The Working Buffer Opportunity:

A proposal for ecologically sound and economical viable riparian buffers on agricultural lands

Photo Credit: United States Dept. of Agriculture

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May, 2015

Funding and support provided by NOAA and Puget Sound Partnership.
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Introduction

Individuals in environmental organizations, government agencies, and tribes along with fisherman and farmers throughout the Puget Sound region recognize the importance of sustaining natural resources for future generations. In our managed landscapes, returning to pre-settlement conditions is neither feasible nor would it sustain our current population. We will need to work together to develop a mosaic of natural resource lands, farmlands, and urban areas that meet our needs and recover habitats. This is especially important as the impacts of climate change may begin to threaten our ability to harvest food, fiber and sustain fisheries.

Washington State ranks 17th in the nation for agricultural production, reaching $9.89 billion in products in 2012. In Snohomish County alone, we have approximately 1,400 farms on over 70,500 acres of farmland. Agricultural production supports around 18,000 jobs in the state and $2.2 billion in personal income (USDA, 2014). Protection of Washington farmland is a performance metric for the state of Washington, and the stated goal of Snohomish County governance (WAGOV, 2015; Snohomish County, 2005).

The agriculture industry is not alone in relying on natural resources and contributing to community sustainability. Non-treaty commercial and recreational fishing in Washington, for example, supported over 15,000 jobs and $540 million in personal income in 2006 (WDFW, 2008). Providing fishing opportunities into the future was promised in treaties between tribal nations and the United States government (NWIFC, 2011), yet our salmon populations are at a fraction of historic levels and several species are on the Endangered Species List.

Finding creative solutions that enhance Washington’s natural resources and our ability to maintain both economically viable agriculture and healthy fish populations is critical to creating a thriving community.

Agricultural viability intersects with fish habitat recovery most strongly in the riparian zone of our streams and rivers. Privately owned farms are part of an economy and culture that spans four to six generations, with unique and irreplaceable economic and social value that is currently at risk (Snohomish County, 2005; Canty et al., 2012). The lowland Puget Sound landscapes surrounding large rivers and streams where agricultural activities primarily occur are also vital to recovery of threatened Puget Sound Chinook salmon (SBSRF, 2005; Montgomery et al., 2002). Riparian management can mitigate the water quality impacts of farming and restore the stream structure that provides salmon habitat.

One reason for our failure to improve riparian management on agricultural lands is our traditional “no touch” approach to riparian zone creation. Farmers in Washington face high-risk and low profit margins so losing productive land to these no touch buffers is not always an economically feasible option. In addition, continued population growth increases pressure for conversion of working farms into large-lot rural estates in Western Washington. In the last 65 years, the Puget Sound region has lost 60% of its farmland, mostly to urbanization (Canty et al., 2012). Both farming and fish habitat advocates face the same development pressure and conflict as they try to control a dwindling land base.

In Snohomish County, over 80% of farms are less than 50 acres in size. On these smaller farms, a no-touch riparian zone can take a large proportion of available land, creating a significant financial hardship. If we recognize the importance of agricultural land: 1) to our economy, 2) as the alternative to
urbanization, 3) as part of our cultural heritage, and 4) our source of food security, we must figure out how to improve fish habitat while increasing agricultural viability. These two activities must occur on the same landscape.

How can we find a way to help farmers thrive while at the same time recovering stream habitat to restore salmon populations? In a survey of 64 primarily agricultural landowners living along streams in Snohomish and King Counties, landowners were asked if they would be willing to plant a riparian buffer. Only 8% of respondents said “no” with the remaining answering either “yes” or “maybe”. What then, is the barrier keeping 92% of our waterways from being planted with streamside vegetation? Our survey respondents suggest that limited awareness of incentive programs, desire to maintain control of land, mistrust of large distant government agencies, potential loss of income, and lack of willingness to plant wide buffers that are required by many incentive programs are important factors (AFT and SCD, 2014).

One way of providing increased buffering functions on agricultural land is by integrating well-designed agroforestry and runoff management practices near water. Agroforestry is the incorporation of trees into crop or livestock farming to increase ecological functions, increase yield, and diversify farm income. Agroforestry systems can be designed to provide a mix of ecological services while allowing harvest. By implementing what we are calling “working buffers”, we can increase the functional width of buffers while continuing to allow farmers to control and derive income from their land. In the survey mentioned above, 78% of respondents said they would like to retain use of their buffer for one or more activities such as non-timber forest products, grazing, firewood or pole production, or recreation.

This “working buffers” approach is based on a set of logical assumptions, informed by conservation values and our continuing review of available scientific evidence about riparian function:

1. We need to increase riparian zone functions to improve water quality and recover salmon.
2. We want to sustain local agricultural production and economies, to preserve our open space, our culture, and to increase food security.
3. Our current approach to improving riparian zone management is not working quickly or efficiently. Public resources are limited as is landowner willingness to take land out of production.
4. Increasing speed and efficiency of riparian zone enhancement will require collaboration between private streamside landowners and our public agencies. Collaboration requires developing shared interests, trust, and appropriate sharing of costs and risks.
5. Good riparian zone management responds to the character of the site and combines the knowledge of ecologists with the knowledge and efficient stewardship of private landowners.
6. Site specific design solutions that integrate conservation and agroforestry will be different than current practices and will require the experimentation and evolution in both agricultural and conservation techniques.

This paper explores the possibility of a “working buffers” approach. We discuss how water quality and habitat functions could be provided by the design of runoff management and agroforestry systems in the Puget Sound region.
Redefining Riparian Buffers

The term “riparian buffer” describes a vegetated strip that buffers the stream against the activities that lie beyond it. Both natural resource planners and farmers commonly assume that buffers must be composed of native forest vegetation, with the least possible intervention. A buffer is defined as a “no-touch zone” with a distinct boundary – agricultural practices only found beyond that boundary. A working buffers approach requires a broadening of this definition, a blurring of this distinct line between conservation and agriculture, and a more comprehensive approach to the design of buffering functions in agricultural landscapes.

Tremendous energy is expended arguing how wide of a forested riparian buffer is needed, and over the conditions under which landowners should be encouraged or required to plant these systems. Meanwhile, the actual rate of riparian zone improvement is very slow and difficult to track. Federal programs designed to enhance riparian zone condition may not be achieving the desired impacts to recover fish populations (Breslow, 2001; NWIFC, 2011).

In the survey of landowners mentioned above completed by American Farmland Trust and the Snohomish Conservation District, private streamside landowners within priority Chinook recovery areas in Snohomish County were asked a variety of questions about their knowledge and preferences around riparian zone management (AFT & SCD, 2014). Survey results suggest that:

- Most landowners were very unfamiliar with or unaware of the range of public programs to assist with riparian zone management.
- Most landowners would prefer to work with local groups, particularly the Conservation District, and 65% wanted to learn more about assistance programs.
- Only 8% indicated that they were unwilling to plant a riparian buffer. However, 82% indicated they would like to retain ownership of their riparian lands. Willingness to act decreased as buffer width increased, and those most willing were involved in pasture production rather than crop production.
- 78% said they would be interested in having a buffer where they could retain some use like seasonal grazing, fuel or pole harvest, recreation, or non-timber forest product harvest.

These survey results do not apply to every farmer. They do suggest, however, that there may be fertile ground for designing a more flexible, dynamic, and hopefully successful approach to riparian restoration and management where ecology is mixed with agriculture in a public-private partnership.

The Case for Flexible Buffer Widths

The prescription of fixed buffer widths for different types of streams is widely adopted for regulatory purposes. This approach can be easier to enforce especially for protecting existing riparian forest or establishing setbacks for construction. When considering restoration of impaired riparian zones where riparian vegetation would be newly planted, the fixed buffer width approach may not be feasible nor achieve the ecological function desired. Some authors suggest that a more site specific approach aimed at achieving distinct water quality or habitat functions may be a more effective approach (Castelle et al., 1994; Asbjornsen et al., 2013).

Haberstock (2000), for example, outlines an approach whereby the riparian buffer is divided into two management zones with a 35 foot low-disturbance zone next to the waterbody and then a zone of managed forest beyond that. He proposed that the width of the outer zone be based upon specific site...
conditions such as topography and soil characteristics. This approach would allow natural resource planners to determine the appropriate level of management in the second zone as well as the width needed to achieve water quality and habitat functions. It would also allow the landowner to derive economic return from production of timber and non-timber products in this zone.

Literature reviews on buffer width usually provide a range of widths rather than prescribing fixed buffer widths for specific water quality or habitat functions. The Environmental Law Institute compiled research from numerous studies to develop their *Planner’s Guide to Wetland Buffers for Local Governments* (2008). Their findings indicate the wide range of recommended buffers show in Figure 1. Knutson and Naef (1997) found similarly varied buffer widths needed to provide a number of ecological functions shown in Table 1.

![Figure 1: Recommended buffer widths from ELI, 2008.](image)

<table>
<thead>
<tr>
<th>Riparian habitat function</th>
<th>Range of reported widths in meters (feet)</th>
<th>Average of reported widths in meters (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature control</td>
<td>11-46 (35-151)</td>
<td>27 (90)</td>
</tr>
<tr>
<td>Large woody debris</td>
<td>30-61 (100-200)</td>
<td>45 (147)</td>
</tr>
<tr>
<td>Sediment filtration</td>
<td>8-91 (26-300)</td>
<td>42 (138)</td>
</tr>
<tr>
<td>Pollution filtration</td>
<td>4-183 (13-600)</td>
<td>24 (78)</td>
</tr>
<tr>
<td>Erosion control</td>
<td>30-38 (100-125)</td>
<td>34 (112)</td>
</tr>
<tr>
<td>Microclimate maintenance</td>
<td>61-160 (200-525)</td>
<td>126 (412)</td>
</tr>
<tr>
<td>Wildlife habitat</td>
<td>8-300 (25-984)</td>
<td>88 (287)</td>
</tr>
</tbody>
</table>

One reason for the disparity in buffer width recommendations is that buffer widths were difficult to correlate to ecological function. Many landscape characteristics can enhance or compromise buffer effectiveness. Buffer function can be affected by whether surface runoff is spread evenly as sheet flow
through vegetation, the type of vegetation present, slope, soil infiltration rates, and the intensity of adjacent land-use practices (Hruby, 2013). Studies that look at how different buffer widths filter sediment and pollutants indicate that soil type and subsurface soil characteristics affect function (Mayer et al., 2007; Dosskey et al., 2010). In addition, the ability of plants to uptake nutrients and of soils to decompose toxins is different between the growing season and dormant season.

While it is difficult to predict the buffer widths needed to achieve full function a given site, narrower buffer widths do provide habitat and water quality functions. Figure 2 suggests that while buffer widths of one to three site potential tree heights achieve the maximum ecological functions, there are significant benefits achieved by smaller buffers as well (FEMAT, 1993; Naimen et al., 2000).

Research into the buffer widths required to maintain low stream temperatures illustrates the difficulties in prescribing fixed buffers. Sridhar and others (2004) modeled ecological function to conclude that a 100 foot buffer with mature canopy next to the channel caused the greatest stream temperature reductions in the Beckler and Entiat Rivers, Washington. By contrast, an exploratory study by Benedict and Shaw (2012) found that densely planted narrow buffers (5-15 feet) in agricultural landscapes can provide similar effective shading and above-stream air temperature reductions as wider buffers (35 to 180 feet). Air temperature is strongly correlated with stream temperature in several studies (Morill et al., 2005; Erickson and Stefan, 2000; Mohseni and Stefan, 1999).

Figure 2: Functions provided by riparian buffers from Snohomish County Best Available Science (2006), adapted from FEMAT (1993) and Naimen et al. (2000).
The Critical Effects of Concentrated Flow

The ability of a riparian buffer to provide filtration of pollutants and infiltration of surface flows depends, in large part, on how much of the buffer the water is actually flowing across. Dosskey et al. (2002) studied runoff from four crop farms in Nebraska and found that the effective buffer area, the area that field runoff actually flowed across, was only 6%, 12%, 40%, and 81% of the total or gross buffer area. He concluded that the degree to which flows were concentrated were actually more important than buffer width for trapping sediment (Figure 3). This points to the need to implement both dispersal and infiltration practices on the landscape to reduce the amount of concentrated flow reaching surface waters.

![Diagram showing relationship between field runoff areas, gross riparian buffer area, and effective riparian buffer area from Dosskey et al., 2002.](image)

A Proposal for Floodplain Design

We propose that a “one-size-fits-all” approach to riparian buffer design is not as effective as a site-specific design approach. The intensity of farming practices near a stream determines the need for water quality buffering. The potential for channel migration affects the area needed to support stream processes and habitat. Varied topography and soil texture strongly affects patterns of surface runoff and pollutant transport differently at the field and landscape scale. Soil ecology and harvest cycles can affect the ability to absorb and sequester nutrients. It therefore follows that natural resource planners may want to look at current farming practices and potential pollution types, landscape topography and hydraulics and their corresponding soil types, the migration and habitat needs of the stream segment, and the interests of the landowner to design a buffering approach that increases ecological functions while providing agricultural value.

Such an approach could combine on-farm runoff management with a flexible-width, two-zone approach for buffer design (Figure 4):

**The Riparian Buffer Zone** – An inner riparian zone is used to enhance the physical, structural, and biological character of stream habitats. This zone is immediately adjacent to the stream channel and uses the appropriate vegetation to maximize the ecological functions needed for that particular reach (e.g. shade to water, source of litter input, bank stability, and wood recruitment). Low impact harvest could be integrated into the Riparian Buffer Zone (e.g. small fruit, wild greens, boughs, and mushrooms). Timber or pole harvest could be integrated as part of a plan for long-term forest succession (e.g. alder thinning and conifer underplanting). Riparian Buffer Zones are dynamic and
may integrate areas acquired by the public for protection or managed by the landowner for recreational purposes.

**The Working Buffer Zone** – An outer Working Buffer Zone is focused on infiltrating and processing landscape runoff. This zone is immediately beyond the Riparian Buffer Zone and protects stream habitat functions and mitigates water quality while also providing a source of revenue to the landowner. This zone is managed in large part to filter and remove pathogens, nutrients, and toxins from the surrounding area by spreading and infiltrating surface runoff before it reaches the Riparian Buffer Zone as concentrated flow.

![Conceptual model of integrated design using a Riparian Buffer Zone, Working Buffer Zones, and integrated runoff management.](image)

Incorporating best management practices adjacent to or within the Working Buffer Zone that improve the effectiveness of the planted buffer by dispersing or infiltrating surface flows are critical. The Natural Resource Conservation Service identifies several agricultural practices that, when implemented, can reduce concentrated flow and associated erosion (NRCS, 2015):

- **Water spreading** – Contour or near-contour swales can be used to distribute surface runoff for infiltration in drier areas of a property. Level spreader structures or grass filter strips can be used to distribute flow into a buffer.
- **Wetland enhancement, creation and restoration** – Where concentrated flow is inevitable, constructed seasonal wetlands (perhaps associated with biomass production) can infiltrate and denitrify runoff.
- **Water and sediment control basin** – Swales and water detention basins slow runoff, increase soil infiltration and reduce sedimentation across a landscape. Vegetation in control basins can be harvested to further remove nutrients stored in soil after infiltration.
Contour farming – Runoff and soil erosion can be slowed by preparing, planting, and cultivating land on slope contours. Contour buffer strips, narrow strips of permanent, herbaceous vegetation spread out across the farm, also help to slow and disperse surface flows.

What is a Working Buffer?
A “working buffer” is a way of extending the width of a traditional riparian buffer to provide benefits to both natural resources and the farmer through use of agroforestry practices. Simply put, a working buffer is the addition of trees to an area that is still used for agricultural purposes. The USDA defines the term “agroforestry” as the addition of agronomically productive trees to traditional farming involving either crops or livestock. While agroforestry techniques are used all over the world, we propose use of these techniques specifically within floodplains and riparian corridors to increase ecological function of our managed landscape. The following are types of agroforestry practices that could be incorporated into the Working Buffer Zone (explained in more detail in the attached Templates):

Forest Farming – cultivation of specialty crops under a forest canopy. The forest canopy can be managed to provide the appropriate amount of shade as well as timber products through thinning, though constant forested canopy is always maintained. Crops that can be farmed under the canopy include mushrooms, medical plants, nursery cuttings, and ornamental plants. Forest farming can produce large woody debris, shade, and biotic inputs. Selective thinning can provide high-value saw logs and understory crops may include high-value specialty products.

Alley Cropping – growing an annual or perennial agricultural crop simultaneously with a long-term woody crop, both in rows, typically on contour. The trees or shrubs can be harvested for nuts or fruit or be harvested themselves for high-value lumber or veneer logs. Agricultural crops between rows of trees can include corn, hay, or other cultivated crops. Woody crop rows, particularly when combined with water spreading earthworks, provide greater soil development, intercepting and percolating runoff, and increasing the beneficial capture of nutrients. Both the woody crop and the field crop may have economic value.

Silvopasture – grazing livestock under a savannah or woodland canopy. The canopy is managed for timber or fruit/nut production while the understory is managed for seasonal and rotational livestock forage. The canopy may be distributed, clumped, or on contour and associated with fencing or water spreading earthworks. Woody plants increase soil porosity and depth, improving percolation and filtration. The tree canopy and associated soil health benefits may improve pasture quality and yield.

Short Rotation Biomass – Frequently harvested fast-growing trees or shrubs that stump-sprout (coppice) are harvested for biomass. Willow, cottonwood, or hybrid poplar can provide biomass for biofuel, combustion, paper pulp, livestock bedding or feed, or a number of other uses. Historically common throughout Europe, coppice can be grown in seasonally flooded situations, unsuited for tillage or grazing, and provide a yield while establishing nearly permanent shrubland habitat.

These practices are part of a dynamic design for a riparian area that may change over time as trees mature. For example, silvopasture and rotational grazing practices may help control competing Eurasian pasture species during initial tree establishment. As the canopy develops, management may shift to forest farming. Thinning and gap harvests may introduce native species used for specialty products. The finished result may be a multistory native forest with high-value species in the understory.
There are certainly barriers to working buffer management. These practices are not familiar to farm planners or many farmers. Some markets for working buffer products are untested, unproven, or require development and many farming businesses cannot afford to invest in a new product line without financial assistance.

Early adoption, however, may be supported where working buffers and their products can be easily integrated into existing farm operations and where financial incentives are provided to buffer economic risk. For example, grazing operations may benefit from rotational grazing in a silvopasture or dairies may use biomass for bedding or forage. Farm Bill subsidies for agricultural development may subsidize capital costs, and reduce risks for innovative farmers, while more effectively directing farm bill money toward improvement of riparian ecosystem functionality.

Benefits of Working Buffers for Climate Change Adaptation
Working buffers provide a number of benefits that increase the viability of our agricultural communities as well as the health of our natural resources, especially in the face of a changing climate. Climate models for the Pacific Northwest predict that we will experience flashier, more intense flooding in winter months and higher temperatures with less rainfall in summer months (CIG, 2013). These changes have the potential to adversely impact our already endangered salmon runs as well as cause hardship on our agricultural communities. Incorporating agroforestry techniques into our landscapes can be used as a way to mitigate against the effects of climate change and provide farmers with tools for adapting to increased flooding and drought (Schoeneberger et al., 2012). Table 2 illustrates ways agroforestry sequesters carbon, reduces greenhouse gas emissions, allows for species migration, and increases the resilience of agriculture (Schoeneberger et al., 2012). In addition to functions that help farmers adapt to potential droughts and flooding, adding working buffer techniques to their farm increases diversification of products and can reduce economic risk.
Table 2: Agroforestry has the potential to provide mitigation and adaptation benefits in a changing climate (from Schoeneberger et al., 2012).

**Regulation and Working Buffers**

One rationale for the adoption of simple no touch fixed-width buffers is the supposed ease of enforcement. There is practical appeal to a system of critical area management that doesn’t rely on willingness of landowners and can be verified easily upon inspection. What may be lost in that approach, however, is the actual purpose of riparian zone management—the enhancement of fish habitat and water quality at a watershed scale.

Protection of habitat, recovery of fish populations, and improved water quality are all goals that emerge at a larger scale than the individual parcel. Piecemeal implementation of conservation may fail to change the course of ecosystem degradation. Individual buffers that don’t recognize how water is moving in the landscape may meet fixed-width criteria, and still not resolve an acute resource concern.

We have approximately 150 lowland sub-basins throughout the Puget Sound. Each of these sub-basins offers an opportunity to achieve the vision of ecosystem recovery—an end to the downward spiral of aquatic ecosystem degradation. In each of these systems, the land best suited for growing food is intermixed with the land best suited to producing fish. We propose that the best outcome is one where we are able to maintain agricultural production by using methods that protect and enhance fish habitat and water quality.
Conclusion
We do not propose that working buffers are fitted to all situations, or that agroforestry techniques will restore all ecological functions and resolve all conflicts. We do, however, consider working buffers as a vital component of a watershed strategy that could foster partnership between farmers in the business of growing food and public agents working to restore aquatic ecosystems.

Agricultural sub-basins and floodplains provide an opportunity to develop land-use patterns that provide necessary habitat for humans and fish. This sustainable land-use pattern will involve farming as the primary land-use alongside areas set aside for habitat. These farms will need to be economically viable. Unlike government agents, farmers face painfully simple economics. They must make a profit to survive and the easiest way out is to sell land for development. Working buffers offer an opportunity to enter into a public-private partnership for ecosystem stewardship and economically viable farms. This proposal is an attempt to begin exploring this territory.

This process will require experimentation, flexibility and accountability. We may need to identify specific areas where we test the viability of working buffers. Those trial areas will need to decide who designs and manages working buffers. We will need to consider who bears the costs and risks, and who earns the profits. We need to evaluate if we are being effective. These explorations ultimately offer us an irreplaceable value—cultivating and placing the responsibility of stewardship among the people that actually live next to our streams.

Attachments
Attached are four templates that describe in more detail four agroforestry practices: Forest Farming, Alley Cropping, Silvopasture and Short Rotation Biomass production. The templates detail the ecological benefits provided by each type, guidance on when to prescribe each type, and information for farmers as to the species that could be installed and how to manage them.
References


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