Are riparian buffers sufficient or unnecessary? Experimental studies of streamside protection of hydroriparian ecosystems.

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In many jurisdictions streamside protection by means of riparian management areas is intended to protect stream ecosystems, provide wildlife habitat, and serve as corridors for dispersal. How effective is riparian protection at maintaining stream and streamside habitats, and over what time and spatial scales? The edge effects of reducing forests to thin strips along streams may not be sufficient to protect stream and streamside ("hydroriparian") ecosystems, but on the other hand the buffers may be unnecessarily wide. Most of the evidence on which current guidelines are based derives from studies of the source of large woody debris (LWD) which creates habitat complexity within stream channels. These studies have shown that most LWD that has any influence on channel morphology enters from 30 m or less from the bankfull margin. Riparian buffers also contribute to the maintenance of streambank stability. Given that spawning and rearing habitat for many salmonids is dependent upon the complexity of channels and maintenance of suitably-sized gravels the current guidelines may be adequate for salmonids. Thus far there have been few evaluations of these practices even for salmonids.

There are several past and ongoing studies of forestry-stream interactions and these studies have made significant contributions to the continuing development of riparian management guidelines. The Carnation Creek study on the west coast of Vancouver Island was the first detailed study in Canada to evaluate the effects of forest practices on a coho salmon population and its habitat. The Stuart-Takla Forestry-Fishery project is focused on sockeye salmon spawning habitat but also considers other biodiversity values in a somewhat replicated study design. Other studies in Canada, such as the Catamaran Brook and Copper River studies in Atlantic Canada, also have a primary focus on salmonids and salmonid habitat. In the absence of salmonids or a community water supply riparian guidelines provide minimal protection to hydroriparian habitats, i.e., no reserve zone or buffer strip of trees.

Streamsides provide important habitat to a wide variety of organisms and is one of the most species rich and productive parts of most landscapes. In addition, there are many species of amphibians and invertebrates that are only found in headwaters, many of which lack salmonids. Headwaters provide important sources of organic matter to downstream reaches and the rate of supply depends on the storage potential, i.e., channel complexity, of the upstream reach. Small streams are also sources of prey that migrate downstream to fish-bearing reaches. The small volumes of water in headwaters are particularly sensitive to the heating effects of sunlight and this may contribute to warming of downstream reaches in some landscapes. The effectiveness of riparian protection for the conservation of organisms other than salmonids has not been rigorously evaluated. Our research group has a number of studies underway to test the effectiveness of BC's Riparian Guidelines from the Forest Practices Code for conserving a variety of ecosystem components (funding from FRBC, NSERC, UBC and BC Environment). In particular, several of these are directed to small fish and fishless streams in coastal and interior BC.

Coastal Western Hemlock Zone

At UBC's Malcolm Knapp Research Forest just outside of Vancouver, we are in the precutting phase of a four-year study to examine the effectiveness of buffer strips at protecting streams and streamside habitats. Thirteen small streams (S4, S5, and S6 according to the BC Forest Practice's Code) will receive one of four treatments (controls, 30 m buffers, 10 m buffers, no buffers) with at least three replicates of each treatment (cutting will occur in 1998). Each of the treatments will extend 200-250 m along the stream reach on both sides of the channel. We have one year (1997-98) to examine pretreatment conditions before the treatments are applied, and will follow the responses of the system in detail for two to three years and then less intensely in the following years. The research team includes more than 15 scientists from four institutions (UBC, BC Environment, SFU, BC Forest Service). Some of the component studies include: water quality and temperatures, stream invertebrates, fish (non-anadromous cutthroat in four of the streams), bacteria and algae, organic carbon dynamics, terrestrial invertebrates, vascular plants, amphibians, and windthrow hazard. The general hypothesis to be tested is that increasing amounts of riparian reserve will result in greater conservation of biological values of those areas. These studies are being integrated and an ecosystem model will be developed that can be parameterised by the information gained by these studies. There are currently no studies available for most biological measures to evaluate the effectiveness of riparian reserves as a conservation tactic.

Small streams are tightly connected to their surroundings for many reasons, but one of the most critical is the supply of organic carbon in the form of leaf litter from surrounding forest. In small streams up to 90% or more of the energy base of the stream ecosystem comes from litter fall. The harvest of riparian forest to the stream bank, or even close to it, reduces the type and amount of litter inputs and can have a profound impact on the character and productivity of the stream food web. Some of the organic carbon enters the stream in dissolved form (like tea) and is metabolized by bacteria and certain algae at the base of the food web. Our studies include examination of the effect of the management of riparian areas on the supply of organic carbon to these small, woodland streams. We are also doing experiments to determine how the transition from conifer to deciduous tree inputs might affect the stream community.

The increased light available in streams where the forest has been removed or reduced to buffer strips may enhance algal growth. Some studies suggest the shift to higher light favours species of algae which are less palatable to those organisms that feed on algae. We are sampling algae and bacteria growing on experimental substrates as a means to evaluate changes in primary productivity and algal composition.

Invertebrates make up the greatest proportion of the world's biodiversity and are useful indicators of the condition of the hydroriparian ecosystem. Streams have a diverse array of invertebrates, especially insects, which form the food base of populations of fish and other predators such as larvae of the Pacific Giant Salamander. The invertebrates in the streams and the riparian areas are sampled at regular intervals. Changes in microclimate, the food base, and temperature regimes of the streams and streamside areas will be reflected in the populations of invertebrates.

Other studies include mark-recapture studies of terrestrial stages of amphibians in the surrounding forests. Use of mark-recapture techniques will allow us to test several hypotheses regarding the responses of amphibians and the mechanisms which drive those responses. Vegetation plots for vascular plants will be examined regularly through the two to three years following treatment to evaluate potential shifts.

Windthrow hazard is considered a major problem associated with exposing trees that have grown up without previous experience with wind. Trees in riparian buffer strips are often blown over in wind storms that exceed their ability to resist. In this part of the study trees which remain standing (windfirm) or are windthrown will be examined to determine the characteristics of individuals in each class of tree.

Other physical and chemical measures of the hydroriparian system are being studied by other project team members. We are considering water quality and quantity, temperature regimes, soil chemistry, and other physical measures.

Experimental food-web studies are proposed to understand how particular species are affected by harvesting near riparian areas. Organisms may be directly affected by the loss or modification of habitat, e.g., increased light, change in temperature regime, and other edge effects. Alternately, changes in the prevalence of their resources, predators, or parasites may contribute to the changes in populations of some species. To isolate some of the mechanisms at work we are also conducting two food-web experiments, one for stream organisms and the other for the terrestrial stages of amphibian populations. These experiments will refine our understanding of the direct and indirect effects of habitat alterations on these communities which will better guide our directions for management practices.

Finally, we will use the conceptual model we have derived as a guiding framework for evaluating our understanding of the functioning of these ecosystems. Using that framework we can create computer simulations to predict the outcome of other management practices as a means to compare riparian management practices under other stand and landscape conditions. Ultimately a management model based on local stand conditions, and that could be used by forest managers, may be an output from this research program.

CAREX **- the CAriboo Riparian EXperiments**

In the dry interior of BC, near Williams Lake (the Cariboo Forest Region), we have initiated a series of studies to address similar questions to those posed above - named “CAREX”, for the CAriboo Riparian EXperiments. One set of studies include a before-after, control-impact design for a series of sites, some of which will have harvesting beyond the riparian reserve area. These sites are being monitored for stream invertebrates, vascular plants, and amphibians. Another study involves comparisons of stream invertebrates and algae within and upstream of recent clearcuts (most without riparian reserves).

A final series of studies in the Cariboo region include experimental manipulations of mechanisms by which streams might be affected by forest practices using flow-through artificial streams. In the experimental stream studies the effects of light, leaf-litter inputs, suspended sediments, and nutrients can be manipulated to isolate the particular cause and effect relationships between forest practices and stream ecosystems.