Managing Riparian Habitat for Fish, Wildlife and Timber

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Introduction

Lower slopes and terraces adjacent to streams are collecting points for soils as alluvium and colluvium. The depth of soil, plus the accumulation of nutrient capital from flooding and from down-migration of mineral and organic matter on slopes, contribute to these sites being the most productive forest soils in the Pacific Northwest and elsewhere. The proximity of these soils to water sets up several linkages that may be regarded as obstacles or opportunities, depending on the creativity of the manager. This report summarizes some data that can be used for judging whether various approaches to riparian management are helpful in reaching desirable future conditions without compromising present habitats.

Riparian sites, especially those below 1500 feet, are typically dominated by hardwoods and shrubs. Typical inventory data show them to have low yields of conifers. Current forest practice rules dictate that even if conifers were present, a high percentage of them within 100 feet of water could not be removed out of consideration for postulated habitat needs for woody debris in streams.

Existing rules for streamside management leave very little incentive for intensive silviculture to improve either timber yield or fish habitat. All Pacific Coast states have rules that specify that streamside cover must remain largely intact to prevent streamwater from becoming excessively warm. EPA has set standards for stream temperatures with a maximum moving mean of 64ºF. Many streams cannot be warmed to that degree, many reach maximum temperatures greater than the threshold under continuous cover. It is not at all clear whether harvesting rules are effective in maintaining temperatures within desirable ranges. They do have a major effect on whether one can improve on existing riparian conditions in the next century or has incentive for doing so.

Oregon's rules allow stand conversion to conifers, but require that most of the yield remain standing at maturity. Conversion requires a high degree of clearing. a great many studies of brush and herb competition have illustrated that reforestation is likely to be unsuccessful in riparian areas without severely reducing brush, hardwood and herb cover. Prohibition of any use of herbicides near water is a major obstacle. Anyone who has attempted reforestation near a stream containing beaver activity is aware of the pitfalls therein, but removing beavers may be regarded as wildlife harassment. Conflict between rules and desired future conditions is a real possibility.

If significant improvement is to be made in salmon habitat as the result of deliberate attempts by landowners and managers, there must be incentives for committing the resources to accomplish some reasonable future goal. This presentation is based on the assumption that reasonable goals will be set for stream temperature and for structural features in streams, whether woody or rocky. In it, I review some recent documentation of experiments the results of which may provide guidance in how to achieve such goals with a minimum of cost and maximum productivity of both fish and timber resources. In the process, it will become evident that certain wildlife resources will be enhanced, but that others may need at least temporary control in order to meet the long-term objectives.

Experiments and Their Findings

Several experiments have been completed that provide evidence regarding stream temperaure consequences of harvesting, aquatic insect productivity following harvest to the streambank, and feasibility of regeneration with different degrees of clearing and vegetation control to within 10 feet of the streambank. Each of these experiments exposes some useful concepts about harvesting and regeneration, and their impacts on the stream system and fishery.

Temperature effects

For approximately three decades, prevailing thought has been that any exposure of a stream to sunshine would cause intolerable warming of water. Much of this was stimulated by some findings by Brown and Krygier (1970) that a stream draining a watershed that had been completely clearcut and burned demonstrated a sharp increase in diurnal maximum temperature compared with uncut watersheds or a watershed with patch clearcuts and narrow buffers. The clearcut basin, unlike the uncut or partially cut basins, had a very shallow, linear stream with a flat bedrock bottom. It was fully exposed by intense fire with heavy fuel loads in the riparian zones. It was therefore very subject to maximum exposure to sun per unit of water volume. There were no other examples (replications) of that treatment, and it is not surprising that a temperature difference was reported.

Does harvesting near streams inevitably raise water temperature? If temperature rises, does it stay warm? To answer those questions, Zwieniecki and Newton (1999) observed 16 streams traveling through harvested units with varying degrees of buffering shade. They also documented warming trends in streams over their full lengths to determine whether harvest units caused a departure from the temperature trends from source to outlets. They observed that:

1. Water warms from the time it enters a stream until it reaches close to average air temperature, corroborating the observations made in 1990 by Sullivan et al,(1990). They concluded that net warming resulting from harvests could only be determined in terms of an increased rate of heating above the normal trend for a given reach.
2. Within harvest units, the degree of warming depended on whether sun actually hits open water. Buffers of a range of widths and sizes of unit displayed an unclear relation to degree of warming, and the degree of *net* warming was small. Streams with buffersof hardwoods, conifers or brush no more than 40 feet wide on south sides of open water did not show measurable net temperature increase even when clearcut on both sides of the stream for a half-mile.
3. Excess heat absorbed in a clearcut is no longer detectable within 300 meters downstream in the woods.

Temperature of water fluctuates considerably between day and night. It is observed that entire stream systems fluctuate simultaneously; warm reaches during the daytime do not appear to lead to warm spots downstream during night as would occur if the hot spot really travels down into the woods. But cooling appears to occur before water travels far under cover. It is difficult to justify a model that predicts that all energy inputs are conserved, and that inputs of radiant energy are universally cumulative.

Among other things, when one monitors entire stream lengths for an entire summer, one observes that streams with little cover fluctuate in temperature much more than those under cover. Mean temperatures may be no greater in the absence of cover than under full cover even where peak temperatures might be somewhat higher. Outgoing radiant energy loss is an important cooling mechanism just as incoming radiation is a warming mechanism. There are also cool places at confluences with cold tributaries, and in bottoms of deep pools where fish can escape. During the hottest periods during summer, fish will migrate upstream to cooler waters. Perhaps more to the point, peak temperatures are typically sustained only briefly.

There are cool streams and warm streams, differing in geology and local climate. One size definitely does not fit all. We found the only common denominator was in discharge rate per unit of basin area. Streams with higher discharge rates at the time of summer low flow tend to be cooler than those with very low flows. This may have less to do with flow than with the reality that those with low flows are in warmer climates and higher nighttime temperatures. However, both follow the same rules when it comes to losing heat quickly with downstream flow under closed canopies.

In short, broad rules for buffers as temperature regulation devices may need re-examination, and perhaps revision, to make them compatible with the need for improved species composition in riparian stands.

Reforestation

Current forest practice rules in all three Pacific coastal states prohibit most harvesting of conifers within designated stream buffers. The goal for Oregon's forest practice rules is the development of a late-successional forest in the zone most likely to influence the stream. Our data suggest that the current condition of riparian zones at low elevations (as observed by Kajsa Wing (unpublished data, OSU Dep't of Forest Science, 1999), is poor, and that prohibition of harvesting will prevent achievement of conifer development goals in the foreseeable future. Much of the future supply of woody debris will be alder of very limited durability and life span. The need for upgrading conifer components is widespread (Lorensen, 1993)

Newton and Cole (1998) reported on experiments in which a variety of seedling types were used in conjunction with patch clearcutting to the water's edge on a series of streams in the Coast Range and Cascades, low elevations. We created 12 clearcuts spanning streams for 300 or 600 feet, and reforested with mixtures of hemlock, western redcedar and two stock sizes of Douglas-fir. A quarter of all seedlings were protected with Vexar for animal damage. Half of each planting was site prepped with a fall application of glyphosate to suppress the deciduous brush and tall grasses such as Reed canarygrass. Plantings extended to 60 feet inside uncut buffers on each end of every clearcut, sprayed and unsprayed. Experimental plantations extended from 10 feet to 90 feet from the streambank; a few were flooded in midwinter.

Several important findings showed up in these experiments. First, large seedlings grew faster than small ones, an old concept that is perhaps even more relevant in riparian zones where competition grows rapidly. Hemlock and cedar did not grow as rapidly as Douglas-fir, and did no better under effects of shrubs or overtopping. Overtopping of any kind had a strongly suppressive effect on all planted trees. One of the greatest frustrations was that beavers decimated planted trees within 50 feet of any stream where there was a resident population, whether burrows were visible or not. Underplanting seedlings of tolerant species as a means of improving future stocking did not work under an alder buffer even when only 20-60 feet from the edge of a clearcut; either shrubs or residual overstory trees caused severe suppression. Those seedlings that remain alive after four years are making negligible increments under significant overtopping. Untreated shrub understories tend to explode under relatively narrow strip stands of hardwoods, further complicating seedling environments in years after harvest if untreated.

Some states have prohibitions on use of herbicides in riparian zones. Fortunately, Oregon permits ground application to 10 feet of the bank. This should be adequate. Even though clearcutting and yarding represents adequate site preparation in the year of planting, a total prohibition on herbicides within the buffer system will make it very difficult to achieve a reasonable stocking of conifers. None of the conifer seedlings grow well until overstory stocking is reduced to very low levels. Oregon law permits clumping of residual basal area, which is highly desirable in terms of leaving clearcut gaps for regeneration. However, if significant residual shrub root systems remain after removing overstories, our data suggest that the seedlings will struggle or fail. Data from these and related upland experiments suggest that it may be easier to broadcast apply herbicides before logging than afterwards, and that the deciduous shrubs may be especially sensitive in an understory situation.

Extensive experience with herbicide residue studies has shown that the products typically used for understory treatment, or other use in riparian zones (glyphosate, imazapyr, triclopyr and 2,4-D)(Newton et al, 1984; Newton et al, 1990; Newton et al,1994; Newton and Cole, 1997) are immobile after application and very low in toxicity. Glyphosate and imazapyr are virtually non-toxic to fish, and the moderately toxic esters of triclopyr and 2,4-D hydrolyze very quickly to acid forms on soil and vegetation that have negligible potential for injuring fish or wildlife. All residues are virtually immobile in terms of any postulated movement toward streams. In our review of literature on the subject of safety to the aquatic resources as well as to practitioners, use of the above chemicals provides no known risks, and may be the only method that enjoys that degree of safety (Newton and Dost, 1984).

Stream productivity

The primary measure of potential stream productivity for fish is in terms of total photosynthesis. Phytoplankton are highly productive in many of the nutrient-rich streams of the sedimentary formations of the Oregon and Washington Coast Ranges. Consumption of plankton by aquatic insects leads to a primary source of fish food.

Walsh (1996) and Newton and Cole (1998) observed that clearcuts across second- and third-order streams that removed all shrub and tree cover led to an approximate doubling of abundance of large aquatic insects. Our observations covered the season from May to October, revealing that some insects have peaks seasons of productivity different from others. We observed a general maximum in early and late summer, but there were some groups of genera that were not sampled. We also did not sample during winter because of obvious difficulties with fluctuation of water levels. Thus, we did not have a universal sampling that would provide certainty that over-all productivity was increased by clearings.

We conducted our investigations over a period of four years and in six streams, including clearcuts and uncut reaches, and including cross-stream clearcuts and one-sided (north) clearcuts in which shade remained on the south side. Walsh (1996) reported some changes in species composition at the genus level; Newton and Cole (1998) observed that the major orders of insects were present in harvested and unharvested streams, and that none decreased in abundance following harvest. They also observed that within harvest units, there were increases in most orders of insects in clearcuts, but that a short distance downstream from each clearcut, there was no obvious indication of change as the result of harvesting. It seems unlikely that clearings of the size we used (300 feet to half-mile long) is likely to have a negative on total abundance of large insects. There is supporting literature suggesting that increased photosynthesis will lead to more biomass in insects. While our data are not ambivalent, they are not conclusive because of some gaps in seasonal sampling. There certainly is no indication that harvest activities as conducted in our experiments decreased productivity.

Summary

Our experiments pertaining to influence of streamside harvesting on prospects for future development of conifers, on stream temperatures and on stream productivity, including data relevant to safety of herbicides, have included two dozen streams in western Oregon and northern California. They have included streams passing through the 40,000 acre Fountain fire in which all cover was destroyed for many miles of two important fish-bearing streams. These experiments suggest that temperature of water is responsive to climate, geology and, to some degree, local shading, and that vegetation management chemicals are environmentally attractive in comparison with other tools used for the same purposes. Temperature elevation is limited to exposure of water to direct sunshine; clearcutting to the north side of open water did not cause detectable warming in clearcuts extending along half-mile reaches of fish-bearing streams. When harvest units did cause an increase of up to 3° F, the increase was no longer detectable within 300 meters downstream in terms of departure from natural warming trends.

Experiments also indicated that successful reforestation in riparian zones will depend on having very little cover taller than the planted trees. Shade tolerant trees offer very little advantage over Douglas-fir. Herbicides applied by ground systems are an effective and safe tool to use near water to effect adequate competition control without significant contamination of water.

The same experiments that contributed to analyses of temperature and reforestation indicated that stream productivity is not depressed, and are likely to increase stream productivity as indicated by summer insect abundance.

Overall, it appears reasonable to develop orderly harvest/rehabilitation programs in riparian zones that will generate future supplies of desirable conifers, both to ensure woody debris and also financial incentives for managing this resource. Wildlife will undoubtedly be an unwitting beneficiary of this management, but some species including beavers may require intermittent control in order to succeed in maintaining the rest of the system.

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