Riparian Buffers in an Agricultural Setting

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King County

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1.0 INTRODUCTION

1.1 Problem Statement

King County, like other local jurisdictions in the Puget Sound region, has overlapping and sometimes conflicting mandates to support the recovery of salmonids listed under the Endangered Species Act (ESA) and maintain a healthy, viable agricultural industry. A rapidly growing regional population coupled with an increased interest in local food and food security have amplified the need to resolve longstanding conflicts. The conflict is particularly acute in larger river floodplains that are both critical for salmon recovery and productive agricultural areas. In the last several years, intensive efforts have been initiated to integrate these mandates in ways that balance the needs for both salmon and farms.

Individual Snoqualmie Valley farmers, often in partnership with non-profits, tribes, or other salmon recovery groups, have voluntarily planted native vegetation and trees along many waterways (known as riparian areas, or riparian buffers) to benefit salmon and other wildlife. Salmon recovery plans call for many more acres to be planted. In discussions during King County's 2015-2017 Snoqualmie Fish, Farm, Flood initiative (FFF Phase 1), participants grew concerned with the potential of riparian restoration actions to displace several thousands of acres of agricultural lands, and the effects this could have on the viability of agriculture in the Snoqualmie Valley. Uncertainty exists about where and how much agriculture land would be converted because riparian trees are usually planted on a voluntary basis, unless done for mitigation. There is a desire to implement riparian restoration in a way that prioritizes riparian functions on different types of waterways for salmon recovery, while also reducing potential adverse impacts to agricultural activities and the amount of acres for growing food, and in fact benefitting farmers. Moreover, the direct loss of farmable acres is not the only way that riparian restoration can affect agriculture. Riparian buffers can also complicate field drainage maintenance, harbor wildlife that may damage crops, create obstructions to flood flows, and shade crops. Riparian buffers often also provide benefits to agriculture, including shade for livestock, controlling bank erosion, and creating habitat for pollinators.

In 1985, the King County Comprehensive Plan update designated five Agricultural Production Districts (APDs) across the county. These districts were established to maintain contiguous farming communities, acknowledging that the most profitable farms are usually found in blocks with other farms and support services, and few non-agricultural uses (King County 1985). The 41,100 acres designated as APDs represent some of the best soil and growing conditions in the county and contain most of the county's commercial agriculture (King County 2009). The Snoqualmie APD is the second-largest in the county (over 14,500 acres) and straddles the Snoqualmie River from Fall City north to the county line.

The Snohomish Basin Salmon Conservation Plan (Salmon Plan) recommends a buffer width of 150 feet along all fish bearing water courses to restore riparian functions and improve degraded water quality based on a previous review of the best available science, modeling and an assumption that it would not be possible to get the best, widest riparian areas needed (Snohomish Basin Salmonid Recovery Technical Committee 2004). The Salmon Plan prioritizes riparian plantings with a goal of 150-ft buffers along 65-85% of total stream length based on fish use. For example, the plan recommends that at least 85% of the mainstem Snoqualmie River should have an intact riparian buffer, while 65% of length in smaller watercourses should be buffered. The percent targets highlight that plantings are critical to the survival of salmon but also do not aim for 100% planting of the length of the watercourses in the Snoqualmie Valley.

The Snoqualmie Valley Agricultural Production District (Snoqualmie APD) contains just over 150 miles of waterways. Almost all are used by anadromous fish, but roughly half of that length is comprised of small tributaries, many of which are actively maintained for agricultural drainage. An analysis of GIS data during FFF Phase 1 in 2014 showed that in the APD, 57% of the land within 150 feet of watercourses is in active agricultural use. Most of the land is adjacent to very small tributaries rather than larger streams or rivers (King County 2018b).

Analyses of 2014 riparian conditions in the Snoqualmie APD during FFF Phase 1 indicated that 150-foot buffers on all salmon bearing watercourses in the Snoqualmie APD would affect approximately 4,800 acres of land, or one third of the Snoqualmie APD. While only about 2,400 (50%) of the 4,800 acres was then in production, 2,400 acres represented about one fourth of all actively farmed land in the APD (approximately 9,400 acres). Removal this proportion of farmed acreage within the Snoqualmie APD would likely have significant and long-lasting effects on the Valley's agricultural economy and planting this many acres would be a very large expense.

Riparian buffers are critical for salmon habitat and in some cases they can complicate farming. Both salmon recovery practitioners and local landowners recognize that the 150' everywhere buffer approach of the Salmon Plan does not take into account the relative importance of different watercourses for salmon or potentially variable productivity, uses, or individual needs of different agricultural lands. The ecological functions desired for salmon recovery from the mainstem Snoqualmie are different than those for constructed drainage watercourses. The FFF Phase 1 recognized a more balanced approach to buffers was needed and recommended creating a Buffer Task Force to review the science and explore opportunities for variable-width buffers. This paper along with a companion document, Riparian Buffers in the Lower Snoqualmie Valley: Synthesis of Riparian Best Available Science to Inform Variable-Width Buffers (King County 2019), represents the first step towards that goal.

1.2 Purpose and Goal

The purpose of this document is to summarize the effects of forested riparian vegetation on agricultural land with a goal to inform recommendations made by the Buffer Task Force for variable-width voluntary buffers in the Snoqualmie APD.

This document provides the perspective of current agricultural land managers. At the same time, it is intended to describe the impacts – positive and negative – of planting buffers today on the future viability of farming in the Snoqualmie Valley. Much of the content of this document is driven by concerns expressed by the agricultural community throughout FFF Phase 1. It is important to be specific about the effects of riparian buffers on agricultural land and farm businesses, and the Buffer Task Force will work to balance ecological, societal, and economic values of floodplain riparian areas.

Initial input on the outline and content of this document was received from the Buffer Task Force, the King County Agriculture Commission, and staff at King County. The text is informed by a review of primary literature as well as interviews with 10 farmers and professionals serving the Snoqualmie Valley farming community. Individual farmers are not identified in the text, but those who were interviewed are cited as personal communication in the document.

2.0 SNOQUALMIE VALLEY RIPARIAN PLANTING BACKGROUND

2.1 Overview of Riparian Planting Programs

There are three ways that new forested riparian vegetation is established on agricultural land in the Snoqualmie Valley.

2.1.1 Voluntary

Landowners can voluntarily plant riparian vegetation to achieve desired management objectives. The objectives may include providing high quality riparian function and habitat, reducing erosion, creating a sound, wind, or sight barrier, providing shade for livestock, or a combination of these objectives. The primary organizations and agencies who partner with landowners to provide expertise and funding for buffer plantings in the Snoqualmie APD include the Snoqualmie Tribe, the Tulalip Tribes, Stewardship Partners, Sound Salmon Solutions, and the King Conservation District. Funding for these projects comes from the Snoqualmie Watershed Forum by way of the King County Flood Control District's Cooperative Watershed Management (CWM) grant fund for habitat restoration, and the Department of Ecology.

2.1.1.1 Incentive Programs for Buffers

The Conservation Reserve Enhancement Program (CREP) is a joint federal and state funded program that pays farmers to remove environmentally sensitive land from production. CREP reimburses landowners for the cost of site preparation and the purchase and planting of native trees and shrubs along salmon bearing streams. The program reimburses maintenance costs for up to five years after planting. Landowners are paid rent for a period of 10-15 years by enrolling their land in the program. Minimum buffer widths are 15' for hedgerows and 50' for riparian forest. The maximum width is 180' for riparian forest. CREP plantings are considered a farming practice, therefore when the lease period expires CREP allows landowners to cut the buffer area to generate revenue from timber sales or to restore the site back to active farming. However, local jurisdictions may have restrictions that limit buffer management at the end of the lease period. Landowners who intend to remove buffers after the lease period ends should understand the local land use code restrictions before entering into a CREP lease agreement.

The King Conservation District (KCD) has a cost-share program that covers 90% of the costs to plan, implement, and maintain riparian plantings on farms. This program follows the same standards as CREP but is limited to plantings that cover 1 acre or less.

2.1.2 Mitigation

King County Code (KCC 21A.24) requires mitigation planting to compensate for impacts to a Critical Areas and their buffers from activities requiring a clearing and grading permit, e.g., buildings, farm pads, and dredging for drainage. Some landowners have expressed reluctance to do any voluntary planting to keep areas available for mitigation plantings in case they want to make farm business related improvements on their property in the future. One of the tasks of the FFF Regulatory Task Force is to explore the options and constraints on voluntary plantings as mitigation for future projects.

2.1.2.1 ADAP

Depending on waterway type, King County's Agricultural Drainage Assistance Program (ADAP) requires the planting of between 0 and 3 rows (0-15 feet) of trees and/or shrubs along each side of the waterway after drainage maintenance, although there is some room for flexibility of planting locations. King County will pay for the plantings and the initial three years of maintenance. When future drainage maintenance requires removal of a planted buffer, WDFW, who issues permits for ADAP projects, requires the buffer to be reestablished to the original ADAP specifications once maintenance activities are completed.

2.1.2.2 Regulatory

For Critical Area impacts not associated with ADAP, the mitigation requirements will typically be riparian planting on the parcel where the impact is occurring. Offsite mitigation can be also approved.

2.1.3 Passive Restoration

Trees and shrubs can re-establish through successional processes when land is left fallow for prolonged periods. Once trees in a Critical Area or its buffer reach 4 inches diameter at breast height (dbh), defined as the diameter at 4.5 feet above the ground, the conditions for tree removal are controlled by the Critical Areas Ordinance (KCC 21A.24) and they cannot be removed without a permit. Landowners who do not want woody vegetation to become a permanent part of their farm must actively manage fallow lands on or near wetlands and streams to avoid future regulatory encumbrance.

2.2 Buffer Plantings to Date

Farmers, landowners, the King County Agriculture Commission, and local agricultural service organizations have expressed concern about the scale of buffer plantings on Snoqualmie Valley farmland but there has not been a complete summary of the number of acres planted across the Snoqualmie APD. Since 2005 at least 153 acres of voluntary plantings have been implemented in the Snoqualmie APD for salmon recovery. Of those, 90 acres were on public land and 62 acres were on private land. Data are currently compiled to determine if all of these plantings have established successfully (P. Falcone, personal communication, November 2018). Many of the plantings on public lands were understory plantings in established buffers (B. leDoux, personal communication, November 2018). These totals do not include acres planted for mitigation or CREP.

King County staff have begun an effort to consolidate record-keeping on planting projects funded by the Snoqualmie Watershed Forum's Cooperative Watershed Management (CWM) grants and Department of Ecology funds awarded for salmon recovery planting projects. To effectively evaluate the impact of buffer plantings, records should include planting dimensions (width, length), species composition, maintenance tracking, and land use immediately prior to planting.

3.0 EFFECTS OF RIPARIAN FOREST ON AGRICULTURAL LAND

3.1 King Conservation District Survey

In fall of 2018, KCD sent a survey to all of their customers. Out of the 600 respondents who responded, 239 had waterways with planted vegetation. Of those, 74 self-identified as farmland owners. Tables 1 and 2 summarize farmland owner responses regarding their perceived and realized benefits and concerns with buffers. Because the respondents self-identified as farmland owners, there was no way to distinguish which responses were from commercial farmers. In some cases responses may differ for commercial versus hobby farmers. Because this survey was not designed for this paper, it is important to view these responses as one data set alongside the interviews and literature review.

Table 1. Response to KCD survey question "What do you believe are the benefits of a vegetation buffer (check all that apply)?" (King Conservation District, 2018). n=74

Answer Choices	Percent	Total
Attracts wildlife	83%	61
Stabilizes the shoreline bank	83%	61
Keeps the stream cool for fish	80%	59
Shades out invasive weeds	71%	52
Provides food for fish	66%	49
Creates habitat for bees	65%	48
Improves the visual quality of the property	51%	38
Increases property privacy	46%	34
Provides protection from the wind	37%	27
Creates noise shield	35%	26
Provides shade for livestock	26%	19
Increases crop production on the property	11%	8

Table 2. Response to KCD survey question "What do you believe are some concerns that you may have experienced or could experience with a buffer (check all that apply)?" (King Conservation District, 2018). n=74

Answer Choices	Percent	Total
Challenges with maintenance of the buffer	46%	34
Arrival of nuisance wildlife such as coyotes or deer	28%	20
New or increased presence of Beaver	19%	14

Answer Choices	Percent	Total
New or increased presence of Elk	15%	11
Reduction in crop production because of shading	12%	9
Decreased farm field drainage	8%	6
Increased flooding	6%	5
Increased crop pests	3%	2

3.2 Loss of farmland

Riparian planting in the Snoqualmie Valley will take agricultural land out of production, but the magnitude of that change will not be known until there is a recommendation from the FFF Phase 2 work (Snoqualmie Fish Farm Flood Advisory Committee Draft Final Report, February 2017). The scale of the change will also be influenced by the willingness of landowners to participate in establishing buffers, and the width of the buffers they plant. The loss of farmable land is the primary concern for most landowners when considering planting a buffer. With 57% of the land in the Snoqualmie APD within 150' of a waterway, buffers can take up a large amount of the tillable land on a single farm site. As a reference, a buffer planted 150 feet wide and 145 feet long along each side of a waterway would cover one acre of ground (Table 3). Most voluntary buffer planting programs allow narrower buffers down to 25 feet or less; Ecology grants generally require minimum buffer widths of 100 feet. Beyond the initial planted area, buffers continue to grow out over time and can encroach on farmland beyond the originally planted width.

Table 3. Buffer length and width equal to 1 acre.

Buffer Width *(one side of waterway)*	**Length to equal 1 acre**
150’	290’
100’	435’
50’	871’
25’	1,742’

The value of tillable land varies widely depending on farm uses (Table 4). The gross numbers in Table 4 do not take into account farm inputs, equipment, infrastructure, labor, marketing, sales, or fields left fallow for crop rotation. Rather, the gross income provides a sense of the annual value of an acre of land to a farmer.

Table 4. Gross annual income per acre for agricultural land in the Snoqualmie Valley based on interviews with farmers (Salatin 1996, Maynard and Hochmuth 1997, Moore 2017).

Crop	Annual gross income per acre
Silage corn	$1,500
Hay	$400-$1,500
Wholesale mixed vegetables	$8,000-$15,000
Retail mixed vegetables	$30,000
Beef cattle	$500-$3,500
Lamb	$1,000-$5,000
Meat chickens	$12,500
Eggs	$20,000-$40,000

Riparian buffer plantings can have operational and financial impacts greater than just the dollar value of the potential crop on a site. The area nearest the mainstem Snoqualmie River is often the highest elevation of the farm. These “natural levees” are ideal for early or late season crops (when other parts of the site may be flooded or too wet to farm). They are also often the best place to locate agricultural structures because they have the lowest risk from flooding. As a result, loss of farmland from riparian buffer plantings on high ground can have an especially negative impact on a farm.

Under current King County code, voluntary buffer plantings in Critical Areas cannot be removed without a permit once trees reach 4” diameter at breast height (KCC 21A.24.054). Because these permits would be issued for very limited and specific reasons (such as hazard tree removal or qualified timber harvest) in most cases that portion of land will be permanently unavailable for agricultural production. The immediate economic impact of removing an acre from production is quantifiable, but it is more difficult to quantify the long term effects of loss of farmland in the Snoqualmie APD. Under predicted changes in climate patterns over the next 30-50 years, the Puget Sound region will remain a highly viable place for food production while climate shifts in other regions makes them much less suitable for agriculture than they are now (Mauger et al. 2015). Farmland in the Snoqualmie Valley plays an important role in our region’s local food system and will continue to do so well into the future (King County 2015).

3.3 Water and Flooding

Farming in the Snoqualmie Valley floodplain is often a balancing act between too much water in the winter and too little water in the summer. Any project that tips the water balance can add to an already challenging food production system. Debris from trees can clog waterways, which may reduce the effectiveness of those waterways to drain agricultural land (Dosskey et al. 2017). Farmers emphasize that buffers can make drain tiles hard to maintain, or ineffective. Roots from plantings can clog tiles, and trees along the waterways into which tiles drain make it difficult to access waterways to clear deposited sediment and debris.

Riparian vegetation has a complex relationship with water movement in flood events. Vegetation plantings, in particular east-to-west across the Snoqualmie Valley can change drainage patterns by slowing water dissipation on an individual farm during flood events (Moore 2017). At a catchment scale, riparian vegetation can reduce flooding downstream, and trees generally help make flood peaks smaller and slow them down (Dixon et al. 2016). However, in minor to moderate flood events, some landowners have seen that buffers can help keep a stream in its banks.

Reed canary grass (*Phalaris arundinacea*) is an aggressive, invasive species that commonly establishes in wet farm fields and smaller waterways. Reed canary grass can impede drainage in waterways adjacent to farm fields, leading to fields that are too wet to farm. Reed canary grass transpires such large amounts of water that its removal can lead to an increase in instream flows (Schilling and Kiniry 2007). Shade from trees and shrubs in planted buffers can prevent reed canary grass from establishing on a site (Kim et al. 2006, Miller et al. 2008). Proper site preparation is required if buffer plantings are to shade out reed canary grass (Hovick and Reinartz 2007, Miller et al. 2008).

Riparian vegetation roots stabilize banks and reduce channel migration, which could otherwise lead to farmland loss due to erosion (Thorne 1990, Micheli et al. 2004). Trees and shrubs are more effective than herbaceous vegetation at stabilizing banks along waterways with high flow rates (Simon and Collison 2002, Zaimes et al. 2004). However, smaller channels bordered by grass demonstrated less widening than those bordered by trees or shrubs (Lyons et al. 2000). This is attributed to several causes. Grasses develop a tighter near-surface root mat that may be better than trees and shrubs at preventing erosion (Davies-Colley 1997), large trees that fall in the stream cause significant soil disturbance and can focus stream flows into the bank (Montgomery and Buffington 1997, Trimble 1997), and the voids left by root wads of fallen trees can cause turbulence and localized erosion (Thorne 1990). A study in the Tolt River watershed showed that channel widening only occurred at points where log-jams diverted flow into the bank (Montgomery et al. 1995).

Planting on a single side of waterways has been proposed as a solution for farmers who need access to the waterway for recurrent dredging and beaver management; this would help them avoid the costly step of removing shrubs and trees. DeWalle (2010) found that the majority of the total daily shade on an east-west oriented stream was provided by a buffer on the south side. Buffers on the north side provided shade in the morning and late afternoon when solar intensity was reduced. A study in low elevation, forested streams found that water temperatures with one-sided buffers on forest land were comparable to pre-harvest temperatures (Cole and Newton 2013). Unfortunately, in portions of their study area, shrubs grew up on the “no buffer” side of the treatment, providing shade to the streams, a result that is unlikely in an agricultural setting.

It may be possible to design plantings so that there are access points along the waterway. If these access points are planted with sprouting species, like willows, buffers may be mowed for periodic waterway maintenance and those species will typically regrow without additional buffer management. This mowing for access requires the farmer to invest time and money for equipment to do the mowing and any expense for slash disposal. The cost in time may be outweighed by the reduction in maintenance frequency, especially when reed canary grass growth is the cause of reduced stream velocities and increased sediment deposition.

3.4 Animals

3.4.1 Insects

Many studies examined the value of buffers or hedgerows near agricultural lands as a source of pollinators. Klein et al. (2007) identified 16 studies that found that proximity to "near natural" habitats resulted in higher pollination rates as measured by fruit set, number of seeds, or directly counting pollinator species . Up to 25% higher pollinator visits have been observed on crops with flower strips within 20m than those without (Feltham et al. 2015). Bean yield has been found to be greater at the edges of large monocropped fields due to availability of pollinators at the edges of the field (Free and Williams 1976).

European honey bees (*Apis mellifera*) are relied on for most insect pollination in the US – their life history make them reliable and successful pollinators (Mader et al. 2010). Recent decreases in bee populations have been attributed to pesticides and parasites and there is increased incentive to provide habitat that provides multi-season benefits to honey bees. European honey bees are but one of many native and non-native bees that can provide significant pollination services and benefit from establishment of diverse riparian buffers. Flowering shrubs in a hedgerow or buffer can increase diversity and abundance of pollinating native bees (Vaughan and Black 2006) and a high diversity of flowering buffer species with varied seasons of flowering provides ideal forage habitat for native bee pollinators (Vaughn and Black 2006). Buffer edges also provide valuable habitat for both wood nesting bees and ground nesting species which require undisturbed soil (Cane et al. 2007, Grundel et al. 2010).

Riparian buffers are also known to host both beneficial and harmful insects. The abundance and diversity of predatory insects that prey on crop pests increases with landscape complexity, such as provided by buffer plantings (Chaplin-Kramer and Kremen 2012, Shackelford et al. 2013). Wider buffers supported a greater diversity of these beneficial insects early in the growing season when many crops are most susceptible to pest outbreak (Maria 2014). Potentially problematic, buffers may also provide habitat for pest species (Heimpel et al. 2010).

3.4.2 Mammals

Many farmers in the Snoqualmie Valley have expressed concern that beavers will move in to newly planted buffer areas. Many farmers and landowners have seen how beaver dam construction can change how water flows across a farm and cause flooding in fields. Ponding associated with beaver dams has been seen to increase groundwater levels within 165 feet of the beaver dam (Lowry 1993). Depending on the existing soil conditions, this increased water level could expand farm options - allowing crops to be grown without irrigation - or make the site so wet it is un-farmable.

Because beavers demonstrate preference for certain tree and shrub species, many farmers focus on species selection for buffer plantings to reduce the likelihood of attracting beavers. The King County Beaver Management Technical paper has compiled a summary of beaver forage preferences (Table 5) (King County 2018a).

Table 5. Beaver forage preference by plant species (King County 2018a).

High	Medium	Low	
Willow species (Sitka, Pacific, Hooker's, Scouler's)	Bigleaf maple	Sitka spruce	Twinberry
Black cottonwood	Western redcedar	Bitter cherry	Ninebark
Red alder	Douglas-fir	Red twig dogwood	Western crabapple
Vine maple		Oregon ash	Douglas hawthorn
		Cascara	Nootka rose
		Salmonberry	Spirea (Hardhack)

Beavers demonstrate preference for shrub and tree species as food sources, but are opportunistic and will use a wide variety of vegetation for forage and dam construction. Selecting riparian planting stock based on preferential foraging habits of beavers may help buffer establishment, but may not necessarily prevent them from moving into a site with otherwise suitable habitat features (J. Vanderhoof, personal communication, October 2018). Educating landowners about the tools and legal options for beaver management will help reduce impacts to agricultural land when beavers move into new sites. A recently released technical paper summarizes beaver management options in King County (King County 2018a). Some practitioners have suggested incorporating plant species that beavers typically avoid and that could deter deer or elk movement such as rose, salmonberry, and Sitka spruce (King County 2018a). On a case–by-case basis, it may be possible to determine where minor flooding due to beaver activity could be acceptable and focus buffer plantings in these areas. The King County Beaver Management Working Group has a robust website detailing the options landowners have for beaver management as well as technical support and additional resources (https://www.kingcounty.gov/services/environment/animals-and-plants/beavers/Resources.aspx).

Buffers can serve as habitat or movement corridors for deer and elk which can eat crops, trample on plants, or destroy fences, often causing significant damage in a single visit. Washington Department of Fish and Wildlife has a program to compensate farmers for crop losses from deer and elk depredation. While the program has not been widely used in King County, they do have one recent claim of $7,722.72 for a crop of lettuce that elk ate just before harvest (R. Schreiner, personal communication, October 2018). The new Produce Safety Rule under the Food Safety Modernization Act will require certain farms to track wildlife and bird presence on the farm (U.S. Food and Drug Administration 2015). Many farmers are reluctant to increase potential habitat for birds and wildlife until they better understand the implications of this new rule.

3.5 Shade, wind, and visual barrier

Shade from tree buffers can reduce crop productivity adjacent to buffers (Reynolds et al. 2007). Shade rather than root competition with the plants in the buffer reduced corn yield by 30-70% in the first 30 ft. from the buffer (Awole et al. 2018). Sugar beet yield was reduced by 60% in the first 16 feet, and some reduction in yield was seen as far as 85 feet from the buffer (Borin et al. 2010). In contrast, soybean yield was only impacted in the first 15feet (Borin et al. 2010). While sugar beets and soybeans are not commercial crops in the Snoqualmie Valley, these studies demonstrate that the impact of shade will vary by crop type, height of the riparian vegetation, and distance of crops from the vegetation.

Wind is not a primary environmental challenge to farming in the Snoqualmie Valley, but buffers are frequently planted in other agricultural landscapes as windbreaks. A literature review found crop yield improved 6%-44% with shelter from trees (Brandle et al. 2004). Yield responses varied with crop, windbreak design, moisture condition, and soil properties. The response of plant growth to shelter from wind depends on the relationship of temperature, moisture availability, and mitigating physical damage. In some cases, crop yields near buffers may be reduced due to allelopathy, nutrient competition, moisture competition, shade, or temperature (Kort 1988).

For farmers raising animals, the shade from buffers can provide important benefits to animal health, milk production, and conception rates. Heat stress is responsible for production decreases in dairy cows, beef cows, sows, market hogs, chickens (both broilers and layers), and turkeys (St-Pierre et al. 2003). By modeling different livestock management scenarios across the United States, St. Pierre et al. (2003) determined that lack of some form of heat abatement resulted in $700 million in total losses across animal classes. Shade from buffers can be an important part of heat abatement. In a New Zealand study, milk yield was found to be at least 3% greater for cows with access to shade (Fisher et al. 2010). West (2003) summarized multiple studies and described a 4%-10% increase in milk production for cows with access to shade . These studies were from the southeastern US where higher temperatures and humidity currently have greater impact on milk production than in the Pacific Northwest. However, in the long term, shade provided by riparian buffers may help ameliorate the impacts of climate change as average temperatures rise (Dosskey et al. 2017). With respect to climate change impacts, in temperate ecosystems similar to the Snoqualmie Valley with future summer rainfall predicted to be lower than it is now, shade will provide value in improving animal health (Rowlinson 2008).

Wind protection in winter can also increase milk production and decrease stress on animals (Brandle et al. 2004). Windbreaks can be a component of odor management for livestock production (Dosskey et al. 2017).

Riparian vegetation plays an important role in reducing the input of pesticides, nutrients, and sediment into waterways adjacent to farms. Pesticide drift into surface water can be reduced by buffers, dependent on the timing in the growing season. Wenneker and Van de Zande observed an 80-90% drift reduction when leaves are fully developed in deciduous buffers, and as low as 35-50% when leaves are not fully developed (Wenneker and Van de Zande 2008). Buffers can also reduce non-point source pollution including nutrient and water runoff (Merrington et al. 2002, Schultz et al. 2004). Riparian vegetation and 16-foot grass filters both reduced sediment runoff by 60-90% (Daniels and Gilliam 1996). Jia et al. (2006) found a 30-40% reduction in phosphorus and nitrogen transport from fertilizer applications with 26-foot grass buffers (Jia et al. 2006). They also noted that in their 3-year study, timing spray-irrigated fertilizer applications to avoid high water tables and storm events had more impact on water quality than vegetated buffers. The Synthesis of Riparian Buffer Science further discusses the factors influencing riparian vegetation effectiveness at limiting nutrient, sediment, and pesticide inputs to waterways (King County 2019).

Buffers can obstruct views across a farm and can drop limbs and trees on fences and fields. For livestock producers it is important to see animals in order to efficiently assess health, predation, or other stressors (R. Reinlasoder, personal communication, October 2018). Maintaining the clean lines of their farm, fences and fields in good working order are an important element of running a business. In the King Conservation District 2018 survey there was not a question about views, but 7 of the 74 respondents took the time to write in an answer about buffer concerns related to blocking views, and one respondent expressed a reduced sense of security.

4.0 ENCOURAGING LANDOWNER PARTICIPATION

Incentive programs can help increase landowner participation in voluntary buffer planting projects. A review of buffer payment systems throughout Europe identified consistent elements that led to higher participation by farmers (Dworak et al. 2009). Successful program elements included rates high enough to compensate for lost production, clear guidelines with low administrative barriers, stable funding, and limited input by the farmer to successfully establish and maintain the buffer. The CREP program incentivizes buffer plantings by providing the landowner with an annual rental payment for 10-15 years, however, because of CREP's relatively large buffer requirements, few of the farmers interviewed found that these buffers fit well with long-term profitability of their farm. Providing flexibility in compensation rules for land taken out of production may encourage more landowners to participate. The Spokane Conservation District implemented a pilot program in 2017 that paid farmers per acre based on USDA Risk Management Agency crop rotation values for adjacent crops – typically higher than the amount per acre paid by CREP (Spokane Conservation District 2017)

The farmers interviewed for this paper are committed to being good stewards of the land and other natural resources found on their farms, and they want to know whether buffers are significantly benefiting salmon recovery. To paraphrase one local landowner, it is much easier to give up farmland if you understand what is being gained in return. It is necessary to acknowledge that salmon recovery is a landscape level effort, and it can be difficult to demonstrate some of these habitat improvements on an individual property. KCD's Discovery Farms study is intended to directly engage landowners and farmers in learning how buffers achieve habitat objectives while minimizing farming impacts.

While there are many scientific studies describing the impact of buffer widths on riparian functions (King County 2019), effectiveness monitoring of selected projects can be an important tool in encouraging landowner participation in planting. Engaging landowners in the monitoring process expands the opportunities for farmers to see the direct impacts riparian plantings can have for salmon recovery. The King Conservation District's Discovery Farms Project (Awole et al. 2018) lays the groundwork for this work in the Snoqualmie Valley. KCD is measuring water temperature in waterways along established buffers of different widths to understand the effect of buffers on stream temperatures. In a similar effort, Whatcom Conservation District partnered with other organizations to implement a Discovery Farms program in Whatcom County to validate various practices on dairy farms that are implemented to minimize nutrient inputs to adjacent waterways.

Members of the FFF Buffer Task Force recognize that not all waterways are required or able to provide the full suite of potential ecological benefits. The Buffer Task Force is charged with identifying the primary buffer functions thought necessary for water quality and salmon recovery. The riparian functions expected of the different waterways are likely to be different based on characteristics such as waterway size, solar aspect, and fish use.

5.0 SUMMARY

King County has committed to supporting both salmon recovery and a thriving agricultural sector within their jurisdiction (King County 2015, 2016). As a part of balancing these complex objectives, the Buffer Task Force is exploring the use of variable-width voluntary riparian tree plantings in the Snoqualmie Valley APD to achieve salmon recovery objectives and minimize adverse effects to agriculture. This work recognizes that farmland is a valuable and finite resource in the Snoqualmie Valley.

When researching and writing this document, it became clear that riparian forest impacts were very dependent on context. The way a buffer impacts farming operations depends on elements including the agricultural land use, where the waterway is on the landscape, and the type of waterway. A cattle ranch may welcome trees for shade and water quality protection, while a vegetable farm may experience financial losses from reduced production near their buffer. On a larger waterway tree and shrub roots serve an important role to hold the streambank in place, while smaller waterway banks may receive the same benefit through smaller shrubs and grasses. Willingness of landowners to participate in voluntary riparian buffer planting is similarly dependent on current and future plans for use of the property, available incentives, and individual values and concerns.

While farmers may conceptually support salmon recovery work as part of their larger commitment to environmental stewardship, they are often not willing to agree to the wider voluntary planting options that exist. Buffer planting and maintenance will add new tasks to farm management activities, and can have other potentially adverse impacts on farmland property and agricultural business. Along with King County's Agriculture Drainage Assistance Program, CREP, and easement purchases, it is hoped that varied buffer widths and program incentives will help encourage landowner participation in buffer planting projects. Creative implementation solutions such as one-sided or intermittent buffers also warrant a monitoring strategy to determine if a variable buffer width approach to salmon recovery achieves restoration objectives while taking into account the variety of opportunities and challenges riparian plantings present on the farm landscape.

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