Forest Road Runoff Disconnection Survey of Private Timberlands in Washington

Prepared by:

Douglas Martin
Martin Environmental
2103 N 62nd Street
Seattle, WA 98103

Prepared for:

Washington Forest Protection Association
724 Columbia Street NW, Suite 250
Olympia, WA 98501

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Executive Summary

Forest landowners conducted a road survey on private timberlands, during fall 2008, to document the cumulative effectiveness of past and ongoing road maintenance efforts, including recent Road Maintenance and Abandonment Plans (RMAP), to disconnect road runoff and reduce sediment delivery to streams. Road drainage and hydrologic connectivity data were collected from 179 randomly selected land sections over 1,047 miles of road that were distributed across 16 counties in eastern and western Washington. The results show that most of the surveyed road length (73%) has a low delivery potential (LDP) because the roads occur on flat terrain (e.g., valley bottoms or ridge tops) and do not intersect any particular channel or drain into a wetland that does not connected to a typed water. A small proportion of the road length is orphaned or abandoned (6%) and 21% of the road length had a high delivery potential (HDP) because the roads occur on sloped terrain that could potentially deliver runoff to a stream. Within the HDP road category, about one-half of the road length (9% of total road length) was hydrologically disconnected. Therefore 82% (i.e., 73% + 9% = 82%) of the entire road length had either a low delivery potential or was hydrologically disconnected. About12% of the road survey length was estimated to be hydrologically connected at the time of this survey.

The survey results indicate that road improvements have probably reduce road runoff and the potential delivery of fine sediment to streams. The hydrologic disconnectivity is occurring as a result of several key management activities. First, a high proportion of the road network (73%) has low delivery potential because the roads are located on landscapes that minimize hydrologic connectivity. This reflects initial road planning as-well-as road relocation activities that have occurred under the RMAP process. Second, the presence of orphaned and abandoned roads demonstrates a conscious effort to eliminate high risk roads. Although the proportion of orphaned and abandoned roads is relatively small (6%), they often occur in unstable areas or are very close to streams. Therefore, eliminating road use or complete removal can have a significant positive benefit to streams. Third, the disconnection of approximately one-half of the HDP roads reflects the implementation of multiple BMPs (e.g., increased cross drains, more frequent ditch-outs, grading). Collectively, these data show that a majority of the roads in the survey area have a low probability of delivering sediment to a typed water course. Also, because these data are spatially representative we assume that the results are reflective of the road conditions on most large private lands in Washington. Given the progress to date, we can assume that sediment delivery from forest roads has declined and that it will continue to decline as all of the RMAP's are completed by 2016.

Introduction

A major goal of the Washington Forests & Fish Rules is the implementation of Road Maintenance and Abandonment Plans (RMAP) which are intended to prevent sediment- and hydrology-related impacts to public resources. Forest roads are a significant contributor of management-related sediment to watercourses in forest environments. Therefore, FFR requires that forest landowners upgrade all roads to the new regulatory standards by 2016. As of 2008, all large forest landowners have developed one or more DNR-approved RMAP and are on track to complete their improvements by 2016. Some have completed all required road improvements. However, there is no quantification to date of the amount of the road system that has been disconnected by the RMAP process. To address this question, forest landowners conducted a road survey on private timberlands during fall 2008 to document the extent of road improvements that are designed to disconnect road runoff delivery to streams.

The purpose of the forest road runoff disconnection inventory (i.e., road inventory) is to document the cumulative effectiveness of past and ongoing road maintenance efforts, including recent RMAP efforts, to disconnect road runoff delivery to streams. The goal is to determine the current proportion of road miles that have been hydrologically disconnected. To achieve this goal, forest landowners submit data from a random sample that would provide an unbiased estimate of the proportion of road miles that are hydrologically disconnected. Below is a description of the survey methods and results for the road inventory. Note, this inventory does not try to estimate changes between pre- and post-FFR, but rather to establish current conditions against a time when cross-drain culverts were virtually nonexistent (i.e., pre-1974).

Methods

Data Collection

WFPA conducted a field training session for the road inventory on July 11, 2008. The study objectives, data needs, and reporting procedures were described to the participants. Particular attention was given to explaining how to identify a hydrologically disconnected road segment. The training emphasized the need to be consistent in interpretations and to be conservative in classifying road types. For example, if there was any doubt as to the effectiveness of a BMP to prevent sediment delivery from a road segment, the road segment should not be considered "disconnected." Representatives from 9 companies, WFPA, and the Department of Ecology attended the field training. Companies that were not able to attend the training were contacted by phone and were instructed on how to perform the road inventory.

Martin Environmental acquired road inventory data from fifteen landowners in Washington. Each company submitted road data from a minimum of nine randomly selected sections that are mostly or entirely owned or managed by the company within a county. Several companies with large ownership submitted data from two to four different counties. In some

counties where private land ownership is limited, the private lands among adjacent counties were pooled for the purpose of randomly selecting nine sections (e.g., King and Pierce counties).

Each company provided road data from either an existing database or from a new inventory. Data that were submitted for each section included:

- section legal description,
- lengths of roads with high-delivery-potential (HDP),
- lengths of HDP road sub-segments that are hydrologically connected,
- lengths of roads with low-delivery-potential (LDP), and
- lengths of orphaned and abandoned roads.

The HDP roads were defined as roads within the active road network (i.e., all roads except orphaned and abandoned roads) that could potentially deliver runoff to a stream (Figure 1). The HDP road is composed of road segments that are either connected to or disconnected from a stream as shown in Figure 1. The HDP road does not include portions of the active road network that have a low potential to deliver runoff to a stream (i.e., LDP road).

The connected roads are road segments (Figure 1) that deliver road surface runoff, via the ditch or road surface, to a stream crossing or to a connected drain that occurs within the high delivery potential portion of the active road network. A connected drain was defined as any cross-drain culvert, water bar, rolling dip, or ditch-out that appears to deliver runoff to a defined channel. A drain was considered connected if there is evidence of surface flow connection from the road to a defined channel or if the outlet has eroded a channel that extends from the road to a defined channel.

The LDP roads are portions of the active road network that have a low potential to deliver runoff to a typed water course. A LDP road may include road segments on flat terrain (e.g., dry terraces or ridge tops) that do not intersect any particular channel. For this survey, the LDP roads also included segments that may drain to forested and open wetlands that have no outlet to a defined channel. The LDP segments should not be confused with disconnected segments (Figure 1) that occur within the HDP portions of the road network.

The orphaned and abandoned road types were defined as per WAC 222-24-052(3) and WAC 222-24-052(4), respectively. No data were collected on runoff deliverability from orphaned and abandoned roads.

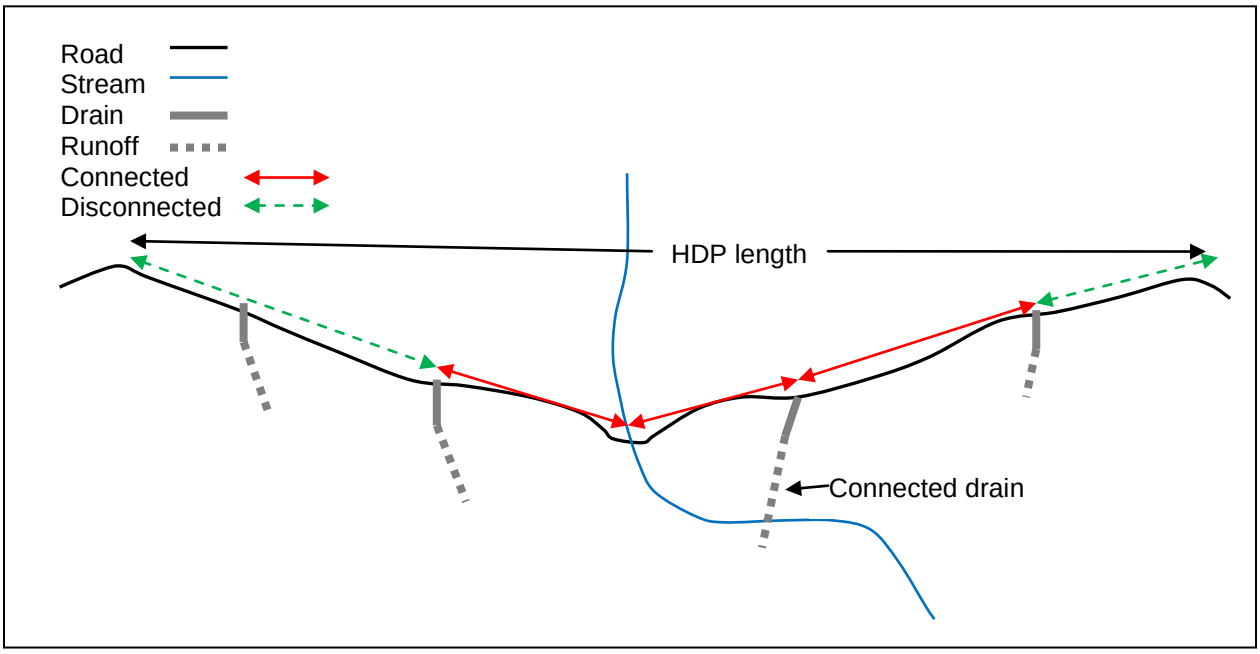

Figure 1: Diagram showing high delivery potential (HDP) road length (sum of the green and red segments) and the connected drainage length (sum of the red segments).

Analysis

The road data was summarized by county and section. In addition to direct summaries of road length by category, the proportion of road that is hydrologically disconnected by road improvements was computed. The proportion disconnected was computed as a function of the HDP road length as follows:

$$\text{disconnected portion} = \left(\frac{\text{HDP length} - \text{connected drainage length}}{\text{HDP length}}\right) \times 100$$

Results

The road inventory provided data from 16 counties, 179 sections, and 1,047 miles of road (Figure 2 and Table 1). Survey data were derived from 9 counties on the Westside and 5 counties on the Eastside of the state. The number of surveyed sections ranged from 4 in Pierce County to 27 in Grays Harbor County. A breakdown by road category shows that most of the surveyed road length (73%) is in the LDP category, a small proportion of the length is orphaned and abandoned (6%), and 21% of the total road length is in the HDP category (Figure 3a). Within the HDP road category, about one-half of the road length (9% of total road length; Figure 3b) is hydrologically disconnected. Therefore 82% (i.e., 73% + 9% = 82%) of the entire road length is either in the LDP category or is hydrologically disconnected. About 12% of the road survey length is estimated to be hydrologically connected.

The hydrologically disconnected roads ranged from 0% to 97% of the HDP road length in the surveyed sections (Figure 4). The distribution of disconnected road lengths is slightly skewed; in 34 sections less than 20% of the HDP road length was disconnected, and in 14 sections more than 80% of the HDP road length was disconnected. The median or 50% of the HDP roads had more than 47% of road length hydrologically disconnected.

A breakdown of the road data at the county scale shows that the proportion of roads in the HDP category ranges from 6% to 43% of the sampled road length in each county (Figure 5). Whatcom County had the highest percentage of HDP roads (43%) followed by Lewis (38%), and three counties (Clallam, Pacific, Pierce) had about 30%. In all other surveyed counties, the percentage of HDP roads was below 20%.

The proportion of HDP road length that is hydrologically disconnected ranged from 22% to 85% among the 16 counties (Figure 6 and Table 1). The highest levels of disconnected roads (> 69% disconnected) occur in five counties on the eastside (Ferry, Kittitas, Klickitat, Pend Oreille, and Stevens) and the lowest levels (< 30% disconnected) occur at three counties on the westside (Clallam, Cowlitz, and Wahkiakum). In Lewis and Whatcom counties, where the percentage of HDP roads is high, the proportion disconnected was also quite high: 44% and 61%, respectively.

Table 1: Summary of road inventory data by county.

County	No. of sections	Road length (mi)					Connected drainage		Hydrologically disconnected[1] (%)
		Orphaned	Abandoned	Low Delivery Potential	High Delivery Potential	Total Roads	(mi)	(%)	
Clallam	24	5.8	10.6	77.1	40.5	134.0	28.6	21.4	29.3
Cowlitz	9	3.3	0.6	47.0	4.8	55.7	3.6	6.5	24.2
Ferry	9	0.0	0.0	50.1	3.3	53.4	1.0	1.8	70.5
Grays Harbor	27	6.5	3.5	115.5	29.6	155.0	18.8	12.2	36.3
Jefferson	12	0.3	0.0	62.7	12.5	75.4	6.3	8.4	49.6
King	5	0.0	0.3	28.7	6.3	35.3	4.2	11.9	33.2
Kittitas	9	0.0	3.4	39.3	4.2	46.9	0.9	1.9	79.2
Klickitat	9	1.5	0.6	37.2	4.6	43.9	1.4	3.2	68.9
Lewis	17	1.2	5.7	46.6	32.7	86.2	18.3	21.3	43.9
Mason	9	0.7	4.0	40.1	8.4	53.1	3.7	7.0	55.5
Pacific	9	0.9	0.1	37.7	14.8	53.6	8.8	16.5	40.3
Pend Oreille	9	0.0	0.0	55.4	13.2	68.6	2.6	3.8	80.1
Pierce	4	0.2	1.3	17.0	7.7	26.2	4.1	15.8	46.3
Stevens	9	0.0	0.0	48.9	4.7	53.6	0.7	1.4	84.5
Wahkiakum	9	0.3	0.8	47.4	11.8	60.4	9.3	15.4	21.5
Whatcom	9	4.4	11.1	10.3	19.7	45.5	7.7	16.9	61.0
All counties	179	25.1	41.9	761.0	218.7	1046.7	120.2	11.5	45.0

[1]The percentage hydrologically disconnected is computed as a proportion of the HDP roads. See text for formula.

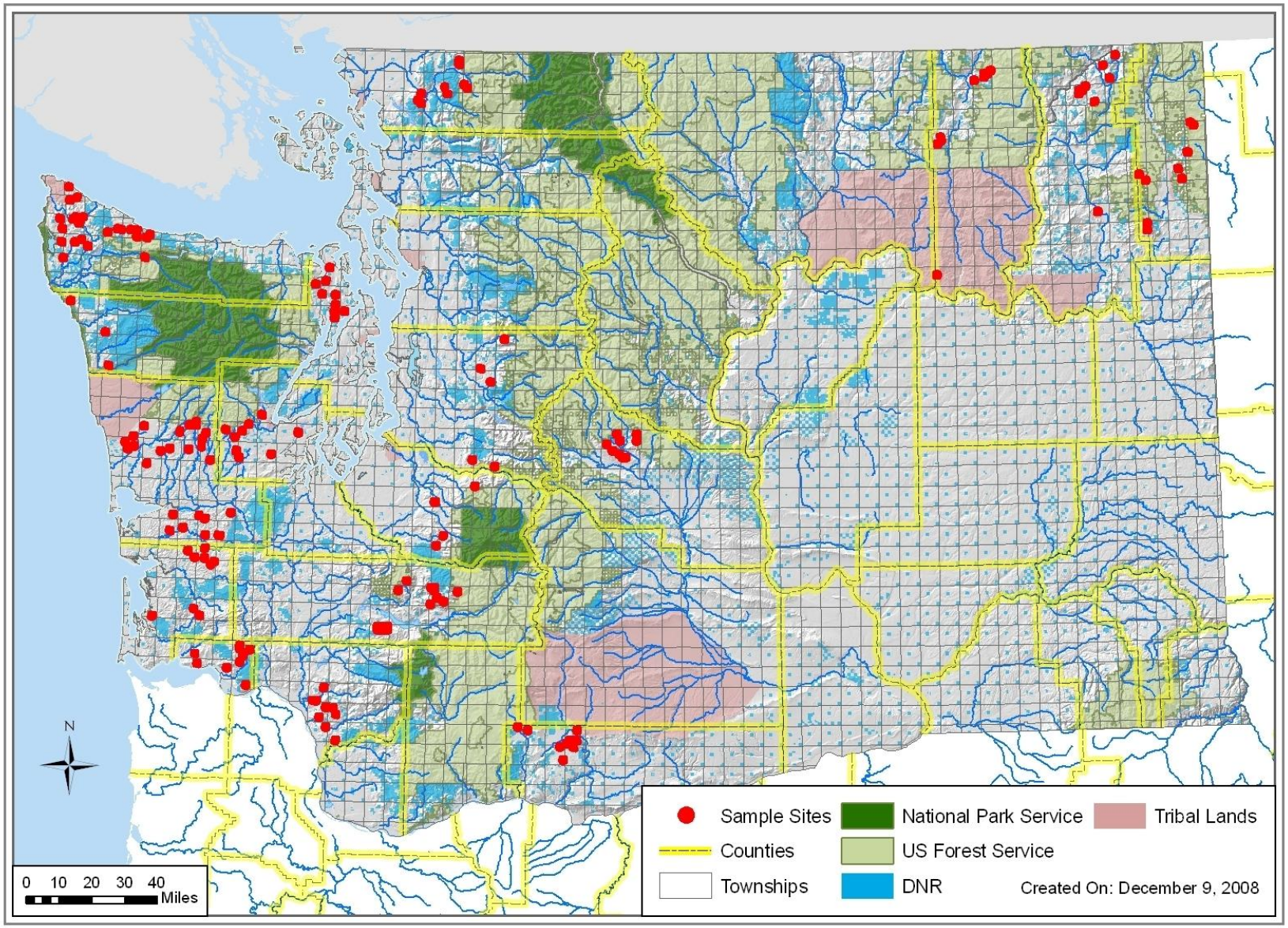

Figure 2: Location of surveyed sections for the road inventory.

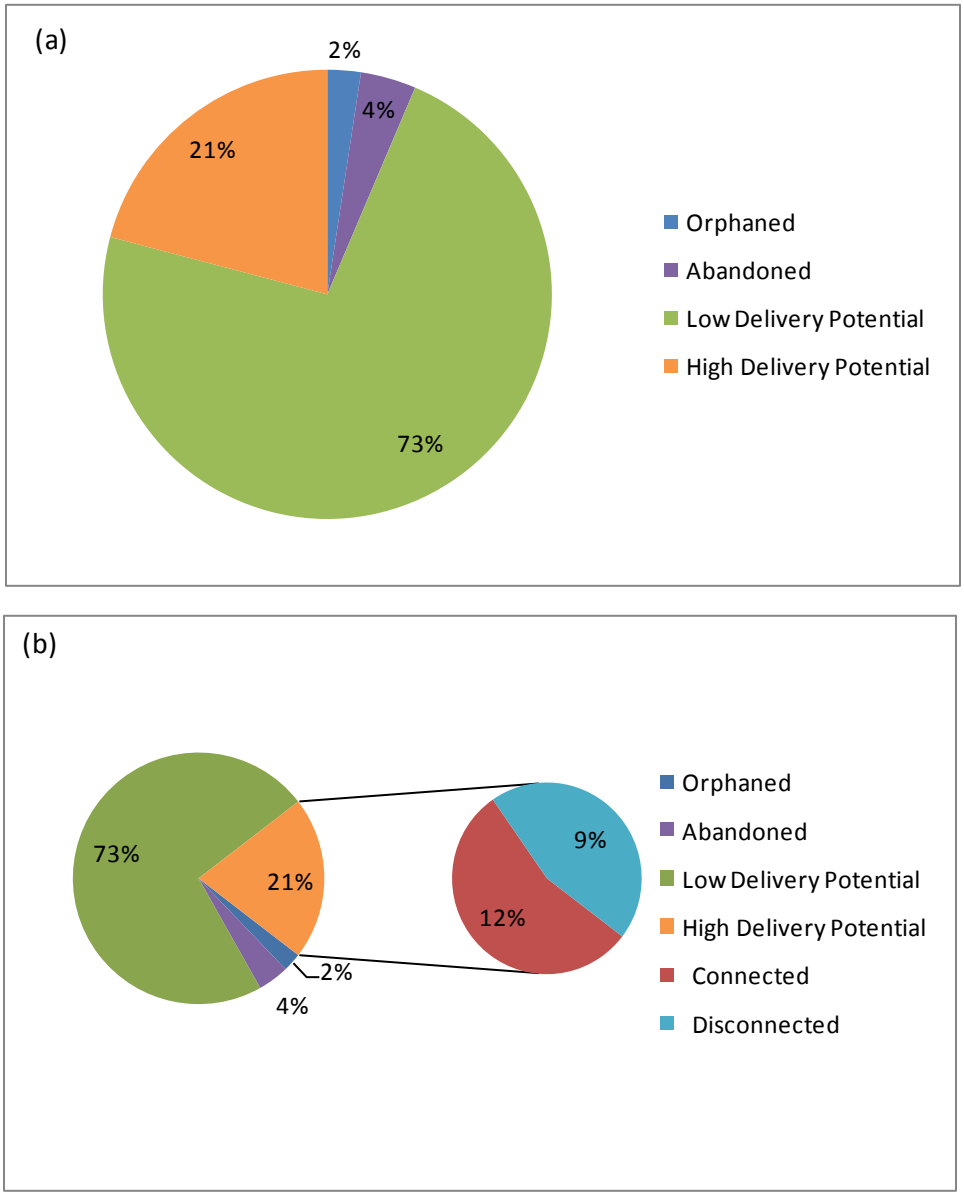

Figure 3: Percentage of total road length (1047 miles) by road category (a) and subcategory (b).

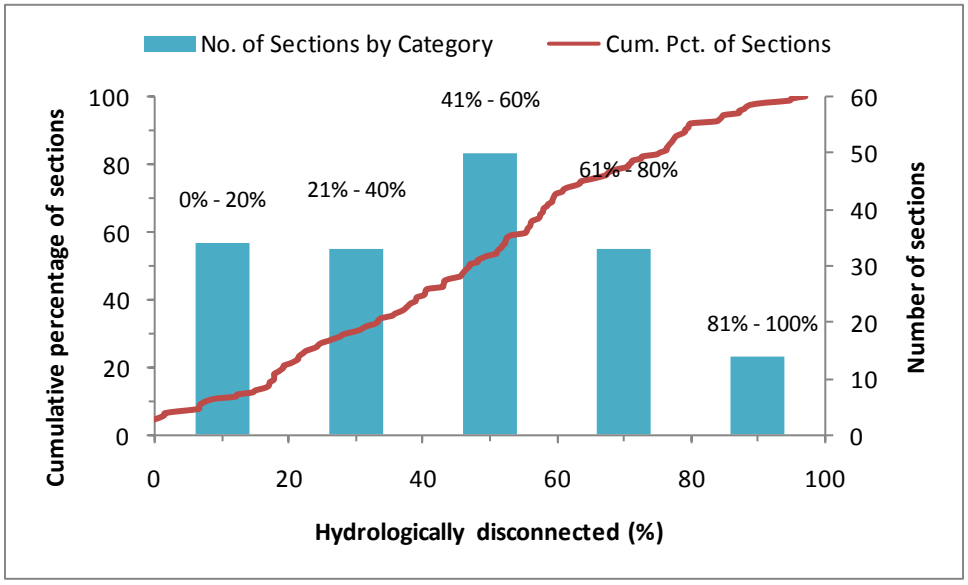

Figure 4: Cumulative percentage and frequency distribution plots of HDP road segments that are hydrologically disconnected by section (N = 164). (Note: 15 of the 179 sections are excluded from this plot because they had no HDP road segments.)

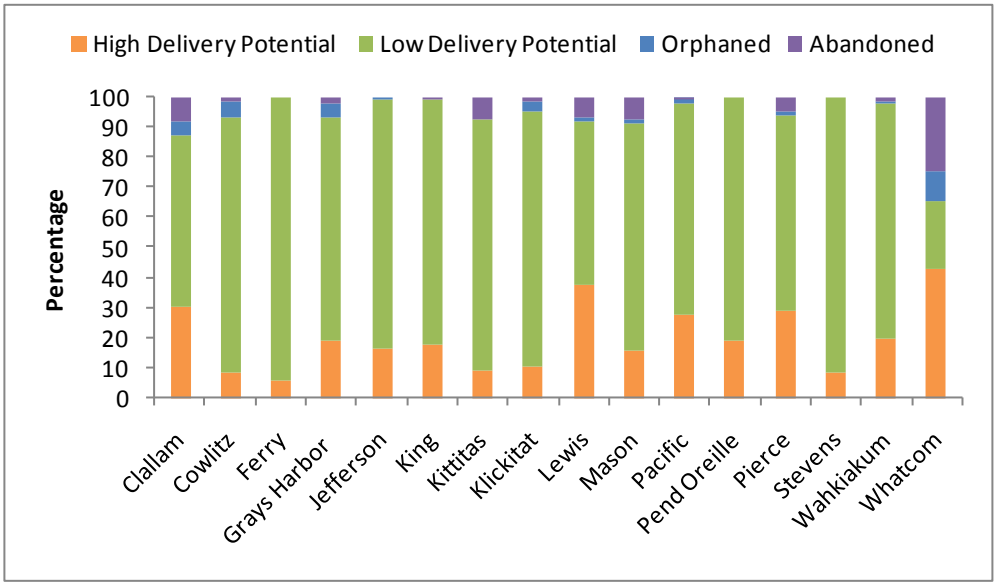

Figure 5: Percentage of total road length by road category for each county.

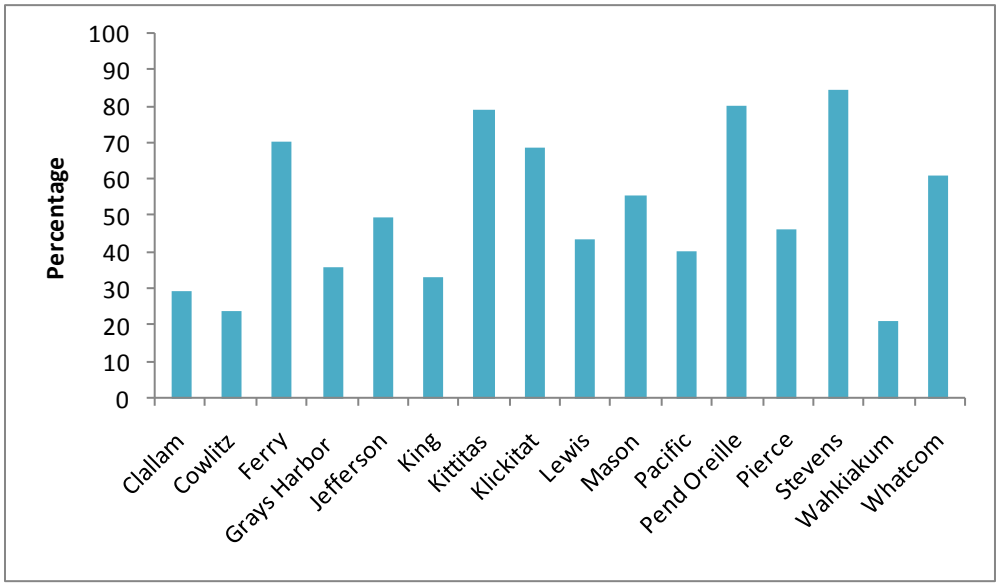

Figure 6: Percentage of HDP road length that is hydrologically disconnected by county.

Discussion

The survey results indicate that road improvements have probably reduce road runoff and the potential delivery of fine sediment to streams. It is well documented that disconnecting the road network from the stream and implementation of BMPs significantly decreases sediment delivered to watercourses (Furniss et al. 1991, Megahan et al. 1992). This survey shows that disconnectivity is occurring as a result of several key management activities. First, a high proportion of the road network (73%) has low delivery potential because the roads are located on landscapes that minimize hydrologic connectivity. This reflects initial road planning as-well-as road relocation activities that have occurred under the RMAP process. Second, the presence of orphaned and abandoned roads demonstrates a conscious effort to eliminate high risk roads. Although the proportion of orphaned and abandoned roads is relatively small (6%), they often occur in unstable areas or are very close to streams. Therefore, eliminating road use or complete removal can have a significant positive benefit to streams. Third, the disconnection of approximately one-half of the HDP roads reflects the implementation of multiple BMPs (e.g., increased cross drains, more frequent ditch-outs, grading). Collectively, these data show that a majority of the roads in the survey area have a low probability of delivering sediment to a typed water course. Also, because these data are spatially representative we assume that the results are reflective of the road conditions on most large private lands in Washington.

The RMAP program requires landowners to complete their road improvements by 2016. At this time, the RMAP's are only partially completed, but the majority are on track to meet the 2016 deadline[1]. Base on the progress to date, we can assume that sediment delivery from forest roads has declined and that it will continue to decline as all of the RMAP's are completed. In addition, it is important to recognize that while hydrologic disconnection is a very important tool, landowners apply a broad suite of BMP to eliminate and minimize sediment delivery. Some BMPs are temporal, such as not hauling on streamside parallel roads during wet weather. Others are spatial, such as stabilizing native surface roads with rock or vegetation.

Literature Cited

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Megahan, W.F., J.P. Potyondy, and K.A. Seyedbagheri, 1992. Best Management Practices and Cumulative Effects From Sedimentation in the South Fork Salmon River: An Idaho Case Study. In: Watershed Management: Balancing Sustainability with Environmental Change, Robert J. Naiman, (Editor). Springer-Verlag, New York, pp. 401-414.

[1] Personal Communication between Gary Graves, Washington Department of Natural Resources and Adrian Miller, Washington Forest Protection Association.