# Wetland Buffers:

# Use and Effectiveness

# APPENDICES

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## Appendix A: Wetland buffers - a field evaluation of Buffer effectiveness in Puget Sound

# Wetland buffers - a field evaluation of Buffer effectiveness in Puget Sound

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## Executive summary

Post-project assessments were carried out on twenty-one sites in King and Snohomish counties to analyze the effectiveness of required buffer widths and to identify factors which influence effectiveness. A protocol was first developed for examining buffer functions and effectiveness and selecting the buffer sites to be examined. The status of the buffers were examined in terms of their ecological functions and effectiveness.

Evaluating the effectiveness of buffers in protecting an adjacent wetland depends on the type of buffer in place, the type and size of the wetland it is protecting, the type of alteration to the buffer (type and concentration of disturbance to the surrounding areas), the width of the buffer, the time elapsed since the change in land use, and the ownership of the buffer and adjacent wetland.

Buffers were altered over time; more than 90% of the buffers examined for this study did not remain in a pristine state after the surrounding land use change was initiated. Of those buffers altered, 76% were altered in a negative manner.

Buffer functions were found to be most reduced as a result of decreased size of the buffer over time. Buffers less than 50 feet in width showed a 95% increase in alteration of the buffer. Where the buffer was greater than 50 feet, only 35% showed alteration. Overall, large buffers reduced the degree of changes to the water quality, the sediment load and the water quantity entering the adjacent wetland, especially over time.

As a rule, buffers are subjected to a reduction in size over time. Of the 21 sites examined, 18 were shown to have reduced buffer zones between one and eight years later.

# I. Introduction

## *Background*

Wetlands are sensitive to environmental changes that originate outside the wetland boundary. The degree of wetland sensitivity to these outside influences is dependent on a variety of factors including the type of wetland being impacted, the type of disturbance influencing the wetland, and perhaps the most important factor, the amount of non-wet buffered area between the wetland and the source of the disturbance. This study was requested by the Washington State Department of Ecology (Ecology) to provide an evaluation of the effectiveness of wetland buffers in reducing impacts to wetland habitats.

## *Purpose*

The purpose of this study was to provide post-project assessments of required wetland buffers. The assessments provide a means to analyze the effectiveness of required buffer widths and to identify factors which influence the effectiveness of the buffer in protecting the wetland from impacts due to human-induced disturbances. Specific objectives of the buffer effectiveness study were:

- to assess effectiveness of buffers in protecting the integrity of wetlands;
- to assess the appropriateness of requiring variable buffer widths based on wetland vegetation community types and Ecology's four-tier rating system; and
- to determine qualitatively or quantitatively which ecological characters of the wetland and adjacent buffer area appear to significantly affect and/or protect wetland integrity.

To accomplish these objectives the following tasks were completed for each wetland site visited:

- a determination of whether the recommended buffer size and type was implemented;
- an evaluation of the type and extent of impacts to the buffer over time;
- an evaluation of the type and extent of impacts to the wetland over time as they were affected by the presence or lack of the buffer;
- identification of the important components of buffer functioning;
- identification of additional questions to assess effectiveness of buffers; and
- recommendation of priorities to use when designing or maintaining buffer characteristics based on interrelationships observed in the field.

# II. Methodology

The following methodology was used for data collection and analysis for the buffer study:

### *Agency contact and Permit Identification*

Local agency staff were contacted to assist in identification of appropriate sites. Agency staff provided a list of potential sites identified by permit applications. In addition, a large source of appropriate buffer sites was obtained from the study assessing the effectiveness of Native Growth Protection Easements performed by King County (Baker and Haemmerly, 1990). Agency and staff contacts are listed in Attachment 1.

### *Permit File Review and Site Selection*

King County files for short plats, formal subdivisions, commercial permits, and wetlands were reviewed along with the State Environmental Policy Act files from the City of Kirkland and the 404 permit files from the Army Corps of Engineers. Information from Snohomish County files examined during the course of a previous study was used as well. Over eight years of permit files were reviewed.

Potential sites were identified based on the following criteria:

- presence of permit requirements for buffers;
- availability and thoroughness of pre-existing site data;
- age of project;
- availability of photographic record for the site (optional);
- location and accessibility of project; and
- agency staff or field personnel knowledge of the site.

### *Field Data Sheet Development*

Data needs for the site specific assessment were identified and individual field data sheets were developed for buffer sites. These are located in Attachment 2.

The buffer data sheets were designed to collect consistent information on each site regarding pre-existing site conditions, permit requirements, design goals and objectives, existing site conditions, and qualitative assessments of success and function of the buffer. Data sheets were structured to collect both permit file and field data in the following general categories of information:

<u>Pre-existing site conditions</u>
Pre-existing conditions present before changes to the buffer area included: plant species diversity; dominant species; community type; pre-existing wetland type and size; surrounding land use; and functioning of wetland. Pre-existing conditions information was obtained from review of the files and/or from personal knowledge of the site by field personnel.

Permit requirements and buffer goals
Permit requirements and goals information was obtained from review of files.

Construction/implementation of permit requirements
Details of the surrounding use changes and buffer enhancement details (if required) were obtained from review of the permit files. Implementation of permit requirements were assessed both from review of the permit files and from on-site analysis.

Existing buffer and wetland conditions
Site conditions recorded for both the buffer zone and the existing wetlands included: plant species diversity; dominant species; viability of species; community type; buffer type and size; wetland type and size; surrounding land use; water quality assessments for sedimentation, turbidity, and chemical inputs; wildlife presence; and potential wildlife habitat available. This information was assessed on-site.

Buffer functions
Information gathered regarding functions of the buffer included: achievement of stated goals; evidence of wildlife use of the area; vigor and/or stability of planted vegetation species; habitat diversity; and impacts to the pre-existing wetland from various identified sources. This information was gathered on-site.

Summary Assessment
The assessment included the identification of probable factors affecting buffer functioning and a general analysis of the wetland/buffer system. Summary information was gathered on-site and was based on site conditions and investigators' knowledge of Pacific Northwest wetlands.

### *Field Site Establishment and Assessment*

Potential sites identified during permit review were field-checked. Actual sites selected for analysis were a subset of the field-checked sites. Selection of actual sites was based on the following criteria:

- construction and implementation of the permitted project and buffer requirements;
- ability to locate the site;
- ability to access the site; and
- availability of pre-existing buffer and wetland conditions information.

Once a site was determined to be appropriate for inclusion in the study, the field assessment was conducted using the field data forms. Sites were assessed by transversing the area to define and characterize the buffer, and examine the wetland to determine if there were any impacts to the wetland as a result of the surrounding land use. A detailed description of the methodology which explains the basis for the field data form questions is provided in Attachment 3.

### *Data Analysis*

Information collected in the field was reviewed and some simple statistical calculations were made regarding the different aspects of the data recorded on the forms.

# III. Results

## *Site Selection Results*

A total of 35 potential buffer sites in King and Snohomish Counties were identified from agency permit files, Puget Sound Wetlands and Stormwater Management Research sites (Cooke et al. 1989a, 1989b), and from projects identified by agency personnel. Varying amounts of pre-existing data were available for the sites. Sites were excluded from the analysis for a variety of reasons. Many sites were excluded because they either could not be located or access was restricted, or they were implemented within the last year and it was not yet possible to evaluate the effects of development on the buffer and wetland. A few sites were eliminated because there was not enough pre-development data available to make a proper assessment of the post-development effects.

Of the 35 identified potential sites, 21 sites were selected as final data collection sites. Approximate locations are shown in Figure 1 and locations and details of these final sites are listed in Table 1.

The 21 sites include projects in:

- urban areas, commercial or public areas, and rural areas;
- areas with various degrees of disturbance to the area adjacent to the wetland. A 200-foot area adjacent to the wetland was set as the area to be assessed (based on the fact that 200 feet is the maximum buffer required by any of the implemented projects);
- areas with varied types of disturbance to the buffer and wetland including physical damage, deposition of garbage, introduction of chemical toxicants, and introduction of invasive species; and
- areas with the size and configuration of the protected wetland varying from less than one acre to tens-of-acres.

All 21 sites were located in areas where the degree of surrounding basin development was greater than 30%. Four sites were located in more rural areas, where the degree of surrounding development was 50% or less. Nineteen sites were in King County and two sites were in Snohomish County. Four sites were at least partially adjacent to agricultural lands, while eight sites had at least 25% second-growth native vegetation.

**FIGURE 1 Locations of Buffer Sites in King and Snohomish Counties.**

Appendix A

**FIGURE 1 Locations of Buffer Sites in King and Snohomish Counties.**

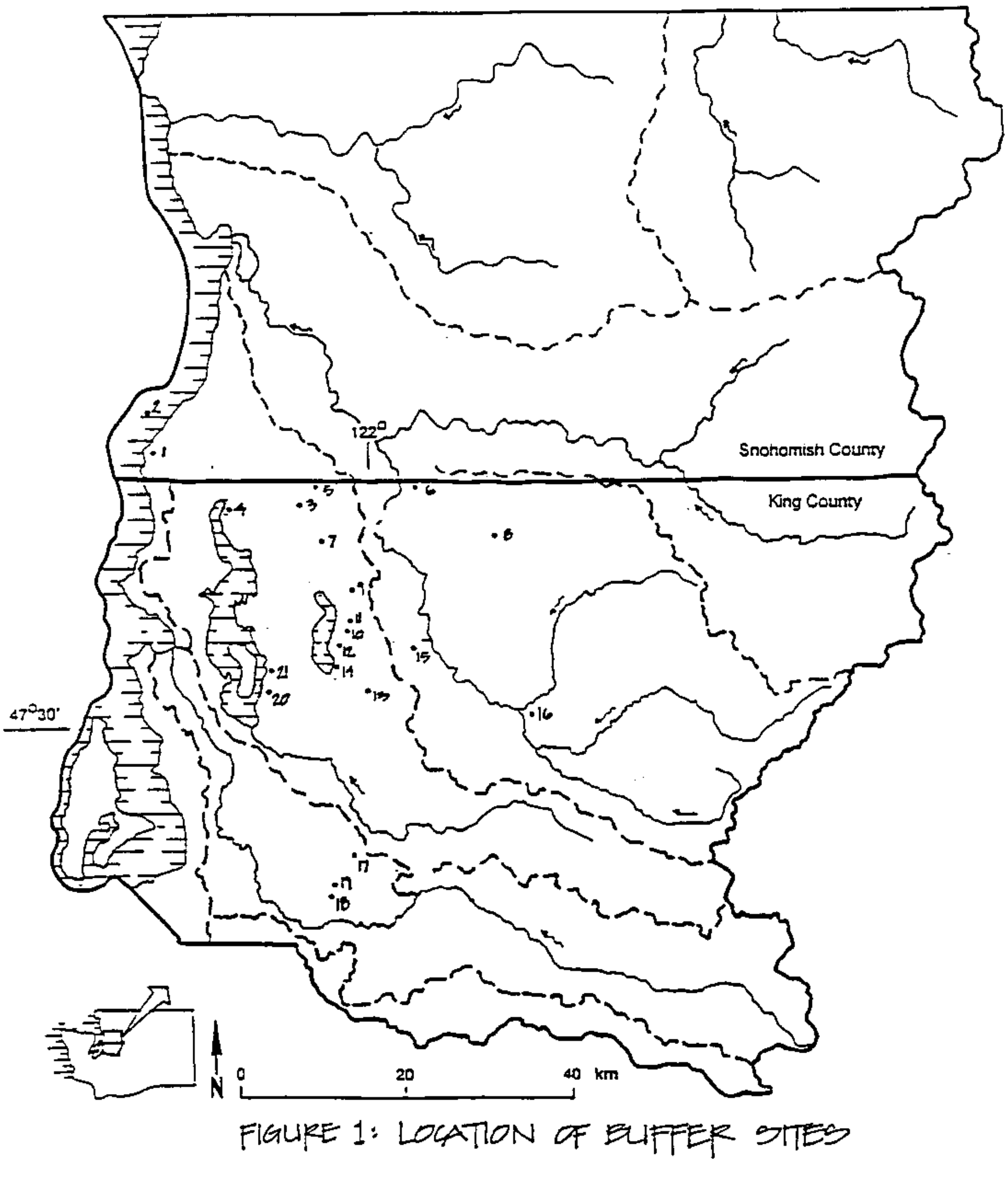



FIGURE 1: LOCATION OF BUFFER SITES

*TABLE 1. Buffer Study Site Locations.*
(Sites are arranged by County from North to South.)

| # | Site location | County | S T R | Basin | Buffer implemented |
|---|---|---|---|---|---|
| **1** | 4th Ave W and 220-224th St SW | Snohomish | /27N/4E | Lake Ballinger | 1989-90 |
| **2** | 127 st SW and 155th Ave N | Snohomish | /28/4E | Lake Serene | 1987 |
| **3** | 108-112 Ave NE and NE 155-158 St. | King | 17/26N/5E | Juanita Creek | 1989 |
| **4** | Inglewood Rd and NE 165th St. | King | 11/26N/4E | East Lake Wash | 1989 |
| **5** | 134-135 Ave NE, and NE 187-190 St | King | 3/26N/5E | Bear Creek | 1986 |
| **6** | 189-196 Ave NE and Snohomish City line and NE 202 St. | King | 6/26N/6E | Bear Creek | 1987 |
| **7** | NE Novelty Hill Rd and 212 E and 220th Ave NE | King | 33/26N/6E | Bear-Evans Creek | 1988 |
| **8** | NE 133 and NE 145th and 214-228 Ave NE | King | 21/26N/6E | Bear Evans | 1987 |
| **9** | 224 Ave NE and Union Hill Rd | King | 9/25N/6E | Evans Creek | 1987 |
| **10** | 221st St and 225 Ave NE and NE 16-20th | King | 28/25N/6E | Evans Creek | 1987 |
| **11** | NE 16 and NE 18th Pl, and 225-226 Ave NE | King | 28/25N/6E | Evans Creek | 1987 |
| **12** | E 212 Ave SE and SE 32nd St. | King | 9/24N/6E | E.Lk. Sammamish | 1983 |
| **13** | Issaquah Pine Lk Rd. | King | 33'22N'6E | E.Lk. Sammamish | 1988? |
| **14** | E. Lk. Samm. Prkwy SE and SE 40th and 204 Ave SE | King | 17/24N/6E | E.Lk. Sammamish | 1986 |
| **15** | SE Duthie Hill Rd and 260-268 Ave SE and SE 32 St. | King | 12/24N/6E | Patterson Creek | 1985 |
| **16** | E SR 203 and NE 24-28th St. | King | 21/25N/7E | Snoqualmie River | 1983 |
| **17** | Kent Kangley Rd. and Witte Rd. | King | 33/22/6 | Jenkins Creek | 1988 |
| **18** | SW Auburn Black Diamond Rd and SE 324 St | King | 13/21N/5E | Soos Creek | 1986 |
| **19** | SE Auburn Black Diamond Rd and SE 325th Pl. | King | 18/21N/6E | Soos Creek | 1987 |
| **20** | 124-128 Ave SE and SE 78-89th | King | 28,33/24N/5E | May Creek | 1987 |
| **21** | 116 Ave SE and SE 76 St. | King | 28/24N/5E | May Creek | 1987 |

Buffers were, without exception, heterogeneous in nature, consisting of a mosaic of different types: paved surfaces; native forest and shrubs; invasive shrubs; mowed lawns; and fences. Buffer widths varied from 0 to greater than 200 feet. All but one of the buffer zones were not uniform in width. Of the 21 sites, four had buffers that were at least partially enhanced. Enhancement consisted of planting other species to increase the density of the existing vegetation, replacement of the pre-existing community, or widening the pre-existing buffer width. The ages of the post-development buffers ranged from two to eight years (1983 to 1989).

The types of disturbances affecting the buffers and adjacent wetlands included grading; filling; removal of vegetation; dumping of yard waste and garbage; inputs of fertilizer, sediment, and toxic substances; and noise pollution from adjacent roads and houses.

Buffer site characteristics are summarized in Table 2.

**TABLE 2. Buffer Site Characteristics.**

| **Site #** | **Buffer width** | **(feet)** | **Wetland Type[1]** | **Buffer Type[2]** | **Age of Buffer** | **Surrounding Use** | **Disturbance Type[3]** |
|---|---|---|---|---|---|---|---|
| **1** | variable | 0-200+ | 1 | pv,shi,shn, fn, f | 1 | residential, native veg | p,ct,cf,s |
| **2** | variable | 0-20 | 2 | f,gr,fn,shn | 2-4 | residential, native veg | ct,cn,p,s |
| **3** | variable | 10-100 | 3 | pv,shi | 3 | residential, native veg | p,ct,s |
| **4** | variable | 0-10 | 2 | pv,f,shi | 4 | agric, native veg, residential | p,ct,cf,s, |
| **5** | variable | 0-50 | 2 | pv,shi,fn | 8 | native veg,residential | p,ct,cf,s |
| **6** | variable | 15-50+ | 3 | f,pv,shn | 4 | residential, native veg | ct,p |
| **7** | variable | 15-100+ | 2 | gr,f,fn,pv | 3 | residential | p,ct,cf,s |
| **8** | variable | 50-200 | 2 | f,shi,shn,gr | 4 | residential, native veg | ct,p,cf,s |
| **9** | variable | 0-100 | 2 | gr,f,shi,fn | 4 | residential, native veg | ct,cf,p,s |
| **10** | variable | 0-50 | 2 | f,gr,fn | 4 | residential | ct,p,s |
| **11** | variable | 15-50 | 2 | shn,shi,pv | 4 | residential, native veg | ct,p,cf,s |
| **12** | variable | 0-50 | 1 | gr,f,pv,shn | 8 | residential, native veg | p,cf,s |
| **13** | variable | 0-35 | 2 | pv,gr, shi | 5 | residential, native veg | p,cf,ct |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **14** | variable | 0-25 | 2 | gr,shi,pv | 5 | residential, agric | p,ct,cf,s,n |
| **15** | variable | 0-50 | 2 | pv,f,gr,shn | 6 | residential, native veg | ct,cf,p |
| **16** | variable | 0-130 | 2 | f,shn,gr | 8 | residential, native veg | cf,p,s,n |
| **17** | variable | 0-150 | 2 | f,shi,shn,gr | 3 | residential, agric | p,ct,cf,s |
| **18** | variable | 0-35 | 2-3 | fn,shi,gr,pv | 4 | residential, native veg | p,ct,cf |
| **19** | variable | 25-200 | 2 | f,shn,pv | 4 | residential, road,creek, native veg | p, cf,n, |
| **20** | variable | 0-25 | 3 | pv,fn,gr | 3 | residential, native veg | p,ct,cf,s |
| **21** | variable | 0-150 | 2 | shn,gr | 4 | residential, native veg, pasture | p,cf,s |

**[1]WDOE wetland category**
Category 1
Category 2
Category 3
Category 4

**[2]Buffer type**
pv=pavement
gr=grass,maintained
shi=shrubs,invasive
shn=shrubs natural
f=forest,native
fn=fence

**[3]Disturbance type**
p= physical disturbance
cf= chemical input fertilizer
ct= chemical input toxics
s= sediments

### *Field Data Site Summaries*

Site information recorded on the field data forms is summarized in Attachment 5. Summaries include the following baseline information: pre-existing conditions for both the buffer and wetland, permit plan requirements and existing buffer and wetland conditions and approximate acreage if available. In addition, each site summary addresses if the wetland buffer width and type implemented as required from the easement and general provisions; what the current condition of the buffer and adjacent wetland are, and if the buffer appears to be functioning; what the critical components affecting functioning of the buffer appear to be; if the buffer goals established by the permit were met, and if they were realistic in terms of providing for all the potential disturbances that could affect the wetland.

# IV. Discussion

The primary objective of the field component was to assess the effectiveness of currently existing buffer zones around wetlands in protecting the wetland from disturbance (of any kind). The investigation was further expanded to include an assessment of the important factors contributing to the success of the buffer zones; identification of the sources of disturbance to wetlands; and an analysis of the apparent response of different categories of wetlands to the disturbances and the efficiency of different buffer types in protecting the different types of wetlands.

It was necessary to define, or at least list criteria of "effectiveness." Ecological function can occur on many different levels, and perception of effectiveness may vary considerably from one scale to another. For example, one function of a buffer may be prevention of human physical intrusion into a site. A fence may be unattractive, and may allow stormwater drainage to pass through, but if it is functioning as a physical barrier, it is at least effective on that level.

The data collected was analyzed mostly in a qualitative manner. A series of questions were developed to determine pre-existing conditions (buffer and wetland), buffer goals, current conditions (buffer and wetland), and whether the goals were achieved.

A result of this analysis was identification of factors affecting the function of buffers and a qualitative hierarchial ranking of the factors affecting buffer function and their importance in terms of wetland protection.

The following section also discusses the appropriateness of existing buffer requirements in terms of different perspectives of value ( e.g., wildlife habitat, aesthetics, ecological functioning etc), based on the results of this study.

### *Buffers, Ecological Requirements and Constraints*

Wetland buffers are physical barriers between a wetland and an external source of disturbance that act to screen the wetland from that disturbance. “Disturbances” can take the form of physical disruption (e.g., mowing, digging), chemical disruption (e.g., inputs of toxicants, fertilizers), competitive disruption (e.g., introduction of invasive species), noise disruption (e.g., road noise), and visible disruption (e.g., removing the tree and shrub canopy that provides screening).

An assessment of potential functions and values of buffers is similar to a list of habitat functions in general. They include but are not restricted to wildlife habitat, water quality enhancement through stormwater filtering, flood storage, groundwater recharge and discharge, seed banking, and aesthetics.

Establishing ecological goals for wetland buffers should include an assessment of the historic, current, and future disturbances to the wetland, and an evaluation of necessary buffer requirements to prevent these disturbances from impacting the wetland. As with any natural system, it is impossible to identify all the ecological factors that could be effected. At the very least, the major factors should be considered, and goals for desired wetland functions and buffer requirements to maintain these functions should be established.

Establishing buffer widths may be done as a risk assessment procedure. The more sensitive the wetland, the greater the risk that the system will be affected by a given disturbance. If the wetland if of little value (usually based on biological functions, but not restricted to that), and the land is valuable, than it may be worth the risk to allow a narrow buffer, because there is not so much to lose if the buffer doesn't function to stop the disturbance to the wetland. On the other hand, if the wetland is a rare system such as bog, or a mature forested wetland, it may not be worth the risk that a narrow buffer will not serve its functions, because the wetland is irreplaceable.

Another important consideration is the concept of “buffer averaging”. Buffers are very seldom of uniform consistency or width. A common upland/transition zone of a natural systems may be a combination of pasture on one edge, forest on another, and shrub on the remaining edge. Each of these areas functions on its own as well as in conjunction with the other areas. Buffer averaging allows variable buffer widths around wetlands. Often, little consideration is given to the different character of the vegetation communities in the buffer. A grass lawn or a cement parking lot do not offer the same functions or values to buffering the wetland as a forested patch. A single entrance point is all it takes for physical disturbance or stormwater inputs to effect the entire wetland. It is, therefore, important to consider the “weakest link” in buffer averaging. The smallest buffer, or the buffer which affords the least protection, should still be capable of maintaining the integrity of the buffer to prevent disturbance to the wetland. Because buffers are often constrained by the physical lay of the land, buffer averaging may be reasonable in some instances without impacting the wetland. An example is where the wetland is located along the toe of a very steep slope. There may only be a few feet available for a buffer.

Wetlands and their surrounding buffers function together; the processes occurring within them are interrelated, and disturbance to any one component of the ecosystem by necessity will effect the rest. Removal or change to the vegetation community in a portion of the buffer may have no effect to the wetland, but it may also show a compounded affect; a small disturbance may be magnified by the next interaction with the different buffer types and eventually be a large effect on the wetland itself. For example, if a small portion of the upland forest is removed, this may afford physical access by humans and domesticated pets to the buffer that remains, and subsequently, to the wetland edge itself.

## ***Buffer Site Functions***

Some functions and values associated with buffer zones and identified for the purposes of this study include stormwater attenuation, water quality improvement, groundwater recharge, discharge, barriers to physical disturbance, and barriers to noise disturbance. Each of these functions is discussed with respect to findings in the 21 study sites.

<u>Stormwater attenuation</u>

Buffer sites that are adjacent to developments are intended to prevent or reduce stormwater entrance into the adjacent wetland. The degree to which the buffer succeeds in this function is related to the topography of the site, to the vegetation in the buffer, and to the effectiveness of modifications made to the buffer in order to enhance this function.

Buffers can act as enhanced catchments (i.e., retention/detention facilities [R/D]), and/or provide biofiltration for stormwater, and provide storage of stormwater. The use of the buffer areas for R/D has variable impacts on both the functions of the buffer, and on the adjacent wetland systems. Use of the buffer for a stormwater function such as R/D defeats the buffer purpose, because the area is no longer a barrier system, but is a holding system. Overflows from the R/D are closer to the wetland and have more of a chance of entering the wetland. One study site included a sphagnum bog. Here, the change in nutrient balance from incoming stormwater was adversely impacting the vegetation community within the bog because the water from the buffered area is directly entering directly the wetland. In contrast, a second site provided for R/D within a dredged pond, down slope from the mature forested system within the pre-existing wetland. The flood storage is designed to occur primarily within the pond in the buffer, and no direct adverse impacts were readily visible within the forested community. No attempt was made to assess pre-development and post-development conditions within this forested community to determine species or community impacts.

<u>Water quality improvement</u>

Water quality functions of the buffer can be provided by biofiltration of sediments within a vegetated system, by nutrient uptake within the vegetated system, and by providing a settling basin for the deposition of suspended solids. Most of the sites contained areas in their buffers that could perform at least a small part of this function. Inputs of stormwater do not always flow into areas where the vegetation and buffer width are sufficient to function as removal areas. Stormwater and surface water was observed to flow through buffer zones and into wetlands in six of the 21 (28%) sites. These sites demonstrated the greatest observable changes in the wetland edge vegetation.

<u>Barrier to physical disturbance</u>

Buffers can provide a barrier against physical disturbance of the wetland. Some buffers are more successful at this than others. For example, a 200-foot forested buffer is more effective than a 25-foot paved sidewalk. Fencing is perhaps the optimum physical barrier if the fence does not have a gate. Fences can also act as visual screens which may afford better protection for wildlife than shrubs or a lawn. Twelve of the 21 sites had fencing along the edge of the adjacent property, although most had gates which allowed entrance to the buffer and subsequently to the wetland. Sixteen of these sites showed evidence of disturbance in the form of disposal of yard waste, and physical deterioration of the vegetation due to trampling from the gate access point.

<u>Barrier to noise disturbance</u>

This function is especially important when the wetland is essential nesting or breeding habitat. This function was not a listed as a permit goal for any of the 21 sites examined, but it was a function that was important for at least two of the sites that were adjacent to busy roads. A shrub barrier or forested zone would be more effective as a sound barrier than a grassy lawn.

<u>Wildlife Habitat</u>

Although assessment of wildlife use and habitat availability was limited to one observation from each site, a preliminary assessment could be made for these components of wetlands functions. Seventeen of the 21 sites listed enhancement of the buffer for wildlife habitat as a goal in the permit. Habitat

components that can be provided by the buffer include vegetation species diversity, structural complexity, community complexity, and shelter. An important use of the buffer for wildlife habitat is to provide shelter and above-ground nesting sites for species that utilize both the wetland (often for feeding) and the upland areas. Buffers with low diversity benefitted greatly from diverse adjacent wetland habitats. Sixteen of the 21 sites contained sufficient species and/or community diversity to act as wildlife habitat. This includes buffers with forested and native upland scrub-shrub zones, as well as native or undisturbed grassy areas.
Sites which were either paved or mown grass offered little habitat for either food or shelter. Areas in buffer zones dominated by reed canary grass provide very little species diversity or habitat complexity. None of the buffers examined were of uniform type along the wetland boundary. This heterogeneous nature enhanced the species diversity component, especially where the buffers tended to be paved, or mown grass.

Although it was not always possible to determine, it appeared that many sites were enhanced by planting species in the buffer. This added structural diversity to the buffer community that was not present previous to the implementation of the change in the surrounding land use.

<u>Aesthetics</u>
A buffer function that is uniquely important to humans is the aesthetic quality of the buffer. This function includes values associated with open space and views, opportunities for passive recreation (e.g., bird watching, walking on paths), and opportunities for education. Human activities within buffers may include placement of interpretive walks, decks or other structures within the buffer, or wetland edge itself, and/or planting non-native ornamental species in the buffer rather than native species.

Only two sites out of the 21 (9%) included buffer enhancement for aesthetic purposes. These included planting of ornamental species for color, and attractive blooms, and development of interpretive walks, and trails and signs. Although incorporation of trails within buffers and wetlands provides the opportunity for human education and recreation, it also encourages intrusion into the wetland by humans and domesticated animals. Trails were found in the buffer zones of six of the 21 sites. Without exception, the trails disturbed the buffer vegetation and gave access to the wetland that resulted in visible deterioration of the wetland edge.

## *Components of "Success"*

A series of questions were asked about the buffers at each site in order to determine if they were effective in protecting the adjacent wetland. The intention of this method of assessment was to establish baseline conditions; to determine if the buffer was established as it was required or designed; and to determine the condition of the buffer over time. Many of the sites were previously assessed in 1988 as a part of a buffer survival and effectiveness study performed by King County Building and Land Development (Baker and Haemmerly, 1990).

Where the information was available, pre-existing conditions were evaluated for all sites. The same detail of information was not available for all the sites.

Of the 21 sites assessed, 20 were implemented as outlined in the easement conditions, however, this was a very subjective assessment due to the lack of detailed description of buffer provisions. Difficulty in assessing buffer functions made it difficult to respond to the question of whether the buffer was functioning. It was first necessary to assess whether the buffer was functioning as outlined in the buffer/easement requirements, and then to next assess what further functions were being performed by the buffer, and what other functions should be present in the buffer zone in order to protect the wetland from disturbance. Given the general and sometimes vague description of the easement goals, results of this study were often difficult to determine. This was compounded by the fact that most of the buffer zones were not "created," but remained from the pre-existing buffer.

All but one of the buffers examined (95%) showed some signs of alteration over time. This surprisingly high number indicates the need for including easement requirements which reflect not only current disturbances, but post-development disturbances as well. This level of impact also suggests a need for monitoring buffers and wetlands after development has occurred in order to identify disturbances before they have adverse impacts on wetlands. This exceeds the 68% alteration found in the BALD 1988 study.

Table 3 lists important components of buffer success that were studied for each site and explained in the following discussion.

Degree of urbanization

The degree of urbanization surrounding a wetland can have a direct correlation with the amounts and kinds of disturbances affecting the wetland. The more developed a basin associated with a wetland, the more potential deleterious inputs there are to the wetland. The Puget Sound Wetlands and Stormwater research Program is examining this trend in the wetlands around King and Snohomish Counties, and will have the results of the study ready in 1992.

Table 4 reviews the degree of adjacent urbanization as it compares to the amount of alteration has occurred in the wetland. Sites rated as "highly altered" display characteristics of the water, vegetation, wildlife and/or soils have visibly changed and deteriorated in the recent past. Sites rated as "moderately altered" show few degradations to the wetland/buffer, although they do not threaten the wetland. "Low alteration" indicates the buffer has been barely modified.

*TABLE 3: Components of Buffer Success*

| | | |
|---|---|---|
| a. | Degree of urbanization | Low < 15% adjacent developed<br>Medium 15 to 45% adjacent developed<br>High >45% adjacent developed |
| b. | Surrounding land use | Urban<br>residential<br>commercial<br>public<br>Rural<br>agricultural<br>forested, native growth |
| c. | Buffer Size and Characteristics | 0-200+ feet of buffer width<br>Variable widths for the total length<br>Characteristics<br>paved surface<br>grass maintained lawn<br>shrubs, invasive (blackberry)<br>shrubs, native<br>forested |
| d. | Time | Time elapsed since project implemented |
| e. | Implementation components | Buffer left in-tact<br>Buffer planted, and/or enhanced |
| f. | Buffer Maintenance | Prevention of encroachment<br>Education of nearby residents |

*TABLE 4   The Number of Altered Buffer Sites Versus the Degree of Adjacent Urbanization/Surrounding use*

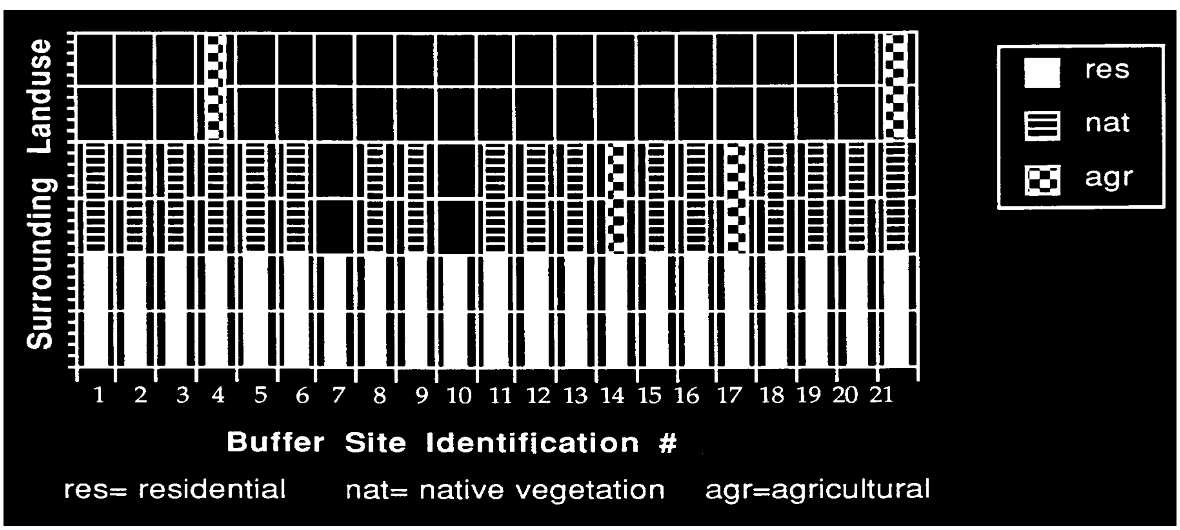
| **Site** | **Level of urbanization %** | **Surrounding use** | | | | **Altered?** |
|---|---|---|---|---|---|---|
| **#** | | **R S** | **RM** | **NV** | **S** | |
| 1 | 75 | X | | X | | highly |
| 2 | 90 | X | | X | | highly |
| 3 | 60 | X | X | X | | moderate |
| 4 | 50 | X | X | | X | highly |
| 5 | 40 | | X | X | | moderate |
| 6 | 85 | X | | | | no |
| 7 | 100 | X | | | | moderate |
| 8 | 95 | X | | X | | low |
| 9 | 70 | X | | X | | moderate |
| 10 | 100 | X | | | X | moderate |
| 11 | 70 | X | | X | | low |
| 12 | 70 | X | | X | | moderate |
| 13 | 85 | X | | X | | highly |
| 14 | 100 | X | | | | highly |
| 15 | 85 | X | | X | | highly |
| 16 | 65 | X | | X | X | highly |
| 17 | 60 | X | X | | | moderate |
| 18 | 85 | X | | X | | moderate |
| 19 | 50 | X | | X | X | low |
| 20 | 85 | X | | X | | highly |
| 21 | 35 | X | | X | | highly |

-------------------
RS= residential single family
RM= residential multifamily
NV= native vegetation, usually forested or shrub growth
S= stream

<u>Surrounding Use</u>
Human use of the areas surrounding a wetland results in direct impact on the wetland from associated activities. Logging, and clearing of vegetation up-slope from a wetland can result in acidification of the surface waters, and release of copper, nutrients, and sediments into the overland flow. This type of adjacent activity was observed in ten of the sites studied. In five cases, the deposited sediment load was still present in low-lying depressions or in the meander channels of rivers and streams. Six of 11 sites (55%) adjacent to developments which use lawn maintenance systems showed apparent effects of the input of fertilizers on the wetland vegetation. This was observed as luxuriant growth near the inlet areas, invasion of the wetland edge by invasive species, and in one case, toxicity symptoms from over-fertilization by nitrogen.

Sites with greater than 60% surrounding area as residential showed varying degrees of disturbance to the buffers and/or wetland. There were 16 sites that showed the adjacent use to be 50% or greater development as single and multiple family residential. Figure 2 shows the breakdown of adjacent use by wetland.

***Figure 2. Surrounding Land Use for Each Wetland/Buffer Site***

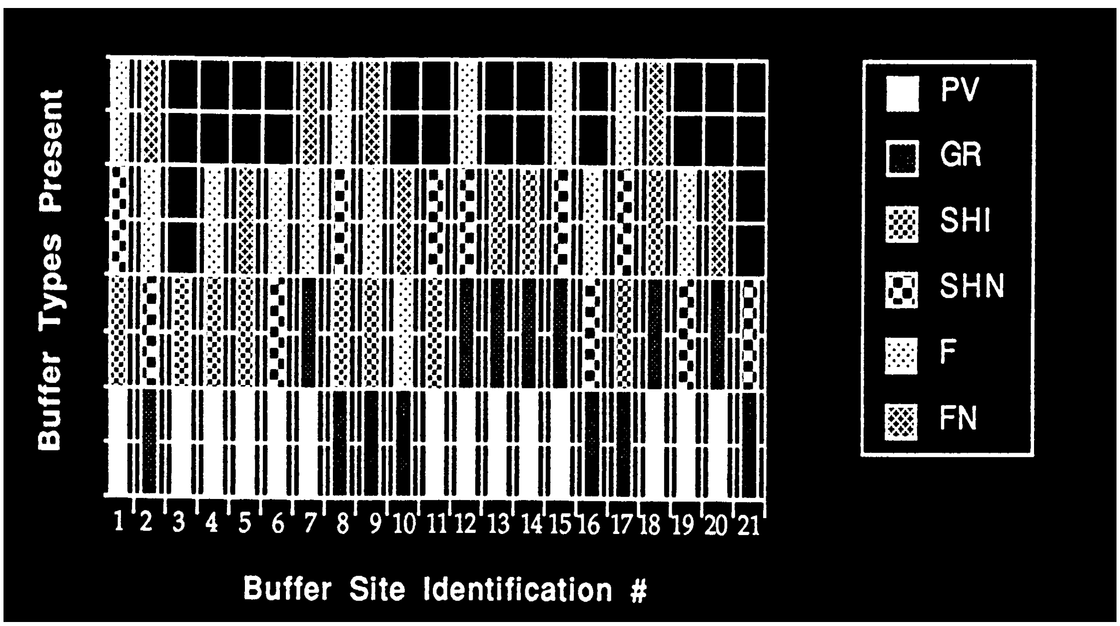



<u>Buffer size and characteristics</u>
Lack of appropriate vegetation densities and/or species diversity contributed to lower function as a community in 15 of the 21 sites. The density question is one not often addressed in vegetation community analysis, but it is important because insufficient densities result in "filling in" with weedy species such as red alder, black alder, black cottonwood, and Himalayan blackberry. Species diversity was lacking in 14 of the 21 (67%), buffer areas which were in-tact. The buffer consisted

predominantly as a monoculture, usually Himalayan blackberry, or lawn grass. These communities offer very little wildlife habitat.

More diverse communities and higher densities of this diverse vegetation is the reason for the success of the buffer in the remaining six sites. The density component is especially important when the buffer width is small (less than 50 feet). A buffer of 25 feet worked in only one out of 25 (5%), where the vegetation was so dense the buffer formed a completely impenetrable barrier. None of the wetlands had a buffer that was uniform in width. The buffer widths ranged from 0 to greater than 200 feet across the length of a wetland edge. Qualitative observations were made in the field which indicated that the buffer areas that were 50 feet or greater showed less impacts to the wetland areas directly adjacent than those areas that were less than 50 feet in width. Nineteen wetlands (90%) had areas where the buffer was less than 25 feet and disturbance to the wetland edge would occur at that point.

***Figure 3 Buffer Types Surrounding Each Wetland***



**2**

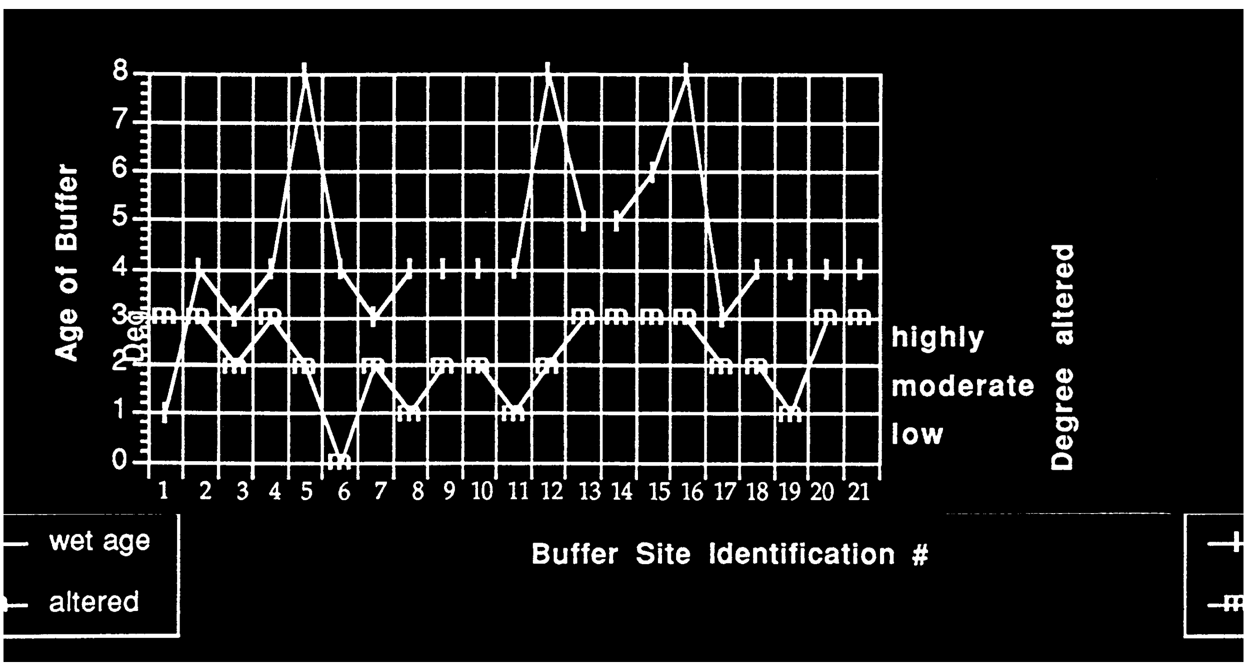
PV=pavement GR=grass,maintained SHI=shrubs,invasive
SHN=shrubs natural F=forest,native FN=fence

<u>Time</u>
One of the criteria for site selection was sites that had been implemented for more than one year. The projects at the study sites ranged in age from two to eight years old.

Two components of age are important in the analysis of the buffer efficiency. The first is the age as it reflects the regulations that were in place at the time of implementation of the project. Projects dating after 1987 required that the buffers be placed outside of the lots. This requirement had one of the highest impacts to preservation of the buffers in an unaltered state. Projects that incorporated the buffer in the lots always resulted in the loss of the natural vegetation community to lawn over time (i.e., 17 out of 17 eligible sites). Ownership of the buffer appears to mean to the homeowner that it is acceptable to remove the natural vegetation and replace the buffer with a less valuable, mown-lawn type of buffer.

The second component of age is the time elapsed since implementation of the buffer. The number of alterations to the buffer increase with the time passed since the buffer was established. Figure 4 illustrates buffer age compared to the degree of alteration of the buffer. Table 5 lists the percentage of buffer alterations over time as indicated by both the 1988 (Baker and Haemmerly, 1990) and this study.

***Figure 4. Buffer Age Compared to the Degree of Alteration of the Buffer***




**3**

*TABLE 5 Percentage of Buffer Alterations Over Time*

| **Year** | **% buffers altered 1991 study** | **% buffers altered 1988 study** |
|---|---|---|
| **1983-84** | **(2/2) 100%** | **2/2) 100%** |
| **1985-86** | **(4/4) 100%** | **(4/7) 57%** |
| **1987-88** | **(11/12) 92%** | **(7/10) 70%** |
| **1989-90** | **(3/3) 100%** | **--** |
| **average** | **(20/21 95%** | **(13/19) 68%** |

Implementation Components
In general, most of the buffers were, at least initially, implemented as required by the easement provisions. Unfortunately, buffers seldom require monitoring and buffer zones were altered with time in over three-quarters of the study sites. Important components of implementation include: whether the buffer was planted, or existed previous to the development or disturbance; if the buffer was enhanced or expanded; and the value of certain species or community types found in the buffer in terms of providing the habitat and functions needed for the buffer.

The higher the density of plants in the buffer the better the protection and the greater the functions. Densities were described as low (e.g., mown lawns, pavement), medium (e.g., open thinned forest with no undergrowth, planted shrub in low densities), and high (e.g., fallow native grasslands [unmown], dense forests with undergrowth, solid shrub layer, either invasive species [blackberry species] or native species [Snowberry, salmonberry, or vine maple]). Lack of appropriate vegetation densities contributed to lower potential for buffering of the buffer zone. Although the determination is subjective, densities as a whole were too low in all the study sites. Buffers appeared to decrease in density over time (where it was possible to determine).

Maintenance Components
There was no instance of a monitoring requirement for the buffers of the 21 sites examined. This lack of maintenance following the implementation (be it leaving the existing community alone, or enhancement of the buffer) is associated with alterations to the buffer over time in 20 out of 21 sites.

## V. Field study conclusions

The primary purpose of this study was to assess the efficacy of buffers in protecting an adjacent wetland. In addition, it was necessary to determine what types of functions buffers offer, and to determine whether these were being met at the study sites.

During the course of the study, it became clear that the goal statements and easement provisions were so general and unspecific that only outright removal of the buffer and severe disturbance to the adjacent wetland could be interpreted as a failure of the buffer to meet the goals. Goal statements, when they existed, were generally written to address a single function of the wetland to the exclusion of all the other important functions that occur. Incomplete understanding of the types of disturbance that may occur to the wetland and buffer as a result of the implementation of a land-use change in the surrounding area is a large factor in the failure of buffer requirements to sufficiently protect the wetland. In addition, none of the easement provisions required monitoring, or provided for post-development analysis of success of the buffer to function fully. By not addressing components of the wetland that can be measured, (vegetation species numbers, densities, and diversity), there is no method of determining if the goals or provisions have been met. As a rule, buffers were most affected by a reduction in size over time. Buffers are being altered, both in the short term, and definitely in the long term. In no sites with 25-foot buffers were the buffers functioning to reduce disturbance to the adjacent wetland, either in the short term or long term. In addition, buffers, regardless of size, appear to be continuously reduced over time. There is argument therefore to provide for the largest buffer possible so that when some of the buffer is lost over time, there is still sufficient buffer to protect the wetland.

The critical components of successful buffer function depend on the type of buffer in place, the type of alteration to the buffer ( and type of disturbance to the surrounding areas), the width of the buffer, the surrounding land use, the time elapsed since the change in land use, and the ownership of the buffer and adjacent wetland. Buffer efficiency at protecting the adjacent wetlands is dependent on the following components:

- <u>the number of lots adjacent to the buffer</u> - the fewer the lots the less the impacts;
- <u>the size of the buffer</u> - the larger the buffer the more protected the wetland;
- <u>the type of buffer in place</u> - vegetation communities which act as; visual screens, physical barriers, sediment filters and chemical filters efficient buffers; and
- <u>ownership of the buffer</u> - buffers owned by landowners that understand the purpose of the buffer are less impacted.

Buffer functions were found to be most reduced as a result of decreased size of the buffer. Buffers less than 50 feet wide showed a 90% increase in alteration of the buffer (19 out of 21), while only 43% (3 out of 7) showed alteration in those buffers where the buffer was greater than 50 feet. Overall, larger buffers reduced the degree of changes to the water quality, the sediment load and the water quantity entering the adjacent wetland.

The findings of this study of a small subset of sites within the central Puget Sound region suggests that on the whole, buffers are not being regulated or enforced in a way that provides for their maximum ability to function. Goals established in easement provisions are inadequate to prevent the alteration of buffers over time, and consequently, are also inadequate to prevent alteration to the adjacent wetland. The study illustrates the shortcomings of the regulatory aspect of wetlands protection from both a biological and a best management policies perspective.

However, an increased understanding of the ecology of wetlands and buffers, the incorporation of as many site variables as possible, and the mandatory monitoring of characteristics that can indicate quantitative changes will result in an increased likelihood of the success of buffer zones to protect adjacent wetlands from disturbance.

## VI. Study limitations

This study has provided us with some valuable insights into the functions of buffers and their ability to protect wetland. However, inherent in this study and its results are several limitations.

No attempt was made during this field study to review all available files or to identify all possible sites; a small number of sites within a limited field radius was chosen for analysis. As a result, the conclusions which can be drawn from this study are limited. Sizes, types and conditions of the sites assessed in this study are a small sub-set of available within the Puget Sound Basin. It is the opinion of the field investigators that the sites visited may actually represent a relatively realistic sample of "typical" sites within this region. It was outside the scope of this study to field check sites located in the major portion of the state of Washington.

Further, sites were visited only once during this study; evaluations of site functions over time are speculative, and are based on site conditions during the visit and investigator expertise. Sites were assessed during March, when many plant species are still dormant or just beginning to break dormancy. As a result, ability to assess health of the system, as well as viability and robustness of some species was limited. Assessment of the functions of various plant groups within the entire wetland was limited and may have been different if the site were visited later in the year. For example, shrub functioning may have been underestimated in some wetlands because the shrubs were not leafed out. Similarly, the ability to assess the effectiveness or appropriateness of planting densities may also have been limited by the time of year.

Finally, most study sites consisted for the most part of younger sites (not greater than 8 years of age). This limited the ability to look at site development and functions over time. This age limitation is a reflection of the relative young "science" presented as wetland ecology. It is the opinion of the investigators that many of the sites observed and assessed will be providing more complex functional value over time.

## VII. Recommendations

The following recommendations are based on the findings and results of this field study and on the professional experience of the authors. Although this component was limited to a field assessment and not a literature search and analysis of the state of buffers, the authors are aware of other field studies which corroborate the findings, conclusions, and recommendations of this study. Citations of those studies are included within the references for this report.

These recommendations are formulated based on several consistent findings: first, that a pre-existing conditions assessment is rarely conducted, and, if conducted, is incomplete; and second, that buffer goals/easement provisions must be based on quantifiable characteristics that allow for an accurate determination of subsequent alterations to the functions of both the buffer and the wetland.

**Pre-existing Conditions Assessment**

This assessment must be conducted for the wetland communities present before the surrounding land use change comes into affect. A through analysis of the vegetation (at the very least), functions of the existing wetland and buffer, and wildlife (if time and budgets are available) should be accomplished. This provides a reference for future monitoring comparisons.

The assessment must be conducted in a manner that collects quantifiable data on existing wetland characteristics. Protocols for similar monitoring of water quality and quantity, vegetation, soils, and wildlife can be found in Horner (1989, 1990), Cooke et al. (1989a, 1989b), and King County (1988). Monitoring protocols are currently being developed by the Puget Sound Wetlands and Stormwater Management Research Program and should be available in a draft form in 1992.

**Establishing Buffer Goals and Objectives**

The goals and objectives of the buffer must be established in such a manner that success or failure of the buffer to protect the wetland can be determined. Future disturbances to the wetland and buffer must be defined in order to incorporate all the functions that the buffer will be required to perform to prevent impacts to the buffer or wetland. These goals must be defined in detail, taking both ecological and aesthetic functions in consideration, and the assessment protocol must be established before the project is implemented. Buffer requirements must be established so that any required enhancements are written into the easement provisions.

**Implementation**

A wetlands ecologist should be involved in the design and implementation of the project in order to ensure the required provisions are implemented. Existing functional natural communities should be used as a model for the buffer if it is determined that the existing buffer will not be able to function sufficiently to protect the adjacent wetland from the projected disturbances.

**<u>Monitoring/Enforcement</u>**

Monitoring of buffers and adjacent wetlands over time is necessary to ensure maintenance of their characters and functions. A monitoring program should be established for the buffer and wetland which incorporates the quantifiable components of the baseline/pre-existing conditions. Changes in the characteristics, especially vegetation community (e.g., species composition, percent cover, species density) can be discovered before the alterations become so great that the wetland is at risk. A timeline should be written into the easement provisions so that monitoring requirements can be bonded. There should be some means to ensure the requirements are being met, and that the buffer requirements are maintained over time.

**<u>Maintenance</u>**

Alterations to the buffer should be immediately remediated. Maintenance of the buffer for the function goals established should be included in the easement requirements along with the monitoring program. Maintenance may include control of non-native invasive species, replanting of species removed, and enhancement of buffer vegetation to improve certain functions that are not being met.

To summarize, it is important to look at each new project and define a plan for the implementation of the project to avoid impacts to the wetland. This can best be accomplished by first, determining the potential sources of impact to the wetland given the surrounding current and projected future land use, in conjunction with the type of wetland to be influenced; and second, establishing goals wetland functions that consider these sources of potential disturbance, and by requiring buffers of sufficient size ( minimum of 50 feet, regardless of the type of buffer) and type that can fulfill these goals, over time. It is also necessary to establish a quantified assessment of the pre-existing wetland and buffer communities in order to establish if the buffers are functioning to protect the wetland from impacts due to land use changes over time.

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King County Resource Planning Section. 1988. Puget Sound Wetlands and Stormwater Management Research Program: Initial year of Comprehensive Research Report to Washington State Department of Ecology, Coastal Zone Management Program, by King County Resource Planning Section, Seattle, Wa.

United States Army Corps of Engineers, 1985. Wetland Plants of the Pacific Northwest.

# Attachments

**<u>Attachment 1</u> - AGENCY AND STAFF CONTACTS**

The following agencies and staff were contacted to identify potential sites

KING COUNTY, Building and Land Development
Technical Services Section
Tina Miller, Heather Stout, Laura Kaye
Subdivision Products Section
Howard Haemmerly

CITY OF KIRKLAND,
Joan Brill

CITY OF BELLEVUE,
Toni Craemer

ARMY CORPS OF ENGINEERS,
Michelle Walker

**Attachment 2 - BUFFER SITE FIELD DATA FORMS**

Investigator(s) ___________________________________ Date _________________________________

___________________ County _______________________________________________________

_ Weather ______________Site/Project Name ________________________________________

___________Site Location/Address ________________________________________________

1. **CONDITIONS ADJACENT TO WETLAND** (within 200 feet)

A. Name of Basin __________________________

B. **SIZE OF BASIN**

| | Large | Medium | Small |
|---|---|---|---|
| Size of Basin | | | |

C. **LOCATION OF WETLAND IN BASIN**

| | Upper third | Middle third | Lower third |
|---|---|---|---|
| Location of wetland in basin | | | |

D. **CURRENT LAND USE ADJACENT TO WETLAND**

| Zoning | Use | Percent | Comments/Conditions |
|---|---|---|---|
| Residential | | | |
| single family | | | |
| multi family | | | |
| Commercial | | | |
| Industrial | | | |
| Business Park | | | |
| Agriculture | | | |
| Native Vegetation | | | |

E. Historical Land Use Adjacent to Wetland. How was this assessed?

2. **EXISTING WETLAND TYPE AND SIZE** (non-compensation wetland)

A. **EXISTING WETLAND TYPE AND SIZE**

| Community Type | Percent Total Wetland | Size of Wetland (Acres) |
|---|---|---|
| POW | | |
| PEM | | |
| PSS | | |
| PFO | | |
| PAB | | |

DOE Wetland Category:

B. **EXISTING WETLAND VEGETATION**

| Strata | Species (listed by dominance) |
|---|---|
| Canopy | |
| Subcanopy | |
| Shrubs | |
| Herbs | |
| Grasses/Sedges | |

3. **BUFFER CHARACTERISTICS** (within approximately 200 feet of wetland edge)

A. **BUFFER CHARACTERISTICS**

| | Pre-existing | Required | Current |
|---|---|---|---|
| Slopes | | | |
| Intrusions (i.e. humans, runoff, pets) | | | |
| Sp. Complexity (low, med, hi) | | | |
| Comm. Complexity (low, med, hi) | | | |

B. Date of Construction or Permit (i.e. age of buffer):

C. **BUFFER DIMENSIONS**

| Percentage, Condition and Dimension of Buffer Type | Pre-existing | Permit Requirements | Existing |
|---|---|---|---|
| Forest | | | |
| Shrub | | | |
| Pasture | | | |
| Landscaping/ Grasses | | | |
| Residential | | | |
| Business Park | | | |
| Industrial | | | |
| Paved Surface | | | |

## 4. WETLAND AND BUFFER CONDITIONS

### A. WETLAND/BUFFER CONDITIONS

| | WETLAND Yes | WETLAND No | BUFFER Yes | BUFFER No | Specifics/Comments |
|---|---|---|---|---|---|
| Runoff | | | | | |
| point source | | | | | |
| non-point source | | | | | |
| chemical | | | | | |
| physical | | | | | |
| Turbidity in Wetland | | | | | |
| Oil/Grease | | | | | |
| Erosion | | | | | |
| Siltation (L,M,H) | | | | | |
| Wildlife Use | | | | | |
| birds | | | | | |
| mammals | | | | | |
| fish | | | | | |
| amphs/repts | | | | | |
| prey species | | | | | |
| Habitat Features | | | | | |
| snags/cavities | | | | | |
| brush/cover | | | | | |
| food species | | | | | |
| veg. complexity | | | | | |

B. Are there impacts to the installed buffer? Y / N Describe:

C. What was the probable source of adverse impacts to the buffer?

D. Are there impacts to the wetland? Probable source:

E. Are the impacts to the wetland correlated to:

a) impacts to the buffer?
b) presence/absence of the buffer?
c) condition (size/type) of the buffer?

Describe:

F. Were the requirements met? Y / N Describe:

5. **BUFFER FUNCTIONS**

A. **BUFFER FUNCTIONS**

| Buffer Functions | Pre-existing | Goal | Current |
|---|---|---|---|
| Biofiltration/sediment | | | |
| Nutrient Uptake | | | |
| Habitat Diversity | | | |
| Protection from Intrusion | | | |
| Flood Storage | | | |
| Wetland and Surficial Ground Water Recharge | | | |

B. Are the functional purposes evident?

C. Were buffer goals appropriate, attainable, realistic?

7. **SUMMARY**

A. What appears to be functioning properly on this site, what does not function on this site?

B. General comments on buffer effectiveness.

C. Suggestions for increasing buffer functioning?

Additional Comments:

**<u>Attachment 3</u> - FIELD FORM METHODOLOGY**

The buffer data sheets were designed to collect consistent information on each site regarding pre-existing conditions, permit requirements, design goals and objectives, existing site conditions, and qualitative assessments of success and functioning of the buffer. Data sheets were structured to collect both permit file and field data, however all portions of the field data sheets were recorded <u>on site</u>.

Preliminary information was entered into the data sheet before proceeding to the remainder. This information included investigators name(s), date, site name and site location.

<u>Section 1</u> was designed to assess permit requirements and conditions present before the surrounding land use was changed (development installed). This information was obtained primarily from the permit files, however in several cases where the investigator was familiar with the site, the information was known.

Pre-existing wetland community types were identified (according to the Cowardin classification), as well as the dominant species present in each strata, if known. This information was obtained from the descriptions of pre-existing site conditions in the permit files.

<u>Sections 2 and 3</u> were designed to describe the existing buffer and wetland details. Soils, and vegetation and structure aspects were described. This information was also obtained from the permit files.

<u>Section 4</u> was designed to assess land use within 200 feet of the wetland, and the wetland itself. Basin information can be obtained from USGS topographic maps. Current land use was identified by viewing at the surrounding area.

Wildlife habitat features such as snags, logs, beaver dams, brush, and forage were noted. Actual wildlife use was identified on the basis of observed wildlife, tracks, holes or nests. Some assumptions regarding wildlife use were made based on site conditions. Additional detail was provided when needed.

<u>Section 5</u> addresses buffer functions past goals for the buffer after implementation of the project, and current.

Several questions in sections 4 and 5 were designed to elicit the opinion of the investigators as to the appropriateness of the various aspects of the buffer. This was strictly an assessment based on the investigators expertise and site conditions.

<u>Section 6</u> is a summary section. Probable factors affecting buffer and compensation wetland functioning were identified and a general analysis of the wetland system was given. This section provided an opportunity for further comments not solicited from specific questions on the form.

**<u>Attachment 4</u> - SPECIES LIST**

## Plant Species Key

### Trees

ACERMACR - Acer macrophyllum - Big Leaf Maple
ALNURUBR - Alnus rubra - Red Alder
FRAXLATI - Fraxinus latifolia - Ash
PICESITC - Picea sitchensis - Sitka Spruce
POPUTREM - Populus tremuloides - Trembling Aspen
POPUTRIC - Populus trichocarpa - Western Cottonwood
PSEUMENZ - Pseudotsuga menziesii - Douglas' Fir
RHAMPURS - Rhamnus purshiana - Cascara (Buckthorn)
THUJPLIC - Thuja plicata - Western Red Cedar
TSUGHETE - Tsuga heterophylla - Lowland Hemlock

### Shrubs

ACERCIRC - Acer circinatum - Vine Maple
BERBNERV - Berberis nervosa - Cascade Oregon Grape
CORNSTOL - Cornus stolonifera - Red Osier Dogwood
CORYCORN - Corylus cornuta - Hazelnut
CRAE - Crataegus spp. - Hawthorne
CYSTSCOP - Cytisus scoparius - Scott's Broom
GAULSHAL - Gaultheria shallon - Salal
HOLODISC - Holodiscus discolor - Oceanspray
ILEXAQUI - Ilex aquifolium - English Holly
LEDUGROE - Ledum groenlandicum - Bog Labrador Tea
LONIINVO - Lonicera involucrata - Black Twin-berry
MENZFERR - Menziesia ferruginea - Fool's Huckleberry
OEMLCERA - Oemleria cerasiformis - Indian Plum
PRUNEMAR - Prunus emarginata - Bittercherry
PYRUFUSC - Pyrus fusca - Ninebark
RIBEBRACT- Ribes bracteosum - Common Current
RIBESANG - Ribes sanguineum - Red Current
ROSAGYMN - Rosa gymnocarpa - Little Wild Rose
ROSAPISO - Rosa pisocarpa - Clustered Wild Rose
RUBUDISC - Rubus discolor - Himalayan Blackberry
RUBULASI - Rubus laciniatus - Evergreen Blackberry
RUBUPARV - Rubus parviflorus - Thimbleberry
RUBUSPEC - Rubus spectablilis - Salmonberry
RUBUURSI - Rubus ursinus - Dewberry
SALILASI - Salix lasiandra - Pacific Willow
SALIPEDI - Salix pedicellaris - Bog Willow

SALISCOU - Salix scoulerleriana - Scouler's Willow
SALISITC - Salix sitchensis - Sitka Willow
SAMBRACE - Sambucus racemosa - Red Elderberry
SORBAMER - Sorbus aucuparia - European Mountain Ash
SORBSCOP - Sorbus scopulina - Cascade Mountain Ash
SPIRDOUG - Spirea douglasii - Douglas' Hardhack
SYMPALBA - Symphoricarpos albus - Snowberry
TAXUBREV - Taxus brevifolia - Pacific Yew
VACCOXYC - Vaccinium oxycoccos - Bog Cranberry
VACCPARV - Vaccinium parvifolium - Red Huckleberry
VACCSCOP - Vaccinium scoparium - Whortleberry

**Ferns/Horsetails**

ATHYFELI - Athyrium felix-femina - Lady Fern
BLECSPIC - Blechnum spicant - Deer Fern
DRYOAUST - Dryopteris austriaca - Mountain Woodfern
EQUIARVE - Equisetum arvense - Common Horsetail
EQUIHYEM - Equisetum hyemale - Common Scouring Rush
EQUITELMA- Equisetum telmateia - Giant Horsetail

**Herbs**

ACTERUBR - Actea rubra - Bane Berry
ANAPMARG - Anaphalis margaritacea - Pearley Everlasting
BIDECERN - Bidens cernua - Nodding Beggar-tick
CIRCARVE - Circium arvense - Canada Thistle
CLAYLANC - Claytonia lanceolata - Western Spring Beauty
CONVSEPI - Convolvus sepium - Hedge Bindweed
DICEFORM - Dicentra formosa - Bleeding Heart
DIGIPURP - Digitalis purpurea - Foxglove
EPILANGU - Epilobium angustifolium - Fireweed
EPILWATS - Epilobium watsonii - Watson's Fireweed
GALI - Galium spp. - Bedstraw
GALITRIF - Galium trifidum - Small Bedstraw
GEUMMACR - Geum macrophyllum - Bigleaf Cinquefoil
GNAPULIG - Gnaphalium uliginosum - Marsh Cudweed
GYMNDRYO - Gymnocarpium dryopteris - Oakfern
HEDEHELI - Hedera helix - English Ivy
HIERNUDI - Hieracium spp. - Hawkweed
HYPEFORM - Hypericum formosum - Western St.Johnswort
HYPEPERF - Hypericum perforatum - Common St.Johnswort
IMPA - Imaptiens spp.- Touch-Me-Not
IRISPSEU - Iris pseudachorus - Yellow Flag
LEMNMINO - Lemna minor - Water Lentil (Duck weed)

LICH - Lichen spp.
LINNBORE - Linnaea borealis - Twin Flower
LOTUCORN - Lotus corniculatis - Bird'sfoot Trefoil
LUDWPALU - Ludwigia palustris - Water Purslane
LYSIAMER - Lysichitum americanum - Western Skunk Cabbage
MAIADILA - Maianthemum dilatatum - False Lily of the Valley
MENYTRIF - Menyanthes trifoliata - Bogbean
MIMUGUTT - Mimulus guttatus - Yellow Monkeyflower
MONTSIBE - Montia siberica - Western Springbeauty
MUSC - Musci spp. - Moss
MYOSLAXA - Myosotis laxa - Small Flowered Forget-me-not
NUPHPOLY - Nuphar polysepalum - Yelloy Pond Lily
OENASARM - Oenanthe sarmentosa - Water Parsley
OPLOHORR - Oplopanax horridum - Devil's Club
PETASAGI - Petasites sasgittatus - Colt's Foot
PLANLANC - Plantago lanceolata - English Plantain
PLANMACR - Plantago macrocarpa - Alaska Plantain
PLANMAJO - Plantago major - Common Plantain
POLYGLYC - Polypodium glycyrrhiza - Polypody Fern
POLYHYDR - Polygonum hydropiper - Marshpepper Smartweed
POLYMUNI - Polystichum munitum - Sword Fern
POTANATA - Potamogeton natans - Floating-leaved Pondweed
POTEPALU - Potentilla palustris - Marsh Cinquefoil
PTERAQUI - Pteridium aquilinum - Braken Fern
RANUREPE - Ranunculus repens - Creeping Buttercup
RORI - Rorippa spp. - Watercress
RUMECRIS - Rumex crispus - Curley Dock
SCUTLATE - Scutellaria lateriflora - Mad-dog Scutellaria
SMIL - Smilacina spp. - False Solomon's Seal
SOLADULC - Solanum dulcamara - Deadly Nightshade
SPAREMER - Sparganium emersum - Simple-stem Bur-reed
SPAREURO - Sparganium eurycarpum - Broad-fruited Bur-reed
SPHA - Sphagnum spp. - Sphagnum Moss
STACCOOL - Stachys cooleyae - Stachys' Horse-mint
STELMEDI - Stellaria media - Chickweed
TREAMPL - Streptopus amplexifolius - Clasping-leaved Twisted-stalk
TIARTRIF - Tiarella trifoliata - Foamflower
TOLMMENZ - Tolmiea menziesii - Pig-a-Back Plant
TRILOVAT - Trilliumn ovatum - Western White Trillium
TYPHLATI - Typha latifolia - Cattail
URTIDIOI - Urtica dioica - Stinging Nettle
URTILYAL - Urtica dioica var.lyallii - Lyal's Nettle
UTRIMINO - Utricularia minor - Lesser Bladderwort

UTRIVULG - Utricularia vulgaris - Greater Bladderwort
VEROAMER - Veronica amnericana - American Brooklime
VEROSCUT - Veronica scutellata - Marsh Speedwell
VIOL - Viola spp. - Violet

**Grasses/Sedges and Rushes**

AGROSCAB - Agrostis scabra - Winter Bentgrass
AGROTENU - Agrostis tenuis - Colonial Bentgrass
ALOPAQUI - Alopecurus aquatilis - Common Timothy
ALOPPRAT - Alopecurus pratensis- Water Timothy
CAREAQUA - Carex aquatilis - Water Sedge
CAREARCT - Carex arcta - Clustered Sedge
CAREATHR - Carex athrostachya
CARELAEV - Carex laeviculmis - Smooth Stem Sedge
CAREOBNU - Carex obnupta - Slough Sedge
CAREPARV - Carex parryana - Parry Sedge
CAREPAUC - Carex pauciflora - Few-flowered Sedge
CAREROST - Carex rostrata -
CARETUMI - Carex tumulicola - Foothill Sedge
CAREUNIL - Carex unilateralis - One-sided Sedge
CAREVESI - Carex vesicaria - Inflated Sedge
DACTGLOM - Dactylis glomerata - Orchard Grass
ELEOOVAT - Eleocharis ovata - Ovoid Spikerush
ELEOPALU - Eleocharis palustris - Common Spikerush
FESTRUBR - Festuca rubra - Red Fescue
GLYCELAT - Glyceria spp. - Mannagrass
GLYCGRAN - Glyceria grandis - Reed Mannagrass
HOLCLANA - Holcus lanatus - Common Velvetgrass
JUNCACUM - Juncus acuminatus - Tapered Rush
JUNCBUFF - Juncus bufonius - Toad Rush
JUNCEFFU - Juncus effusus - Soft Rush
JUNCENSI - Juncus ensifolius - Dagger-leaf Rush
JUNCTENU - Juncus tenuis - Slender Rush
JUNCUNIC - Juncus unicialis - NCN
LOLIPALU - Lolium palustriis - Perennial Ryegrass
LUZUPARV - Luzula parviflora - Small-flowered Woodrush
PHALARUN - Phalaris arundinaceae - Reed Canary Grass
PHLEPRAT - Phleum pratense - Timothy
POAPALU - Poa palustris - Fowl Bluegrass
POAPRAT - Poa pratensis - Kentucky Bluegrass
PUCCPAUC - Puccinellia pauciflora - Small-Flowered Puccinellia
SCIRCYPE - Scirpus cyperinus - Wool-grass
SCIRMACR - Scirpus microcarpus - Small-fruited Bullrush

**Attachment 5 - BUFFER SITE COMPLETED FIELD FORMS**

**(species eight letter codes are found in Attachment 3)**

**BUFFER SITE** #1 **LOCATION:** 84th Ave W and 220-224th St SW Snohomish
**STR:** /27N/4E THOMAS BROS. PAGE: 58 DRAINAGE: Lake Ballinger

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**TYPE OF LAND USE CHANGE:** Created wetland to east.

**PRE-EXISTING SITE CONDITIONS:** Sphagnum bog; some open water; few residences to west; a road cutting the wetland in half; second half of bog filled. Bog receiving stormwater runoff from nearby houses.

**CURRENT ADJACENT LAND USE:** 75% single family residential, 25% native vegetation.

**BUFFER REQUIREMENTS:** None required; none set by NGPE to protect bog wetland from runoff from west and east; protect bog wetland from physical disturbance (bog is degrading from trampling).

**BUFFER DIMENSIONS?** Various, 10% PSS 6 to 10 feet, 10% shrubs and garbage. Along road (30%) - 0 feet, to west (40%) - 200+ feet, to east - 150+ feet, to north and south - 25 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1989-90

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** Slopes 4:1; species complexity high; community complexity medium; filled in portion currently restored to POW/PEM/PSS. The buffers are functioning as variably as their widths. There is no buffer along the road. Road runoff enters the wetland directly, presumably adding a high heavy metal load and changing the pH. The buffer to the north is functioning because there is a physical barrier, and stormwater is diverted to other directions. The buffer to the west is 500+ feet and is functioning well as there is very little evidence of disturbance to the wetland from this direction. The buffer to the south allows people to enter, and this is has resulted in paths being established in the buffer.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** Two+ acres total, 70% POW, 10% PEM, 20% PSS. The bog is dying as a result of past inputs of stormwater. Category 1 wetland. There is a heavy Potentilla Palustris infestation of the floating mat, which is taking over the mat community. It is not known if the new buffer and the created wetland across the road will help in treating the wetland, help to re-establish the pH, and decrease the heavy metal content. The physical disturbance from people entering the wetland from the south is causing degradation along the foot path. Runoff= point and non-point, chemical, siltation, turbidity, oil, grease. Wildlife= birds, mammals, amphibians. Habitat= snags, brush/cover, complex vegetation. Vegetation= Thujplic, Tsughete, Pinumont, Sali scou, Salilasi/ Kalmmicr, Ledugroe, Spirdoug, Potenate, Nuphpoly, Patepalu, Drosrotu, Sphag, Vaccoxyc, Careobnu, Eriospp, Junceffu.

**CRITICAL COMPONENTS OF FUNCTIONING:** Protection from physical disturbance along east, north and west sides of the wetland. Protection from stormwater inputs from the residences to the west, and the road that bisects the wetlands north/south.

**WERE THE BUFFER GOALS MET?** Partially; variable as the buffer types and widths for the most part; the physical disturbance to the north is gone, the disturbance to the south is quite bad and the bog community is degrading quite badly. The stormwater inputs from the west are probably no longer a problem as they are being treated in the created wetland.

**BUFFER SITE** #2 **LOCATION:** 127 St SW and 55 Ave W, Snohomish
**STR:** /28 N/4E THOMAS BROS. PAGE: 48 DRAINAGE: Lake Serene?

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**TYPE OF LAND USE CHANGE**: Single family residential development

**PRE-EXISTING SITE CONDITIONS:** Diverse vegetation communities, wetland mosaic of POW, PSS, and PFO. Slopes were steeper 3:1. Upland buffer was less developed and had up to 50% native vegetation.

**CURRENT ADJACENT LAND USE:** 90% single family residential, 10% native vegetation

**BUFFER REQUIREMENTS:** Not located

**BUFFER DIMENSIONS?** Various, 0 to 20 feet throughout

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987-1989

**IMPLEMENTED AS PLANNED?** As far as can be determined, yes.

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** Slopes 2:1 for 50%, 3:1 for 50%. Human, dogs intrusion into buffer, a structured outlet built into the wetland; species complexity med to low given many community types, community complexity high. (5%) yard waste and debris, (85%) grass lawn fencing and beauty bark, (10%) planted native shrubs; runoff= fertilizer inputs, oil and grease, small amount of siltation occurring non-point and physical inputs via landscaping debris; wildlife= bullfrogs, and domesticated animals, little to no small mammal, few birds, no fish visible; habitat features= snags, brush, and food species (willows, crab apples).

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** Two to five acres of mixed POW (40%), PEM (10%), PSS (30%), and PFO (20%); probably a Category 2 wetland; vegetation= Alnurubu, Thujplic, Tsughete, Spirdoug, Salispp, Pyrufusc, Lemnmino, Ludwpalu, Scirmicro, Junceffu, Irispseu, Typhlati, Agrospp, Juncensi, Oenasarm, Carerost

**CRITICAL COMPONENTS OF FUNCTIONING:** Little or no protection from either physical disturbance as lawn beckons people to the wetlands edge, or from stormwater inputs as grass acts little to absorb toxicants and the buffer is fertilized lawn. Overflow from the road enters the edge directly so siltation is likely a problem during large storm events. Impacts to the wetland are apparent from the low species diversity on the edge, algal blooms, siltation, and presence of garbage around the edge.

**WERE THE BUFFER GOALS MET?** For the most part, no. The buffer is highly modified and currently contains debris. The wetland shows some signs of impact which are expected to get worse. Impacts are due to impacts to the buffer itself, the lack of buffer in some places, and the inadequate size of the buffer in others.

**BUFFER SITE** #3 **LOCATION:** 112th Ave NE and 108th Ave NE between 155 and 158th St. King County
**STR:** 17/26/5E THOMAS BROS. PAGE: 4 DRAINAGE: Juanita Creek

**TYPE OF LAND USE CHANGE:** Five large single family residential units

**PRE-EXISTING SITE CONDITIONS:** 60-year, second growth forest (mixed deciduous/coniferous) bordering 19 acre scrub/shrub wetland that grades into Lake Washington.

**CURRENT ADJACENT LAND USE:** Surrounding land use= 60% residential (80% single family, 20% multi-family), and 40% native vegetation. Site is an abandoned farm.

**BUFFER REQUIREMENTS:** 50-foot buffer required, allowed development right to edge of wetland

**BUFFER DIMENSIONS:** Various, 10 to 100 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** fall 1989

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** Not only no buffer, but first 20 feet of wetland are acting as a buffer for the rest of the wetland. Highly impacted. Residents are cutting down trees for view, yard debris is being deposited, back yards extend into the wetland; 20% forested, 65% residential, 10% lawns and 5% paved surface; there is a trail that runs along the margin of the wetland which gives access for humans and pets into the wetland; species complexity is low to moderate, community complexity is low to moderate; impacts to the buffer include clearing, invasion by pets, a walkway within the buffer, fill, and storm drain construction.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 2.5 acres total, 50% PEM, 50% PSS/PFO. Invasive species are out-competing natural vegetation (Rubudisc replacing COST, Salispp) Vegetation= Alnurubu, Oemlcera, Rubuspec, Rubudisc, Salispp, Spridoug, Typhlati, Veroamer, Ranurepe, Equiarve, Agrospp, Junceffu, Holcspp, Scirmicro, Phalarun, Ludwpalu. Runoff= non-point, small chemical and physical disturbance, some turbidity in water, oil and grease present, high siltation in places. Wildlife use= low on the south side, moderate to high for birds, mammals, amphibians. Habitat features= snags, brush/cover, food species, and vegetation complexity.

**CRITICAL COMPONENTS OF FUNCTIONING:** Siltation is occurring from the stream channel at the top of the property. The stream has been channelized and placed through a culvert into and out of the wetland. There is obvious decreased water quality and habitat complexity resulting from both lack of buffer and type of buffer, where present (lawn). Fences have been built into the buffer and yard waste thrown over them just out of sight. Access into the buffer and wetland via the path that runs adjacent to the wetland.  This encourages human and pet intrusion.  Wetland and buffer degradation has occurred since 1988.

**WERE THE BUFFER GOALS MET?**  The buffer is acting as biofiltration and nutrient uptake for part of its length, habitat diversity is maintained for 1/3 of the diameter of the wetland, not much but some help, physical intrusion is blocked by fences and in thick vegetation zone, however entrance can occur at other points.  Goals to the south along the road were to build a 10-foot grassy walkaway.  In this instance the goal was met, but was unrealistic in terms of buffering the wetland from any negative impact.  Setbacks for the houses should not have been included in the lots, and trails should not have been built in the buffer.

**BUFFER SITE** #4 **LOCATION:** Inglewood Rd. and NE 165th St King County

**STR:** 11/26/4E THOMAS BROS. PAGE: 3 DRAINAGE: East Lake Washington

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**TYPE OF LAND USE CHANGE:** Single family residential, 5 units built

**PRE-EXISTING SITE CONDITIONS:** A scrub-shrub wetland contiguous to Lake Washington. The buffer to the south was old growth black cottonwood, willow, and big leaf maple. The wetland has been receiving nutrient-rich overflow from an adjacent golf course for many years.

**CURRENT ADJACENT LAND USE:** 25% single family residential, 25% multifamily residential, 25% road edge adjacent to a golf course, 25% adjacent to Lake Washington

**BUFFER REQUIREMENTS:** None set. There were no setback requirements established for this project.

**BUFFER DIMENSIONS:** Various, 0 feet along the southern boundary, 5 to 10 feet along the eastern boundary, the Lake to the west, and 0 feet to the north where there is an existing multifamily residential unit.

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** Fall 1988, winter 1989

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** 25% open lake, no buffer to north or south where there are high density single family and multifamily residences. The edge of the wetland is acting as the buffer to the rest of the wetland. Yard debris and fill is being deposited, trees are being cut down for a view, invasive vegetation (Himalayan blackberry) is taking over. The wetland is being mowed and ornamental species are planted in the wetland on the north side. The road to the east and the ten-foot buffer strip are not large enough to filter sediments, oil and grease, point and non-point source pollution, and nutrients that come off the golf course. Wildlife non-existent except for rats.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 9.5 acres. (15%) PEM, (30%) PFO, (65%) PSS, plus adjacent to Lake edge. Possible Category 2 wetland. There is a high impact from the residents to the north and south where physical damage is occurring from cutting down of trees, removal of shrubs, deposition of yard waste, invasion by blackberry. The shifting of the water table such that ten very large trees fell down within a year of the development going in. Runoff=chemical inputs, mostly nutrients that come off the golf course, sedimentation, oil and grease, point and non-point source pollution. Wildlife use= birds, mammals, amphibians, prey species and possibly fish. Habitat features= few snags, high brush/cover, high food species, and vegetation complexity.   Vegetation= Poputric, Alnurubu, Salilasi, Saliscou, Salisitc, Cornstol, Oemlcera, Loniinvo, Rubuspec, Rubudisc, Spirdoug, Tolmmenz, Ranurepe, Scirmicro, Phalarun, Carespp..

**CRITICAL COMPONENTS OF FUNCTIONING:** The wetland is currently functioning as the buffer to the rest of the wetland.  The residents appear to consider the wetland edge their property for placing debris, and cutting down trees.

**WERE THE BUFFER GOALS MET?** No, because there were no buffer goals established.  There is no buffer for a large portion of the site.

**BUFFER SITE** #5 **LOCATION:** 134-135 Ave NE, and NE 187-190 St. King County
**STR:** 3/26N/5E THOMAS BROS. PAGE: 4 DRAINAGE: Bear Creek

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**TYPE OF LAND USE CHANGE:** Several units of single family residences.

**PRE-EXISTING SITE CONDITIONS:** Unknown, except that a portion likely was native vegetation.

**CURRENT ADJACENT LAND USE:** 40% single family residential, 60% native vegetation

**BUFFER REQUIREMENTS:** 50-foot throughout

**BUFFER DIMENSIONS:** Various, 0 to 50

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1986

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** There is minimal species or community complexity in the 50-foot buffer and no vegetation along the edge of a gravel road also included in the 50-foot buffer. Runoff= point and non-point, chemicals. Wildlife use is moderate to high for birds, and low for mammals. Bush cover habitat is high and there are a few snags, but food species and vegetation complexity are both low. There has been repeated dumping of debris, both lawn waste and refuse. There has also been some filling in the buffer. Portions of the buffer act to trap sediment and nutrients, but this capacity is low, protection from intrusion is variable and flood storage and groundwater recharge is minimal. Dumping is a problem. The development has altered the hydrology and there is lots of tree death.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 15 to 20% POW, 80 to 85% PSS acreage unknown wetland, probably Category 2. There are some definite negative impacts to the wetland resulting from dumping, filling, landscaping, and allowing runoff to directly enter the wetland. Runoff= point and non-point source, chemical (nutrients from fertilizer, road runoff (heavy metals). Wildlife= mammals, fish, amphibians, and prey species. Habitat features= few snags, many brush/cover possibilities, lots of food species, and the vegetation complexity is moderate to high. Vegetation= Salispp, Spridoug, Potepalu, Phalarun.

**CRITICAL COMPONENTS OF FUNCTIONING:** The gravel road along the edge of the wetland offers no real buffering capacity. The wetland is receiving runoff with elevated nutrient contents directly from the lots. Species richness in the buffer is lacking and the back side of a few of the lots no longer has the 50-foot buffer left. The lots have claimed the area for lawn and now mow the area constantly. The variable buffer width and the type of buffer implemented seem to be the cause for the non-functioning of the buffer. Stormwater and physical disturbance are reaching the wetland via the sections of the buffer that are non-existent or greatly reduced, or are of less capacity for functioning as a buffer (gravel road).

**WERE THE BUFFER GOALS MET?** Some of the buffer goals were met initially, but over time these have been limited and it is projected that the buffer functioning will decrease even more over time, as increased urban pressure is met. A 50-foot buffer was not maintained over time. The wetland looks good despite the many limits to the buffer. Enforcement of buffers would really help here as well as policing the dumping. Some of the buffer should be increased in size, or made into more protective buffer communities (e.g., shrub). NGPE should be taken out of private hands. The plat requirements were in conflict with resource protection requirements.

**BUFFER SITE** #6 **LOCATION:** 189-196 Ave NE and Snohomish City line and NE 202 St. King County
**STR:** 6/26N/6E THOMAS BROS. PAGE 5 DRAINAGE: Bear/ Evans Creek

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**TYPE OF LAND USE CHANGE:** Construction of many single family lots

**PRE-EXISTING SITE CONDITIONS:** Old second growth forested almost 100%

**CURRENT ADJACENT LAND USE:** 85% single family residential, 15% native vegetation.

**BUFFER REQUIREMENTS:** 50+ feet, oil separators and R/D ponds not in the buffer.

**BUFFER DIMENSIONS:** Various, greater than 50 feet in general. 50+ feet in forested area, with 15% of the buffer 15-foot paved road setback.

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The species and community complexity is moderate to high. There is runoff into the buffer from street. The buffer looks intact and not impacted to a large degree. No visible debris, but there is cutting of trees.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 80% PSS, 20% PFO wetland is approximately 2 acres in size, a Category 3 wetland. The wetland is healthy and shows little impact from surrounding development. Runoff is point source from stormwater placed through a culvert. Wildlife use= moderate bird, small mammal, and amphibian use. Habitat features include snags, brush/cover, food species, and vegetation complexity. Vegetation= Thujplic, Alnurubu, Rubuspec, Pyrufusc, Loniinvo, Gaulshal, Potenate, Ranurepe.

**CRITICAL COMPONENTS OF FUNCTIONING:** The buffer is functioning for biofiltration, nutrient uptake from adjacent lots, habitat diversity, and protection from intrusion. Flood storage is not really an issue, but the wetland is a basin and could act in this capacity, too. One factor which may contribute to of the lack of debris is the high cost of the homes, and the point that most houses appear to have landscaping services that remove the debris to off-site locations.

**WERE THE BUFFER GOALS MET?** Yes. They were not only met, but are providing the best protection seen for this study. There has been no visible degradation since the 1988 study.

**BUFFER SITE** #7 **LOCATION:** NE Novelty Hill Rd. and 212 E and 220th Ave NE, King County
**STR:** 33/26N/6E THOMAS BROS. PAGE: 11 DRAINAGE: Bear-Evans Creek

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**TYPE OF LAND USE CHANGE:** High density single family residences

**PRE-EXISTING SITE CONDITIONS:** 100% forested, old, second growth with moderate to high species and community complexity.

**CURRENT ADJACENT LAND USE:** 100% single family homes, small lots

**BUFFER REQUIREMENTS:** 30 feet

**BUFFER DIMENSIONS:** Various, 15-foot beauty bark setback from the wetland edge and road, low species or community complexity. Zero to 100 feet in areas that are landscaped, 0 to 50 feet on the back of the residential lots.

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1988

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** Sediment entrapment, few domestic animals, but no signs of wildlife, no birds, amphibians, or small mammals. Where there is vegetation in the buffer, the species are complex. The buffer has been removed in some places, or the underbrush has been removed and beauty bark placed in its stead.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 100% PFO, mixed conifer and deciduous wetlands restricted to thin corridors. Runoff= point and non-point source carrying nutrients and stormwater, siltation is high. Wildlife use is limited to a few birds, and dogs and cats. Habitat features in the wetland are a few snags, some brush for cover, and low species complexity. Vegetation= Thujplic, Tsughete, Alnurubu, Rubuspec, Gaulshal, Oemlcera, Lysiamer, Ranurepe, Oenasarm, Scirmicr.

**CRITICAL COMPONENTS OF FUNCTIONING**: The buffer is failing to function because it does not exist for a large portion of the area surrounding the wetland. Biofiltration is low, nutrient uptake is low, habitat diversity is low, no protection from intrusion, flood storage is good because located in a basin. There is no noise screening from the Novelty Hill road and wildlife doesn't appear to use the site. There is physical damage due to deposition of debris and garbage. There is nutrient input into the wetland from lawn fertilizer service.

**WERE THE BUFFER GOALS MET?** No. The requirements set by the NGPE were too small to adequately protect the wetland from the density of the lots. Many of the lots had the buffer incorporated into the back of the lot. These have since been made lawn and are now included into the property. Much wetland area has been lost since the 1990 inventory. The lots are located on steep banks that are adjacent to the wetland edge. Lack of a buffer and steepness of slope has made erosion a problem, so siltation is high. Cement trucks have cleaned out into the wetland in two areas. There is a need for enforcement after construction, and an inspector on site during development. Comparison to 1988 study shows continued heavy siltation, continued removal of buffer, because very few of the houses were in at the time.

**BUFFER SITE** #8 **LOCATION:** NE 133 and NE 145th and 214-228 Ave NE, King County
**STR:**21/26N/6E THOMAS BROS. PAGE: 12 DRAINAGE: Bear Creek

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**TYPE OF LAND USE CHANGE:** Phased of units of single family residences, medium density.

**PRE-EXISTING SITE CONDITIONS**: Medium age second growth forest, some newly logged, (late 70s interspersed with wetlands (BBC 25,26,27), some large, some small.

**CURRENT ADJACENT LAND USE:** 95% single family, 5% native vegetation, near phase 1 of the development.

**BUFFER REQUIREMENTS:** 50 feet, fences off the lots abutting the water, and an educational brochure to be given to residents explaining the wetlands and their value.

**BUFFER DIMENSIONS:** Various, 50 to 200 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The buffer does not receive runoff. It does offer a diverse vegetation community so there is habitat for birds, small mammals and limited amphibian populations. There are a few snags, and lots of brush for cover. The buffer is cleared in some places to the lakes' edge. There are deposits of yard debris along the bottom of many lots. There is a path that has been cut throughout the buffer edge around the lake. This enables people and pets to access the wetland directly.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** BBC27= 80% POW, 20% PSS, 16.5 acres in size. The wetland is a likely a Category 2 wetland. There is impact in the wetland due to runoff problems, siltation, turbidity, etc. Runoff= point and non-point source inputs of nutrients and stormwater. There is some siltation, and a minor amount of turbidity, although both have been a problem during the different construction phases. Wildlife use includes birds and some amphibians. There are a few snags, and shrubs, and there are many food species growing in the wetland. Vegetation complexity in the wetland is low because so much of the area is open water. Vegetation= Alnurubu, Oemlcera, Rubuspec, Ranurepe, Scirmicro.

**CRITICAL COMPONENTS OF FUNCTIONING:** There is biofiltration, nutrient uptake, habitat diversity from diverse community left, flood storage because the wetland is in a basin.

**WERE THE BUFFER GOALS MET?** Not for stormwater intrusion and sedimentation, but yes for everything else. Prevention of intrusion would be hard to do even given a 200-foot buffer. The only solution would be to fence off the wetland from access.

**BUFFER SITE** #9 **LOCATION:** 224 Ave NE and Union Hill Rd., King County
**STR:** 9/25N/6E THOMAS BROS. PAGE: 17 DRAINAGE: Evans Creek

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**TYPE OF LAND USE CHANGE:** Construction of many lots of single family residential units.

**PRE-EXISTING SITE CONDITIONS:**

**CURRENT ADJACENT LAND USE:** 70% single family residential units, 30% native vegetation (young second growth).

**BUFFER REQUIREMENTS:** 50 feet

**BUFFER DIMENSIONS:** Various, 0 to 100 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** Mostly yes. There were a few small areas where the NGPE was cleared but mostly as planned.

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The buffer varies from lawns to multi-canopy communities. Forested, shrub and residential areas are all included in the buffer. There is some landscaping debris left all over the site. The buffer receives point and non-point source runoff which is nutrient and road runoff laden. The buffer is mowed for about 25% of its length. There are signs of domestic animals, birds and small mammals. There is a diverse habitat with many snags, brush for cover and food species.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 70% PFO mixed conifer hardwoods, 15% PEM cattail, enhanced R/D pond, 15% PSS. The buffer has been removed in some areas and there is no buffer left between the wetland and the houses. The presence of simple lawn buffers does little to fulfill many of the attributes. Lawns abut the wetland and landscaping debris is thrown into the wetland. The R/D pond receives too much nutrient laden water from the commercial lawn care companies and it is loaded with algae. Vegetation= Thujplic, Alnurubu, Tsughete, Acermacr, Rubuspec, Oemlcera, Loniinvo, Ribespp, Typhlati, Veroamer, Oenasarm, Scirmicr.

**CRITICAL COMPONENTS OF FUNCTIONING:** The buffer is currently functioning to act as biofiltration and nutrient uptake for most of the stormwater that passes into the wetland. This does not work for those areas where the buffer has been removed. It also acts for flood storage

**WERE THE BUFFER GOALS MET?** The goals were met but they were too simplistic. There is little community complexity to offer diverse habitat for wildlife. The buffers were placed in the lots and over time many of the homeowners have leveled the buffer and made more lawn out of the area. The rest of the buffer looks good. The R/D ponds look sufficiently large to contain large storm events. Water quality has improved since 1988 after construction. The amount of siltation has decreased.

**BUFFER SITE** #10  **LOCATION:** 221St and 225 Ave NE , and NE 16-20th St., King County
**STR:** 28/25N/6E  THOMAS BROS. PAGE: 23  DRAINAGE: Evans Creek

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**TYPE OF LAND USE CHANGE:** High density single family residences

**PRE-EXISTING SITE CONDITIONS:**

**CURRENT ADJACENT LAND USE:** 100% small lot single family residences

**BUFFER REQUIREMENTS:** 50-foot

**BUFFER DIMENSIONS:** Various, 0 to 50-foot buffer

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** There are steep slopes (60 to 80 degree), low species complexity, and moderate community complexity. Forested, grass landscaping and residential areas to buffer. Erosion is a factor because of the steepness of the slopes. The forested areas has some wildlife habitat value because of a few snags, and some brush for cover. The buffer has been impacted by removal over time of that portion which was included in the lots. Portions are now grassy lawn.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 100% PFO. Acreage less than 10 acres and is a Category 2 wetland. The wetland has been impacted over time by channelizing the stream that flows through it. Vegetation species complexity has been lost as a result of the loss of buffer. The wetland is now completely surrounded by homes. Much landscaping debris has been deposited into the wetland over time. Vegetation= Thujplic, Tsughete, Acermacr, Rubuspec, Cornstol, Acercirc, Spirdoug, Sambrace, Vaccparv.

**CRITICAL COMPONENTS OF FUNCTIONING:** The buffer no longer acts for biofiltration or removal of fertilizer amendments. There is marginal habitat diversity, and the protection from intrusion is afforded only by the steepness of the slope, not the buffer itself. There are no flood storage or recharge functions.

**WERE THE BUFFER GOALS MET?** Yes, but these goals were not sufficient to ensure maintenance of the wetland in an unaltered state. The wetland was in effect "hidden" behind the houses. There should have been an additional 50 to 100 feet of buffer left beyond the lots.

**BUFFER SITE** #11 **LOCATION:** NE 16 and 20th, and 221-225 Ave NE, King County
**STR:** 28/25N/6E THOMAS BROS. PAGE: 23 DRAINAGE:Evans Creek

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**TYPE OF LAND USE CHANGE:** Construction of multiple single family residences

**PRE-EXISTING SITE CONDITIONS:** 100% upland forest (mixed coniferous/deciduous)

**CURRENT ADJACENT LAND USE:** 70% single family residential, 30% native vegetation (40 year old second growth)

**BUFFER REQUIREMENTS:** 50 feet

**BUFFER DIMENSIONS:** Various, 5 to 50 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** There are moderate to level slopes. The species and community complexity are moderate to high. The 50-foot buffer has been maintained for most of the length around both wetlands. There are a few places where it disappears; one is along a road that accesses the wetland where it is simply a paved surface. There is debris along the lot edges that abut the wetland.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 2 wetlands; Evans Creek 28, 29; both are likely to be Category 2 wetlands. Runoff= point and non-point source inputs of road runoff and fertilizer laden water. There are physical disturbances to certain access points in the wetland, wildlife common, especially birds, and many small mammal indicators as well as amphibians. Habitat potential high= snags, shrubs for cover, food species and vegetation complexity. Vegetation= Tsughete, Thujplic, Acercirc, Sambrace, Rubuspec, Oemlcera, Cornstol, Spirdoug Polymuni, Urtidioe.

**CRITICAL COMPONENTS OF FUNCTIONING:** The functions of biofiltration and nutrient uptake occur in the R/D ponds and grass-lined swales that are located prior to discharge to the wetland and buffer zone. Habitat value overall is high although in a few places the buffer breaks down and is very small.

**WERE THE BUFFER GOALS MET?** Yes, and they appear to have held up better than most over time, and perform better than the goals stated they needed to.

**BUFFER SITE** #12 **LOCATION:** E 212 Ave Se and SE 32nd St., King County
**STR:** 9/24N/6E THOMAS BROS. PAGE: 24 DRAINAGE: East Lake Sammamish

**TYPE OF LAND USE CHANGE:** Construction of single family residential units

**PRE-EXISTING SITE CONDITIONS:** 80% forested upland, 20% agriculture fields

**CURRENT ADJACENT LAND USE:** 70% single family residences, 30% native vegetation

**BUFFER REQUIREMENTS:** 25 feet

**BUFFER DIMENSIONS:** various, 0 to 50 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1983

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The buffer has been reduced and fences established along the back of all lots examined. The buffer was incorporated within the fenced lots. Most (90%) of the buffer areas have been altered over the time this project has been in. The attitude of the owners interviewed is that it is their property to do with what they want. There was very little dumping of yard waste.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 54 acres. King County inventoried as wetland #ELS 30. Possibly Category 1 wetland. 60% PEM (Typhlati Phalarun), 30% PSS (Rubudisc, spirdoug), and 10% BOG. Bog portion looks like it is being encroached by Typha and spirea. There are minimal inputs of point and non-point stormwater. There is fertilizer input from some of the lots near the bog and PEM zone. Siltation is high in some areas. Wildlife use high for birds, medium to high for mammals, and medium (potential) for amphibians. There are many snags and much brush vegetation for cover. There are food species present, vegetation complexity overall high but low in some areas. Also, edges at access points are solid Himalayan blackberry. Vegetation= Alnurubr, Thujplic, Tsughete,

**CRITICAL COMPONENTS OF FUNCTIONING:** There is no prevention of stormwater input which is causing degradation of bog and an increase in size of Typha/Phalaris PEM zone. Most of the buffer acts as a physical barrier, noise reduction is achieved from most of the development, visible screening good, high habitat value in some places for upland habitat.

**WERE THE BUFFER GOALS MET?** Yes, for physical and visible barrier, but not for stormwater input.

**BUFFER SITE** #13 **LOCATION:** Issaquah Pine Lake Rd, King County
**STR**: THOMAS BROS. PAGE: 30 DRAINAGE: East Lake Sammamish

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**TYPE OF LAND USE CHANGE:** Construction of many single family residential units.

**PRE-EXISTING SITE CONDITIONS:** Open space, agricultural.

**CURRENT ADJACENT LAND USE:** 85% single family residential (with 50% pavement buffer, and 35% houses adjacent buffer
grass) and 15% native vegetation.

**BUFFER REQUIREMENTS:** 100-foot consisting of grassy swales.

**BUFFER DIMENSIONS:** Various, 0 to 35 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1986

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The buffer has landscaping debris deposited and the species complexity and community complexity are both low. Much of the buffer consists of mowed lawn combined with a paved portion that abuts to the residential lots. The wildlife value is low but there are still birds and small mammals. There are signs of domestic animals present. There are a few snags and brush for cover present, and there are food species present. The buffer was installed but is currently being mowed along with the landscaping so that the shrubs are cut off.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 90% POW, 5% PEM, 5% PSS. 1.5 acres compensation, and four acres original wetland. Possible Category 2 wetland. There is debris deposited into the wetland, mostly as a result of landscaping activity. Runoff= point and non-point source including heavy fertilizer inputs. There is a small amount of siltation currently present although during construction this was a problem. Bird use is high and small mammal use is moderate to low. There are no snags or brush in the wetland, but food species are present and vegetation complexity is low to moderate. Vegetation= Thujplic, Alnurubu, Tsughete, Pyrufusc, Cornstol, Salispp, Rubuspec, Loniinvo, Oemlcera, Sambrace, Typhlati, Junceffu, Scirmicr, Phalarun, Veroscut, Carespp, Oenasarm, Lysiamer.

**CRITICAL COMPONENTS OF FUNCTIONING:** The functions of the buffer are limited. There is little to no biofiltration or nutrient uptake functions present. In fact, the presence of lawns increase the rate of fertilizer input to the wetland. Habitat diversity is low and there is no protection from intrusion. The edge of the open water zone is too steep for a good emergent community to develop.

**WERE THE BUFFER GOALS MET?** No, the vegetation for the buffer was planted but is being subsequently mowed for viewing purposes. The goals could be achieved and if the mowing is discontinued it will perhaps function in the future if replanted, but it is not currently functioning. There is no monitoring and no enforcement of the buffer requirements set with the plat.

**BUFFER SITE** #14 **LOCATION:** E. Lk. Sammamish Prkw SE and SE 40th and 204 Ave SE, King County
**STR:** 17/24N/6E THOMAS BROS. PAGE 29 DRAINAGE: East Lake Sammamish

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**TYPE OF LAND USE CHANGE:** Construction of multiple units of single family residential

**PRE-EXISTING SITE CONDITIONS:** An old farm site. Grass pasture, blackberries, orchard and a small area with hemlock, cedar forest near the current wetland.

**CURRENT ADJACENT LAND USE:** 100% single family residential

**BUFFER REQUIREMENTS:** 15 feet from top of stream bank and 25 feet from the centerline of the stream or swale

**BUFFER DIMENSIONS:** Various, 0 to 25 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1986

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The NGPE is outside the lots, but there is no buffer on most of the wetland proper. Where it exists, it is so narrow that it functions only as a visual screen. There is yard waste in the wetland off the back of lots one to seven; animal scat and physical disturbance from humans. Runoff enters the wetland directly from the site. There are a few snags and brush for cover present, and there are food species present. Physical damage has resulted in the buffer that does exist as a result of human intrusion.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 95% PFO, 5% PSS. 1.5 acre wetland; likely a Category 3 wetland. Runoff= point and non-point source including fertilizer inputs. Physical damage has occurred in wetland as a result of human paths that cross the wetland. It is a long-linear wetland and is easily impacted from either side. Bird life is present in large numbers, but diversity is low. The wetland is an expanded riparian corridor. Vegetation= Alnu rubu, Thujplic, Tsughete, Poputric, Ssali sitc, ZRubuspec, Rubudisc, Rubulasi, Spirdoug, Oenasarm, Lysiamer, Athyfeli, Phalarun

**CRITICAL COMPONENTS OF FUNCTIONING:** The buffer is basically not functioning because it is not present for most of the length of the wetland. It is acting as a visual barrier only in the few areas where there is a little bit of vegetation left.

**WERE THE BUFFER GOALS MET?** No, because there was no buffer installed and there was a 15 to 25-foot requirement.

**BUFFER SITE** #15 **LOCATION:** SE Duthie Hill Rd. and 260-268 Ave., King County
**STR:** 12/24/6E THOMAS BROS. PAGE 24 DRAINAGE: Patterson Creek

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**TYPE OF LAND USE CHANGE:** Construction of many units of single family residential

**PRE-EXISTING SITE CONDITIONS:** Forested young second growth, area logged in 1974

**CURRENT ADJACENT LAND USE:** 85% residential single family units, 15% native vegetation young second growth

**BUFFER REQUIREMENTS:** 50-foot buffer, monitoring central wetland

**BUFFER DIMENSIONS:** Various, 0 to 50 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1985

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** Slope 1:4; the vegetation species complexity is low to moderate, and the community complexity is low (where the lawns have taken over the buffer). Stormwater enters the wetland. Runoff flows through culvert in the buffer to the wetland so the buffer does not act as biofilter or nutrient uptake. There are a few birds in the forested area, and there is a small amount of brush for cover in the shrub area.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 15% PEM, 65% PSS, and 20% PFO. 10+ acres in size; possible Category 2 wetland. The permit allowed stormwater to enter wetland. There is some erosion. Runoff= point and non-point source so that fertilizer rich water enters the wetland. Physical disturbance is high to wetland because of the lack of buffer. Wildlife is high for birds, although species diversity is low, and a few small mammals. There are prey species in the wetland. There are a few snags and brush cover is good for habitat. Vegetation= Alnurubu, Acermacr, Acercirc, Tsughete, Thujpllic, Sambrace, Rubuspec,Rubudisc, Rubulasi, Oemlcera, Cornstol, Spirdoug, Carespp, Phalarun, Ranurepe, Oenasarm, Junceffu, Scirmicr.

**CRITICAL COMPONENTS OF FUNCTIONING:** Buffer is missing or is now lawn so biofiltration and nutrient uptake as well as physical barrier protection are all limited. Habitat diversity is low so wildlife potential is also low. Flood storage is being performed by the wetland so the buffer does not need to provide this.

**WERE THE BUFFER GOALS MET?** Initially yes, but over time the buffers that were incorporated into the lots have disappeared into more lawn space. Wildlife, water retention, and open space are in natural condition. Monitoring should have been done so all the changes could be documented. Now, a fence should be put up as a barrier, and a dense shrub layer planted to prevent further invasion into the wetland.

**BUFFER SITE** #16 **LOCATION:** East side of SR 203 and NE 24-28th St., King County
**STR:** 21/25N/7E THOMAS BROS. PAGE 72 DRAINAGE: Snoqualmie River

**TYPE OF LAND USE CHANGE:** Construction of single family residences, low density

**PRE-EXISTING SITE CONDITIONS:** Pasture land and some young second growth forest

**CURRENT ADJACENT LAND USE:** Residential 65%, native growth 35%

**BUFFER REQUIREMENTS:** 25 feet in areas away from the Creek, and 100 feet adjacent to the Creek.

**BUFFER DIMENSIONS:** Various, 0 to 130 feet. (25% along SR 203 missing)

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1985

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The buffer is route 203 for a section which means there is no buffer and the road runoff flows directly into the wetland. The buffer has been mowed extensively, excavated/or bulldozed in some areas, and trampled in others. The portion that backs onto lots appears to be in the best shape. Only one instance of yard waste was seen. The areas with thick buffer are diverse and healthy and show lots of wildlife, especially birds.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 15+ acres, 70% PEM, 10% PSS, 15% PFO; probably a Category 2 wetland. Banks of the Creek are disturbed physically and chemically (oil residue). Banks of the creek have been highly disturbed by shoes, tires from OTV's. Erosion and sedimentation is occurring in the creek. Vegetation has been trampled in many places (worse than in 1988). Water was clear in 1985, but is now somewhat turbid in places. The stream is salmonid habitat (home owner). Vegetation= Typhlati, Phalarun, Junceffu, Juncensi, Juncaccu, Careobnu, Scirmicr, Oenasarm, Spirdoug, Poputric, Thujplic, Alnu Rubu, Sali Scou, Sali Sitch, Rubuspec, Rubudisc, Oemlcera, Loniinvo, Pyrufusc.

**CRITICAL COMPONENTS OF FUNCTIONING:** Biofiltration occurs for half of the buffer at least along areas where buffer is forested and/or is greater than 50 feet wide (see from presence of invasive species and lack of sediment). Nutrient uptake occurs in areas off back side of lots, but not along SR203. Habitat diversity in forested buffer areas that are thick (greater than 25 feet), but not very diverse off areas that are typha, Phalaris PEM type wetlands that are adjacent to SR203. The buffer is also not aesthetic along SR203. Vegetation community is lacking in the buffers along the road, and in areas north of the PEM pasture. It is good in forested area. Physical disturbance is high in many places within the wetland. The buffer is therefore not functioning in preventing physical disturbance.

**WERE THE BUFFER GOALS MET?** For the most part. The worst problem is the lack of buffer along SR203 where the worst source of point and non-point stormwater inputs. There is also a lot of physical disruption around the wetland and buffer zone. This was also a problem in 1988 during the last buffer analysis.

**BUFFER SITE** #17 **LOCATION:** Kent Kangley Road and Witte Rd. SE, King County
**STR:** 33/22N/6E THOMAS BROS. PAGE: 57, 58 DRAINAGE: Jenkins Creek

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**TYPE OF LAND USE CHANGE:** Construction of a golf course to the south and a club house on the hill above the wetland to the east. Plus several multifamily residential units to the east.

**PRE-EXISTING SITE CONDITIONS:** Uphill was a forest, to the south was forest, and more of a native vegetation zone (now golf course)

**CURRENT ADJACENT LAND USE:** 10% Golf course, 25% single family residential, 35% multifamily residential, and 10 % agricultural.

**BUFFER REQUIREMENTS:** 50 feet

**BUFFER DIMENSIONS:** Various, 0 to 150 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1983 to 1988, with most of the work occurring in 1988

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** 50% is 25 to 150-foot forest buffer, 30% is 0 to 50-foot shrub buffer, and 20% is 0 to 50-foot landscaping grasses. Intrusions consist of physical invasion including erosion and a minor amount of siltation and chemical including point and non-point runoff. The wildlife habitat potential is good. There are many birds, small mammals, and amphibians. The vegetation complexity for both species and community in the intact areas is high.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 15% PEM (carex, grass), 20% PSS (willow, spirea) and 65% PFO (cedar hemlock); 28 acres; possible Category 2 wetland. Runoff= point and non-point source pollution including heavy metals loadings, oil and grease from road runoff and siltation. Wildlife use is high for birds, small mammals, and amphibians and the prey species numbers is low although is increasing with the new lots above the wetland. Habitat features are excellent for all, snags, brush/cover, food species, and vegetation complexity. Vegetation= Tsughete, Thujplic, Alnurubr, Poputric, Oemlcera, Rubuspec, Loniinvo, Smabrace, Menzfere, Oplohorr, Salilasi, Saliscou, Spridoug, Phalarun, Carespp, Scircype, Ranurepe, Athyfeli, Polymuni, Glycgran.

**CRITICAL COMPONENTS OF FUNCTIONING:** The buffer functions for upland wildlife habitat, as a protective barrier to physical intrusion. The wetland is so large that any deficient buffer areas are still buffered by the first few feet of the wetland itself. There is no buffer along the road, and in fact the road crews bulldoze the wetland edge every year causing physical damage to the wetland. There is road runoff that has been shown to result in high heavy metals loadings in the vegetation.

Biofiltration and sedimentation is occurring in the R/D pond built adjacent to the buffer along the NE edge of the wetland. In effect, loss of buffer along the periphery has resulted in loss of 50 feet of wetland around the perimeter.

**WERE THE BUFFER GOALS MET?** Various. The permittee was required to renew the vegetation along the logging road along the eastern border of the wetland and it has never been done. Loss of functions along the south where the golf greens maintenance abuts the wetland in places so mowing and fertilizer input is high to the wetland. The road along the eastern border has cut into the buffer and so is now directly adjacent to the wetland in places allowing runoff and physical intrusion into the wetland. Goals were attainable but were not all attained because of human activities.

**BUFFER SITE** #18 **LOCATION:** SW Auburn Black Diamond Rd, and SE 324 St., King County
**STR:** 13/21N/5E THOMAS BROS. PAGE: DRAINAGE: Soos Creek

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**TYPE OF LAND USE CHANGE:** Single family residences, multiple units

**PRE-EXISTING SITE CONDITIONS:** Forested, scrub-shrub wetland with surrounding medium age second growth forest, few
residences.

**CURRENT ADJACENT LAND USE:** 85% single family residences, 15% native vegetation.

**BUFFER REQUIREMENTS:** 25 feet, 50-foot building setback

**BUFFER DIMENSIONS:** Various, 0 to 35 feet

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** There are areas cleared of vegetation to the north. The wetland to the east goes off the property and there is no buffer there. There is a lot of dumping (tires, refuse). Yard waste dumping is the worst on this site of any studied; huge mounds of grass and wood clippings. There is spraying of herbicides along the road directly adjacent to the wetland. There has also been some clearing along the road. Physical damage is perhaps the greatest threat.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** Wetland is 3 acres: Possibly a Category 2 or 3 wetland. 15% PEM (Phalarun,Juncensi), 65% PSS (Salispp), 20% PFO (Alnurubr). The wetland is also located off the plat and is receiving most of the disturbance from there. There is also horse activity in the wetland which is affecting water quality. There is obvious siltation input as well as turbidity mostly due to fecal material and trampling from horses. There are a few snags and shrub cover (willows) is extensive. The density of bird life is great, but not sure about diversity. There are a few snags, and brush cover is high. The wetland is mostly emergent reed canary grass meadow, but does have a little PSS and PFO. The overall wetland is diverse. Vegetation= Alnu rubr, Sali lasi, Salisitc, Spirdoug, Symphalba, Oemlcera, Athyfeli, Urtidioe, Phalarun, Junceffu, Carespp.

**CRITICAL COMPONENTS OF FUNCTIONING:** Biofiltration of road runoff and lot runoff is not happening to the extent it should. Pesticides used to kill a section of the buffer are also entering the wetland. Habitat diversity is minimal because of the narrow width of the buffer. There is no buffer along the road to stop noise or afford an aesthetically pleasing view of the wetland.

**WERE THE BUFFER GOALS MET?** Yes, but they were not appropriate. The wetland edge was mistakenly marked and so the buffer was not as large as was thought. The site adjacent has no buffer at all and there are some problems with human and horse intrusion into the wetland.

**BUFFER SITE** #19 **LOCATION:** SE Auburn Black Diamond Rd., and SE 325 Pl.
King County
**STR:** 18/21N/6E THOMAS BROS. PAGE: DRAINAGE Soos Creek

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**TYPE OF LAND USE CHANGE:** Construction of single family residential

**PRE-EXISTING SITE CONDITIONS:** Auburn Black diamond rd, Covington Creek (class 1 stream), forested (20%) and pasture (25%).

**CURRENT ADJACENT LAND USE:** 50% residential units, 20% native vegetation (mixed coniferous/deciduous and shrubs), 30% Auburn Black Diamond rd and Covington Creek.

**BUFFER REQUIREMENTS:** 50 foot plus 15-foot building setback, home owners to form an association to monitor the wetland and buffer.

**BUFFER DIMENSIONS:** Variable, 25 to 200

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** As best as can be determined

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** There is some road gravel that is now running a path within 25 feet of wetland CC19. Some of buffer is forested. Vegetation= PSEUMENZ, ACERCIRC, ALNURUBR, ROSA SPP., SALISCOU,SAMBRACE, RUBUPARV, RUBUSPEC, GAULSHAL, RUBUURSI, DICEFORM, POLYMUNI, PTERAQUI, URTIDIOE.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** Covington Creek 19 CLASS 2, 10+ acres. Covington Creek is a Class 1 stream. Runoff= point and non-point. Signs of domestic animals in wetland, so no nesting birds or small mammals. Vegetation= RUBUSPEC, SPIRDOUG, ALNURUBR, POPUTRIC, THUJPLIC, TSUGHETE, RUBUDISC, SALILASI

**CRITICAL COMPONENTS OF FUNCTIONING:** Wildlife habitat, physical protection from owners, noise block from Auburn Black Diamond Rd., drainage block from source and non-point pollution, fertilizer from houses, flood storage, habitat diversity

**WERE THE BUFFER GOALS MET?** Mostly, the road through the buffer was not addressed in the requirements. One owner heard nothing about a home owner's booklet or discussions to preserve the buffers and wetlands.

**BUFFER SITE** #20 **LOCATION:** 124-128 Ave SE and SE 78-89th St., King County
**STR:** 28,33/24N/5E THOMAS BROS. PAGE 28 DRAINAGE:May Creek

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**TYPE OF LAND USE CHANGE:** Multiple units of high density single family residences

**PRE-EXISTING SITE CONDITIONS:** 30+ year old second growth forest,

**CURRENT ADJACENT LAND USE:** 85% high density, single family residents (65% lots, 15% paved, grassy sidewalks), 15% young second growth native vegetation.

**BUFFER REQUIREMENTS:** 25 feet

**BUFFER DIMENSIONS:** Various, 0 to 25

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987 to 1989

**IMPLEMENTED AS PLANNED?** Yes

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** The buffers were established at 25 feet in 1987, but have been lost to the back of lots, or for sidewalk area since then. It even looks like a sidewalk was being used for the buffer in a few places. There is lots of yard waste along the buffer/wetland edge.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** 10% PEM (mostly reed canary grass), 80% PSS (spirea, some willow), and 10% PFO (alder cedar); probably Category 3 wetland. The wetlands on the site are small Category 3 type, mostly PSS, low diversity with lots of invasive species. Runoff= point and non-point source with definite nutrient loadings, and possible road runoff. Wildlife potential is low for birds (crows and robins) because of lack of habitat. There are a few snags and some brush areas that are suitable habitat, but the wetlands are so small that not many creatures can survive. Vegetation= Thujplic, Tsughete, Alnurubr Poputric, Acercirc, Rhampurs, Salix spp, Spirdoug, Rubuspec, Loniinvo, Junceffu, Phalarun, and Ranurepe.

**CRITICAL COMPONENTS OF FUNCTIONING:** The encroachment into the buffer on so much of the site means there is very little left for buffering functions of any kind. A 25-foot strip does not leave much for noise control let alone cover, food, biofiltration, nutrient uptake. Invasive species of blackberry are taking over these areas.

**WERE THE BUFFER GOALS MET?** Perhaps the first year, but not currently.

**BUFFER SITE** #21 **LOCATION:** 116 Ave SE 76 St., King County
**STR:** 28/24N/5E THOMAS BROS. PAGE: 28 DRAINAGE: May Creek

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**TYPE OF LAND USE CHANGE:** Construction of multiple single family residences

**PRE-EXISTING SITE CONDITIONS:** Forested, 30+ years old second growth, pasture, and low density residential.

**CURRENT ADJACENT LAND USE:** 35% single family residential, 15% agricultural fields, 50% native vegetation (30+ years second growth).

**BUFFER REQUIREMENTS:** Variable. 50 feet on wetland (Class 2, King Co.), 200 feet on creek (class 5)

**BUFFER DIMENSIONS:** Various, 0 to 150, and within the 25-foot floodplain

**WHEN WAS THE LAND USE CHANGE IMPLEMENTED?** 1987

**IMPLEMENTED AS PLANNED?** As far as can be determined

**BUFFER: CURRENT CONDITIONS AND FUNCTIONING:** Biofiltration, nutrient uptake on lots adjacent to wetland, habitat diversity limited because they cut down much of the vegetation and replanted with ornamental shrubs, flood storage since uphill from the stream, and protection from intrusion where buffer is intact.

**WETLAND: CURRENT CONDITIONS AND FUNCTIONING:** Wetland is medium size greater than 1 <10 acres, Class 2 (King Co.); forested and scrub/shrub, adjacent to Class 5 stream. It functions as flood storage from stream, diverse habitat availability. Runoff= point and non-point. Fertilizer inputs affecting wetland in areas adjacent to two lots where invasive species are present (JUNCEFFEU, and PHALARUN). There is no buffer by road near entrance so wetland edge is highly disturbed. Cement truck washout into wetland and ranurepe, and junc effu only there. Vegetation= THUJPLIC, ALNURUBR, POPUTRIC, RHAMPURS, RUBUDISC, RUBULASI, OEMLCERA, PRUNEMAR, LYSIAMER, OENASARM, RANUREPE, MAIADILA, STACCOOL, SCIRMICR, CARESPP, PHALARUN, JUNCEFFU, JUNCENSI.

**CRITICAL COMPONENTS OF FUNCTIONING:** There is limited biofiltration for nutrients and sediment. (stream murky in places where buffer is missing), habitat diversity, visual screen, flood storage actually quite good for stream.

**WERE THE BUFFER GOALS MET?** Some yes, some no. Did not ascribe buffer as NGPE and residents who abut wetland and stream have included the buffer into their lots and mowed much of the buffer. Also, there was no buffer left on wetland that abuts the entrance road and there is extreme disturbance to wetland there. Buffer is functioning where it is intact, but disturbance is occurring where there is no buffer.

# Appendix B. Information Sources

The following sources of information were utilized in the literature search for Wetland Buffers: Use and Effectiveness.

A. Computer Search Programs.

AFSA; Enviroline; Water Resources; NTIS; Pollution; Life Sciences; AGRICOLA; and Biosis.

B. On-Line Library Collections.

University of Washington libraries: Natural Sciences; Fisheries; Forestry; Engineering; and Architecture.

C. Existing Bibliographies.

King County Sensitive Areas Ordinance Bibliography (1990); "Wetland Buffers: An Annotated Bibliography (Castelle et al., 1991a); "Wetland Compensatory Mitigation Replacement Ratios: An Annotated Bibliography (Castelle et al., 1991b); "Wetlands Protection" (USEPA Bibliographic Series, 1988).

D. Research Centers.

Natural Resources Research Institute (Duluth, MN); Center for Wetlands (University of Florida, Gainesville); School for Oceanography (Louisiana State University, Baton Rouge); College of Forest Resources (University of Washington, Seattle); College of Forestry (Oregon State University, Corvallis).

E. Washington State Agencies.

Department of Ecology; Puget Sound Water Quality Authority; Department of Fisheries; Department of Transportation.

F. Federal Agencies.

Federal Highway Administration; U.S. Fish and Wildlife Service; U.S. Soil Conservation Service; U.S. Forest Service; Environmental Protection Agency; and the U.S. Army Corps of Engineers.

G. State Agencies.

California Department of Fish and Game; Oregon Department of Transportation; Idaho Transportation Department; Maryland Department of Natural Resources; Delaware Department of Wetlands & Aquatic Protection.

H. County Planning Departments.

King; Kitsap; Pierce; San Juan; Snohomish; Thurston; Whatcom.

I. City Planning Departments.

Auburn; Bellevue; Bellingham; Des Moines; Everett; Federal Way; Kirkland; Redmond; Renton; Tukwila.

J. Professional Organizations.

Association of State Wetland Managers; Environmental Law Institute Society of Wetland Scientists.

K. Environmental Organizations.

Audubon Society; Conservation Foundation; Geraldine R. Dodge Foundation.

L. Individuals Contacted.

J. Hoffmann, URS Consultants, Cleveland, Ohio; G. Rollins, California Dept. of Fish and Game; P. Dykman, Oregon Dept. of Transportation; D. Evans, City of Eugene Public Works; R.B. Tiedemann, Idaho Transportation Dept.

## Appendix C. Buffer Needs of Wetland Wildlife

# Buffer Needs of Wetland Wildlife

**Washington State Department of Wildlife**
**Habitat Management Division**

**Final Draft: February 12, 1992**

**The Fragment Connection** by William Stolzenburg, *Nature Conservancy*, July/August 1991 (p. 20):

"Fragmentation entails a biological fallout more complicated than an arithmetic reduction of living open space might intuitively suggest. Ecologists have lately begun to see more clearly what happens when, say, a big forest suddenly becomes a small forest squeezed by development. From the isolated remnant disappear the wide roamers--the bears, big cats and wolves. The same goes for the deep forest specialists, types like the hooded warbler, the goshawk and the marten. Flooding in from the outside are the generalists, the common species of the edge--the starlings and cowbirds, the opossums and raccoons. Like an onion peeled by the layers, there comes a point when the core becomes nothing but the edge, a place where the generalists rule." Page 20.

"According to population theory, the fewer the individuals, the more potentially devastating the purely random forces of nature. A roll of the demographic dice can leave a small population with too many old, too few females, too little genetic variability--too little internal rebound to survive. Natural catastrophes, like fires, storms, droughts and disease--blows that might dent a big population--can crush a small one."

**WETLANDS - PROVIDE FOOD, WATER, SHELTER FOR FISH AND WILDLIFE**

Wetlands and their buffers are essential for wildlife. The complex interface of land and water is used to meet life needs by 85% of terrestrial wildlife species in the State (Brown, 1985; Thomas, 1979).

One value provided by wetlands is production and maintenance of the public's fish and wildlife resources. If there is to be no-net-loss of wetland area and function, it is essential that wetland protection measures and buffers be planned to protect fish and wildlife.

**WETLAND SYSTEMS = WETLANDS + ADJACENT UPLANDS**

Wetlands and the uplands adjacent to them form a physical, hydrologic, chemical and biologic system. Native fish and wildlife populations have evolved with this system and take advantage of interactions.

Large numbers of wetland dependent wildlife need not only the wetland but also the adjacent upland to meet essential life needs: food, water, shelter from climatic extremes and predators, structure and cover for reproduction and rearing of young. For example, waterfowl feed primarily in wetlands but most species nest on dry ground where nests will not be flooded. In the Columbia Basin, heavy grazing next to wetlands removed buffer vegetation and reduced waterfowl production by 50% (Foster et al. 1984). A wetland may be preserved but if the waterfowl nesting habitat in the adjacent upland is lost, a component of the wetland's function is lost.

**DISTURBANCE AND LOSS OF WILDLIFE FUNCTION**

A person approaching heron or a flock of waterfowl can agitate and flush them even at distances greater than 200 feet. In 1976-7, Department of Wildlife found migratory bird use increased 30-50 fold on three Columbia Basin wetlands where parking lots and access were relocated to areas 0.25 to 0.5 mile from the wetlands (Foster et al. 1984). Conversion of farm lands to office park along North Creek in King and Snohomish counties, significantly reduced the function of the areas wetlands for migratory waterfowl although the wetlands remain.

Many of the wet pasture areas that provide waterfowl feeding are frequently not scored high in wetland rating systems because of low diversity of plant life. If there is to be no-net-loss of wetland wildlife function, even these will need sufficient buffers.

**HABITAT FOR MOST SPECIES = PLANT STRUCTURE OVER DISTANCE**

Animals evolved with different plant communities and hydrology in and around wetlands. They depend upon plant communities and their associated physical structures both inside and outside the wetland. To retain full complements of wetland dependent wildlife, the plant structure in adjacent uplands needs to be retained for sizable distances from the wetland edge.

Wetland dependent wildlife such as salamander, waterfowl, beaver, and mink use the adjacent uplands to meet essential life needs. They are dependent on both the wetland and the adjacent uplands. The buffer zones are areas where animals have needed separation and interspersion to reduce competition and maintain populations. The more narrow the buffer left around a wetland when land use changes, the more susceptible the wetland becomes to loss of habitat function and productivity. Remaining wetland wildlife are more concentrated and more vulnerable to disease and predation.

**WETLAND BUFFERS - ALSO ESSENTIAL FOR WETLAND-RELATED WILDLIFE**

Natural vegetation next to wetlands moderates extreme environmental conditions. Plant structures provide microclimates that keep water and surface temperature cooler in summer and warmer in winter than surrounding areas.

Lush and divergent vegetation in wetland buffers provides 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. They receive heavy use by animals that concentrate near wetlands but are not necessarily wetland dependent. In Grant County loss of wetland buffers and the cover they provide significantly reduced pheasant populations to 20% previous levels.

Wetland buffers provide nutrients and cover for aquatic systems and their organisms. Large organic debris has been shown to be essential for native fish populations. It provides for pool development and fish hiding cover. Also important is small organic debris, the leaf litter from trees and shrubs. Ninety percent of the biological energy in some aquatic systems comes from leaf litter. Buffers help to maintain existing fish and aquatic invertebrate levels. They also maintain water quality by filtering sediments and pollutants.

**WETLANDS WITH OPEN WATER COMPONENTS - NEED LARGER BUFFERS**

Brown (1985) reports that 50 vertebrate species use the water-shrub edge for primary breeding or feeding; 46 use the water-forest edge, 98 use the riparian zone of herbaceous wetland, and 85 use ponds. Medin and Clary (1990-1991) found more than 3 times the bird biomass and species richness and mammal density and biomass in beaver ponds wetland complex than in adjacent riparian areas. USFWS reports show that wetland dependent species, dependent in part on open water, needed large buffers.

**EVEN SMALL WETLANDS NEED BUFFERS**

Size is not the main determinant wetland value to wildlife and need for protection. A Columbia basin study (Foster et al. 1984) showed that there was an inverse relationship between wetland size and waterfowl production. Highest density of ducklings were observed on wetlands of five acres or less in size and were particularly abundant on wetlands from 0.1 to 1.0 acre. In this study 68% of nests were within 100 feet of water and all but six of the rest were within 300' of the water.

Many amphibians achieve their highest densities in small wetlands (McAllister and Leonard, pers. observation). Long-toed salamander is one example. It cannot survive in the presence of healthy fish populations. It breeds in small temporary ponds. In small headwater streams of the Pacific Northwest, amphibians are the dominant vertebrates. Their numbers and biomass in these small streams are often greater than that of coldwater fishes in their optimal habitat (Bury et al. 1991).

Small wetlands are frequently very sensitive to impacts. For example, when stream gradient is greater than 4%, most beaver pond wetlands are less than 2 acres in size. They are very sensitive to silting and increased stream flows from logging in a watershed. They suffer greater losses from "blowouts" in high flow events. They may lose their soils and all vegetation in such an event.

**DRY CLIMATES CONCENTRATE WILDLIFE USE**

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' vs. 328'). Mudd (1975) showed minimum riparian area for maximum pheasant and deer use to be 75 feet in one eastern Washington study.

**SUMMARY**

To retain wetland dependent wildlife in important wildlife areas, buffers need to retain plant structure for a minimum of 200-300 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.

In western Washington wetlands with important wildlife functions should have 300' upland buffers for high impact (urban) land uses and 200' upland buffers for low impact (rural) land uses. In eastern Washington wetlands with important wildlife functions should have 200' upland buffers for high impact land use and 100' buffers for low impact land uses.

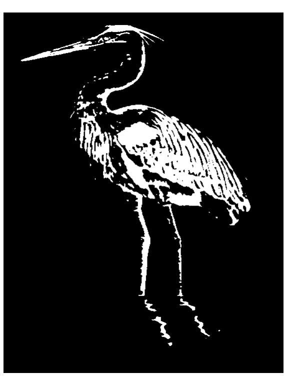
Priority species or especially sensitive animals or wetland systems such as bogs/fens or heritage sites may need even larger buffers wetlands to prevent disturbance or isolation of subpopulations or other loss of wetland function or value. See Attachments 1, 2, and 3 for buffer ranges.

**WETLAND DEPENDENT SPECIES USE OF NON FORESTED BUFFERS TO WETLANDS**

**Wildlife Needs in Herbaceous Vegetation Next To Wetlands:**

## Blue-winged teal

Literature: Sousa, Patrick J. 1985. USFWS HEP Model. Select grassy vegetation for establishment of nest sites (Bellrose 1976). They need 3 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 (Higgins, 1977). Blue-winged teal nests in North Dakota averaged 840 feet from water (Duebbert and Lokemoen, 1976). Optimum nest cover values are assumed to occur at less than 820 feet from any wetland other than ephemeral wetlands.



## Great Blue Heron

Literature: Short, H. L. and R. J. Cooper, 1985. USFWS HEP Model. Great blue heron tolerate human habitation and activities about 328 feet from a foraging area and occasional, slow moving, vehicular traffic about 164 feet from a foraging area.

**WETLAND DEPENDENT SPECIES USE OF NON FORESTED BUFFERS TO WETLANDS (cont.)**

**Wildlife Needs in Shrub Vegetation Next To Wetlands:**

## Beaver

Literature: Allen, Arthur W. 1983. USFWS HEP Model. HEP Model models on 600' from wetland edge. Trees and shrubs closest to water are used first (Bradt, 1938). Majority of beaver feed within 328 feet of water. Study in dry environs: 90% beaver feed 100' from water (Hall, 1970).

## Belted Kingfisher

Literature: Prose, Bart L. 1985. USFWS HEP Model. Broods use shrub cover along water for concealment (White, 1953. Roosts were 100 to 200 feet from water.

**WETLAND DEPENDENT SPECIES USE OF NON FORESTED BUFFERS TO WETLANDS (cont.)**

**Wildlife Needs in Either Shrub Or Herbaceous Vegetation in Buffers:**

## Red-winged Blackbird

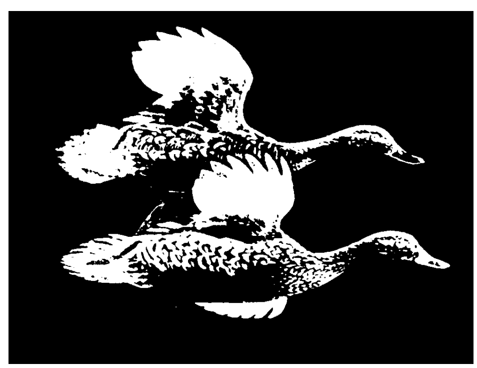
Literature: Short, Henry L. 1985. USFWS HEP Model. Red-winged blackbirds nest in wetlands. Only foraging sites within 656 feet of wetlands that contain nest sites are assumed useful to blackbirds.

## Lesser Scaup

Literature: Allen, Arthur W. 1985. USFWS HEP Model. The majority of lesser scaup nests have been recorded within 33 feet of the water's edge. They have been found up to 1300 feet from water. The most preferred nesting habitat for lesser scaup is assumed to occur when a 164 foot zone surrounding permanently flooded intermittently exposed, and semipermanent wooded 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.

## Gadwall

Literature: Sousa, Patrick K., 1985. USFWS HEP Model. The average distance from nest sites to water was less than 150 feet in several studies of gadwalls: Miller and Collins, 1954; Gates, 1962; Vermeer, 1970. But gadwall nests in North Dakota averaged 1150 feet from water, Duebbert and Lokemoen (1976). Gadwalls typically select the tallest, densest, herbaceous or shrubby vegetation available in which to nest.



**WETLAND DEPENDENT FOREST SPECIES USE OF WETLAND FOREST BUFFERS**

## Wood Duck

Literature: Sousa P.J. and A. Farmer. 1983. USFWS HEP model. Limiting features: open water, marsh or shrubs & snags: 14 inch tree minimum but best nest in 24-30 inch dbh. Distance 0-1149 feet from water but 262' average, (Gilmer, 1978). Most nests within 600' of water (Grice and Rogers, 1965).

## Mink

Literature: Allen, Arthur W. 1981. USFWS HEP Model. Limiting features: cover surface water. Mink use forest 600' from open water (Melquist, 1981, and Linn and Birks, 1981). Most use is within 328' of wetland edge. Mink cover requirements: 75-100% forested. Den sites in Idaho were placed up to 328' from wetland edge.

## Beaver

Literature: Allen, Arthur W. 1983. USFWS HEP Model. Beaver feed up to 600' from wetland edge. Trees and shrubs closest to water are used first (Bradt, 1938). Majority of beaver feed within 328' of water. Study in dry environs: 90% beaver feed 100' from water (Hall, 1970).

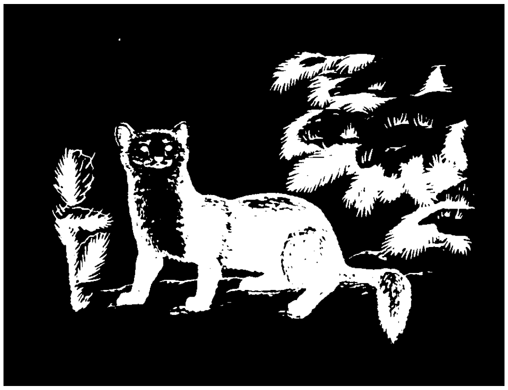
## Lesser Scaup

Literature: Allen, Arthur W. 1986 USFWS HEP Model. Nest up to 165' from water in herbaceous layer.

**WETLAND RELATED SPECIES USE OF FORESTED BUFFERS OF WETLANDS**

## Pileated Woodpecker

Literature: Schroeder, 1983: USFWS HEP Model. Pileated's nesting within 492' of water. Most nest within 164' of water.



## Marten

Literature: Allen, Arthur W. 1982. USFWS HEP Model. Timber harvest decimates marten populations (Yeager, 1950). In Wyoming no use of harvested timber stands for 1 year (Clark and Campbell, 1976). In Maine, no use of clear-cut for 15 years (Soutiere, 1979).
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Attachment 1: Buffer Size

The question is always asked: How big do buffers need to be and what is the minimum size buffers can go down to? However, the question we need to ask is: What is needed to maintain a healthy wetland habitat system over time so that functions of that wetland are retained in changing rainfall pattern, in drought periods, in high rainfall events, in times of plant and animal diseases? The narrower the vegetated upland adjacent to wetland, the more susceptible wetland wildlife are to stresses and disturbances. Also the narrower this zone is, the more susceptible the area is to loss of habitat function and productivity through natural changes or human induced impacts. The following is a summary of buffer needs of selected species.

Buffer Zone Needs of Fish and Wildlife:

600 feet or larger:
bald eagle nest, roost, perch, feeding - forest;
cavity nesting ducks (wood duck, goldeneye, bufflehead, hooded merganser) - forest;
heron rookery - forest;
woodland caribou - forest;
Western pond turtle - forest/nonforest;
American white pelican nest colonies;
sandhill crane nest and feeding - forest/nonforest.

450 feet:
common loon nest sites;
pileated woodpecker. High use in wetland forest buffer zones.

300-330 feet:
beaver - forest/shrub;
dabbling duck nesting (mallard, teal, redhead, etc.) - forest;
mink - forest/shrub;
gray wolf-forest;
distance (disturbance free) to preserve heron feeding in wetland;
distance from shoreline development to preserve black brant feeding in eelgrass beds.

200 feet:
(height of tallest tree in Western Washington):
Columbia-white tailed deer in agriculture/forestry environment;
trout and salmon influence zone (Western Washington)
Beller's ground beetle - forested/nonforested;
Hatch's click beetle - forested/nonforested;
long-horned leaf beetle - forested/nonforested;
moose in agricultural/forestry environments;
spotted frog (Western Washington).

165 feet:
lesser Scaup nesting - forested/nonforested;
harlequin duck - forested/nonforested.

100 feet:
(potential height of tallest tree in Eastern Washington)
trout and salmon food source, shade and undercut banks;
trout and salmon influence zone (Eastern Washington) and
source of large organic debris - forested;
spotted frog (Eastern, Washington) - forested/nonforested;
Van Dyke's Salamander - forested.

30 feet:
muskrat feeding and denning.

We know from the existing body of scientific literature that many of the wetland dependent species have some critical life needs met in both the aquatic area adjacent to the wetland and upland areas adjacent to the wetland. From these studies we can obtain a picture of the depths of the buffer zone needed. We estimate what functions could be expected to be retained over time with different size buffers. For example:

| | | |
|---|---|---|
| 300 foot buffers forested | - | waterfowl breeding and feeding retained; diversity of mammal habitat including beaver, mink, muskrat, deer if connected via stream corridors or vegetation to other habitats. Much of the habitat for cavity nesting ducks. Diverse bird habitat including raptors, woodpeckers and song birds. |
| 200 foot buffers forested | - | waterfowl breeding but some reduced numbers. Most components but some reduction of mammal populations. Most forest interior species as well as forest edge species on larger systems. Some of the mink and beaver remain. Total complement of large organic debris for salmonid fishes, and amphibians. Minimum size for high level wildlife use in western Washington. |
| 100 foot buffers forested | - | waterfowl nests such as mallard but reduced populations. Salmonid and nonsalmonid fishes but reduced large organic debris in some systems. Diverse song bird populations. Reduced populations of beaver especially on low gradient streams in western Washington. May eliminate mink and marten except in larger forested wetland systems. Minimum size for high level wildlife use in eastern Washington. |
| 50 foot buffers | - | warm water fishes; muskrat and small mammals only mammals represented. Reduced song bird use. |

Attachment 2:  Priority Species Identified by WDW PHS Program

Buffer requirements listed in Rodrick, E. and R. Milner. 1991 Management Recommendations for Washington's Priority Habitats and Species, Washington Department of Wildlife:

Priority species are wildlife species of concern due to their population status and their sensitivity to habitat alteration.

Bald Eagle - design Management Plan to meet needs:
nest - 1300; roost - 1300-2600;  perch - 160-1000'; feeding - 1500'.

Common Loon
nest - 450'

| | |
|---|---|
| Priority Fish Species - Buffers on streams: | |
| Cutthroat trout | 50-200' |
| Dolly varden (Bull trout) | 50-200' |
| Mountain sucker | 50-200' |
| Mountain whitefish | 50-200' |
| Pygmy whitefish | 50-200' |
| Rainbow trout and steelhead | 50-200' |
| Dunn's salamander | |
| Type 4 and 5 stream | 25-69' |
| Great Blue Heron | |
| colony or rookery | 820-981' |
| Harlequin duck | |
| nesting streams | 165' |
| Mountain caribou | 1300' on lakes and fens >1/4 Acre. |
| Osprey | |
| nest | 130-660' |
| water bodies with nest | 200' on entire water body. |
| Yellow billed cuckoo | |
| riparian areas > 4 acres | 300' |
| Mule Deer | |
| fawning in riparian | |
| unforested | 600' |
| forested | tall stands of conifers > 5 acres. |
| Sandhill crane | |
| nest | 1300' |
| feeding | 2600' |
| Van Dyke's salamander | 90-150' Forested wet talus edge |
| Western Pond turtle nest | 660' around wetlands. |

Attachment 3: Use Of Vegetated Wetlands by Fish for Breeding, Feeding, Predator Avoidance, Thermal Protection:

Estuarine Habitats:
Wetland Use

| | | |
|---|---|---|
| Sources: | Brown (1985) | Simenstad, C.A. et al. Habitat Assessment Protocol. EPA 910/9-91-037 |

| Fishes | Activity | Structure Used |
|---|---|---|
| Pacific herring | Breed | Eelgrass |
| tube snout | Breed/feed | Eelgrass |
| threespine stickleback | Breed/feed | Marsh |
| bay pipefish | Feed | Eelgrass |
| walleye | Feed | |
| shinner perch | Feed | Eelgrass |
| striped seaperch | Feed | Eelgrass |
| saddleback gunnel | Feed | |
| black rockfish | Feed | |
| prickly sculpin | Feed | Marsh |
| buffalo sculpin | Breed/feed | Marsh |
| Pacific staghorn sculpin | Breed/feed | Eelgrass/marsh |
| starry flounder | | Eelgrass/marsh |
| chum salmon | | Eelgrass/marsh |
| chinook salmon | | Marsh |
| pink salmon | | Marsh |
| cutthroat trout | | Marsh |
| crescent gunnel | | Eelgrass |
| kelp perch | | Eelgrass |
| lingcod | | Eelgrass |
| penpoint gunnel | | Eelgrass |
| snake prickleback | | Eelgrass |
| northern anchovy | | Eelgrass |
| eulachon | | Eelgrass/marsh |
| surfperches | | Eelgrass |

Freshwater Habitats (From WDW)

| | | |
|---|---|---|
| cutthroat trout | feeding | marsh/pond/stream/ wet pasture/forest |
| coho salmon | feeding | marsh/pond/stream wet pasture/forest |
| Olympic mudminnow | feeding/breeding | marsh/stream/wet pasture/forest. |

From Brown (1985) Appendix 10:

| Fishes | Activity | Vegetation/water |
|---|---|---|
| shinners | feeding | stream vegetation |
| tench | feeding/breeding | stream/lake/marsh |
| bullheads | breeding | pond/lake/stream |
| threespine stickleback | breeding | pond/lake/stream |
| black crappie | breeding | pond/lake/stream |
| yellow perch | breeding/feeding | pond/lake/marsh stream |

From Brown (1985) Appendix 2:

Loss of adjacent forest vegetation through forest practices are expected to impact 51 species of fish in waters adjacent to the forest practice and 29 species of fish off site.

Buffers Recommendations on Both Sides of Stream for Fish:

| Priority Species Management Recommendations | USFWS Habitat Suitability Index | Erman, D.C., J.D. Newbold, K.B. Roby. 1977. Evaluation of Streamside Bufferstrips for Protecting Aquatic Organisms. Cal. Water Resource Center |
|---|---|---|
| Provide L.O.D. | Erosion control & undercut banks | Maintain stream sediments and fish food chain. |
| 50-200' | 100' | 100' |

Attachment 4:  Western Washington Wetland Associated Species

Condensed from Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington, E. Reade Brown, U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, June 1985:

208 terrestrial species dependent upon structure for primary breeding or feeding in wetland systems and type of structure needed:

M - Dependent on only mature forested wetland and/or wetland and upland for a primary breeding or feeding function.  Therefore these species are dependent on mature forest structure.  Trees in Mature Forest average a minimum of 21 inches dbh.

O - Dependent on only old growth forested wetland and/or upland for a primary breeding or feeding function.  Old-growth dependent.

XX - Species has primary breeding and/or feeding listed only in wetland.  This demonstrates a strong wetland association.

Priority Species (Underlined are Wetland Associated Priority Species.)

*(State and Federal Concern Species) SE-State Endangered; FT-Federal Threatened; ST-State Threatened; FC2-Federal Candidate Category 2; FC3-Federal Candidate Category 3; FP-Federal Proposed; SC-State Candidate; SM-State Monitor).

| | Herbaceous | Shrub | Tree |
|---|---|---|---|
| AMPHIBIANS | | | |
| Northwestern salamander | x | x | x |
| long-toed salamander | x | x | x |
| Pacific giant salamander | | | x |
| Olympic salamander | | | x |
| Dunn's salamander *(SC) | | | x |
| Western red-backed salamander | | | xM |
| rough-skinned newt | x | x | x |
| western toad | x | x | |
| Pacific tree frog | x | x | x |
| tailed-frog | | | x |
| red-legged frog | x | x | |
| Cascades frog | x | x | x |
| spotted frog *(SC) | x | x | x |
| | | | |
| REPTILES | | | |
| painted turtle | x | x | |
| western pond turtle *(ST,SC,FC2) | x | x | |
| western skink | x | x | |
| sharptail snake *(SM) | | | x |
| ring-necked snake *(SM) | | x | |
| gopher snake | x | x | |
| western terrestrial garter snake | x | x | |
| common garter snake | x | x | |

| | Herbaceous | Shrub | Tree |
|---|---|---|---|
| BIRDS | | | |
| American bittern | x | | |
| great blue heron *(SM) | XX | | XX |
| green-backed heron *(SM) | | XX | |
| Canada goose | XX | | |
| wood duck | x | | xM |
| green-winged teal | XX | | |
| mallard | XX | | |
| northern pintail | XX | | |
| blue-winged teal | XX | | |
| cinnamon teal | XX | | |
| northern shoveler | XX | | |
| gadwall | XX | | |
| Eurasian wigeon | XX | | |
| American wigeon | XX | | |
| harlequin duck | | | xM |
| Barrow's goldeneye | | | xM |
| bufflehead | | | xM |
| hooded merganser | | | xM |
| common merganser | | | xM |
| turkey vulture *(S) | x | | x |
| osprey *(SM) | | | XXO |
| black-shouldered kite | x | | XX |
| bald eagle *(ST, FT) | | | x |
| northern harrier | XX | | |
| sharp-shinned hawk | | | x |
| Cooper's hawk | | | x |
| red-tailed hawk | | | x |
| rough-legged hawk | x | | |
| merlin *(SM) | XX | XX | |
| American kestrel | x | | xM |
| gyrfalcon *(SM) | XX | | |
| ring-necked pheasant | XX | | |
| ruffed grouse | | | x |
| Virginia rail | XX | | |
| sora | XX | | |
| American coot | x | | |
| sandhill crane *(SE) | XX | | |
| killdeer | XX | | |
| spotted sandpiper | XX | | |
| common snipe | XX | | |
| least sandpiper | XX | | |
| marbled murrelet *(SC, FP) | | | xO |
| band-tailed pigeon | | x | x |
| mourning dove | x | | x |
| common barn owl | x | | |

| | Herbaceous | Shrub | Tree |
|---|---|---|---|
| western screech owl | x | x | xM |
| great-horned owl | | | xM |
| barred owl *(SM) | | | xM |
| long-eared owl | x | x | XX |
| short-eared owl | XX | | |
| northern saw-whet owl | | | XXM |
| common nighthawk | x | | |
| Vaux's swift *(SC) | x | x | xO |
| chipping sparrow | | x | |
| savannah sparrow | XX | | |
| fox sparrow | | x | |
| song sparrow | x | x | |
| Lincoln's sparrow | XX | XX | |
| red-breasted sapsucker | | | XX |
| downy woodpecker | | | x |
| northern flicker | | x | xM |
| olive-sided flycatcher | | | x |
| western wood-pewee | | x | xM |
| willow flycatcher | | XX | |
| Anna's hummingbird | x | x | x |
| rufous hummingbird | x | x | x |
| yellow-breasted chat | | XX | |
| western tanager | | x | xM |
| black-headed grosbeak | | x | x |
| lazuli bunting | | x | |
| rufous-sided towhee | | x | |
| hermit warbler | | | xM |
| common yellowthroat | XX | XX | |
| MacGillivray's warbler | | XX | XX |
| Wilson's warbler | | x | x |
| Bohemian waxwing | XX | | |
| cedar waxwing | | | x |
| northern shrike | XX | XX | |
| European starling | x | | x |
| Hutton's vireo | | x | |
| warbling vireo | | | x |
| red-eyed vireo | | | x |
| yellow warbler | | x | |
| black-throated warbler | | x | |
| Townsend's warbler | | | xM |
| black-capped chickadee | | x | xM |
| chestnut-backed chickadee | | | xM |
| red-breasted nuthatch | | | xM |
| white-breasted nuthatch | | | xM |
| Bewick's wren | | | x |
| house wren | | | x |
| winter wren | | | xM |
| marsh wren | XX | | |
| golden-crowned kinglet | | | xM |

| | Herbaceous | Shrub | Tree |
|---|---|---|---|
| ruby-crowned kinglet | | x | x |
| western bluebird *(SC) | x | x | |
| Swainson's thrush | | | x |
| hermit thrush | | | x |
| American robin | x | x | |
| varied thrush | | | xM |
| water (American) pipet | x | | |
| tree swallow | x | x | xO |
| violet-green swallow | x | x | xM |
| northern rough-winged swallow | XX | | |
| cliff swallow | x | | |
| barn swallow | x | | |
| gray jay | | x | xM |
| Steller's jay | | | x |
| American crow | x | x | xM |
| common raven | x | x | xM |
| Hammond's flycatcher | | | xM |
| western flycatcher | | | xM |
| black phoebe | XX | XX | |
| purple martin *(SC) | XX | XX | XXM |
| golden-crowned sparrow | | x | |
| white-crowned sparrow | | x | |
| dark-eyed junco | x | x | |
| red-winged blackbird | XX | | |
| yellow-headed blackbird | XX | | |
| Brewer's blackbird | x | XX | |
| brown-headed cowbird | x | x | x |
| northern oriole | | | xM |
| pine grosbeak | | | xM |
| purple finch | | | x |
| red crossbill | | | xO |
| pine siskin | | | xM |
| lesser goldfinch | x | x | |
| American goldfinch | x | x | |
| evening grosbeak | | | x |
| MAMMALS | | | |
| Virginia opossum | x | | XX |
| Pacific water shrew *(SM) | | | x |
| dusky shrew | | | x |
| Pacific shrew | | x | |
| water shrew | | | XX |
| Trowbridge shrew | | | x |
| vagrant shrew | x | | |
| shrew mole | | x | x |
| broad-footed mole | x | | |
| coast mole | x | x | |
| Townsend's mole | x | | |
| pallid bat *(SM) | x | | x |

| | Herbaceous | Shrub | Tree |
|---|---|---|---|
| big brown bat | x | XX | xM |
| silver-haired bat | | | xO |
| hoary bat | | x | xM |
| California myotis | | | xO |
| long-eared myotis *(SM) | | | xO |
| Keen's myotis *(SM) | x | x | |
| little brown bat | x | x | xO |
| fringed myotis | x | x | |
| long-legged myotis *(SM) | | x | x |
| Yuma myotis | x | x | xM |
| Townsend's big-eared bat *(SC,FC2) | | | x |
| coyote | x | x | |
| black bear | x | x | |
| raccoon | x | x | x |
| wolverine *(SM, FC2) | | | x |
| river otter | | XX | XX |
| marten | | | xM |
| striped skunk | x | x | |
| ermine | | | x |
| mink | XX | XX | XX |
| spotted skunk | x | x | |
| bobcat | x | x | |
| elk | x | x | x |
| mule and black-tailed deer | x | x | |
| Columbian white-tailed deer | x | x | x |
| mountain beaver | | x | |
| yellow-pine chipmunk | | x | |
| beaver | | XX | XX |
| bushy-tailed woodrat | | | x |
| dusky-footed woodrat | | | x |
| deer mouse | x | x | |
| western harvest mouse | x | | |
| southern red-backed vole | | | xM |
| gray-tailed vole *(SM) | XX | | |
| long-tailed vole | x | x | |
| montane vole | x | | |
| creeping vole | x | x | |
| water vole | XX | | |
| Townsend's vole | x | | |
| northern bog lemming *(SM) | x | | |
| western jumping mouse | x | | |
| Pacific jumping mouse | x | x | |
| porcupine | x | x | x |
| nutria | XX | | |
| brush rabbit | x | | x |
| eastern cottontail | x | x | |

78 Other species listed in Brown as having primary breeding and/or feeding in wetland systems without reference to structure:

| | |
|---|---|
| Cope's giant salamander*(SM) | riparian to springs and creeks. |
| <u>Van</u> <u>Dyke's</u> <u>salamander</u> *(SC) | wet meadows, marshes, bogs, swamps. |
| ensatina | riparian forest/shrub to sloughs. |
| bullfrog | riparian ponds and wetlands. |
| racer | riparian to flowing systems. |
| <u>common</u> <u>loon</u> *(SC) | herb/grass riparian on lakes. |
| pied-billed grebe | ponds, lakes and marsh and riparian. |
| <u>horned</u> <u>grebe</u> *(SM) | lakes and estuary. |
| <u>red-necked</u> <u>grebe</u> *(SM) | estuary. |
| eared grebe | estuary, lakes and marshes. |
| <u>western/Clark's</u> <u>grebe</u> *(SM) | lakes and estuary. |
| double-crested cormorant | estuary. |
| great egret *(SM) | beach, marsh, lakes and ponds. |
| <u>black-crowned</u> <u>night</u> <u>heron</u> *(SM) | sloughs, lakes, ponds, marshes. |
| tundra swan | beaches, lakes, and wet meadows. |
| <u>trumpeter</u> <u>swan</u> | beaches, lakes and wet meadows. |
| greater white-fronted goose | grass, wet meadow, estuary. |
| snow goose | wet meadow, estuary. |
| brant | estuary. |
| canvasback | estuary, lakes and sloughs. |
| redhead | estuary, lakes, ponds. |
| ring-necked duck | sloughs, ponds, lakes. |
| greater scaup | estuary, lakes. |
| lesser scaup | estuary, lakes, ponds. |
| oldsquaw | saltwater. |
| ruddy duck | estuary, lakes, ponds, marshes. |
| black-bellied plover | estuary, beach, wet meadow. |
| lesser golden plover | estuary and beach. |
| snowy plover | saltwater beach. |
| semipalmated plover | saltwater beach and estuary. |
| greater yellowlegs | estuary, lakes, ponds, marsh, meadow. |
| lesser yellowlegs | estuary, lakes, ponds, marsh, meadow. |
| solitary sandpiper | riparian stream, lakes, ponds, marsh. |
| willet | freshwater beaches. |
| wandering tattler | saltwater beaches. |
| whimbrel | riparian grass on saltwater beaches. |
| <u>long-billed</u> <u>curlew</u> *(SM) | ponds, marsh. |
| marbled godwit | saltwater and freshwater beaches. |
| ruddy turnstone | saltwater beach. |
| black turnstone | saltwater beach. |
| surfbird | saltwater beach. |
| red knot | estuary and saltwater beach. |
| sanderling | estuary and saltwater beach. |
| semipalmated sandpiper | estuary beach and riparian and marsh. |
| Baird's sandpiper | beach, lakes, ponds, and wet meadows. |
| pectoral sandpiper | beach, pond, marsh, wet meadow. |
| sharp-tailed sandpiper | marsh. |

| | |
|---|---|
| rock sandpiper | saltwater beaches. |
| dunlin | estuary, beach, grass and wet meadow. |
| buff-breasted sandpiper | beach and marsh. |
| short-billed dowitcher | beach and grass. |
| long-billed dowitcher | beach, slough, lakes, ponds and marsh. |
| Wilson's phalarope | estuary/beach, pond/marsh, wet meadow. |
| red-necked phalarope | estuary. |
| Franklin's gull | lake, pond, beach. |
| Bonaparte's gull | estuary and lakes. |
| Heerman's gull | estuary and beach. |
| mew gull | estuary, beach, river. |
| ring-billed gull | estuary, beach, wet meadow. |
| California gull | estuary/beach, river, lake/wet meadow. |
| herring gull | estuary, beach, river, lake. |
| Thayer's gull | estuary, saltwater beach. |
| western gull | estuary and beach. |
| glaucous-winged gull | estuary and beach. |
| glaucous gull | estuary and beach. |
| Caspian tern *(SM) | estuary and beach. |
| common tern | estuary, beach and river. |
| black tern *(SM) | ponds, marsh, grass and wet meadow. |
| rock dove | saltwater beaches. |
| belted kingfisher | estuary, stream, lake, marsh, pond. |
| horned lark | saltwater beaches. |
| American dipper | riparian beaches, river and stream. |
| red fox | wet meadow. |
| grizzly bear *(SE, FT) | wet meadow. |
| long-tailed weasel | wet meadow. |
| mountain lion | stream and spring riparian. |
| harbor seal *(SM) | estuary, beach, river. |
| Nuttall's cottontail | wet meadow. |

Note: Other priority species dependent upon vegetated wetlands include: cackling Canada goose, dusky Canada goose, Olympic mudminnow*(SC,FC2), sandroller*(SM), cutthroat trout, Beller's ground beetle*(SC,FC2), Hatch's click beetle*(SC, FC2), long-horned leaf beetle *(SC, FC3), Oregon silverspot butterfly*(ST, SC, FT).

Other species of special concern associated with wetlands: Olympic salamander*(SM), great egret*(SM), Aleutian Canada goose*(SE, FE); yellow-billed cuckoo*(SC); pileated woodpecker*(SC); Lewis' woodpecker*(SC); ash-throated flycatcher*(SM).

Attachment 5: Eastern Washington Wetland Associated Species

Condensed from Thomas, Jack Ward. 1979. Wildlife Habitats in Managed Forests - the Blue Mountains of Oregon and Washington. U.S. Department of Agriculture. Forest Service. Agriculture Handbook No. 553:

Wetland type
m - marsh (cattail, rush or sedge)
d - deciduous trees and shrubs
s - flowing waters (streams, rivers and sloughs)
l - standing waters (ponds, lakes and reservoirs)

Trees
M - Mature (80-159 years) plus Old Growth (160+ years)

Priority Species (Underlined are both in Thomas and WDW Priority Species)

*(State and Federal Concern Species) FE-Federal Endangered; SE-State Endangered; FT-Federal Threatened; ST-State Threatened; FC2-Federal Candidate Category 2; FP-Federal Proposed; SC-State Candidate; SM-State Monitor)

266 Species with primary breeding and or feeding in wetland systems:

**Wetland and/or Buffer Components**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| AMPHIBIANS | | | | |
| tiger salamander*(SM) | m/d | x | | |
| long-toed salamander | m/d | x | | x |
| tailed frog *(SM) | s | x | | |
| Great Basin spadefoot toad | m | x | x | x |
| western toad | m/d | x | x | x |
| Woodhouse toad *(SM) | m/d | x | x | |
| Pacific treefrog | m/d | x | x | x |
| spotted frog *(SC) | m/d | x | x | x |
| leopard frog | m/d | x | | |
| | | | | |
| REPTILES | | | | |
| painted turtle | s/p | x | x | x |
| western skink | s/l | x | x | x |
| ringneck snake *(SM) | d | x | x | x |
| common garter snake | m/d | x | x | x |
| side-blotched lizard | s/l | x | x | |
| yellow-bellied racer | s | x | x | x |
| gophersnake | s/l | x | x | x |
| western terrestrial garter snake | m/d | x | x | x |
| western rattlesnake | m/d | x | x | x |
| rubber boa | s | x | x | x |

**Wetland and/or Buffer Components (cont.)**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| BIRDS | | | | |
| eared grebe | m | x | | |
| pied-billed grebe | m | x | | |
| double-crested cormorant | s | x | | |
| American bittern | m/d | x | x | |
| Canada goose | m | x | x | x |
| mallard | m | x | x | x |
| gadwall | m/d | x | x | x |
| pintail | m | x | x | |
| green-winged teal | m/d | x | x | x |
| blue-winged teal | m | x | | |
| cinnamon teal | m | x | | |
| American wigeon | m/d | x | x | x |
| northern shoveler | m | x | | |
| redhead | m | x | | |
| ring-necked duck | m/d | x | x | x |
| lesser scaup | m | x | x | |
| <u>harlequin</u> <u>duck</u> | s | x | x | x |
| ruddy duck | m | x | | |
| <u>sandhill</u> <u>crane</u> *(SE) | m | x | x | |
| Virginia rail | d | x | x | x |
| sora | d | | x | x |
| American coot | m/d | x | x | x |
| <u>snowy</u> <u>plover</u> *(SE, FC2) | m | x | | |
| killdeer | m | x | | |
| common snipe | m | x | | |
| <u>long-billed</u> <u>curlew</u> *(SM,FC2) | m | x | x | |
| spotted sandpiper | m | x | | |
| willet | m | x | | |
| American avocet | m | x | | |
| Wilson's phalarope | m | x | | |
| California gull | m | x | x | |
| ring-billed gull | m | x | x | |
| Franklin's gull | m | x | x | |
| <u>Forster's</u> <u>tern</u> *(SM) | m | x | x | |
| black tern *(SM) | m | x | | |
| dipper | s | x | x | x |
| winter wren | s | | x | x |
| long-billed (marsh wren) | m | x | x | |
| northern waterthrush | d | x | x | |
| common yellow throat | m | x | x | |
| turkey vulture *(SM) | s/l | x | x | |
| prairie falcon | m/d | x | | |
| <u>peregrine</u> *(SE, FE) | m/d | x | x | x |
| rock dove | s | x | | |
| black swift | m/d | x | x | |
| white-throated swift | s/l | x | x | |

**Wetland and/or Buffer Components (cont.)**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| Say's phoebe | s/l | x | x | x |
| barn swallow | m/d | x | | |
| cliff swallow | m | x | x | x |
| common raven | s/l | x | x | x |
| marsh hawk (northern harrier) | m | x | x | |
| blue grouse | s | x | x | x |
| ruffed grouse | d | | x | x |
| sharp-tailed grouse*(SC, FC2) | s | x | x | |
| sage grouse *(SC, FC2) | s | x | x | |
| bobwhite | d | x | x | x |
| California quail | d | x | x | x |
| mountain quail | s/l | x | x | x |
| gray partridge | s | x | | |
| red-necked pheasant | m/d | x | x | x |
| upland sandpiper *(SE) | m | x | | |
| short-eared owl | m | x | x | |
| hermit thrush | s/l | | | xM |
| veery | d | | x | x |
| water (American) pipet | m | x | | |
| Wilson's warbler | d | | x | x |
| bobolink | m | x | x | |
| western meadowlark | m/d | x | x | |
| dark-eyed junco | s | x | x | x |
| poorwill | m | x | x | x |
| Townsend's solitaire | s/l | x | x | x |
| orange-crowned warbler | d | | x | x |
| Nashville warbler | d | | x | x |
| Lincoln's sparrow | d | x | x | x |
| black-crowned night heron*(SM) | d | x | x | x |
| solitary sandpiper | d | x | x | x |
| black-chinned hummingbird | d | x | x | x |
| calliope hummingbird | d | x | x | x |
| eastern kingbird | d | | x | x |
| willow flycatcher | s/l | | x | x |
| gray flycatcher | s/l | x | x | x |
| black-billed magpie | m/d | x | x | x |
| gray catbird | d | | x | x |
| sage thrasher | d | | x | x |
| American robin | m/d | x | x | x |
| Swainson's thrush | s/l | | x | x |
| loggerhead shrike *(SC) | d | x | x | x |
| MacGillivray's warbler | d | | x | x |
| Treeyellow-headed blackbird | m | x | x | |
| red-winged blackbird | m/d | x | x | |
| Brewer's blackbird | m/d | x | x | x |
| brown-headed cowbird | m/d | x | x | x |

**Wetland and/or Buffer Components (cont.)**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| lazuli bunting | d | x | x | x |
| lesser goldfinch | d | x | x | |
| green-tailed towhee | d | x | x | x |
| rufous-sided towhee | d | | x | x |
| sage sparrow *(SC) | d | | x | x |
| chipping sparrow | d | x | x | x |
| Brewer's sparrow | d | x | x | x |
| white-crowned sparrow | d | x | x | x |
| fox sparrow | s/l | | x | x |
| song sparrow | d | | x | x |
| yellow-billed cuckoo *(SC) | d | | x | x |
| dusky flycatcher | d | x | x | x |
| bushtit | d | | x | x |
| yellow warbler | d | | x | x |
| yellow-breasted chat | d | | x | x |
| American goldfinch | d | x | x | x |
| cedar waxwing | d | | x | x |
| American redstart | d | x | x | x |
| northern oriole | d | | x | x |
| house finch | d | x | x | x |
| western flycatcher | d | | x | x |
| olive-sided flycatcher | d | x | x | x |
| golden-crowned kinglet | s/l | | x | x |
| ruby-crowned kinglet | d | | | x |
| yellow-rumped warbler | d | | | x |
| black-throated gray warbler | d | | x | x |
| Townsend's warbler | d | | | x |
| western tanager | d | | x | x |
| red crossbill | d | | | xM |
| goshawk *(SC) | d | | x | xM |
| sharp-shinned hawk | d | | x | x |
| Cooper's hawk | d | x | x | x |
| merlin*(SM) | d | x | x | xM |
| mourning dove | d | x | x | x |
| long-eared owl | d | x | x | x |
| rufous hummingbird | d | x | x | x |
| western kingbird | d | x | x | x |
| Hammond's flycatcher | d | | x | x |
| western wood pewee | d | | x | x |
| Steller's jay | d | x | x | x |
| common crow | d | x | x | x |
| varied thrush | s/l | | x | x |
| solitary vireo | d | | | x |
| red-eyed vireo | d | | x | x |
| warbling vireo | d | | x | x |
| black-headed grosbeak | d | x | | x |

**Wetland and/or Buffer Components (cont.)**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| evening grosbeak | d | | x | x |
| purple finch | d | x | x | x |
| Cassin's finch | s/l | x | x | x |
| pine siskin | d | x | x | x |
| great blue heron | m/d | x | | xM |
| red-tailed hawk | d | x | x | x |
| golden eagle *(SC) | m/d | x | x | x |
| bald eagle *(ST, FT) | m/d | x | x | xM |
| osprey *(SM) | s/l | x | x | xM |
| great horned owl | m/d | x | x | x |
| common flicker | d | x | x | x |
| pileated woodpecker *(SC) | s/l | | | xM |
| Lewis' woodpecker *(SC) | d | x | x | x |
| yellow-bellied sapsucker | d | | | x |
| Williamson's sapsucker | d | | | xM |
| hairy woodpecker | d | | | x |
| downy woodpecker | d | | | x |
| red-breasted nuthatch | s | | | xM |
| pygmy nuthatch | s | | | xM |
| wood duck | d | x | x | xM |
| Barrow's goldeneye | d | x | x | xM |
| bufflehead | d | x | x | xM |
| hooded merganser | d | x | x | xM |
| common merganser | d | x | x | xM |
| American kestrel | d | x | x | xM |
| barn owl | m/d | x | x | xM |
| (western) screech owl | d | x | x | xM |
| pygmy owl | d | x | x | x |
| barred owl | d | x | x | xM |
| saw-whet owl | d | x | x | x |
| Vaux's swift *(SC) | m/d | | | xM |
| ash-throated flycatcher *(SM) | s | x | x | xM |
| violet-green swallow | d | x | x | x |
| tree swallow | d | x | x | x |
| black-capped chickadee | d | | | x |
| mountain chickadee | d | | | x |
| chestnut-backed chickadee | d | | | x |
| brown creeper | d | | | xM |
| house wren | d | x | x | x |
| western bluebird *(SC) | d | x | x | x |
| mountain bluebird | d | x | x | x |
| starling | m/d | x | x | x |
| house sparrow | d | x | x | x |
| burrowing owl | s | x | x | x |
| belted kingfisher | s/l | x | x | x |
| bank swallow | m/d | x | x | |
| rough-winged swallow | m/d | x | x | |

**Wetland and/or Buffer Components (cont.)**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| MAMMALS | | | | |
| western jumping mouse | m/d | x | x | x |
| small-footed myotis *(SM) | m/d | x | x | |
| western pipistrelle *(SM) | m/d | x | x | |
| western big-eared bat | m/d | x | x | x |
| yellow-bellied marmot | s/l | x | x | |
| bushy-tailed woodrat | d | x | x | x |
| puma (cougar) | d | x | x | x |
| bobcat | m/d | x | x | x |
| opossum | d | x | x | x |
| snowshoe hare | s | x | x | x |
| whitetail jackrabbit | s | x | x | |
| wolverine *(SM, FC2) | m/d | x | x | x |
| elk | s | x | x | x |
| mule deer | s/l | x | x | x |
| white-tailed deer | m/d | x | x | x |
| porcupine | s/l | x | x | x |
| western gray squirrel *(SC) | d | | | x |
| hoary bat | d | x | x | x |
| little brown myotis | m/d | x | x | xM |
| Yuma myotis | m/d | | | xM |
| long-eared myotis *(SM) | m/d | x | x | xM |
| long-legged myotis *(SM) | m/d | x | x | xM |
| California myotis | m/d | x | x | xM |
| silver-haired bat | m/d | x | x | xM |
| big brown bat | m/d | x | x | xM |
| eastern fox squirrel | s/l | | | xM |
| northern flying squirrel | s/l | | | x |
| raccoon | m/d | x | x | xM |
| fisher *(SC) | s/l | | | xM |
| vagrant shrew | m/d | x | x | x |
| dusky shrew | s/l | | | x |
| Merriam shrew *(SC) | s | x | x | |
| coast mole | s/l | x | x | x |
| pygmy rabbit *(ST, ST) | s | x | x | |
| yellow pine chipmunk | d | x | x | x |
| Townsend ground squirrel | s/l | x | x | x |
| W. ground squirrel *(SM) | s/l | x | | |
| Columbian ground squirrel | s/l | x | x | x |
| G.-Mantled ground squirrel | s/l | x | x | x |
| northern pocket gopher | d | x | x | x |
| Great Basin pocket mouse | s/l | x | x | x |
| western harvest mouse | s/l | x | x | x |

**Wetland and/or Buffer Components (cont.)**

| | Wetland Type | Herbaceous | Shrub | Tree |
|---|---|---|---|---|
| deer mouse | m/d | x | x | x |
| n. grasshopper mouse *(SM) | s/l | x | x | x |
| heather vole | s/l | x | x | x |
| mountain vole | s/l | x | x | x |
| long-tailed vole | s/l | x | x | x |
| coyote | m/d | x | x | x |
| gray wolf *(SE, FE) | m/d | x | x | x |
| red fox | m/d | x | x | x |
| black bear | m/d | x | x | x |
| short-tailed weasel | d | x | x | x |
| long-tailed weasel | m/d | x | x | x |
| badger | d | x | x | x |
| striped skunk | m/d | x | x | |
| northern water shrew | s/l | x | x | x |
| beaver | d | x | x | x |
| water vole | d | x | x | x |
| muskrat | m/d | x | x | x |
| nutria | m/d | x | x | x |
| mink | m/d | x | x | x |
| river otter | m/d | x | x | x |

Other eastside wetland associated Priority Species include silver-bordered bog fritillary, sandroller, westslope cutthroat trout, black-necked stilt, green-backed heron, great egret, Clark's grebe-Western grebe, horned grebe, pied-billed grebe, trumpeter swan, moose, mountain caribou, pygmy shrew.

Other species of special concern associated with wetlands: Tiger salamander*(SM), great egret*(SM), Aleutian Canada goose*(SE, FE); pileated woodpecker*(SC); Lewis' woodpecker*(SC); ash-throated flycatcher*(SM).