorporated the buffer within residential lots resulted in the loss of the natural vegetation community to lawn over time. Buffer functions were found to be reduced most often as a result of decreasing the effective size of the buffer. Nearly all of the buffers that were less than 50 feet wide at the time they were established demonstrated a significant decrease in effective size within a few years; in some instances, degradation was so great that the buffers were effectively eliminated. Fewer than half of the buffers that were originally at least 50 feet wide showed demonstrable degradation.

The ability of vegetated buffers to abate noise has been analyzed by Harris (1985). Harris studied vegetated borders along busy streets, and concluded that the insertion loss per foot through an evergreen vegetated buffer was between 0.2 to 0.3 decibels(A), and a 20-foot wide mature evergreen buffer would provide an insertion loss of approximately 4 to 6 decibels(A). (A loss of 3 to 4.5 decibels(A) corresponds to approximately tripling the distance between the source of noise and the receptor.)

Josselyn et al. (1989) studied the effects of public activities on waterbirds in wetland habitats in the San Francisco Bay region. In measuring bird disturbance responses (usually movement to another location within the site), they found the distance from the human activity causing a disturbance ranged between 50 and 175 feet. The distance varied between species and habitats, with dabbling ducks exhibiting the most sensitivity. The Washington Department of Wildlife (WDW) (Appendix C, this report) concluded that "a person approaching heron or a flock of waterfowl can agitate and flush them even at distances of 200 to 300 feet. This is especially true for grazing waterfowl on shallow wetlands and wet pastures or black brant on open water."

<u>Wetland Species Distribution and Diversity</u>
Often, the health of a particular type of habitat is measured by the presence or abundance of a particular species of plant or animal or by the presence of particular community types called indicators. These indicator species and communities are used to determine the amount or extent of protection that a habitat needs in order to remain viable. Protection afforded to wetlands and streams by buffers has been assessed using various species of birds and animals as indicators.

Milligan (1985) studied bird species distribution in 23 urban wetlands in King County, Washington. She found that bird species diversity, richness, relative abundance, and the breeding numbers were moderately positively correlated with wetland buffer size. Specifically, increases in species diversity were associated with wetland buffer size increases from 50 to 100 to 200 feet. Milligan concluded, however, that wetland size and the amount of wetland edge were more important than buffer size. Her work suggested a minimum 50 feet of buffer for bird habitat preservation. Finally, Milligan noted that larger buffers may be required for wetlands adjacent to high intensity land uses.

The following information is summarized from <u>Buffer Needs of Wetland Wildlife</u>, prepared by the Department of Wildlife and attached as Appendix C to this report.

In herbaceous vegetation next to wetlands, blue-winged teal use select grassy vegetation for establishment of nest sites. They need three acres of upland for each acre of wetland for breeding. The annual loss of untilled upland nesting cover is a major factor contributing to suppressed duck production, regardless of water conditions. Because of conversion of adjacent uplands, teal and gadwall production in Washington state has been significantly reduced (Zeigler, pers. comm., February 1992). Blue-winged teal nests in North Dakota averaged 256 meters from water. Optimum nest cover values are assumed to occur at less than 250 meters from any wetland other than ephemeral wetlands. Great blue herons tolerate human habitation and activities about 100 meters from a foraging area and occasional, slow moving, vehicular traffic about 50 meters from a foraging area.

In shrub vegetation next to wetlands, the beaver use zone includes an area 600 feet from the wetland edge. Trees and shrubs closest to water are used first. A majority of beaver feed within 328 feet of water. In dry environments, 90% of the beaver feed within 100 feet of water. Belted kingfisher broods use shrub cover along water for concealment. Roosts were 30.5 to 61 meters from water.

In either shrub or herbaceous vegetation in buffers, foraging sites within 200 meters of wetlands that contain nest sites are assumed useful for blackbirds. The average distance from gadwall nest sites to water was less than 45.8 meters in several studies of gadwalls, but nests in North Dakota averaged 351 meters from water. Gadwalls typically select the tallest, densest, herbaceous or shrubby vegetation available in which to nest. The majority of lesser scaup nests have been recorded within 10 meters of the water's edge. They have been found up to 0.4 kilometers from water. The most preferred nesting habitat for lesser scaup is assumed to occur when a 50-meter zone surrounding permanently flooded, intermittently exposed, and semipermanent flooded wetlands with 30 to 75% canopy cover of herbaceous vegetation. Lesser scaup most frequently are observed on wetlands with at least half of the shoreline bordered by trees and shrubs.

In forested buffers, the limiting features for wood duck use are open water, marsh or shrubs and snags. They distance from 0 to 1149 feet from water but average 262 feet. Most nests are within 600 feet of water. Beaver feed up to 600 feet from the wetland edge, using trees and shrubs closest to water first. Lesser scaup use forest buffers, nesting up to 165 feet from water in herbaceous layers. Mink use forested buffers within 600 feet from open water. Most use is within 328 feet of the wetland edge. Mink need 75 to 100% forested cover. Den sites in Idaho were placed up to 328 feet from the wetland edge. Pileated woodpeckers nest within 492 feet of water; most nest within 164 feet. Because of impacts caused by timber harvest to the marten populations, WDW management guidelines recommend no harvest within 200 feet of riparian corridors.

McMahon (1983) found that vegetated buffers were important for survival of juvenile coho salmon, both for temperature moderation, cover and increased food supply. Brook trout are also extremely susceptible to elevated temperatures, and Raleigh (1982) recommended a 30-meter (98-foot) buffer width with 50 to 75% midday shade as optimal. Eighty percent of this buffer should be vegetated, for erosion control, for maintaining the undercut bank areas, and for providing essential cover for the trout along the bank. Raleigh et al. (1984) described similar habitat requirements for rainbow trout, and recommended the same size and make-up for buffer areas.

Some researchers have assessed the value of buffers for several species concurrently, and offer general buffer recommendations. Mudd (1975) studied the Touchet River, analyzing current conditions along the river, and the amount of riparian and wetland wildlife habitat that existed. Bird, mammal, and plant species were surveyed, although game species were studied most. Mudd found that a minimum of 75 feet of natural riparian, primarily mature, vegetated buffer promoted optimum wildlife populations for pheasant, quail, mourning dove, and deer.

The WDW (Appendix C, this report) summarizes that:

> "To retain wetland-dependent wildlife in important wildlife areas, buffers need to retain plant structure for a minimum of 200 to 300 feet beyond the wetland. This is especially the case where open water is a component of the wetland or where the wetland has heavy use by migratory birds or provided feeding for heron. The size needed would depend upon disturbance from adjacent land use and resources involved.
>
> Influence of the water table on the landscape and vegetation is often reduced on the eastside of the state with more abrupt wetland-upland edges. Wildlife use tends to be concentrated closer to water in drier climates. Hall (1970) showed more narrow beaver use on streams in eastern California than had been reported in the literature (100 feet vs. 328 feet). Mudd (1975) showed minimum riparian area for maximum pheasant and deer use to be 75 feet in one eastern Washington study.
>
> In western Washington, wetlands with important wildlife functions should have 300-foot upland buffers for intense land uses and 200-foot upland buffers for low intensity land uses. In Eastern Washington, wetlands with important wildlife functions should have 200-foot upland buffers for intense land use and 100-foot buffers for low intensity land uses.
>
> Priority species or especially sensitive animals or wetland systems such as bogs/fens or heritage sites may need even larger buffers around wetlands to prevent their loss to disturbance or isolation of subpopulations or other loss of wetland function or value."

Wetland Buffer Determination Models and Recommendations

Washington State agencies and local governments are not the first to consider the question of wetland buffer protection and buffer sizes. Others, most notably in the eastern United States, have researched wetland buffers and provided methods or models for establishing required buffer distances.

<u>State of New Jersey</u>
A wetland buffer delineation method was developed by Rogers, Golden, and Halpern, Inc. (1988) for the New Jersey Department of Environmental Protection for the protection of tidal and non-tidal wetlands of the coastal zone. This method, designed primarily to maintain water quality, is dependent upon three factors: vegetative cover, soil characteristics, and percent slope. The investigators incorporated a modified version of the Manning's Equation (used in hydraulics to relate runoff to a number of slope variables) to graph relationships among: (1) mean runoff velocity; (2) the roughness coefficient of vegetation; (3) vegetation type; (4) percent slope; (5) sediment trap efficiency; (6) sediment particle size; and (7) buffer width.

The New Jersey method resulted in buffer width recommendations that varied from 25 to 645 feet, depending upon buffer vegetative cover type, slope, and degree of development impact. Based upon this method, specific buffer recommendations were made for coastal New Jersey. Three-hundred-foot buffers were recommended around wetlands which are designated as providing habitat for threatened, sensitive, or endangered species, and around those wetlands designated as a wildlife refuge, management area, or sanctuary. They were also recommended between wetlands and any facility that involves hazardous substances or wastes; septic fields, spray fields, or sewage application areas; and mineral extraction activities, including sand and gravel pits. A minimum of 25 feet was recommended for residential development if the buffer is forested, with a minimum 50-foot buffer for shrubby and herbaceous buffers. No buffers were recommended for projects if the site drainage patterns would be completely diverted away from the wetland, before, during, and after construction (such a practice, however, may have adverse impacts on wetland hydrology). The authors emphasized, however, that although no buffers would be needed to protect wetland water quality if all site drainage were diverted, other functions should be evaluated to determine appropriate buffer widths. (Present factors, such as noise attenuation, maintenance of wetland hydrology, and the availability of upland habitat for wildlife, indicate that buffers are important even if water quality is not an issue.) This method also recommended significantly larger buffers (up to twice as large) if a portion of the buffer is unvegetated or impervious. Additional buffer widths of up to 30 feet are recommended depending upon soil characteristics such as organic matter content and soil drainage class.

New Jersey Water Supply Reservoirs

As a part of a comprehensive watershed management project for the State of New Jersey, a parameter based buffer model was developed by Nieswand et al. (1990) for application to all watersheds above water supply intakes or reservoirs. The primary buffer function sought by the model was nearshore water quality protection. Input requirements for the model include a combination of slope, width, and time of travel across the strip. As a result of their study, Nieswand et al. recommended a minimum 300-foot width for terminal reservoirs and their tributaries due to their "critical position." The 300-foot recommendation excludes slopes in excess of 15% and strip impervious surfaces such as roads, where widths should be greater. For non-terminal reservoirs and pumping stations, the recommended buffer was a minimum of 100 feet excluding slopes and impervious surfaces. For perennial streams and lakes, the recommended buffer was a minimum of 50 feet with the same exclusions.

New Jersey Pinelands

Roman and Good (1983 and 1986) developed a model to determine buffer widths for the New Jersey Pinelands Area, a sensitive complex of uplands, wetlands, and aquatic communities in southeast New Jersey. The model evaluated relative wetland quality and relative impacts of development. Relative wetland quality was determined by vegetation, surface water quality, potential for water quality maintenance, wildlife habitat, and socio-cultural values. Relative impact of development was determined by the potential for site specific impacts, the potential for cumulative impacts on a regional basis, and the significance of watershed-wide impacts. The final values assigned during the scoring process determined final buffer requirements ranging from 50 to 300 feet. Prior to any evaluation, however, a determination of the presence of threatened or endangered species is made. If the wetland is known to support such species and is critical to their survival, the wetland is assigned a buffer of 300 feet.

Wekiva Basin, Florida

Brown and Schaefer (1987) derived a formula for the Wekiva Basin, Florida, using four factors to determine the width of buffer zones: (1) the wetland boundary; (2) the erodibility of soils in the zone immediately upland of the wetland boundary; (3) the depth to groundwater in the upland area immediately adjacent to the wetland; and (4) the habitat requirements of aquatic and wetland-dependant wildlife species.

Rather than setting general recommendations, Brown and Schaefer (1987) gave a detailed formula for a case-by-case determination. The method relied first upon accurate wetland delineations and slope and erodibility determinations. Buffer width recommendations ranged from 43 (for a slope of 3% or less and soils with low erodibility) to 87 feet (3% slope and high erodibility). Larger buffers were required if the ground water table is expected to be lowered as a result of development activity. Buffer widths of 78 to 392 feet were recommended for drawdowns of between one and five feet. Another variable in their model was the maintenance of suitable habitat. In some instances, recommended buffer widths exceeded 500 feet for the specific Floridian ecosystem used in this modeling effort. Finally, Brown and Schaefer addressed the use of buffers for noise reduction and concluded that a minimum of 42 feet of forested buffer is adequate, but that this width should increase to 60 feet if the buffer zone is deforested.

<u>Washington Model Wetlands Protection Ordinance</u>
The Model Wetland Protection Ordinance developed by the Washington Department of Ecology as guidance for local government offered a buffer determination method based on wetland rating categories. The rating categories were defined according to functions and values, sensitivity, rarity, and replaceability of the wetland. Recommended buffers were 200 to 300 feet for Category I; 100 to 200 feet for Category II; 50 to 100 feet for Category III; and 25 to 50 feet for Category IV. These buffer widths can be raised or lowered based on specific criteria.

III. Agency survey

The agency survey provides a synthesis of existing regulatory requirements for wetland buffers for significant state programs in the nation and key Washington county and city programs. The purpose of the synthesis is twofold. The first is to confirm the methods and standards for buffer widths that have been adopted through legislative processes by regulatory agencies. The second is to evaluate the effectiveness of the buffer standards.

The synthesis of regulations includes information on the overall regulatory program of the state or local government; specific buffer width requirements; wetlands rating[2] or other methods used to establish buffer widths; and the administrative effectiveness of the regulatory program. The adopted buffer requirements for states, counties, and cities are summarized in Table 1.

Rapid changes are occurring in Washington State and the nation in the formulation of growth strategies and wetlands protection programs. Many jurisdictions that do not currently have regulations in place are in the process of drafting them, and some are in the process of amending regulations already in place (e.g., Thurston and Island counties). Information on proposed buffer requirements for Washington counties and cities is generally not provided in the regulatory synthesis, however, it is summarized in Table 2.

The data used in this study were collected in April and May of 1991. Washington State local government data was updated in February 1992. The information was collected primarily by contacting state and local agencies directly and requesting all relevant laws, regulations and guidelines. The Washington State data was updated according to information currently available to Ecology. Personal communications are cited only when the information provided was not contained in an official agency publication. Only those agencies who have adopted specific regulatory programs which cover wetlands have been included in the regulatory synthesis. Table 2, the summary of proposed programs, includes as many programs as the investigators could find; it is not necessarily the exhaustive list and the proposed standards presented are changing rapidly. Information is presented in alphabetical order by jurisdiction.

Background

Any environmental regulatory program, whether it is administered at the federal, state, or local level, may be divided into three basic components: (1) laws, or enabling legislation to grant the necessary power to regulate certain activities in prescribed areas (e.g., Shoreline Management Act and King County Sensitive Area Ordinance); (2) regulations, which implement and interpret the laws and are mandatory (e.g., Washington Administrative Code and Code of Federal Regulations); and (3) guidelines, which are typically non-binding, flexible advice, on how best to bring projects into compliance with applicable laws and regulations.

[2] A wetlands rating system is a process that differentiates wetlands according to specific characteristics or functional attributes. Protective measures can be varied, with the highest levels of protection given to the highest rated wetlands.

For at least the last two decades, a major policy objective of federal, state and many local governments has been a consistent approach to wetland regulation based upon the scientific information. In November of 1989 the U. S. Army Corps of Engineers and the U. S. Environmental Agency entered into a Memorandum of Agreement (MOA) for determination of mitigation under the Clean Water Act Section 404(b)(1) Guidelines. This MOA clarified the standards for determining "appropriate and practicable" measures to offset unavoidable impacts. These include: 1) avoidance, which does **not** include compensatory mitigation and allows permit issuance only for the least environmentally damaging practicable alternative; 2) minimization, which requires appropriate steps to minimize the adverse impacts through project modifications and permit conditions; and 3) compensatory mitigation, which is allowed only after all appropriate and practicable minimization has been required.

Ecology's <u>Model Wetland Protection Ordinance</u> incorporates the same three-step hierarchy for evaluating proposed projects in wetlands. The ordinance contains a wetlands rating system for establishing required buffer zone widths and compensatory acreage replacement ratios. Such linkage was suggested in 1984 by the Office of Technology Assessment.

The Office of Technology Assessment (OTA) undertook a wetland study in the early 1980s at the request of the Senate Committee on Environment and Public Works and its Subcommittee on Environmental Pollution (OTA, 1984) to address a range of policy options for dealing with wetland use and regulation. One of the policy options articulated in the study is directly applicable to Ecology's current investigations of wetland buffers and compensatory mitigation. OTA found that categorizing wetlands by relative value (low vs. high), combined with a regulatory strategy that would allow the protection of wetlands based upon those categories, would allow regulatory programs to be "tailored" to protect specific types of wetlands (Eric Metz, OTA Wetlands Advisory Panel Member, pers. comm. April 1991). The Environmental Protection Agency is currently considering such a system for regulating wetlands under the Clean Water Act (Reilly, 1991).

Subsequent to the OTA study, The Conservation Foundation convened the National Wetlands Policy Forum to take a broad look at wetland policy, and to recommend ways to better protect and manage wetlands (The Conservation Foundation, 1988). The Forum recommended establishing a national interim goal of achieving no overall net loss of the nation's wetlands base, and a long term goal of increasing the quantity and quality of the nation's wetland resource base. At the present time, these goals are widely accepted by the federal, state, and local governmental regulatory community. The no-net-loss policy goal lies at the heart of every major wetland protection program in the state of Washington, for example, the Puget Sound Water Quality Management Plan, the 2010 Action Agenda, and the Governor's Executive Order for wetlands protection.

In Washington State there are several key wetland regulatory and policy documents guiding local government wetlands protection efforts. Guidelines (Chapter 365-190 WAC, "Minimum Guidelines to Classify Agriculture, Forest, Mineral Lands and Critical Areas") have been adopted by the Department of Community Development for use by local governments in compliance with the Growth Management Act. These guidelines encourage Washington State counties and cities to make their actions consistent with the intent and goals of Executive Orders 89-10 and 90-04 for the protection of wetlands as they existed on September 1, 1990. The guidelines encourage counties and cities to consider Ecology's model ordinance, and to consider the use of a wetland rating system.

The Puget Sound Water Quality Authority has incorporated a wetlands protection element into the 1991 Puget Sound Water Quality Management Plan. One part of this element (W-4.1) recommends local adoption of a comprehensive approach to wetlands protection using both regulatory and non-regulatory tools. The Plan amendments recommend that local regulations address several elements, including wetland buffers. The plan refers to Ecology's model ordinance for guidance on wetlands protection standards.

National Survey of State Programs

At least sixteen states throughout the country utilize existing laws and regulations to protect wetlands. These are summarized below:

CALIFORNIA

Regulatory Program: The California Coastal Act of 1976 contains the only statewide requirements for wetland protection and management, and the Act applies only to wetlands within California's coastal zone. In 1981, the California Coastal Commission adopted a comprehensive set of guidelines for assistance in determining the commission's wetland jurisdiction. The guidelines established permitted uses in wetland areas, provided specific functional criteria for establishing wetland buffers, and provided standards for determining compensatory wetland mitigation. The process of drafting and adopting the interpretive guidelines was long (nearly two years), very controversial, and relied extensively upon expert scientific opinion (Metz and DeLapa, 1980).

To provide a scientific basis for the guidelines, the commission hired Dr. Christopher Onuf, a salt marsh ecologist, to prepare scientifically supportable standards for protecting wetlands from land use impacts (Onuf, 1979). The report issued by Onuf included two case studies assessing actual attempts by local governments to protect and manage wetlands in a manner consistent with California Coastal Act policies. The case studies included the City of Carlsbad's Agua Hedionda Specific Plan for protecting a coastal lagoon, and the City of Santa Barbara's Environmentally Sensitive Draft Report on the Goleta Slough for protecting a coastal slough. In addition, the commission convened a panel of federal and state agency wetland regulatory experts to review Onuf's recommendations. Along with the Onuf report, literature reviews, technical workshops, and informal interviews with scientists were conducted by commission staff, and constituted the basis of the recommendations contained in the guidelines for determining buffer widths. As a result of the firm scientific foundation for the regulatory concepts contained in the guidelines, subsequent commission decisions which relied upon those principals were upheld in court (Metz and Zedler, 1983).

Rating System: Not actually a rating system, the act distinguishes between "wetlands" and "degraded wetlands." Under the act's system, only "degraded" wetlands are candidates for any type of compensatory mitigation. The California State Department of Fish and Game is responsible for determining whether a wetland qualifies as a "degraded" wetland, a determination based in part on whether the wetland "...is so severely degraded and its natural processes so substantially impaired that it is no longer capable of recovering and maintaining a high level of biological productivity without major restoration activities." The "degraded wetland" classification does not affect buffer width.

Buffer Requirements: The act itself does not contain specific requirements for buffer widths. Buffers are determined on a case-by-case basis using standards contained in the guidelines. The general standard contained in the guidelines is a 100-foot buffer. The precise width is determined based upon the functions, values, sensitivities of the wetland in question; and upon the type, scale, and intensity of the development which is proposed adjacent to the wetland.

Administrative Effectiveness of Regulatory Program: The wetland guidelines have now been in place for ten years. In 1986, the Coastal Commission staff convened a wetland task force and completed an internal assessment of the Commission's wetland program and its effectiveness. The effectiveness of wetland buffer requirements has not been assessed. It is not generally known if buffers were provided, as promised. The guidelines have not been revised or amended since they were adopted in 1981, and they have not been followed consistently by the staff or the Commission. This is due, in part, to the fact that there has not been a full-time wetland coordinator position at the agency since 1983 (Jim Raives, California Coastal Commission, pers. comm., April 1991). Consequently, there has been no overall coordination or technical assistance provided in the wetland area during the past seven years.

To help address these problems, the staff is preparing a wetland regulatory training manual to promote consistent wetland policy within the agency. The agency is also considering reinstating the wetland coordinator position. The task force report recommends that the agency adopt a pro-active wetland program designed to educate the public about wetlands, to reduce conflict with fish and wildlife agencies, and to continue to improve the program.

CONNECTICUT

Regulatory Program: The Connecticut Inland Wetlands & Watercourses Act was passed in 1972. This act and subsequent amendments required municipalities to establish inland wetland agencies to carry out the provisions of the act. These agencies are further obliged by the act to prepare "inventories of regulated areas" which are similar in nature to the National Wetland Inventory maps. While delegating this authority to the individual municipalities, the state has not mandated a specific regulatory program. The state Department of Environmental Protection has issued "Model Inland Wetlands and Watercourses Regulations" as a guide to assist in the implementation of municipal inland wetland regulatory programs. The Department of Environmental Protection acts as a technical advisory panel for the individual municipalities.

Rating System: There is no statewide wetland rating system. All wetlands identified on Connecticut Inventory Maps are afforded the same protection under the law.

Buffer Requirements: While no buffer standards exist in Connecticut, approximately 60% of the municipalities have adopted some form of buffers around "regulated areas" (Doug Cooper, Department of Environmental Protection Water Resources Unit, pers. comm., March 1991). These range from 25 to 150 feet and are usually in areas providing significant local habitat functions (R. Palumbo, City of Millford Planning Dept., pers. comm., March 1991).

DELAWARE

Regulatory Program: Delaware regulates wetlands through the Tidal Wetlands Act of 1973, and the Sub Aqueous Law of 1986. The legislation does not contain specific requirements for buffers. For this reason, the Delaware Department of Natural Resources and Environmental Control has developed a new Freshwater Wetlands Act which is currently being reviewed in the legislative process. The proposed bill is based closely on Delaware's Tidal Wetlands Act of 1973. The proposed Freshwater Wetlands Act would include buffer requirements and a five-tier rating system.

Rating System: The proposed rating system is consistent with Ecology's four-tier rating system, the except for Class 5 wetlands which include and are limited to human-made detention facilities and receive minimal protection under the proposed act. In the proposed Freshwater Protection Act, Class 1 and 2 wetlands will be clearly defined on regulatory maps prepared by the Department of Natural Resources and Environmental Control. The project proponent, or developer, is responsible for delineation of Class 3 through 5 wetlands. All other wetlands are regulated as Class 3 wetlands unless specifically reassigned by the department to another class.

Buffer Requirements: Buffer requirements range from up to 300 feet for Class 1 wetlands, and up to 100 feet for Class 2 wetlands. These buffer areas will be included in the jurisdictional maps. Buffers associated with Class 1 wetlands are protected as if they were Class 2 wetlands, and buffers associated with Class 2 wetlands are protected as if they were Class 3 wetlands. The rationale is that wetland acreage will be increased while at the same time discouraging peripheral impacts to significant wetland systems. Other classes of wetlands are assigned buffer designations on a case-by-case basis. For example, significant alteration of a Class 3 wetland may result in the department upgrading that wetland's status to a higher class so it may receive greater protection under the law.

ILLINOIS

Regulatory Program: The Interagency Wetland Policy Act of 1989 is the first piece of wetland protection legislation passed by the State of Illinois. This law establishes a no-net-loss goal for acreage and function and provides for enhancement of existing wetlands by conditioning state funded projects. This act established an Interagency Wetlands Committee to advise the State Department of Conservation in the development of administrative guidelines.

Rating System: No rating system is contemplated as of this writing.

Buffer Requirements: Buffer requirements are not included as an expressed provision in the act.

LOUISIANA

Regulatory program: The State of Louisiana has no statewide wetland protection legislation. The Coastal Zone Management Act of 1990 has enabled the state to regulate land use in wetlands in a portion of southern Louisiana. Wetlands within the Coastal Zone Boundary are regulated by the Department of Natural Resources (DNR). The Coastal Zone Boundary is a political line that limits DNR jurisdiction, it is not ecologically based. Furthermore, only tidally influenced wetlands (fresh or salt water) are covered under the act. This act requires compensatory mitigation for all wetland impacts and establishes the framework for mitigation banking programs. The state DNR is currently drafting detailed rules and regulations relating to mitigation policy and mitigation banking. The Louisiana DNR also has a division responsible for management of the Coastal Restoration Trust Fund. This fund may also be utilized for restoration and creation of wetland areas deemed suitable by the state legislature. This fund is supported by state oil and gas revenues directly.

Rating System: The Habitat Evaluation Procedure (HEP) developed by the U.S. Fish and Wildlife Service is used for determining mitigation bank credits, for monitoring mitigation projects, and for determining proposed impacts. This rating system considers only fish and wildlife habitat in the evaluation and is not used for determining buffers (that are not required--see below).

Buffer Requirements: The entire Coastal Zone is within the flat alluvial delta of the Mississippi River. Land surface elevations vary by only five feet through the entire area. At certain river flows, the entire land area in southern Louisiana is below the level of the river and is only protected from flooding by existing dikes. The entire coastal zone may also classify as wetland under the Federal Interagency Committee's Technical Criteria. Buffers are not considered important or feasible in this situation.

MAINE

Regulatory Program: Wetlands in the State of Maine are regulated by the Natural Resources Protection Act of 1988 (amended in 1990). The act is implemented by the wetland protection rules, developed by the State Department of Environmental Protection in 1990. The rules establish minimum guidelines that all municipalities must adopt and administer. These standards include a regulatory definition of wetlands, and establish three wetland classes with associated buffer requirements.

Rating System: Under Maine's system, Class 1 wetlands are considered most valuable and include rare and unique habitats, species, and functions. Class 2 wetlands are also considered valuable and include floodplains. Class 3 wetlands do not contain any characteristics of a Class 1 or 2 wetland, and include wet meadows and swamps that are not contiguous to any water body. All land meeting technical criteria in the Federal Manual is considered wetland and placed into this classification system. Class 1 and 2 wetlands under Maine's system are similar to Ecology's Category I and II wetlands, respectively. Under Ecology's four-tier rating system, Maine's Class 3 would be divided into two Categories, III and IV.

Buffer Requirements: Class 1 and 2 wetlands are considered sensitive and require buffers. Class 1 wetlands require 100-foot buffers and Class 2 requires 50-foot buffers.

MARYLAND

Regulatory Program: The State of Maryland passed the Non-tidal Wetland Protection act in January of 1989 (based upon The Tidal Wetland Act of 1974). This act contains a no-net-loss policy for the state, and establishes statewide buffer standards. Buffer requirements are taken directly from The Tidal Wetland Act.

Rating System: A two-tier wetland rating system is employed in Maryland, which includes "areas of special state concern," and all other wetlands. A wetland is considered an "area of special state concern" if it provides habitat for rare, threatened, or endangered plants or animals, or contains a unique habitat or plant association within the state boundaries.

Buffer Requirements: Wetlands considered "areas of special state concern" require a 100-foot buffer, while all other wetlands have a mandatory 25-foot buffer.

MICHIGAN

Regulatory Program: The Goemaere-Anderson Wetland Protection Act of 1979 is the primary piece of legislation governing land use in wetlands in the state of Michigan. Administrative rules promulgated in 1988 enable the state Department of Natural Resources (DNR) to comprehensively administer the wetland management program. In August of 1984, this state became the first in the nation to assume 404 program responsibilities from the U.S. Army Corps of Engineers. This program is primarily focused on expediting the permit application process. Built into the assumption rule is a 90-day time limit for permit review. All wetlands contiguous with lakes, streams, or ponds and all isolated wetlands greater than five acres are covered under the state regulatory program.

Rating System: The State has developed its own methodology for wetland identification that relies more heavily on the presence of hydrophytic vegetation than the methodology presented in the Federal Manual. There is no standardized rating system employed in this state. Wetlands are rated individually by DNR staff and are given a ranking based on a state-developed ranking methodology that also utilizes a great deal of subjective habitat and functional determinations.

Buffer Requirements: There are no buffer requirements for the state of Michigan.

MINNESOTA

Regulatory Program: The Wetland Conservation Act of 1991 (H.F. 1) is Minnesota's main statute governing wetland areas. It includes several key elements: (1) requiring the Board of Water and Soil Resources to adopt rules within the next two years (by 1993) to determine the public value of wetlands and to be the basis for assuring adequate wetland replacement; (2) establishing a restoration and compensation program; (3) establishing a no-net-loss goal for the state; and (4) requiring special protection for peatlands.

Rating System The act protects all wetland types and sizes, with some exemptions. Replacement must be restoring or creating wetland areas of at least equal public value for those wetlands on agricultural lands and at a two to one replacement ratio for non-agricultural lands. Calcareous fens are offered total protection (avoidance of all activities). Also, peatlands are offered special protection by designating certain lands as scientific and natural areas. Replacement is not required for those wetlands also receiving a general permit under the federal Clean Water Act; for activities in Type 1 wetlands on agricultural lands, except bottomland hardwood wetlands; and activities in Type 2 wetlands that are two acres or less in size.

Buffer Requirements: There are no buffer requirements for the state of Minnesota.

NEW HAMPSHIRE

Regulatory Program: New Hampshire's enabling legislation for regulating wetlands is its Fill and Dredge in Wetlands law (RSA 482-A). This statute provides the authority for the state's administrative rules that establish the New Hampshire Wetlands Board (Chapter Wt 100 through Wt 800). The board consists of the commissioners and directors of several state departments, as well as county and municipal government representatives. The board has developed and administers wetland protection rules and regulations for the state. Regulated wetlands include fresh water and salt water wetland areas, as defined by the methodology presented in the 1989 Federal Manual for the Identification and Delineation of Wetlands.

Rating System: Freshwater wetlands are divided into 3 general types: bogs, marshes, and swamps. The law incorporates a priority system based on the rarity and difficulty in restoration of the bog or marsh environment. Priority judgement is also based on the location and relative size within the individual watershed. The rules specify certain habitats and functions as being more "valuable" than others. Specifically, bogs are considered to be the most valuable, followed by marshes, and then swamps. Other specific criteria used by the Board when processing permit applications include: (1) the impact on plants, fish, and wildlife, including rare and endangered species; (2) the impact of the proposed project on public commerce and recreation, with special attention to those projects in or over public waters where boating is possible; (3) the extent to which a project interferes with the aesthetic interests of the general public; (4) the impact upon abutting land owners; (5) the benefit of a project to the interests of the general public, including but not limited to streambank improvement, safety, roadway improvement, and recreational improvements; (6) the impact of a proposed project on quality or quantity of water in watersheds or waters that are public water supplies; and (7) the potential of a proposed project to cause or increase flooding.

Buffer Requirements: Wetland areas are rated and, if considered "valuable" by the Board, are protected by a mandatory 100-foot buffer. Tidal areas are automatically considered valuable, and all tidally influenced areas have a 100-foot buffer requirement.

NEW JERSEY

Regulatory Program: The State of New Jersey has three statutes that protect wetlands: (1) the Coastal Zone Management Act of 1970 that regulates land use in all coastal wetlands; (2) the Freshwater Protection Act of 1988 that provides protection for freshwater wetlands statewide; and (3) a statute that governs activities in the New Jersey Pine Barrens.

Rating System: Coastal wetlands are not rated, however, there are three categories for wetlands covered by the Freshwater Protection Act: (1) those with exceptional resource value; (2) those with intermediate resource value; and (3) those with ordinary resource value. Wetlands with exceptional resource value include those which discharge into certain trout production waters or their tributaries and wetlands with habitat for threatened or endangered species. Wetlands of ordinary resource value include certain isolated wetlands, and human-made drainage ditches, swales, or detention facilities. Wetlands of intermediate resource value include those with no exceptional or ordinary attributes.

Buffer Requirements: The Coastal Zone Management Act can provide for up to 300-foot buffers for coastal wetlands. The Freshwater Protection Act provides for protection of "transition areas" based on the rating category. Exceptional resource value wetlands are assigned buffers of 75 to 150 feet; intermediate resource value wetlands are assigned buffers of 25 to 50 feet, and ordinary wetlands receive no buffer. In the New Jersey Pine Barrens, buffers up to 300 feet may be required.

NEW YORK

Regulatory Program: The New York Freshwater Wetlands Act of 1975 is the only statewide wetland legislation. Under the act, the state regulates:

> "...wetlands greater than 12.4 acres in size; wetlands of unusual local significance; and Class 1 wetlands which are at or near a water body used primarily as a water supply."

Delineation of wetland boundaries is primarily based on vegetation indicators. Within the state of New York, the Adirondack Park Agency also regulates wetlands pursuant to the act on park agency land. The park agency requires a permit for any work in wetlands greater than one-half acre in size.

Rating System: Wetlands regulated in the state of New York are placed into one of four Classes. Class distinctions are based on habitat and vegetation associations, as well as value estimates related to flood control and water quality.

Buffer Requirements: Under the Department of Environmental Conservation Program, wetlands meeting the minimum size requirement are afforded a 100-foot buffer (Patricia Rexinger, NY Dept. of Environmental Conservation, pers. comm., March 1991). The Adirondack Park Agency establishes buffer widths on a case-by-case basis. (Ray Curren, Adirondack Park Agency, pers. comm., March 1991).

Administrative Effectiveness of the Regulatory Program: The New York Freshwater Wetlands Law of 1975 was one of the first wetland protection measures initiated by any state. There have been no significant amendments to this statute since its inception.

OREGON

Regulatory Program: Oregon has a state removal/fill law that is administered by the Oregon Division of State Lands (ODSL) (ORS 541.605-541.695). A permit is required for removal from a waterway of 50 cubic yards or more of material from one location in any calendar year, or the filling of a waterway with 50 cubic yards or more of material at any one location at any time. This law also applies to "waters of the state," which include navigable and non-navigable rivers, bays, estuaries, permanent and certain intermittent streams, and salt and freshwater wetlands.

Oregon also has a mitigation law (ORS 541.626) that applies to fill or removal from estuaries. In addition, in 1989 the Oregon Legislature passed Senate Bill 3, which requires a statewide wetland inventory, and calls for the preparation of Wetland Conservation Plans by local governments. Senate Bill 3 is implemented by administrative rules on wetland inventory and wetland conservation plans (ORS 196.668-196.692).

Rating System: ODSL is developing a broader based functional methodology for all wetlands. The goal is to develop a habitat based model, like that described below for estuarine systems, if there is sufficient information for freshwater wetlands.

The administrative rules for estuarine mitigation contain a habitat based model for weighing relative values of selected estuarine habitat types. Two models exist, one for the Columbia River Estuary, and one for all other estuaries. Substrate, salinity regime, and vegetation are evaluated for relative habitat value, but the output is used only for calculating compensatory mitigation, not for determining buffer width. A comparison is made between values lost and values replaced, with the goal of no overall net loss of estuarine surface area, productivity, diversity, or natural habitat areas.

Buffer Requirements: Senate Bill 3 requires buffers but provides no standards. A senior ODSL staff contacted for this survey believes that determining buffer widths must be addressed on a case-by-case basis, and would depend upon the local planning context. Buffer type and width should be determined based upon the adjacent land use proposed, and the position of the wetland in the landscape. ODSL staff do not support the assignment of buffer widths to wetlands based upon a wetland classification system, which is believed to be "too simplistic" of an approach.

PENNSYLVANIA
Regulatory Program: Pennsylvania does not currently have comprehensive wetland protection legislation at the state level. The only existing law that requires wetland protection is the Dam Safety and Encroachments Act of 1979.

Rating System: According to Section 105.17 of the proposed rules for Dam Safety and Waterway Management, which are administered by the Department of Environmental Resources, Pennsylvania rates wetlands using two categories:

> "The existing regulations contain special permitting criteria for projects affecting 'important' wetlands. The Department has determined that all wetlands will be more appropriately regulated through the establishment of two wetlands categories; namely exceptional value wetlands and all other wetlands. Although all wetlands are valuable and subject to the requirements of this chapter, exceptional value wetlands are special wetlands that deserve enhanced protection. Exceptional value wetlands include wetlands that provide habitat for important, threatened or endangered species, and protect water quality."

Buffer Requirements: The act requires that dams be set back 300 feet from "important" wetlands and watercourses. The State Department of Environmental Resources regulations makes it clear that the setback mentioned does not apply to land uses other than dams.

RHODE ISLAND
Regulatory Program: The Rhode Island Freshwater Wetlands Act of 1971 is administered pursuant to the Department of Environmental Management Rules and Regulations (1989). The rules contain jurisdictional definitions and activities requiring permits. Activities included in this permit procedure include wetland fill, as well as water quality and flood water impacts. Buffers are required.

Rating System: The state employs a "Wetland-Wildlife Evaluation Model" as a method for determining affected areas (Models for Assessment of Freshwater Wetlands, University of Massachusetts at Amherst, Publication No. 32). This rating system is applied on a case-by-case basis. The evaluation includes a determination of whether the land is considered "unique" or "valuable." This assessment is based on cultural and biological parameters, including fish and wildlife habitat values. Rhode Island's "Rules and Regulations Governing the Enforcement of the Fresh Water Wetlands Act," March 1981, defines the above terms as follows:

(a) Unique Wetland - The term "Unique Wetland" as used herein shall refer to those wetlands having special ecological or cultural significance within Rhode Island and possessing one or more of the following characteristics:
1) presence of rare or endangered plants and animals;
2) presence of plants of unusually high visual quality and infrequent occurrence:
3) presence of plants or animals at or near the limits of their geographic range;
4) unusually high production of native waterfowl;
5) annual use by great numbers of migrating waterfowl, shore birds, marsh birds or wading birds;

6) "outstanding" wildlife diversity and production as determined by the aforementioned "Wetland-Wildlife Evaluation Model";
7) presence of outstanding or uncommon geomorphological features;
8) presence of outstanding archaeological evidence;
9) availability of reliable scientific information concerning the geological, biological or archaeological history of the wetlands; and
10) designation as rare, endangered, exemplary or unique by the Rhode Island Natural Heritage Program.

(b) "Valuable Wildlife Habitat" shall refer to:

1) those marshes, swamps and bogs that are characterized by "high" diversity and production of wildlife, according to the aforementioned "Wetland-Wildlife Evaluation Model," and (2) those rivers and ponds classified by regulation as Category A, B, or C by the DEM Division of Fish and Wildlife.

Buffer Requirements: The Rhode Island Department of Environmental Management maintains maps of designated wetland areas that are regulated. Included on these maps is an additional 50-foot buffer area that is also regulated.

VERMONT

Regulatory Program: The Vermont legislature passed a statewide wetland protection act in 1986. Vermont Wetland Rules, developed by the state's Water Resources Board, were adopted in 1990. The rules apply to all land identified as wetland by methodology presented in the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands.

Rating System: Buffer requirements apply to three classes of wetlands. Class determinations are based upon habitat functions and values, as well as open space and aesthetic concerns. According to the wetland rules:

> "Class One wetlands are those wetlands that, in and of themselves, based on an evaluation of the functions in Section 5 (i.e., water storage for flood water and storm runoff, surface and groundwater protection, fisheries habitat, wildlife and migratory bird habitat, hydrophytic vegetation habitat, threatened and endangered species habitat, education and research in natural sciences, recreational value and economic benefits, open space and aesthetics, and erosion control through binding and stabilizing the soil), are exceptional or irreplaceable in their contribution to Vermont's natural heritage and are therefore so significant that they merit the highest level of protection under these rules.
>
> Class Two wetlands are those wetlands, other than Class One wetlands, which based on an evaluation of the functions in Section 5, are found to be so significant, either taken alone or in conjunction with other wetlands, that they merit protection under these rules.
>
> Class Three wetlands are those wetlands that have not been determined by the Board to be so significant that they merit protection under these rules either because they have not been evaluated or because when last evaluated were determined not be sufficiently significant to merit protection under these rules."

Vermont's Class One and Two wetlands closely correspond to Ecology's Category I and II in its recommended four-tier rating system. Wetlands considered Class Three in the Vermont system include Ecology's Category III and IV. Class Three wetlands are not protected under Vermont's wetland rules.

Buffer Requirements: Class One and Two wetlands under the Vermont system require buffers of 100 and 50 feet, respectively.

Washington Survey of County Programs

Five counties (Clark, Island, King, Pierce, Snohomish, and Thurston) in Washington State have existing wetlands regulations in place. Of these, King County has by far the most fully-developed program protecting wetlands. Many of the other counties are in the process of developing wetlands programs for compliance with the state's Growth Management Act (GMA) of 1990. Washington's adopted county regulations are as follows:

CLARK

Regulatory Program: Following more than a year of public involvement and development, Clark County adopted a wetlands protection ordinance in February 1992.

Rating System: The ordinance contains a five-tier wetlands rating system. Category V wetlands are typically small, isolated, rural wetlands dominated by invasive species. These are exempt from regulation.

Buffer Requirements: Buffer requirements are complex and provide for a high degree of site-specific flexibility. Standard buffer widths are 300 feet for Category I, 200 feet for Category II, 100 feet for Category III, and 50 feet for Category IV wetlands. Standard buffer widths can be reduced by up to 40%, depending on the quantity of the existing buffer and potential enhancement of the buffer.

Buffer widths for rural zones are reduced by 50% to 150 feet for Category I, 100 feet for Category II, 50 feet for Category III, and 25 feet for Category IV wetlands. In the rural zones, buffer widths cannot be further reduced.

ISLAND

Regulatory Program: Island County was one of the first counties in the state to adopt wetlands protection regulations. In 1984, the county adopted these wetland provisions as an overlay zone within the County's zoning ordinance which includes a wetlands rating system, buffers, and mitigation requirements. Regulated wetlands include those defined under the federal Clean Water Act, with exemptions for smaller wetlands.

Rating System: Island County has a three-tier rating system:

> Category A: Wetlands 1/4 acre or larger with the "presence of a protected species or an outstanding habitat for a protected species" and those with a "predominance of native wetlands species over introduced or non-native wetland species."

Category B: Wetlands that include all marshes, bogs, swamps, and lakes regulated by the Shoreline Management Act and the county's Shoreline Master Program, as well as all other wetlands one acre or larger that exhibit a predominance of non-native wetland plant species. Mitigation sites are included.

Category C: Wetlands created by humans "where no wetland before existed." These wetlands are not regulated.

Buffer Requirements: A 100-foot buffer is required for Category A wetlands; a 25-foot buffer is required for Category B wetlands; and no buffers are required for Category C wetlands. Buffers widths may be modified by the county planning director on a case-by-case basis, and reduction of the buffer may be allowed "to provide a reasonable buildable area for a single family residence or accessory building on a lot legally established prior to the effective date of the ordinance.

Administrative Effectiveness of Regulatory Program: The Board of Island County Commissioners feels that their program is a responsible approach to wetlands protection. They use a two category rating system because of its simplicity yet effectiveness.

KING

Regulatory Program: The King County Sensitive Areas Ordinance (KCSAO) passed by the county council in 1990 is in many ways a pioneering document. This ordinance attempts to define all major environmental areas of public concern, including wetlands, throughout the county. The accompanying map folio to the KCSAO includes all regulated land as it pertains to the KCSAO. Alteration of wetlands and required buffers is not allowed without an appropriate mitigation plan that enhances or protects the wildlife habitat, natural drainage, and/or other valuable functions of wetlands. Delineation is based on the 1989 Federal Manual.

Rating System: The ordinance contains a three-tier rating system for wetlands. The King County Wetland Inventory (1990) of existing wetlands was based on a variety of sources, including National Wetland Inventory and field verification. The inventoried wetlands were rated using distinctions based exclusively on habitat, plant associations and size.

Class 1 wetlands are wetlands assigned the Unique/Outstanding #1 rating in the King County Wetlands Inventory, 1983, or meeting the following criteria: providing habitat for threatened, endangered species; having 40 to 60% permanent open water in dispersed patches with two or more classes of vegetation; being wetlands ten acres or more in size and having three or more wetland classes, one of which is open water; or having rare plants.

Class 2 wetlands are those wetlands assigned Significant #2 rating in the King County Wetlands Inventory, or with the following: greater than one acre in size; equal to or less than one acre in size and having three or more wetland classes; wetlands equal to or less than one acre that have a forested wetland class; and/or the presence of heron rookeries or raptor nesting trees.

Class 3 wetlands are those assigned the Lesser Concern #3 rating in the King County Wetlands Inventory, or inventoried wetlands that are equal to or less than one acre in size, having two or fewer wetland classes.

Buffer Requirements: Alteration of wetlands and required buffers is not allowed without an appropriate mitigation plan that enhances or protects the wildlife habitat, natural drainage, and/or other valuable functions of wetlands. Buffers are established as follows:

Class 1 wetlands:	100 feet
Class 2 wetlands:	50 feet
Class 3 wetlands:	25 feet

Additional buffer requirements may be set by the county in sensitive areas including critical drainage areas, locations of hazardous materials, critical fish and wildlife habitat, landslide or erosion hazard areas adjacent to wetlands, groundwater recharge and discharge, and trail or utility corridors.

Minimum building setbacks of 15 feet are required from the edge of the wetland buffer. Prohibitions on the use of hazardous or toxic substances and pesticides or certain fertilizers in this area may be imposed.

Administrative Effectiveness of the Regulatory Program: The county is finding that dividing the KSAO into two separate documents would ease administration of the program. These documents would include a general policy statement and overview of the program, and an accompanying set of detailed regulations. Experience has shown that the standards contained in the KSAO are complex and affect many departments within the county which has lead to some confusion. Weekly meetings held by county staff are used to formalize interpretations of those KSAO provisions that have needed further definition. Since the KSAO has been enacted in such a short time, it is premature to judge its effectiveness (Cindy Baker, King County KSAO Implementation Coordinator, pers. comm., May 1991).

PIERCE

Regulatory Program: In January 1992, the Pierce County Council adopted Ordinance No. 91-128S3, the Pierce County Wetland Management Regulations. The ordinance requires that by September 1992, the director of Planning and Land Services report to the Council's Planning and Environment Committee on implementation of the ordinance.

Rating System: The ordinance establishes a four-tiered rating system. Category I wetlands are those of exceptional resource value, based on attributes which may not be adequately replicated through creation or restoration. Category II wetlands have significant resource value. Category III wetlands have important resource value based on vegetative diversity. Category IV wetlands are those of ordinary value based on monotypic vegetation and hydrologic isolation.

Buffer Requirements: Buffers range from 25 to 150 feet, based on wetland rating category, with the ability to modify (increase, decrease, or average) buffer widths dependant on specific allowances.

SNOHOMISH
Regulatory Program: On May 30, 1990, Snohomish County Council adopted the Aquatic Resource Protection Program (ARPP), consisting of policies and ordinances for the protection of aquatic resources (Freeman, 1990). A referendum petition placed the ARPP on the November 1990, ballot and it was subsequently suspended. Until early 1991, the ARPP was administered as policy. In early 1991, the Snohomish County Council voted to eliminate the Aquatic Resource Protection Program for use even as a policy document.

Until a new wetlands program is approved, the wetland protection policy in Snohomish County that is currently in operation is contained in the Comprehensive Plan. Through SEPA review, categorizations and buffers are determined based on site-specific information.

Rating System: The county does not employ a wetland rating system at this time, although a three-tiered system was developed for the ARRP.

Buffer Requirements: An average 50-foot buffer is required adjacent to a wetland. The county works with the applicant and determinations are made on a case-by-case basis.

Administrative Effectiveness of the Regulatry Program: The county employs six full-time and two part-time biologists who review wetland issues and permits. The Snohomish County Planning Department and Planning Committee are developing a new wetlands program (Marilyn Freeman, Snohomish County Planning, Pers. Comm., May 1991).

THURSTON
Regulatory Program: The Environmentally Sensitive Areas Chapter of the Thurston Regional Planning Council Comprehensive Plan, completed in 1988, regulates wetlands greater than one acre. Special plans are required for certain developments, and the county can also require "building and development coverage, setbacks, size of lots and development sites, height limits, density limits, restoration of ground cover and vegetation, or other measures for environmental protection." A wetlands map included in the Comprehensive Plan depicts the general outlines of wetland areas in the county. In November 1990, the county drafted revisions to its Environmentally Sensitive Areas chapter.

Rating System: None, although the draft standards include a four-tier rating system.

Buffer Requirements: The county does not require standard buffers adjacent to wetland areas, but using its general wetlands polices established in the Environmentally Sensitive Areas Ordinance, the county may require up to 200-foot buffer on a case-by-case basis. The draft standards use the same buffer zone widths (25 to 300 feet) as the Ecology's model ordinance.

Washington Survey of City Programs

Since the Growth Management Act Guidelines were enacted, many Washington cities have, or are in the process, of developing regulations concerning development in and around wetlands. At least 28 Washington cities now require wetlands protection. The majority of these cities have specific wetland buffer requirements.

ANACORTES

Regulatory Program: The City of Anacortes regulates wetlands through a subsection of the city's Zoning Ordinance No. 1917. This subsection, called "Non-tideland Wetland Protection," applies to all lands in, or within, 25 feet of a non-tidal wetland greater than 10,000 square feet. Non-tidal wetland permits are issued if an activity is determined to be in the public interest, is water-dependent, and meets other detailed requirements.

Rating System: None.

Buffer Requirements: No regulated activity in or within 25 feet of a non-tidal wetland may be conducted without a permit.

BAINBRIDGE

Regulatory Program: The City of Bainbridge adopted a wetlands protection ordinance in February, 1992.

Rating System: Bainbridge has developed a four-tier rating system that is a modification of the Washington State and Puget Sound Wetlands Rating Systems.

Buffer Requirements: Buffers are specified as 150 feet for Category I wetlands, 100 feet for Category II wetlands, 50 feet for Category III wetlands, and 25 feet for Category IV wetlands.

BELLEVUE

Regulatory Program: The City of Bellevue regulates wetlands through the City of Bellevue Land Use Code, the City of Bellevue Comprehensive Plan, and the City of Bellevue Sensitive Areas Notebook. Bellevue's regulated wetlands are defined as follows:

> "Those sensitive areas 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. For purposes of applying this definition wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated by water or covered by shallow water at some time during the growing season of each year."

Rating System: Wetland buffers are regulated through a rating system that includes Type A, B, and C wetlands. Wetlands are rated according to their relationship to Type A or B riparian corridors and by size (Sensitive Areas Notebook, Section 3.3)..

Buffer Requirements: Type A Wetlands require a 50-foot buffer, and Type B Wetlands require a 25-foot buffer. Type C wetlands are not regulated by the City of Bellevue; however, if a Type C wetland is determined to have certain significant (not defined) functions and values, the city may decide to regulate that wetland and require a buffer (Kim Eggebraten, City of Bellevue, Storm and Surface Water Utility, pers. comm., April 1991). Adjustment of buffers may be possible when required setbacks exceed 50% of area encompassed by the property.

BELLINGHAM
Regulatory Program: After two years and completion of a comprehensive inventory, the City of Bellingham adopted a Wetlands Ordinance in December 1991.

Rating System: The ordinance includes a three-tiered rating system.

Buffer Requirements: Buffers are 100, 50, and 25 feet for Category I, II, and III wetlands, respectively.

BONNEY LAKE
Regulatory Program: The City of Bonney Lake adopted a Sensitive Areas Ordinance in August 1991. The code has a wetlands protection element that regulates wetlands as defined under the federal Clean Water Act and ponds under 20 acres and their submerged aquatic beds. One of the goals of the ordinance is for no-net-loss of wetlands functions and values. Sensitive Areas Permits and special studies are required for wetlands impacts.

Rating System: The city uses Ecology's four-tier rating system. The minimum size for regulation is 5,000 square feet of a Category IV wetland.

Buffer Requirements: Type I wetlands require a 200-foot buffer; Type II require a 100-foot buffer; Type III require a 50-foot buffer; and Type IV require a 25-foot buffer. A 15-foot setback may be required for some projects.

BOTHELL
Regulatory Program: The City of Bothell adopted an interim critical areas ordinance in December 1991.

Rating System: The city's rating system is the same as King County's three-tier system, providing varying regulatory requirements for Categories 1, 2, and 3.

Buffer Requirements: Buffer requirements are established as ranges. They include 75 to 150-foot buffers for Category 1, 50 to 100-foot buffers for Category 2, and 25 to 50-foot buffers for Category 3.

BURLINGTON
Regulatory Program: In August 1991, the City of Burlington adopted interim regulations for critical areas as an addition to the Municipal Code.

Rating System: None.

Buffer Requirements: A minimum 25-foot buffer is required unless a wetlands study, requested by the Planning Director, recommends a greater width.

CAMAS
Regulatory Program: The City of Camas added an environmentally sensitive areas chapter to the zoning code in August 1991. Prior to issuance of a SEPA threshold determination within identified wetlands areas, the applicant is required to submit a wetlands report that serves as the basis for wetlands protection requirements.

Rating System: None.

Buffer Requirements: Buffers are required for all development proposals and activities adjacent to wetlands. The required buffer width will be established by the Planning Director based on information contained in the wetlands report and will generally be 50 feet. However, the buffer may be reduced to 25 feet for wetlands determined to be of low quality and increased to 100 feet for wetlands of higher quality.

DES MOINES
Regulatory Program: Wetlands within the City of Des Moines are subject to the regulations in Ordinance No. 853. All areas considered wetland according to the 1989 Federal Identification and Delineation Manual are regulated within the city limits.

Rating System: A wetland rating system has been developed that assigns each wetland into one of two categories:

> "Significant Wetlands" include the following: (1) any wetland assigned either the Class 1 or Class 2 rating by King County; (2) any wetland showing significant changes since being inventoried; (3) wetlands having any threatened or endangered species; (4) wetlands within a stream corridor greater than or equal to one acre in size having one or more wetland classes; or (5) wetlands within a stream corridor having three or more wetland classes.
>
> "Important Wetlands" are defined as follows: (1) any wetland that has been assigned the Class 3 wetland rating by King County; (2) any rated wetland that has significantly changed conditions since being inventoried; or (3) a collection of wetlands within a stream corridor, which is less than one acre in size having two or fewer wetland classes.

All wetlands are placed into one of these two categories. This two-tier rating system is based on the King County Wetland Inventory.
Buffer Requirements: Buffer standards are based on the two-tier rating system. A significant wetlands require a 100-foot buffer, and important wetlands require a 35-foot buffer. Additional buffers may be required if, for example, rare plant or animal species are present, or a unique wetland exists.

EATONVILLE
Regulatory Program: The city adopted a wetlands protection ordinance in September 1991.

Rating System: Eatonville incorporates Ecology's four-tier rating system in their ordinance.

Buffer Requirements: Required buffer widths are 50 to 100 feet for Category I wetlands, 35 to 50 feet for Category II wetlands, 25 to 35 feet for Category III wetlands, and ten to 25 feet for Category IV wetlands.

ENUMCLAW

Regulatory Program: The City of Enumclaw passed a Critical Areas Ordinance in January 1992 which provides wetlands protection regulations.

Rating System: The city uses Ecology's four-tier rating system.

Buffer Requirements: The buffer requirement for Category I wetlands is 100 feet, for Category II wetlands is 75 feet, for Category III is 50 feet, and for Category IV wetlands is 25 feet. Certain conditions allow buffers to be reduced by a maximum of 25%, or increased.

EVERETT

Regulatory Program: The City of Everett adopted Environmentally Sensitive Area Policies and Zoning Regulations in 1991.

Rating System: The regulations classify wetlands into four categories based on wetland size, wetland class (forested, shrub-scrub), and to some degree, functions, and values.

Buffer Requirements: The regulations include 100, 75, 50, and 25-foot buffers for Categories I through IV.

FEDERAL WAY

Regulatory Program: The Federal Way Zoning Code classifies and regulates wetlands and other sensitive areas. The Zoning Code defines "regulated" wetlands that include any wetland that has been mapped and classified by King County; any other wetland that is functionally related to a mapped wetland; or any wetland, whether or not mapped, that has or is functionally related to a wetland that has any significant or valuable (not defined) functions.

Rating System: None.

Buffer Requirements: All regulated wetlands have a setback requirement of 100 feet. Encroachment into the buffer is permissible under certain, limited circumstances. For example, if a wetland setback area encompassed an entire building lot, and if reasonable use of property could not be attained, buffer encroachment would be allowed, but a mitigation plan would probably be required. These issues are determined on a case-by-case basis (Susan Meyer, Consulting Wetland Specialist to the City of Federal Way, pers. comm., April 1991).

Administrative Effectiveness of the Regulatory Program: Administration of these buffer standards is sometimes difficult due to the lack of clear, consistent comprehensive guidance.

KIRKLAND

Regulatory Program: Chapter 90 in the City of Kirkland Zoning Code contains wetland regulations. The city's definition of "regulated" wetland's is very similar to that which is used by the City of Federal Way (see above).

Rating System: None.

Buffer Requirements: A 50-foot setback is required around all wetlands.

Administrative Effectiveness of the Regulatory Program: The wetlands protection regulations are somewhat difficult to administer because they are open to interpretation (Joan Liebermann-Brill, City of Kirkland Planning Department, pers. comm., March 1991).

LACEY

Regulatory Program: In July 1991, the City of Lacey adopted a Wetlands Protection Ordinance.

Rating System: Lacey uses Ecology's four-tiered rating system with an added "Category V" wetland. Category V criteria are wetlands that do not meet the requirements of Categories I through IV and are Type 2 to 5 waters as defined by the Washington Forest Practice Rules and Regulations. Type 1 waters are specifically excluded from this category.

Buffer Requirements: The City of Lacey's buffer widths are:

Category I:	200 to 300 feet
Category II:	100 to 200 feet
Category III:	50 to 100 feet
Category IV:	25 to 50 feet
Category V:	50 to 200 feet

The city's ordinance includes buffer averaging, criteria for increasing and decreasing buffer width, and a building setback requirement which corresponds to the required yard area setback for the underlying zone.

LYNDEN

Regulatory Program: The City of Lynden passed a Sensitive Areas Ordinance which amended the Municipal Code in September 1991. Within the ordinance, the city declares that there is no land within the city limits which can be considered wetlands, except areas within the shorelines of the city that are protected through the Lynden Shoreline Master Program. There may be wetlands in the urban growth areas that could potentially be annexed by the city, but the ordinance leaves that issue to future consideration.

Rating System: None.

Buffer Requirements: Sensitive area buffers are a minimum of 25 feet and a maximum of 100 feet.

MILTON

Regulatory Program: Milton adopted Ordinance 1148 on August 6, 1991.

Rating System: The ordinance utilizes Ecology's four-tier rating system.

Buffer Requirements: The City of Milton's buffer widths are 200 to 300 feet for Category I wetlands, 100 to 200 feet for Category II wetlands, 50 to 100 feet for Category III wetlands and 25 to 50 feet for Category IV wetlands.

OLYMPIA

Regulatory Program: The City of Olympia adopted amendments to its zoning code in March 1992.

Rating System: The city utilizes Ecology's four-tier rating system.

Buffer Requirements: Required buffer widths are 200 to 300 feet for Category I wetlands, 100 to 200 feet for Category II wetlands, 50 to 100 feet for Category III wetlands and 25 to 50 feet for Category IV wetlands. Provisions are provided to reduce buffer widths if wetland buffers are enhanced.

Administrative Effectiveness of the Regulatory System: The city is revising its Environmentally Sensitive Areas Chapter. The current buffer rating system is seen as inadequate, and will be modified to a system that incorporates wetlands quality in addition to size. The current ordinance effectively prohibits any development within a wetland, and an amended ordinance may allow increased flexibility while assuring protection. Olympia will be utilizing the regional mapping system prepared in 1992 (Steve Morrison, pers. comm., September 1991).

PORT ANGELES

Regulatory Program: In November 1991, the City of Port Angeles adopted their Wetlands Protection Ordinance.

Rating System: The city uses Ecology's four-tier rating system.

Buffer Requirements: The city's buffer widths are 200 to 300 feet for Category I wetlands, 100 to 200 feet for Category II wetlands, 50 to 100 feet for Category III wetlands and 25 to 50 feet for Category IV wetlands.

PUYALLUP

Regulatory Program: On September 3, 1991, the City of Puyallup adopted a new chapter of the Municipal Code entitled Wetlands Protection Regulations.

Rating System: The City of Puyallup has adopted a four-tier rating system that is similar to Ecology's rating system. Category I and II wetlands have no minimum size requirement. Category IV has a 10,000 square foot minimum size requirement, but also includes wetlands less than 5,000 square feet that are a functional part of an interconnected aquatic system containing two or more wetlands.

Buffer Requirements: Category I, II, III, and IV wetlands have 150, 100, 50, and 25-foot minimum buffer widths respectively.

REDMOND
Regulatory Program: The City of Redmond is in the process of adopting a Critical Areas Ordinance that includes a comprehensive wetlands section. Because the development of the Critical Areas Ordinance has taken more time than anticipated, the city adopted an interim wetlands protection ordinance in September 1991. The interim ordinance (Ordinance No. 1649) has no standards and states the following policy:

> "Retain and protect the important biological and hydrological functions of wetlands through conditions on new development to assure no-net-loss of wetland acreage, function, and value in the Redmond Planning area."

Rating System: None.

Buffer Requirements: None.

SEATTLE
Regulatory Program: In October 1990, the City of Seattle adopted interim regulations to protect critical areas. Wetlands reports or additional information for project review may be required by the director to ensure more thorough analysis of alternatives.

Rating System: None.

Buffer Requirements: Required wetland buffers are 25 feet.

SHELTON
Regulatory Program: Not available.

SNOQUALMIE
Regulatory Program: The City of Snoqualmie adopted a sensitive areas chapter into their municipal code in August 1991. Wetlands protection regulations include a three-tier rating system, mitigation requirements, and buffer standards.

Rating System: Snoqualmie's rating system is similar to King County's:

> Class 1 Wetlands - wetlands assigned the unique/outstanding #1 rating in King County's Wetlands Inventory, 1983; or which meet any of the following criteria:
> (1) the presence of species listed by the federal government or state as endangered or threatened, or the presence of critical or outstanding actual habitat for those species; (2) wetlands having 40 to 60% permanent open water in dispersed patches with two or more classes of vegetation; (3) wetlands equal to or greater than 10 acres in size and having three or more wetland classes, one of which is open water; or (4) the presence of one or more plant species on a landform type which do not often occur in King County.
>
> Class 2 Wetlands: wetlands assigned the significant #2 rating in the King County Inventory or any wetlands which meet any of the following criteria (1) wetlands greater than one acre in

size; (2) wetlands equal to or less than one acre in size and having three or more wetland classes; (3) wetlands equal to or less than one acre that have a forested wetland class; or (4) the presence of heron rookeries or raptor nesting trees.

Class 3 Wetlands: wetlands assigned the lesser concern #3 rating the King County Inventory, or uninventoried wetlands that are equal to or less than one acre in size and that have two or fewer wetland classes, none of which are a forested wetland class. Isolated wetlands are included in the Class 3 category.

Buffer Requirements: The ordinance requires 100-foot buffers for Class 1 wetlands, 50-foot buffers for Class 2 wetlands, and 25-foot buffers for Class 3 wetlands. In addition, a building setback line of 15 feet is required. There are permitted uses in the buffers and wetland areas, provided mitigation or enhancement plans are approved by the city. Allowed activities include stream crossings, stream relocations, trails in buffer areas, landscaping, utilities in wetland or stream buffer, roads, and other rights of way.

TACOMA

Regulatory Program: In February 1992, the Tacoma City Council adopted a Critical Areas Ordinance that includes wetlands protection.

Rating System: The Tacoma ordinance includes use of Ecology's four-tier rating system.

Buffer Standards: Buffer requirements are 200 feet for Category I wetlands, 100 feet for Category II wetlands, 50 feet for Category III wetlands, and 25 feet for Category IV wetlands.

TUKWILA

Regulatory Program: On June 10, 1991, the City of Tukwila passed a Sensitive Areas Ordinance with wetlands protection regulations.

Rating System: The ordinance uses the King County rating system to establish development standards and criteria.

Buffer Requirements: Buffer widths for wetlands are 100 feet for Type 1, 50 feet for Type 2, and 25 feet for Type 3 wetlands.

TUMWATER

Regulatory Program: In August 1991, the City of Tumwater adopted a Conservation Plan as part of their Comprehensive Land Use Plan. The Plan addresses natural resource lands conservation and critical areas protection, including an element which specifies wetlands regulations.

Rating System: Tumwater incorporates Ecology's four-tier rating system.

Buffer Requirements: Tumwater requires 25 to 300-foot buffers based on wetland category. There are some low intensity uses permitted in the wetland buffer area, for instance: relocation of electric facilities, natural gas, cable, and telephone facilities; and installation or construction in improved road rights-of-way.

WENATCHEE
Regulatory Program: Effective September 1, 1991, the City of Wenatchee passed a Resource Lands and Critical Areas Development Ordinance that includes wetlands regulations.

Rating System: The ordinance incorporates Ecology's four-tier rating system.

Buffer Requirements: Buffer requirements for Category I, II, III and IV wetlands are 250, 150, 75, and 50 feet, respectively. Criteria are provided that allow buffers to be reduced by a maximum of 50% depending on the adjacent conditions.

TABLE 1
Adopted[3] Wetland Buffer Standards

STATE	Buffer Requirement	Rating System	Buffer Range
California	yes	yes	100 feet
Connecticut	no	no	none
Delaware	yes	yes	0 to 300 feet
Illinois	no	no	none
Louisiana	no	yes	none
Maine	yes	yes	25 to 100 feet
Maryland	yes	yes	25 to 100 feet
Michigan	no	no	none
Minnesota	no	no	none
New Hampshire	yes	no	0 to 100 feet
New Jersey	yes	yes	0 to 300 feet
New York	yes	no	0 to 100 feet
Pennsylvania	yes	yes	300 feet
Oregon	no	no	none
Rhode Island	yes	no	50 to 100 feet
Vermont	yes	yes	0 to 100 feet

COUNTY	Buffer Requirement	Rating System	Buffer Range
Clark	yes	yes (I-V)	25 to 300 feet
Island	yes	yes (A-C)	25 to 100 feet
King	yes	yes (1-3)	25 to 100 feet
Pierce	yes	no	100 feet
Thurston	yes[4]	no	0 to 200 feet

CITY	Buffer Requirement	Rating System	Buffer Range
Anacortes	yes	no	25 feet min.
Bainbridge	yes	yes (I-IV)	25 to 150 feet
Bellevue	yes	yes (Class A-C)	0 to 50 feet
Bellingham	yes	yes (1-3)	25 to 100 feet
Bothell	yes	yes (1-3)	25 to 150 feet
Bonney Lake	yes	yes (I-IV)	25 to 200 feet
Burlington	yes	no	25 feet
Camas	yes	no	25 to 100 feet
Des Moines	yes	yes (Sig & Imp)	35 to 100 feet
Eatonville	yes	yes (I-IV)	10 to 100 feet

[3] State information includes proposed as well as adopted standards.

[4] Applied on a case-by-case basis

CITY Cont.	Buffer Requirement	Rating System	Buffer Range
Enumclaw	yes	yes (I-IV)	25 to 100 feet
Everett	yes	yes (1-3)	35 to 100 feet
Federal Way	yes	no	100 feet
Kirkland	yes	no	50 feet
Lacey	yes	yes (I-V)	25 to 300 feet
Lynden	yes	no	25 to 100 feet
Milton	yes	yes (I-IV)	25 to 300 feet
Olympia	yes	yes (I-IV)	25 to 300 feet
Port Angeles	yes	yes (I-IV)	25 to 300 feet
Puyallup	yes	yes (I-IV)	25 to 150 feet
Redmond	no	no	none
Seattle	yes	no	25 feet
Shelton	yes	yes	25 to 150 feet
Snoqualmie	yes	yes (1-3)	25 to 100 feet
Tacoma	yes	yes (I-IV)	25 to 200
Tukwila	yes	yes (1-3)	25 to 100 feet
Tumwater	yes	yes (I-IV)	25 to 300 feet
Wenatchee	yes	yes (I-IV)	50 to 250 feet

TABLE 2
Proposed Wetland Buffer Standards

COUNTY	Buffer Requirement	Rating System	Buffer Range
Clallam	yes	yes (I-IV)	25 to 200 feet
Grant	yes	yes (I-IV)	25 to 150 feet
Jefferson	yes	yes (I-IV)	25 to 300 feet
Kitsap	yes	yes (I-V)	25 to 150 feet
San Juan	yes	yes (I-IV)	35 to 200 feet
Thurston	yes	yes (I-IV)	25 to 300 feet
Whatcom	yes	yes (I-IV)	25 to 200 feet

CITY	Buffer Requirement	Rating System	Buffer Range
Auburn	yes	yes (I-IV)	25 to 300 feet
Blaine	yes	yes (I-III)	25 to 100 feet
Bothell	yes	yes (I-III)	50 to 200 feet
Edmonds	yes	yes (I-III)	50 to 150 feet
Everson	yes	yes (I-IV)	25 to 100 feet
Ferndale	yes	yes (I-IV)	25 to 150 feet
Fife	yes	yes (I-IV)	25 to 150 feet
Fircrest	yes	yes (I-IV)	25 to 200 feet
Gig Harbor	yes	yes (I-V)	15 to 150 feet
Hunts Point	yes	no	25 feet
Issaquah	yes	yes (I-IV)	25 to 100 feet
Kent	yes	No	50 to 150 feet
Longview	yes	yes (I-IV)	25 to 300 feet
Mill Creek	yes	yes (I-IV)	0 to 150 feet
Mt. Vernon	yes	no	25 feet
Nooksack	yes	yes (I-IV)	25 to 100 feet
Normandy Park	yes	yes (I-II)	35 to 100 feet
North Bend	yes	yes (I-III)	25 to 100 feet
Port Townsend	yes	yes (I-IV)	25 to 300 feet
Poulsbo	yes	yes (I-IV)	10 to 100 feet
Redmond	yes	yes (I-IV)	0 to 150 feet
Renton	yes	yes (I-III)	25 to 300 feet
Sedro-Woolley	yes	yes (I-III)	25 to 50 feet
Steilacoom	yes	yes (I-IV)	25 to 150 feet
Sumner	yes	yes (I-IV)	25 to 300 feet

IV. Summary and conclusions

- Wetland buffers are essential for wetlands protection. No scientific study, no government agency, and no recommendations made during any communications with wetlands specialists nationwide suggested otherwise.

- Wetland buffers reduce the adverse impacts of adjacent land uses to wetlands. Wetland buffers also provide important habitat for wildlife which utilize wetlands and buffer areas for essential life needs. Buffers reduce wetland impacts by moderating impacts of stormwater runoff including stabilizing soil to prevent erosion; filtering suspended solids, nutrients, and harmful or toxic substances; and moderating water level fluctuations. They reduce the adverse impacts of human disturbance on wetland habitat including blocking noise and glare; reducing sedimentation and nutrient input; reducing direct human disturbance from dumped debris, cut vegetation, and trampling; and providing visual separation. They also provide essential habitat for wetland-associated species for use in feeding; roosting; breeding and rearing of young; and cover for safety, mobility and thermal protection.

- Buffer effectiveness increases with buffer width. As buffer width increases, the effectiveness of removing sediments, nutrients, bacteria, and other pollutants from surface water runoff increases. However, for incrementally greater sediment removal efficiency (e.g., from 90 to 95%), disproportionately larger buffer width increases are required (e.g., from 100 to 200 feet).

  As buffer width increases, direct human impacts, such as dumped debris, cut or burned vegetation, fill areas, and trampled vegetation, will decrease.

  As buffer width increases, the numbers and types of wetland-dependent and wetland-related wildlife that can depend on the wetland and buffer for essential life needs increases.

- Appropriate buffer widths are based on four variables: (1) existing wetland functions, values and sensitivity to disturbance; (2) buffer characteristics; (3) land use impacts; and (4) desired buffer functions.

- Wetlands with important functions and values or wetlands which are sensitive to disturbance will require greater buffers to reduce the risk of disturbance. Wetland functions, values, and sensitivity are attributes that will influence the necessary level of protection for a wetland. Those systems which are extremely sensitive or have important functions will require larger buffers to protect them from disturbances, which may be of lesser threat to a different site. Where wetland systems are rare or irreplaceable (e.g., high quality estuarine wetlands, mature swamps, and bogs) larger buffer widths will ensure a lower risk of disturbance.

- The uplands immediately adjacent to the wetland vary in their ability to reduce adverse effects of development, most importantly in relationship to slope and vegetative cover. Buffers with dense vegetative cover on slopes less than 15% are most effective for water quality functions. Dense shrub or forested vegetation with steep slopes provide the greatest protection from direct human disturbance. Appropriate vegetation for wildlife habitat depends on wildlife species present in the wetland and buffer. Effectiveness is also influenced by ownership of the buffer.

- Land uses associated with significant construction and post-construction impacts need greater buffers. Construction impacts include erosion and sedimentation, debris disposal, vegetation removal and noise. Post-construction impacts are variable depending on the land use, but residential land use, in particular, can have significant impacts. Residential land use is associated with yard maintenance debris, domestic animal predation, removal of vegetation and trampling. Wetland areas and their buffers should not be included in residential lots.

- Appropriate buffer widths vary according to the desired buffer function(s). Temperature moderation, for example, will require smaller buffer widths than some wildlife habitat or water quality functions. Buffer widths for wildlife may be generalized, but specific habitat needs of wildlife species depend on individual habitat requirements.

- Buffers of less than 50 feet in width are generally ineffective in protecting wetlands. Buffers larger than 50 feet are necessary to protect wetlands from an influx of sediment and nutrients, to protect wetlands from direct human disturbance, to protect sensitive wildlife species from adverse impacts, and to protect wetlands from the adverse effects of changes in quantity of water entering the wetland.

- In western Washington, wetlands with important wildlife functions should have 200 to 300-foot buffers based on land use. In eastern Washington, wetlands with important wildlife functions should have 100 to 200-foot buffers based on land use. To retain wetland-dependent wildlife in important wildlife areas, buffers need to retain plant structure for a minimum of 200 to 300 feet beyond the wetland. This is especially the case where open water is a component of the wetland or where the wetland has heavy use by migratory birds or provides feeding for heron. The size needed would depend upon disturbance from adjacent land use and resources involved. Priority species may need even larger buffers to prevent their loss due to disturbance or isolation of subpopulations.

- Buffer widths effective in preventing significant water quality impacts to wetlands are generally 100 feet or greater. Sensitive wetland systems will require greater distances and degraded systems with low habitat value will require less.
  The literature indicates effective buffer widths for water quality range from 12 to 860 feet depending on the type of disturbance (e.g., feedlot, silviculture) and the measure of effectiveness utilized by the author. For those studies which measured effectiveness according to removal efficiency, findings ranged from 50 to 92% removal of specific pollutants in ranges of 62 to 288 feet. Studies which measured effectiveness according to environmental indicators, such as levels of benthic invertebrates and salmonid egg development in the receiving water, generally found that 98-foot buffers adjacent to streams were effective. These latter buffer distances may be conservative for wetlands where lower water velocities and presence of vegetation result in increased sediment deposition and accumulation.

- Buffers from 50 to 150 feet are necessary to protect a wetland from direct human disturbance in the form of human encroachment (e.g., trampling, debris). The appropriate width to prevent direct human disturbance depends on the type of vegetation, the slope, and the adjacent land use. Some wetlands are more sensitive to direct disturbance than others.

- Some state agencies and many local governments rely upon wetlands rating systems to establish buffer widths. These rating systems are typically based upon perceived wetland value and upon acceptable levels of risk to the wetland from adjacent land uses. Of 16 states surveyed, ten require wetland buffers and eight incorporate wetlands rating, either adopted or proposed. Of five Washington counties, with adopted wetlands protection ordinances, all five require buffers and four utilize wetlands rating systems (the fifth is currently proposing an amendment which incorporates rating). Of 28 identified cities with wetlands protection ordinances (or interim ordinances), 27 contain specific buffer standards and 20 utilize wetlands rating systems. The city without specific standards has adopted an interim policy statement.

- Specific buffer requirements vary widely at the state and local level. This has resulted in differing buffer requirements and levels of wetland protection that are not necessarily effective. For example, the buffer requirements of many agencies are less than those that are reported in the literature to be effective.

  State buffer requirements range from 0 to 300 feet; Washington county buffer requirements range from 0 to 200 feet; and Washington city buffer requirements range from 0 to 300 feet.

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