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An ecological assessment of Oregon's CREP cumulative impact incentive program

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Background
Riparian vegetation is known to have strong effects on stream ecosystems, potentially ameliorating negative impacts resulting from human activities, including agricultural production. Riparian vegetation shades streams and can improve groundwater exchange, both of which result in lower water temperatures (Blann et al. 2002). The roots of riparian vegetation provide structural support for the soil which reduces streambank erosion leading to a decrease in sedimentation and water turbidity (Gosselink et al. 1990; Dosskey 2001). Riparian vegetation also filters nutrients found in runoff from lands used for agriculture and cattle grazing, which results in lowered nutrient input into streams (Likens & Bormann 1974; Dosskey 2001). Finally, riparian vegetation can increase instream structure through inputs of large woody debris and the exposure of roots along the streambanks; this increased structure creates habitat for many aquatic organisms (Benke et al. 1985; Sweeney et al. 2004).

While riparian vegetation has important effects on the condition of streams, little is known about whether these impacts are produced by riparian buffer programs that are generally implemented at small scales and are often spatially isolated from each other. Thus, an important question is: Can these small scale programs influence stream condition either at the scale at which the programs are implemented or in a cumulative fashion such that multiple buffers along a stream influence whole-stream condition? The scale at which riparian buffers influence stream condition has rarely been considered for cropland areas, with the exception of two studies of Midwestern croplands (Roth et al. 1996; Lammert & Allan 1999). The multiple scales in these studies were small sections of riparian buffers and larger areas which included uplands. Notably, these studies came to different conclusions; while one study suggested that small scale riparian buffer condition best explained stream condition (Lammert & Allan 1999), the other study found that larger scales that included upland use best explained stream condition (Roth et al. 1996). A problem with these studies is that while the small scales considered riparian buffer type only, the larger scales incorporated both riparian and upland areas. Any effects of increasing amounts of riparian buffer along the streams might be masked by considering upland use simultaneously since upland use can potentially influence stream condition (Harding et al. 1998).

Exotic weeds in riparian buffers - Invasive, exotic plants are more common in areas that are highly disturbed (Hobbs and Huenneke 1992; Parker et al. 1993; Gentle and Duggin 1997; Anderson 1999; Vujnovic et al. 2002). Riparian areas, with their high flood frequency and scouring, provide such an environment for establishment of exotic plants. In addition, stream flow may provide a convenient mechanism for dispersal of seeds. In fact, spread of invasive plants through riparian areas has been documented (Barton et al. 2004; Thomas et al. 2006; Richardson et al. 2007). Thomas et al. (2006) described movement of an invasive plant (*Dioscorea oppositifolia*) from an upstream population to downstream areas with highly suitable habitat for the species. However, little data is available on subsequent spread of exotics to upland areas. In addition to describing downstream movement, Thomas et al. (2006) also found that upland movement of *D. oppositifolia* was related to soil type, therefore spread to upland areas may be an interaction between time and site conditions. Finally, few studies have investigated the relationship of seed bank, vegetation and seed rain (Gurnell et al. 2006; 2007).

Several studies have found difference in seeds present in the soils seed bank compared to vegetation (Hanlon et al. 1998; Abernathy and Willby 1999; Gurnell 2006).

The purpose of this study is to determine the effectiveness of Oregon's CREP program on a variety of indicators of stream health; stream physical characteristics, macroinvertebrates and presence of invasive plants. Specifically we will select areas of cumulative impact buffers for an in depth assessment and determine their effectiveness compared to control (unbuffered) reaches and a series of shorter buffered areas whose total buffer area is equal to the total length of cumulative impact buffer. This comparison will allow us to assess whether cumulative impact buffered areas have a higher impact than shorter buffers.

Site Selection – In February 2008, we contacted cooperating landowners and Josh Thompson and Ryan Bessette at the Wasco County soil and water conservation office in order to make site visits to perform final site selection. We selected nine buffered areas and three unbuffered areas to sample. We concentrated our site selection on Fivemile, Eightmile and Fifteenmile Creeks in Wasco County. These three creeks became the focus of our study because they are geographically close to each other, have similar surrounding land-uses, and differed in the amount of CREP buffers on each creek. We selected two buffered areas and one unbuffered area on Fivemile Creek; three buffered areas and one unbuffered area on Eightmile Creek; and four buffered areas and one unbuffered area on Fifteenmile Creek. Buffer lengths varied and ranged from 0.6 km to 7.3 km. Permission was obtained from all the producers associated with these buffers.

Macroinvertebrate sampling – Macroinvertebrates were collected from a total of 51 sites across the study area during the period of 1 July to 23 July 2008. Fourteen sampling sites were established on Fivemile Creek, 17 sites on Eightmile Creek, and 20 sites on Fifteenmile Creek. Forty nine of these sites were in the streams adjacent to the location in which buffer plant sampling was conducted and two sites were found at the end of buffers that exceeded 7km in length to provide information on stream reach quality over particularly long buffers. These 51 samples are currently being processed in the laboratory and the macroinvertebrate community data will be analyzed once the laboratory processing is complete in accordance with the original proposal. The sampling design will provide information on changes in stream reach quality with increased buffer length relative to the upstream end of each buffer and non-buffered reaches.

At the time of macroinvertebrate sampling, a suite of environmental variables were measured that will provide information on important correlates of macroinvertebrate community composition. These environmental variables included: water turbidity, pH, and conductivity; substrate size (i.e., pebble counts); wetted width and depth; and continuous water temperature. Continuous water temperature was recorded using Hobo™ dataloggers that were placed at each site for five days with temperature readings taken every 30 minutes.

After the macroinvertebrate sampling was completed, water chemistry samples were taken at 20 of the sites. These sites were a subset of the macroinvertebrate sampling sites and were located at the upstream end and the farthest downstream site within each buffer as well as at non-buffered sites. Unfortunately, at this time most of 5 Mile Creek had gone dry and samples were taken only from the most upstream buffer on this creek. These samples have been sent to an environmental consulting firm for analysis of nitrite/nitrate and total phosphorous.

Plant sampling – During macroinvertebrate sampling, we placed seed traps in the stream to collect seeds that are being dispersed downstream via water. Artificial grass doormats, 20 cm X 20 cm in size, were attached to the stream bottom at the edge of the water so that the entire mat was covered with water. Traps were left in place for five days, at which time they were collected, stored for 3 days at 5ºC until they were planted in the greenhouse. Traps and any sediment that was collected on them were planted whole in pots with commercially available potting soil in the greenhouse.

Table 1 provides a list of the species that have been identified to date from the soil samples and the seed traps.

Future work on this portion of the project includes: completing data entry, identification of plants grown from soil samples and seed traps in the greenhouse, and statistical analysis comparing the species found in the soil seed bank and seed traps to extant vegetation.

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Table 1: List of herbaceous species, their functional type (graminoid/forb), and origin (native/exotic) found in soil samples from Wasco County CREP buffers. Species in bold are listed as class “B” noxious weeds in the state of Oregon. Species with the origin listed as N &E (Native & Exotic) indicates that there is some disagreement regarding the origin of the species.

Species name	Graminoid/Forb	Native/Exotic
Amaranthus albus	Forb	Exotic
Centaurea stoebe	**Forb**	**Exotic**
Chamaesyce maculate	Forb	Native
Convulvulus arvensis	**Forb/Vine**	**Exotic**
Conyza canadensis	Forb	Native
Danthonia californica	Graminoid	Native
Echinochloa crus-galli	Graminoid	Exotic
Epilobium spp	Forb	
Fraxinus spp	Tree	
Gaura mollis	Forb	Native
Holcus lanatus	Graminoid	Exotic
Lactuca seriola	Forb	Exotic
Malva neglecta	Forb	Exotic
Marrubium vulgare	Forb	Exotic
Medicago lupulina	Forb	Exotic
Medicago sativa	Forb	Exotic
Nepeta cataria	Forb	Exotic
Oenothera caespitosa	Forb	Native
Panicum milleaceum	Graminoid	Exotic
Plantago lanceolata	Forb	Exotic
Plantago major	Forb	Exotic
Poa compressa	Graminoid	Exotic
Polygonum achoreum	Forb	Native
Polygonum bistortoides	Forb	Native
Polygonum lapathifolium	Forb	Exotic
Polygonum persicaria	Forb	Exotic
Potentilla norvegica	Forb	Native
Puccinellia spp	Graminoid	
Rumex crispus	Forb	Exotic
Setaria viridis	Graminoid	Exotic
Sonchus asper	Forb	Exotic
Sonchus oleraceus	Forb	Exotic
Taraxacum officinale	Forb	Exotic
Verbascum blattaria	Forb	Exotic
Verbascum thapsus	Forb	Exotic
Verbena bracteata	Forb	Native