Sediment and Road Density Reduction

Sediment eroded from forest roads and delivered to a stream network may impact the habitat of endangered salmon species. Sediment can be estimated for alternative harvest practices using existing models of sediment production and delivery, such as SEDMODL and WEPP. A more convenient measure of the environmental impact of forest roads would seem to be road density, defined as the total road length in a landscape divided by the landscape area. A strategy to reduce environmental impacts would presumably include reducing road density. As part of a larger WA State Department of Natural Resources-sponsored study on the economic and environmental costs of road density reduction in a 36-square mile planning area in Eastern Washington, University of Washington School of Forest Resources researchers constructed a 25-year harvest and transportation plan using both a conventional road building approach and a road minimizing alternative. Contrary to expectations, study results showed that the road-minimizing alternative did not reduce simulated sediment production.

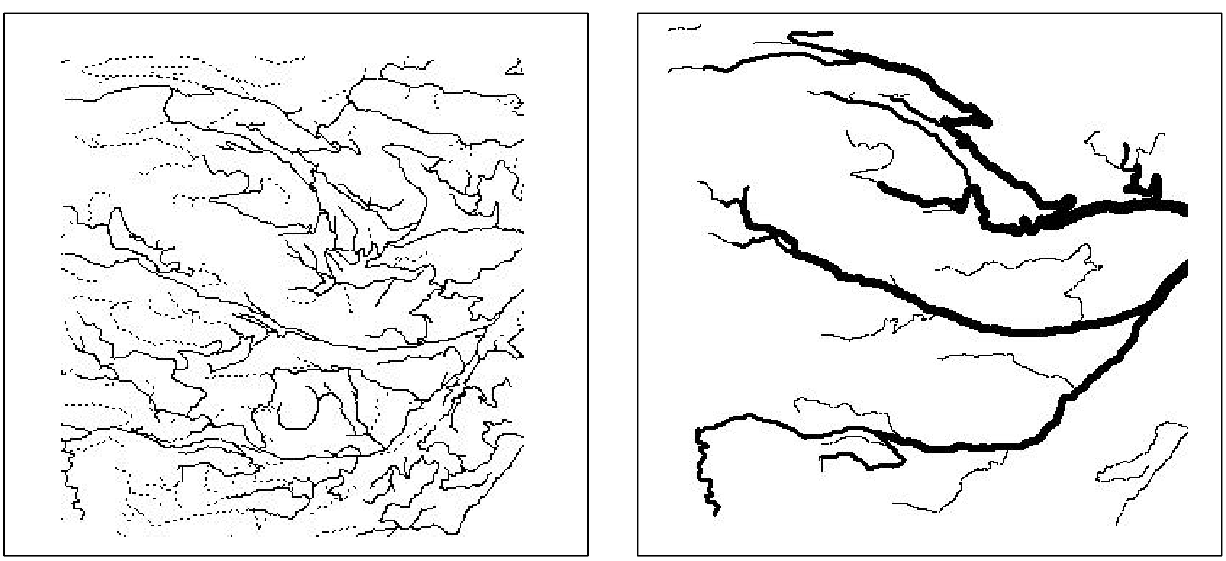
Road Length vs. Road Use

The critical question is whether roads themselves or road use (construction and haul activities) are the source of sediments. If roads themselves are the source of sediments, reducing road density will reduce road sediment. However, if road use is the source of sediment, reducing road density will not necessarily reduce management traffic and the sediment such traffic produces.

Forest soils in the Pacific Northwest tend to be protected by a layer of vegetation and litter and thus produce little surface flow or sediment delivery to streams. Soil disturbances such as fires or landslides expose soil to erosion, but vegetation rapidly covers exposed areas and eliminates erosion. Similarly, road construction exposes soils to erosion, but roads will stabilize and revegetate if left undisturbed. However, logging haul traffic provides ongoing disturbance, and thus sediment delivery, to streams. The study findings that road density reduction did not reduce sediment delivery supports the road use hypothesis.

Road Elimination

A road network has a branching structure, much like a tree or stream network. Like these networks, most of the length of a road network is in the smallest branches, or spur roads, while most of the volume is carried in a main stem, or primary road. Eliminating unused spur roads can dramatically reduce the total road network length, and can eliminate the first few hundred feet along the spur road, but not the remaining miles along secondary and primary haul roads. If harvest volume and management traffic is maintained at the same level, total traffic, and thus traffic related sediment, would not decrease. A program of road density reduction that identifies and eliminates only substantially unused road segments



The road network covers most of the planning area (left: existing roads are solid, proposed roads are black). Most of these roads remain unused in a 25 year harvest plan (right: thicker lines represent more haul traffic).

eliminates those roads producing minimal sediment delivery and retains those roads producing the majority of sediment delivery.

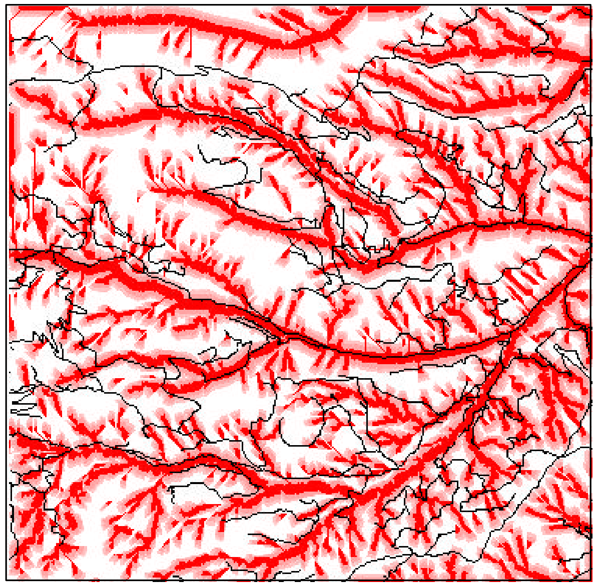
Road Surfaces

Improving road surfaces helps eliminate sediment. Graveling or paving roads can be costly, however, and even after paving, significant sediment can still result from cut-and-fill slopes and roadside ditches. Model results for the study area suggested that even a combination of road density reduction and gravel surfacing would produce sediment well in excess of background levels.

Stream Proximity

Model results for the study area also suggested that separation of roads from streams appears to be a more effective means of reducing sediment delivery than road elimination. While sediment is produced on all forest roads used in timber harvest operations, its delivery to a stream is a function of its distance to the stream. The farther the sediment flows across the forest floor, the more it is filtered and the less likely it is to reach the stream network. Roadside ditches and culverts that deliver to stream crossings short circuit filtering.

To reduce sediment delivery, road alignment should avoid streams wherever possible. The ridge network, the topographic opposite of the stream network, never crosses and always maximizes its distance from the stream network. A network of primary roads



Sediment delivery decreases with distance from the stream network (darker is higher delivery). Primary haul roads (black) that stay in low delivery (white) ridge oriented alignments (see examples in Northwest and Southeast sections) can route much haul traffic with little stream impact.

following ridge networks (thus crossing stream networks only rarely) would deliver minimal sediment to the stream network, even if most of the road is not graveled or paved. Shifting from a riparian-based to a ridge-based road network would entail an increase in road construction that may be prohibited by a policy of road density minimization.

SUMMARY: Theoretic and simulation analysis suggests that road density is a poor measure of road-related sediment delivery to the stream network. A program of road density reduction will tend to eliminate road sections with the least sediment impact and can even inhibit road realignments that would actually reduce sediment delivery. Road-stream separation, a more effective means of reducing sediment delivery, may even require increasing road density.

Note: Sediment is not the only ecosystem impact of roads. Other impacts include flooding, habitat fragmentation, and landslides. Road density may be a valid indicator of road impacts on these processes, or may be no better an indicator than it is for sediment delivery to streams. Similar landscape scale studies are needed to evaluate the validity of using road density as a measure for these impacts.

Contacts:

Peter Schiess, Finn or Luke Rogers
University of Washington, School of Forest Resources, Seattle, WA 98195-2100
(206)543-1583, http://www.cfr.washington.edu/research.pfc/.