Riparian Buffers: Function, Management, and Economic Implications for Agriculture

Summary

We have made significant progress on our project. We are building a database of water quality impacts by different types of riparian buffers as it relates to species composition, tree size, and depth to the water table. Buffer efficacy to provide shade to streams and the impact on crop production is being determined. Economic models of buffer impact on individual farm operations have been created and are being disseminated to farmers through a series of workshops. Other outreach activities included a field day, two presentations and field visits for Skagit High School students, and meetings with Skagit farmer organizations.

Objectives/Performance Targets

Our goal is to identify what constitutes a functional riparian buffer to protect water quality and improve salmon habitat on agricultural land in western Washington, and to determine the economic impact of such buffers on farm enterprises. Specific objectives include: 1) To determine the effects of buffer width, species composition and management on buffer function including nutrient removal, sediment reduction, shade, and bank stabilization; 2) To conduct economic impact analysis of different riparian buffer designs on individual farm enterprises; and 3) To develop and disseminate buffer recommendations and decision-making tools to farmers, farm agencies, regulators and policy makers dealing with farmland along watercourses in western Washington.

Accomplishments/Milestones

Leveraged Funding

A proposal was prepared in April 2005 by Dr. Johnson and funded by the WSU-Puyallup Chicona Endowment Fund to install a replication of the experimental buffer on Clarks Creek located on WSU-Puyallup farm property in Pierce County, Washington. The grant for $16,537 will cover the cost of clearing the land, installing sampling instrumentation and planting in the spring of 2006. The research site was cleared in October of 2005 in preparation of planting.

Accomplishments/milestones under Objective 1

Experimental buffer maintenance and replanting:

1) Eight-foot hybrid poplar whips were used to replant the experimental site in early April as a result of beaver-induced mortality. By the end of August, the trees were over 15 feet tall and the canopy had closed. In the red alder plots, the trees were approaching 15 feet (in their second growing season) and had closed canopy. Minimal weed control was conducted during the spring and early summer. Shading by the tree canopy prevented weed growth from July on. The grass filter strip at this site was mowed 4 times during the growing season.

Water sampling:

2) Groundwater sampling at the 3 buffer sites began in November of 2004 and continued in December of the same year. In 2005, both groundwater from 120 piezometers and soil water from 251 soil suction lysimeters were sampled in March, April, May, June, September, November and December. In addition, samples from the adjacent water bodies, Joe Leary Slough and the Nookachamps Creek were sampled. The resulting 2,611 water samples were sent to main campus for nitrate and phosphate analysis. Results show that when the tree buffer root systems are at a depth of the water table, they are very efficient in taking up nitrate. Levels as high as 1300 mg/L nitrate were recorded in piezometers located in the blueberry rows. Once the groundwater moved 50 feet to the first row of hybrid poplars (11 year old stand), the nitrate levels were reduced to below 1 mg/L and remained low within the buffer. The transects without a poplar buffer showed a reduction from the blueberry through the grass filter strip which is

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attributable to denitrification processes occurring in these piezometers. An increase in nitrate was observed in the piezometers located at the edge of the slough, presumably due to infiltration from the slough. At the mature buffer site, even though the trees are large (>100' tall), the groundwater level is relatively deep, between 10 and 15 feet below the surface and out of the rooting zone of the trees. Here we observed only a slight reduction in nitrate from the field into the tree buffer. At the experimental buffer site, the tree roots have not yet reached the groundwater and so nitrate levels moving through the buffer were relatively unaffected. It is expected that the buffer trees will begin to intercept nutrients in 2006.

Shade modeling:

1) A contract signed with Jason Cross of Rural Technology Initiative (RTI) to develop Shade Simulation Model and a draft model was developed. Two meetings were held with Drs. Johnson and Henri to refine the model. Final model was completed and delivered in December. We have taken measurements of shading on both sides of the buffers at the blueberry farm and mature forest buffer sites with a Solar Pathfinder to verify the shade model. To address the issue of impact of tree buffers on crop production, we harvested silage corn at two buffers in September. At each buffer site, two transects running from the buffer into the corn were sampled at 25, 75 and 150 feet. Two rows of corn, 8 feet long were destructively harvested and dry biomass was measured. We will use the shade model and the Solar Pathfinder to estimate the shading over the growing season at each of these points to compare with biomass samples.

Accomplishments/milestones under Objective 2

Buffer economic impact analysis:

1) Three models determining economic impact of buffers on farms that were initiated last year have been completed for Potatoes, Blueberries and Raspberries. Carolyn Henri completed Skagit potato case studies evaluating the economic impact of different riparian buffer designs and widths on potato farm enterprise net return. This process included a large amount of input from area potato growers, who provided their farm data for the case studies. A presentation of the results of this analysis was developed into a Power Point presentation and delivered to the annual Skagit Potato Growers meeting in February.

2) Using the blueberry farm's 11-year old hybrid poplar stand as a case study, a paper was prepared and published: Henri, C.J. and J.D. Johnson. 2005. Riparian forest buffer income opportunities: A hybrid poplar case study. J. Soil Water Conserv. 60:159-163.

Accomplishments/milestones under Objective 3

Develop and disseminate buffer recommendations and decision-making tools:

1) In April, Dr. Johnson hosted a field tour of the Experimental buffer site for a group of 40 University of Washington students (and their instructors) enrolled in a Junior-level course dealing with issues facing natural resource professionals. The role of riparian buffers in the landscape was discussed as was issues of the impact of buffers on farming.

2) Drs. Johnson and Henri gave project presentations at several local farm group meetings, including the Skagit Agricultural Leadership Group, Skagit County Agricultural Advisory Board, and the Skagit Potato Growers Annual Meeting. Preliminary field sampling results and economic information were presented.

3) Project website was updated and expanded in August 2005 to include information distributed during field days. Expansion included addition of new buffer economics information, project presentations and additional buffer references. The website is: http://www.puyallup.wsu.edu/agbuffers/.

4) Research project poster was presented at regional Alder Symposium at the University of Washington in March.

5) Dr. Dobrowolski designed the four-week curriculum *Understanding It Inside: Water, Water Quality and Riparian Areas* for high school students. This module answered the following questions:

Why do living organisms need water?
How healthy is the water in our area?
How do humans influence water quality and quantity?

The final week considered the issues of data discussion, inference and assessment.

6) Dr. Dobrowolski designed the curriculum *Inside-Out* for high school students to understand the Skagit River and its watershed, water quality and quantity monitoring, why we sample water (90 minute section); field exercises that focus on group observation and discovery of farm field groundwater chemistry versus surface water, characterizing the riparian/river channel corridor and team "callouts" to present their findings and ask whether their findings reflect their original expectations. The unit finishes with a "round-robin" of insights and observations from each student.

7) In partnership with WSU Cooperative Extension Skagit County staff, two classroom presentations and two field days were held for Mt Vernon High School science and agriculture students. These were held in both the spring (May 24 & 26) and fall (Oct 28 & 29) semesters. In May the presentation was entitled *Water and Watersheds: The Skagit River and its 3000-sq mi watershed* and in October, the topic was fluvial geomorphology and the importance of riparian vegetation to stream bank stability. During the field portion in May, the students learned basic water quality monitoring tools to distinguish nutrient contents between groundwater and surface water sources, which they then applied to groundwater and surface water samples taken at the experimental buffer site. In October, the students collected river flow data, evaluated the substrate materials that are moving during normal flow of the Skagit River and estimated bank stability at the mature buffer site along the lower Skagit River.

8) A field day for crop farmers was held at the Experimental buffer site on July 19 to discuss buffer efficacy as it related to nutrients and fecal coliform removal. The participants also learned about water quality monitoring including a hands-on determination of nitrate in the groundwater.

9) Field tour for Sally Lawrence, Skagit Watershed TMDL lead for WA Department of Ecology. Visit to all three buffer sites in April.

10) Drs. Johnson and Henri held meeting with farmer-cooperator Fred Devries to present preliminary field data and economic data from the experimental site. A similar meeting was conducted for our other farmer-cooperator, Tom Paulus in late November.

11) A computer workshop was presented by Dr. Henri on the use of the economic models was held for dairy and crop farmers November 2. Six members of the farming community attended this workshop and received training, instruction booklets and copies of the models on CD ROM.

Impacts and Contributions/Outcomes

Objective 1:

Currently, there are no data about buffer function including nutrient uptake and shading by different buffer types on low gradient streams in the Pacific Northwest where the majority of the agricultural activities occur. The results from the water quality monitoring is showing that for nutrient removal, one row of hybrid poplars is sufficient to drop nitrate levels to below 1 mg/L. The caveat is that the trees' root systems must be deep enough to intercept the ground water. One row of trees, however, may not provide adequate shade to the adjacent stream to improve salmon habitat. We are applying the shade model at each buffer site to determine the impact of the existing buffers on both the stream and crop. The information generated by the model will help growers assess the impacts of buffer shade on crop production. Shade production information will also be helpful to regulators in assessing the efficacy of buffer placement and size for optimal stream benefit. Site specific, experimental research-based data are not currently available for shade production from buffers in the Pacific Northwest.

Objective 2:

The completed economic models for Potatoes, Blueberries and Raspberries, and user instructions will be available to download from the project's website in 2006. Individual farmers will be able to use these models to assess their own farm economy and the viability of adding conservation buffers to their operation. Publication of our article contributed to the literature concerning the economic viability of riparian buffers (Henri, C.J. and J.D. Johnson. 2005. Riparian forest buffer income opportunities: A hybrid poplar case study. J. Soil Water Conserv. 60:159-163).

Objective 3:

Field visits and workshops at the research sites are providing the local farm and regulatory community with real data on buffer function. This will enable farmers as well as policy makers to make better-informed choices about conservation buffers and their impact on farms. Integration of the buffer research sites into the Skagit High School education curriculum is giving students a basic knowledge of riparian buffer principles based on actual field data, visits to the research sites and hands-on learning. Presentations to the farming community are creating better awareness of the information being generated by the project.