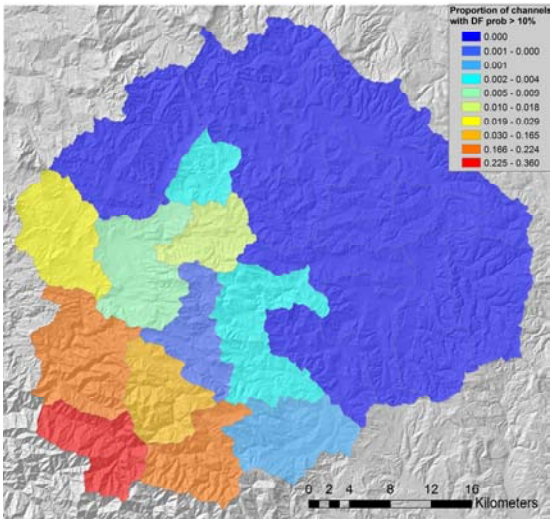
Upper Nehalem Watershed Analysis
Part III – Appendices

Prepared for:

Oregon Department of Forestry



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APPENDIX A

Natural Disturbance Theory and Simulation

Appendix A
Natural Disturbance Theory and Simulation

A-1 The Role of Natural Disturbance in Humid Temperate Mountain Landscapes

The Nehalem watershed located in the northwestern corner of the Oregon Coast Range is considered a "humid temperate forested mountain landscape." The following provides a brief overview of natural disturbance pertinent to that type of landscape. Over decades to centuries episodic disturbances may supply the majority of raw materials to river systems. Erosion dominated by punctuated mass wasting is common in hilly to mountainous terrain of the Pacific Northwest (Dietrich and Dunne 1978, Roberts and Church 1986),

Punctuated disturbances such as fires, large storms, and floods may create numerous aspects of river habitats. For example, mass erosion during storms or following fires often creates coarse-textured terraces in unconfined valleys (Nakamura 1986) that later becomes colonized by diverse riparian forests (Nirenberg and Hibbs 2000). During flooding and heightened sediment supply, channels often become braided and side channels form thereby creating side-channel habitat (Miller and Benda 2000). In addition sediment-related disturbances often create areas of spawning gravel and ponds that become occupied by fish and beaver (Everest and Meehan 1981, Roghair et al. 2002). Sediment-related disturbances also increase rates of channel migration and bank erosion (Beschta 1984) leading to increases in wood recruitment (Piegay and Citterio 1999).

Mass wasting, including debris flows, may also destroy habitats and harm stream organisms. Negative effects of debris flows may include immediate burial of existing habitat and direct mortality of aquatic biota; increased fine sediment in gravels onsite and downstream that suffocates fish eggs in gravel (Everest et al. 1987; Scrivener and Brownlee 1989); increased bedload transport and lateral channel movement due to heightened sediment supply that scours fish eggs; and loss of pools that reduces rearing habitat (Frissel and Nawa, 1992; Hogan et al. 1998).

The sediment supply in mountain environments, such as in the Oregon Coast Range, is characteristically punctuated. This sediment supply typically forms or rejuvenates alluvial or debris fans at river confluences during sediment-related disturbances that follow floods and spates of watershed erosion. In other words, disturbances create many topographic knick points in rivers at confluences. Moreover, alluvial and debris fans expand and contract over time in response to disturbances, or lack of them, and consequently their upstream and downstream zones of influence increase and decrease over time (Benda et al. 2003). In managed and unmanaged watersheds in the Olympic Peninsula, Washington, a landscape physiographically

similar to the Oregon Coast Range, there were statistically significant relationships among debris fans at low-order confluences and gravel substrate, wide channels, and numbers of logs and numbers of large pools. Effects of debris fans on channel morphology extended upstream and downstream of fan perimeters indicating the offside and indirect effects of debris flows. Consequently, certain aspects of channel morphology (pool density, substrate texture, and channel widths) were non-uniformly distributed, reflecting the role of network topology and disturbance history on the spatial scale of morphological heterogeneity. In addition, heterogeneity of channel morphology increased in proximity to low order confluences prone to debris flows.

Punctuated sediment supply associated with mass wasting can trigger migrating waves of channel aggradation downstream in river networks (Mosley 1978; Meade 1985; Benda and Dunne 1997b; Miller and Benda 2000). Such sediment-related disturbances are locally amplified near topographic knick points, including low gradient and wide valley floors, tributary confluences, landslide deposits, canyons, and bedrock outcrops. For instance, the widest floodplains and the highest occurrence of side channels associated with post fire sedimentation occurred in unconstrained, non-canyon areas in conjunction with enlarged alluvial fans (Benda et al. 2003). Moreover in coastal British Columbia, the greatest channel meandering and bank erosion occurred in association with alluvial fans at tributary junctions in a 6th-order river (Church 1983). Consequently, the spatial arrangement of topographic knick points, or response segments, in a watershed (controlled by basin shape, network topology, drainage density, landslide terrain, and canyons) will influence longitudinal patterns of riverine heterogeneity. Biological diversity may track riverine patterns of physical heterogeneity linked to disturbance. For instance, in riparian communities, greater topographic variation in floodplains and terraces should create local variation in inundation and soil moisture regimes that should increase plant diversity (Hupp and Osterkamp 1985; Kalliola and Puharta 1988). In Finland, Kalliola and Puharta (1988) observed that high riparian species diversity tracked physical heterogeneity. Similarly, Hupp and Osterkamp (1985) related riparian species composition in a river in Virginia, USA, to fluvial landforms, implying that increased landform heterogeneity increased species richness.

For aquatic species (e.g., fish and invertebrates), greater habitat heterogeneity may fuel higher diversity. Aquatic habitats that are created by disturbances could promote habitat opportunities for specialized aquatic species or for life stages that require low energy environments, including side channels during winter floods (e.g., Swales and Levings 1989; Reeves et al. 1998). Diversity should be expressed with respect to local potential. For example, fish diversity generally increases along a river profile as river size increases, but maximum local diversity is influenced by local habitat heterogeneity (Matthews 1998), so relative diversity may be maximized under certain topographic or network topological conditions.

Biological productivity may also be greatest in areas that have high physical heterogeneity. Higher productivity can result from higher retention and transferal of nutrients and organic material in geomorphically complex zones such as alluvial floodplain reaches that are comprised of a diverse mosaic of riparian forest patches, floodplain channels, and tributary junctions (Sedell and Dahm 1984; Edwards 1998; Fisher et al. 2002).

A-2 Natural Disturbance in the upper Nehalem Watershed

There was limited information available on the natural disturbance history of the upper Nehalem watershed and surrounding areas, particularly regarding mass wasting, wood recruitment, and channel conditions. Historical maps, aerial photographs and written accounts of historical fires provide limited information on wildfire behavior in the Nehalem watershed. Some information on the history of large floods since the onset of EuroAmerican settlement in the mid-1800s was available. To supplement the limited historical information on natural disturbance, this section references computer simulation results covering natural variability of wildfire occurrence, forest ages, landslides and debris flows, and wood recruitment from humid temperate landscapes in the Oregon Coast Range and southwest Washington. NOAA-Fisheries is presently conducting computer simulations of natural disturbance and its consequences to the types and abundance of aquatic habitats in the Oregon Coast Range (Earth Systems Institute - research, in progress).

A-3 Natural Disturbances: Simulation Results

Fires and Forest Ages: Simulation and Implications for Range of Variability in the Nehalem Watershed

In the Oregon Coast Range (OCR), sequences of stand replacing fires have strongly influenced patterns of forest ages. Forest-replacing wildfires in western Oregon have occurred in a variety of sizes (~1 – 1000 km^2) over the last several millennia and at a mean interval of about 300 years, although there was inter-millennial variability (Teensma 1987; Long et al. 1998). In the OCR, the long-term probability distribution of forest ages at landscape scale (~10^3 km^2) was predicted to be positively skewed (Benda et al. 1998; Wimberly et al. 2000), similar to fire-vegetation age predictions in other landscapes (Johnson and Van Wagener 1984). The right skewness arose because of an approximately equal susceptibility of fires across all age classes that force a decreasing probability of developing very old trees. This yielded the highest proportion of trees in the youngest age classes and a gradual and systematic decline in areas containing older trees.

A forest fire and stand growth simulation model developed for the Oregon Coast Range (Benda and Dunne 1997a), similar to the model employed by Wimberly et al. (2000) was used to illustrate the natural variability of forest ages in an area the size of the upper Nehalem watershed (~400 km^2). The model predicted a long-term average forest age of 270 years in the absence of

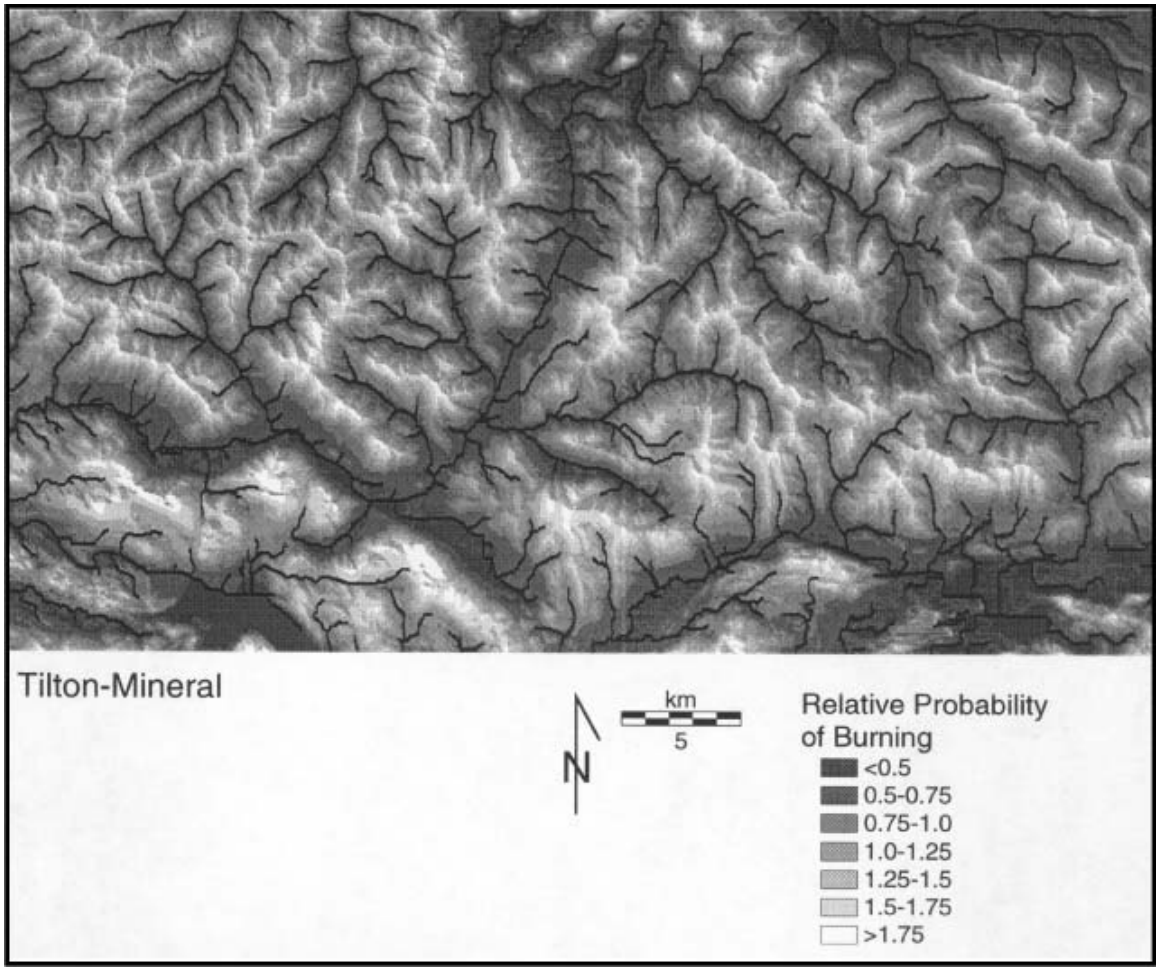
forestry. The model also predicted that on average, over thousands of years, 16 percent of the area would contain trees less than 50 years, 30 percent would contain forests less than 100 years, and 50 percent of the area would contain forests greater than or equal to 250 years. On average approximately 58 percent of the 450-km^2-area would contain old growth forests (old growth defined as forests greater than 250 years old); the minimum proportion was 26 percent and the maximum was 90 percent.

Topography exerts a strong control on fire behavior, including influencing the frequency and severity of fires (Swanson 1981; Benda et al. 1998; Morrison and Swanson 1990). The fire simulation model applied to southwest Washington included an empirically-defined topographic effect on fire frequency (Figure A-2). Based on historical (pre logging) aerial photography, fire frequency was predicted to be highest near ridges and south-facing slopes, areas that could include landslide-prone bedrock hollows located in the upper portions of hillslopes. Fire frequency was predicted to be lowest in the wider and lower gradient valley floors (Figure A-2). Similar burn frequency patterns might be expected in the humid temperate Nehalem watershed. Topographic variation in fire frequency resulted in variations in forest age patterns (Figure A-3). Under natural conditions, approximately 18 percent of landslide-prone bedrock hollows (similar to slide prone features in the Nehalem watershed, see mass wasting assessment) were predicted to have young forests (< 50 years). Moreover, approximately 10 percent of landslide prone hollows were predicted to have forest vegetation less than 25 years old, a time period often linked to low root strength and higher landslide potential (Ziemer 1981). In addition, approximately 14 percent of first-order channels were predicted to be bordered by vegetation less than 50 years old.

Shallow Landslides and Debris Flows

Combining the effects of wildfires on rooting strength and rainstorms on soil saturation over an entire population of landslide sites in a watershed, such as the Nehalem, can be used to consider natural patterns of shallow landsliding in space and time, or the natural background landslide rate. A rate of landsliding can be considered for single site, referred to as a recurrence interval, or a rate can be described for a specific area containing a population of slide sites (e.g., number/area/time). Landslide rates will vary across the study landscape, depending on topography. The natural background landslide rate, characterized by frequency, magnitude (number of slides), and location of landsliding, control the spatial and temporal pattern of sediment supply to higher-order channels in a watershed.

An analysis of natural landsliding was not available for northern coastal Oregon, including the Nehalem watershed. To provide some insights into the natural rates of landsliding and debris flows in the Nehalem, we referred to the analysis of natural disturbance in a similar humid temperate landscape in southwest Washington (United States Forest Service [USFS] 2002).



- Figure A-2. Topographic control on fire probability or frequency estimated using reconstructed stand ages available on historical aerial photography (1939) for a humid temperate landscape in southwest Washington (from Benda et al. 1998). Ridges and south-facing hillslopes have the highest burn frequency (white areas in image) while the larger and wider valley floors have the lowest frequency of fires (darker areas in image).

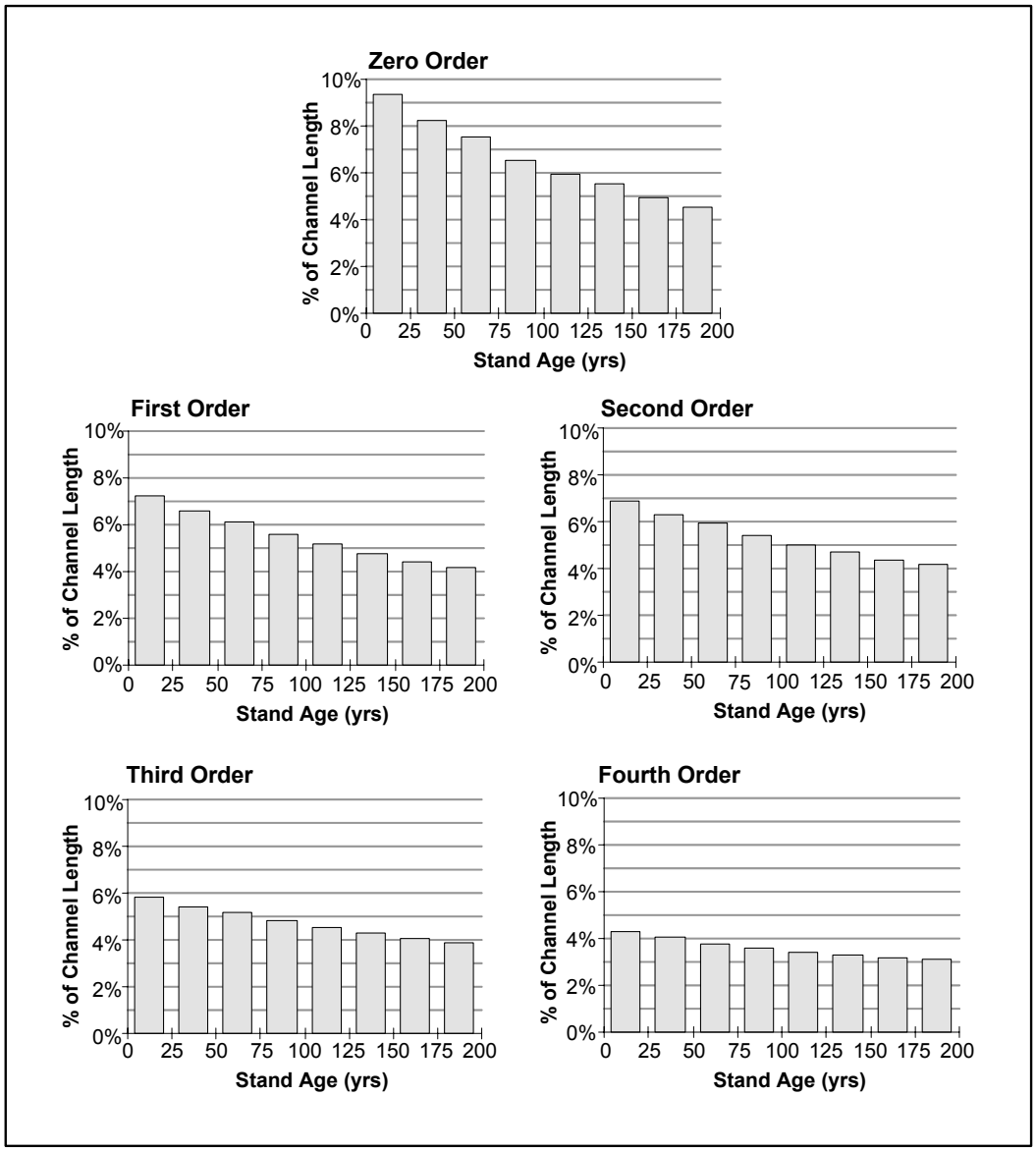


Figure A-3. Predicted natural variation in forest ages for a humid temperate landscape in southwest Washington based on a fire simulation model (Benda and Dunne 1997a) in conjunction with topographic controls on fire (see Figure A-2 and USFS 2002). On average at any point in time, approximately 18% of landslide-prone bedrock hollows (similar to slide prone features in the Nehalem watershed) are predicted to have young forests (< 50 years), equivalent to second growth forests. Approximately 10% of landslide prone hollows are predicted to have forest vegetation less than 25 years old, often considered a period of low rooting strength that contributes to landslide potential. In addition, approximately 14% of first-order channels is predicted to be bordered by vegetation less than 50 years old.

Basin-Scale Natural Landslide Rates in Bedrock Hollows. The long-term rate of landsliding in bedrock hollows is controlled by the rate of soil production, a geological and climatic influence represented by the average calculated soil production rate which governs soil accumulation and changes the balance of gravitational force and root strength. Although landslide rates can be reported on a site basis (i.e., single bedrock hollow), here we present simulations at the basin scale, a context more relevant for watershed analysis.

Landsliding in the simulated watershed in southwest Washington was predicted not to occur uniformly over the age of a growing forest but to concentrate in the first couple of decades following fires when tree root strength is at its lowest point. About 60 percent of landslides were predicted to occur within the first 15 years following fires. This prediction was supported by field evidence of concentrated sliding after fires in the humid forests of the Pacific Northwest (Benda and Dunne 1997a; May and Gresswell 2002). The remaining 40 percent of the landslides from bedrock hollows were predicted to occur within older forests (with higher rooting strength) and hence were triggered by the occurrence of large storms alone (USFS 2002).

Landsliding at a single site was relatively rare, predicted to occur about once every 13 centuries in the study watershed; empirical evidence using radiocarbon dating also indicates recurrence intervals ranging between 500 years and 6000 years in the Oregon Coast Range (Benda and Dunne 1987). In a watershed like the Nehalem, there exist hundreds to thousands of potential landslide sites (hollows) at the scale of a drainage basin, and the natural rate of landsliding will vary with basin size. The frequency, magnitude, and location of natural landsliding are strongly influenced by the number of potential landslide sites, the failure frequency of each (governed primarily by topographically-variable soil infilling rates), and the frequency with which storms intersect recent fires. High densities of shallow landslide sites (e.g., bedrock hollows) occur in steep areas of the simulated watershed in southwest Washington. For example, in a 3 km^2 basin with a landslide site density of 40/km^2, the frequency of landsliding was predicted, on average, once every 25 years, with the number of landslides ranging between one and four (Figure A-4a). As basin size increases to 25 km^2 (with a slide density of 30/km^2 for a total of 750 slide sites), frequency of failure increased to, on average, once every 7 years, with the range of slides varying between one and twenty (Figure A-4b). At a drainage area of 200 km^2 containing 2000 landslide sites (e.g., a slide density of about 10/km^2), landsliding was common, occurred with an average frequency of once every two years, and with the number of slides varying between one and 60. The number of landslides that could occur in any year is a probabilistic outcome of the interaction between topography and climate (e.g., fires and storms). For example, at a basin size of 200 km^2, there was a 25 percent probability of one slide occurring in any year and about a 1 percent chance of 10 slides occurring.

It is informative to express the predicted natural rates of landsliding in 40-year increments since this is often the historical time period of recent logging activities and generally represents the length of the aerial photograph record used in developing landslide inventories. Predicted time series of landsliding from bedrock hollows in 40-year increments in the simulated drainage areas (3, 25, and 200 km^2) in southwest Washington are shown in Figure A-5. In the 3 km^2 basin, the number of landslides within a 40-yr window ranged from 1 to 17, which is equivalent to 1.3 to 6.7 slides/km^2. In addition, there was a 30 percent chance that one slide would occur and an 11 percent chance that greater than 8 slides would occur within the 40-year window (Figure A-5a). At a scale of 25 km^2, the number of slides that could occur during a 40-yr window increased to over 70 (Figure A-5b). At that scale, there was a 60 percent chance of less than 10 slides and about a 10 percent chance of greater than 30 slides. Increasing basin size to 200 km^2, the chance of between 30 and 70 slides was 40 percent and about a 10 percent chance of exceeding 100 slides (Figure A-5c).

Figures A-4 and A-5 reveal that natural landsliding cannot be represented as a single rate but only as a distribution of rates, with each rate of landsliding (in terms of number of slides per specified time period per area) associated with a particular likelihood or probability of occurrence. Landslide probabilities vary at different drainage areas because the landslide site density varies (Figure A-4) as well as the frequency of fires (i.e., Figure A-2). Predicted natural background rates could be used to contrast landslide rates measured from aerial photographs over the past 40 years to more accurately assess the effects of forestry activities on landsliding, including in the Nehalem basin.

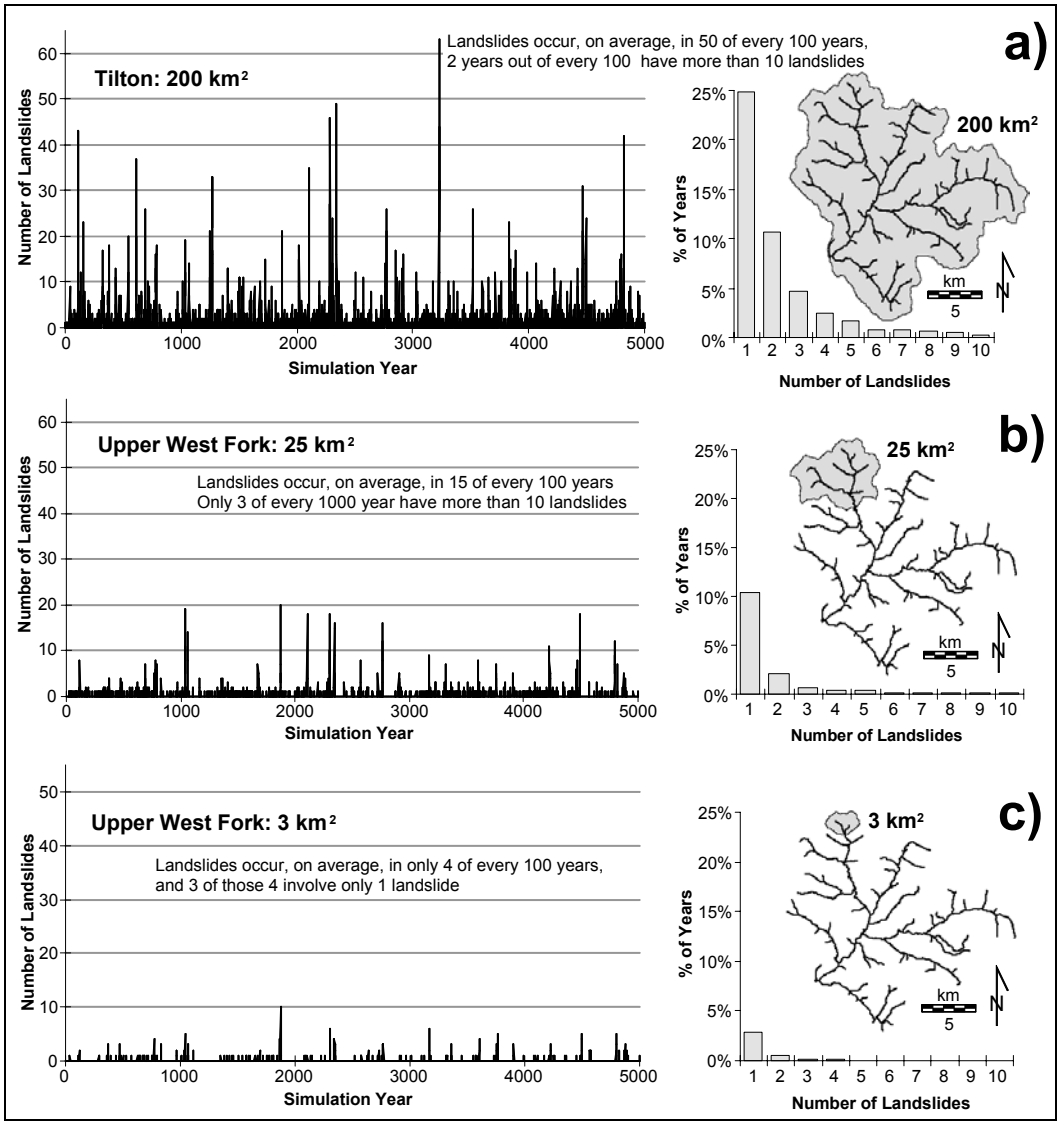


Figure A-4. Predicted time series of shallow landslides for a simulated 200 km^2 watershed in southwest Washington at three spatial scales (a-c).

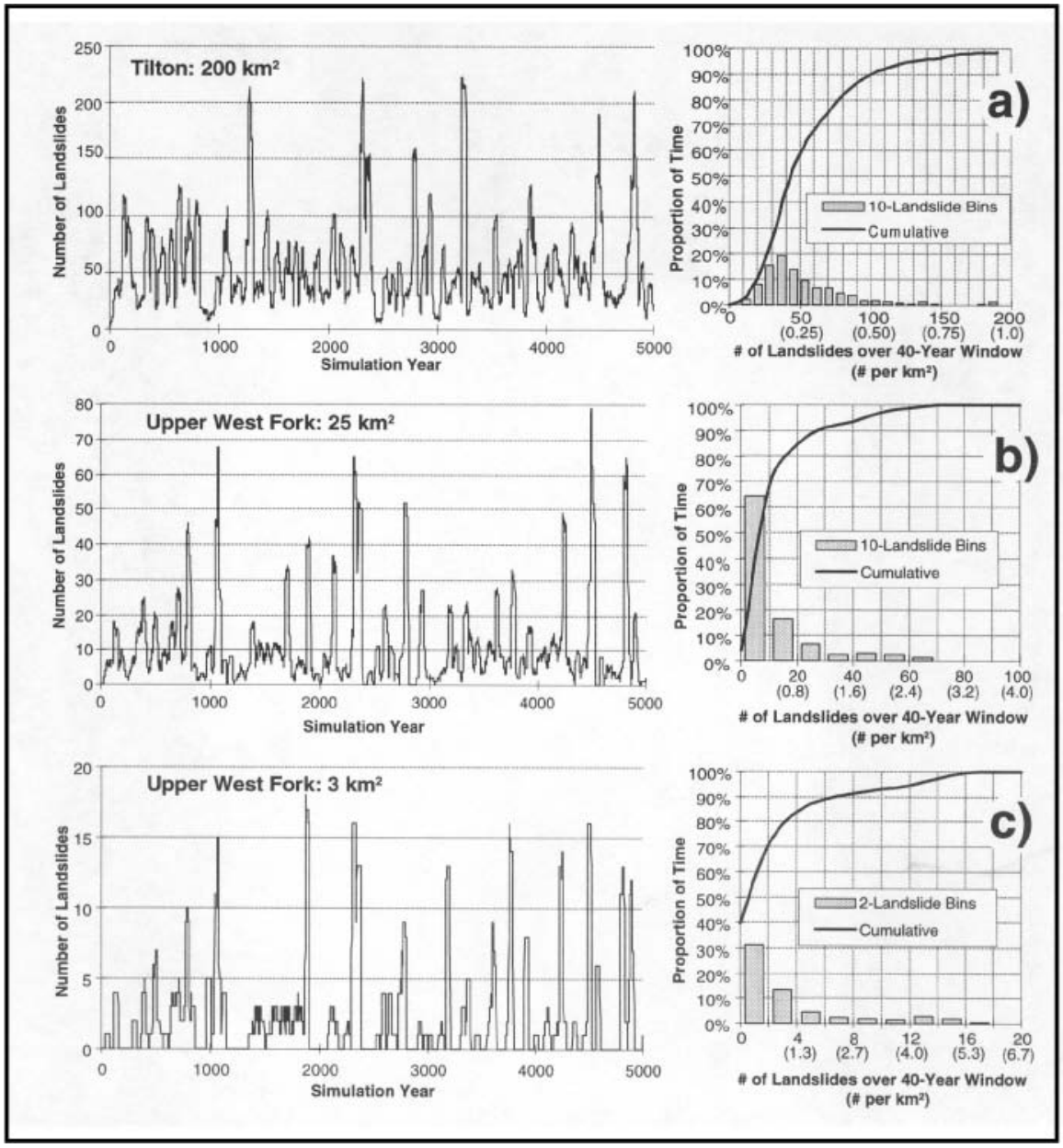


Figure A-5. Predicted time series of shallow landslides for a simulated 200 km^2 watershed in southwest Washington in 40-year time windows at three spatial scales (a-c).

Basin-Scale Natural Debris Flow Rates. Debris flows are initiated by liquefaction of landslide debris concurrently with failure, or immediately thereafter, as the soil mass and reinforcing roots break up. Debris flow scour of sediment and woody debris stored in first- and second-order channels can increase the volume of the original landslide by 1000 percent or more (Benda and Cundy 1990; Robison et al. 1999). Initiation, transport (scour), and deposition of debris flows are controlled by channel gradients and the geometric structure of the low-order channel network. Ten-m digital topographic data in conjunction with a shallow landslide – debris flow model (Miller and Burnett in review) are used to predict channels prone to debris flow scour and deposition in the Nehalem watershed (see mass wasting assessment).

In drainage basins where disturbances of large spatial extent occur, such as fires and rainstorms, natural rates of debris flows are dependent upon the behavior of the entire population of potential debris flow sites. The number of debris flows that occur in a basin during a climatic disturbance is dependent on the number of potential debris flow source areas (trigger hollows, sensu Benda and Dunne 1987), number of potential debris flow channels, the spatial extent of fires and/or storms, and the history of landsliding and debris flows in the basin. Similar to landslides, the frequency of debris flows at the basin scale increases because of increasing number of potential source areas and channels (see USFS 2002). Considered on an annual basis at the scale of 200 km^2, modeled debris flows were generally few in number, with 67 percent of all years predicted to have no debris flow activity (e.g., that is, only a 33 percent chance of one or more debris flows in any year) (Figure A-6a). When debris flows occurred they were generally few in number, with usually less than four occurring in any year. Since landslide inventories typically count debris flows based on an approximate 40-year aerial photograph record, predictions of natural debris flow activity were presented in terms of 40-year windows, similar to shallow landsliding (Figure A-6b). In contrast to the typically low numbers of debris flows occurring annually, there was a much higher likelihood of several dozen debris flows occurring over 40 years in the 200 km^2 Tilton basin. The number of debris flows predicted to occur over 40-year windows varied between about 5 and 80, and averaged about 28 (Figure A-6b). The cumulative distribution function in Figure A-6b showed that there was a 50 percent probability of between 20 and 40 debris flows in a 40-yr period and only a 10 percent chance of exceeding 50 debris flows. Predictions of debris flow over 40-year windows could be contrasted with measured rates in managed forests to better evaluate the impacts of logging-induced landsliding and debris flows.

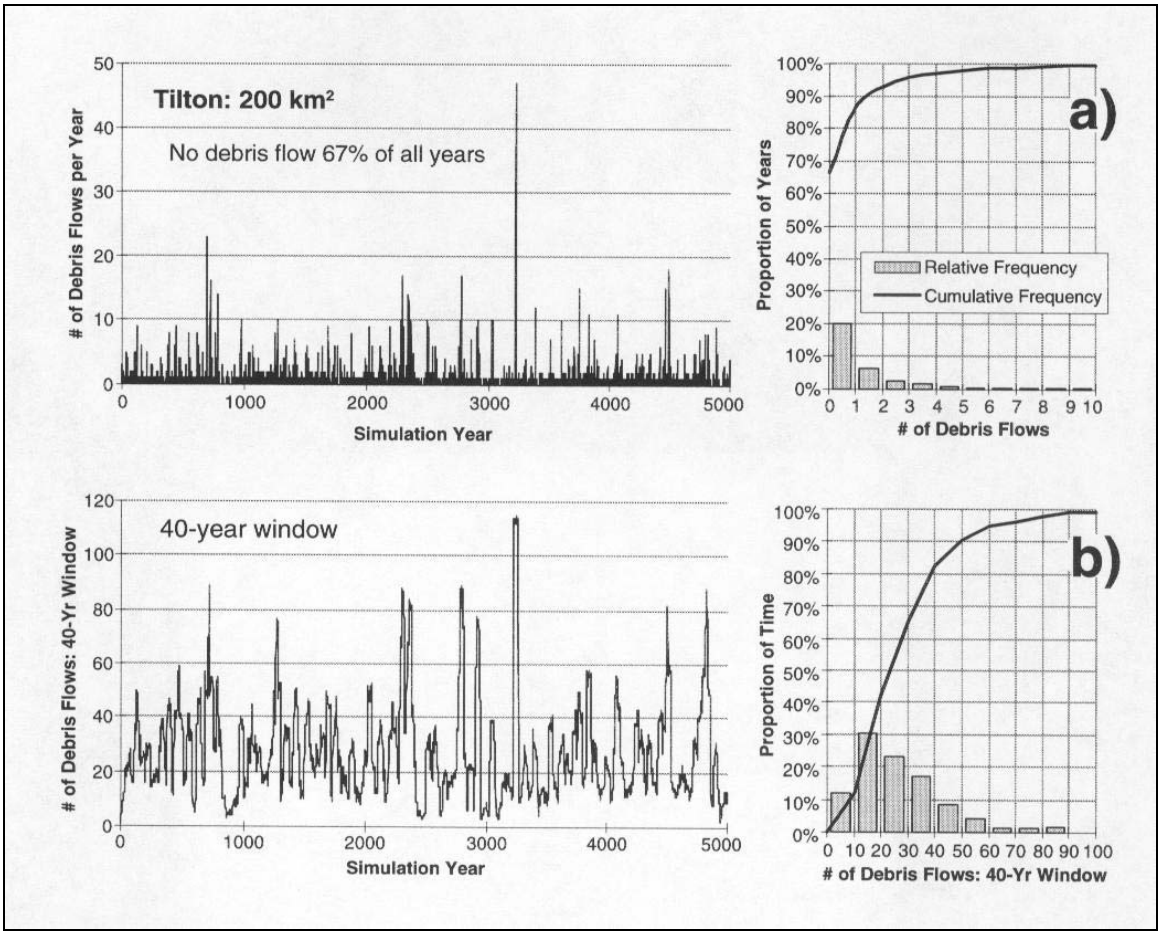


Figure A-6. (a) Predicted time series of debris flows for a simulated 200 km^2 watershed in southwest Washington, and (b) results plotted in 40-year time windows.

Similar to shallow landsliding, the natural background rate of debris flows was not a single value but a distribution of values (or rates in this case). Distributions revealed the range in the natural background rate of debris flows, in terms of frequencies and magnitudes (e.g., number of debris flows). Natural disturbance, therefore, could only be described in terms of probabilities, expressed as the probability of a certain magnitude of event occurring.

Debris flows scour the long-accumulated sediment and woody debris from the floors of first- and second channels exposing channel bedrock. Scoured channels may remain fully or partially exposed to bedrock for decades until soil creep or landslides begin to fill the channel with soil and woody debris (Benda 1990). Hence, a useful way to interpret the recent history of debris flows in a basin, such as in the context of forest management, is to assess the length of scoured debris flow channels in comparison to non-scoured channels.

Since debris flow scour of low-order channels is easily measured from aerial photographs and verified by field checks, the proportion of channels scoured by debris flows may be a potential tool to estimate the state of disturbance (or erosion) in a watershed. The computer model used to assess natural rates of fires, landslides, and debris flows was also used to predict the changing proportion of channel length scoured by debris flow within a 50-year period preceding any year of the simulation (i.e., it was assumed that after 50 years low-order channels will begin to refill with sediment and wood and hence be in a non-scoured state). The predicted change over time in the length of scoured channels is shown for 3, 25 and 200 km^2 basins in the simulated southwest Washington landscape in Figure A-7. The model predicted an increasing frequency but a decreasing magnitude (i.e., length of scoured channels compared to non-scoured channels) with increasing basin area. For example, at a basin size of 200 km^2, the proportion of scoured channels never exceeded 10 percent and averaged about 3.5 percent (Figure A-7a). At a basin scale of 25 km^2, the proportion of scoured channels ranged from zero (10% of the time) to about 20 percent (a condition occurring about 2% of the time, or a 2% probability). There was about a 10 percent chance (or probability) that scoured length would exceed 12 percent of all channels. Decreasing in-basin area to 3 km^2, the potential amount of scour increased, although the likelihood of attaining high proportions of scoured lengths decreased (Figure A-7c). At the smaller basin size, there was only a 10 percent chance of exceeding 25 percent scour and there was a 50 percent chance of no scour at all. Comparing these theoretical predictions of debris flow scour to measured scour lengths in managed forests could indicate how unusual (or not unusual) the present level of debris flow disturbances are in any particular basin.

The proportions of headwater channels scoured by debris flows would vary across watersheds because of topographic variability. Steep hillslopes of high relief should contain a high spatial density of debris flow channels, while other areas in a watershed may have low densities because of low gradients or because hillslopes are formed in mechanically-weak deep-seated landslide debris.

Large Wood

Field surveys of short durations may be insufficient to define the role of rare and episodic processes in the long-term wood budget, including wildfires, windstorms, landslides, and major floods. Simulation models can be used to circumvent that limitation. Thus, we have illustrated the importance of natural disturbances in wood recruitment using the stochastic simulation modeling results from southwest Washington. The model illustrated how disturbances (fires and storms) and forest succession could lead to marked temporal variability in wood storage (Figure A-8). During periods of low disturbance (old-growth forest, no fires or large storms), wood volumes throughout most of the network were relatively low (Figure A-8), with the exception of a few persistent landslide and debris flow areas. At other times, wood storage was predicted to

be considerably higher. Hence, the model indicated that measures of wood storage taken at a single time revealed little about the dynamic nature of wood recruitment and storage.

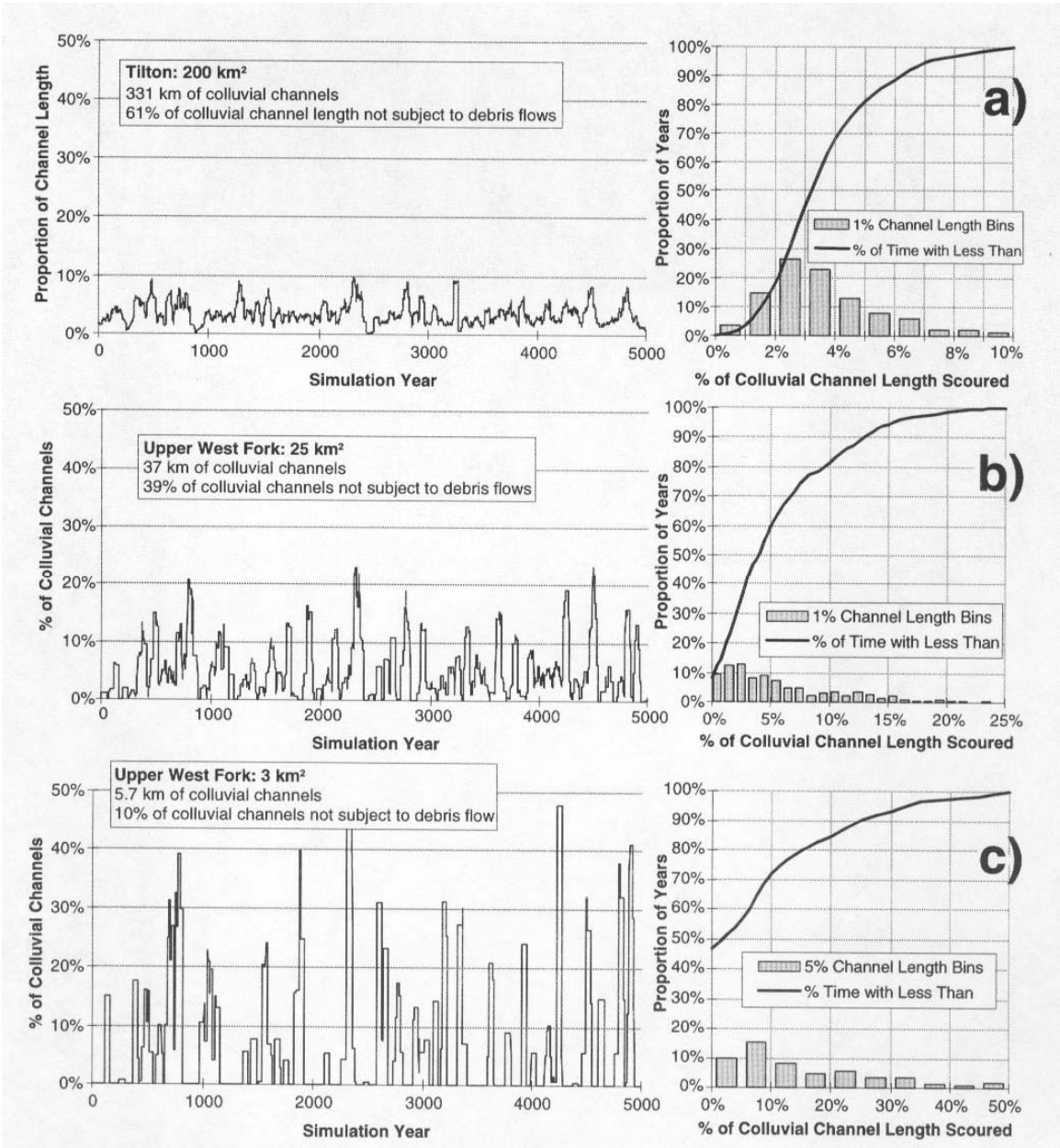


Figure A-7. Predicted time series of debris flow scour (first- and second-order channels) for a simulated 200 km^2 watershed in southwest Washington shown at three spatial scales (a-c).

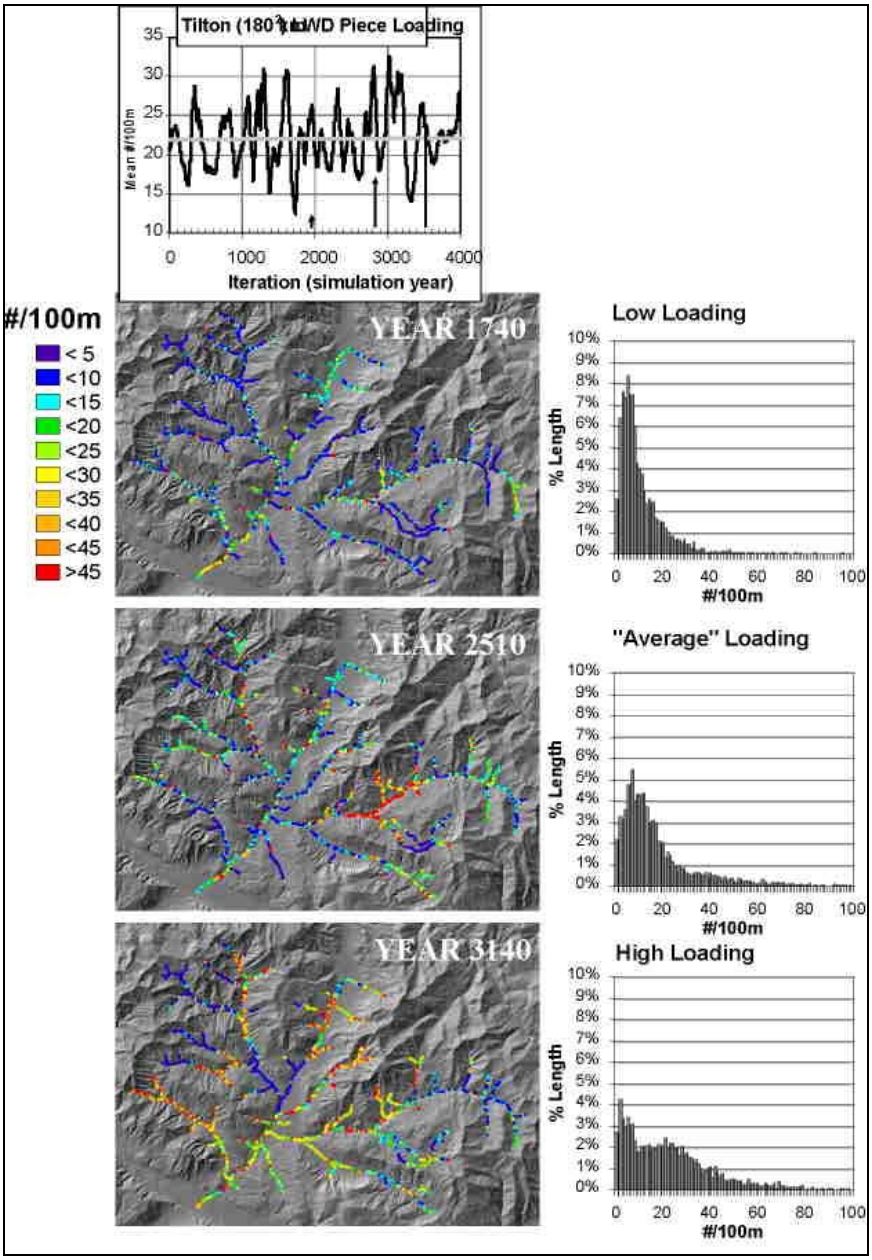


Figure A-8. A simulation model is used to illustrate variation in wood storage in the 3rd– and higher-order network in a 200-km^2 watershed in southwest Washington. Storage throughout the network can vary from low to high depending on the history of fires, storms, and mass wasting. The model predictions also illustrate how temporal variability in wood loading is dependent on the location of different wood recruitment processes, such as debris flows from first- and second-order channels and the variable location of fires. Adapted from Benda et al. 2003.

Model predictions are also useful for illustrating how variation in topography (steep versus gentle hillslopes) and basin size (small versus large bank erosion rates) can create both random and systematic spatial variability in wood storage at the scale of a watershed (Figure A-9). Debris flows and inner-gorge landslides created localized areas of persistently high wood loading. The model also illustrated how the proportion of wood supplied from five different recruitment processes varied spatially throughout the network (Figure A-9). In some areas, fire-killed snag fall dominated, but in others, bank erosion or landsliding dominated. Using a fire frequency of approximately 250 years, the most significant wood recruitment agent to third- and higher-order channels was predicted to be post-fire toppling of trees (42%) followed by chronic mortality (30%) and debris flows (17%).

3.2.3 Evaluating Land Use Disturbance in the Context of Natural Disturbance

Because landscape behavior is dynamic over a range of space and time scales (see Figures A-1 through A-9), evaluating human impacts on terrestrial and aquatic habitats, such as in the Nehalem watershed analysis, can pose a difficult problem. From the preceding review of natural disturbance through the use of simulation models, it was apparent that single value and spatially uniform targets for such things as forest age, landslide rate, debris flow rate, and wood storage were not appropriate. The natural disturbance regime and the natural range of variability in watershed were most accurately represented by a range of values, specifically a distribution of values (i.e., see landslide rates in Figure A-3 or wood storage in Figure A-9). The use of frequency or probability distributions may provide a basis for considering risk assessment strategies. First, the severity of environmental impacts could be evaluated according to the degree of observed or predicted shifts in frequency or probability distributions of various watershed attributes in space or time under various land uses. For example, process rates or environmental conditions that fall onto tails of distributions could be considered exceeding some acceptable range of variability. Second, since distributions define probability of event occurrence, probability density functions of certain landscape processes could underpin risk assessment. For example, the chance of encountering 20 landslides in any year at a scale of 25 km^2 was less than 1 percent (Figure A-4) and such an erosional condition probably requires either widespread fire or wholesale clearcutting. The third, and the most challenging avenue, would involve estimating the level of disturbance (i.e., its regime) that is optimal for certain types of ecosystems and species.

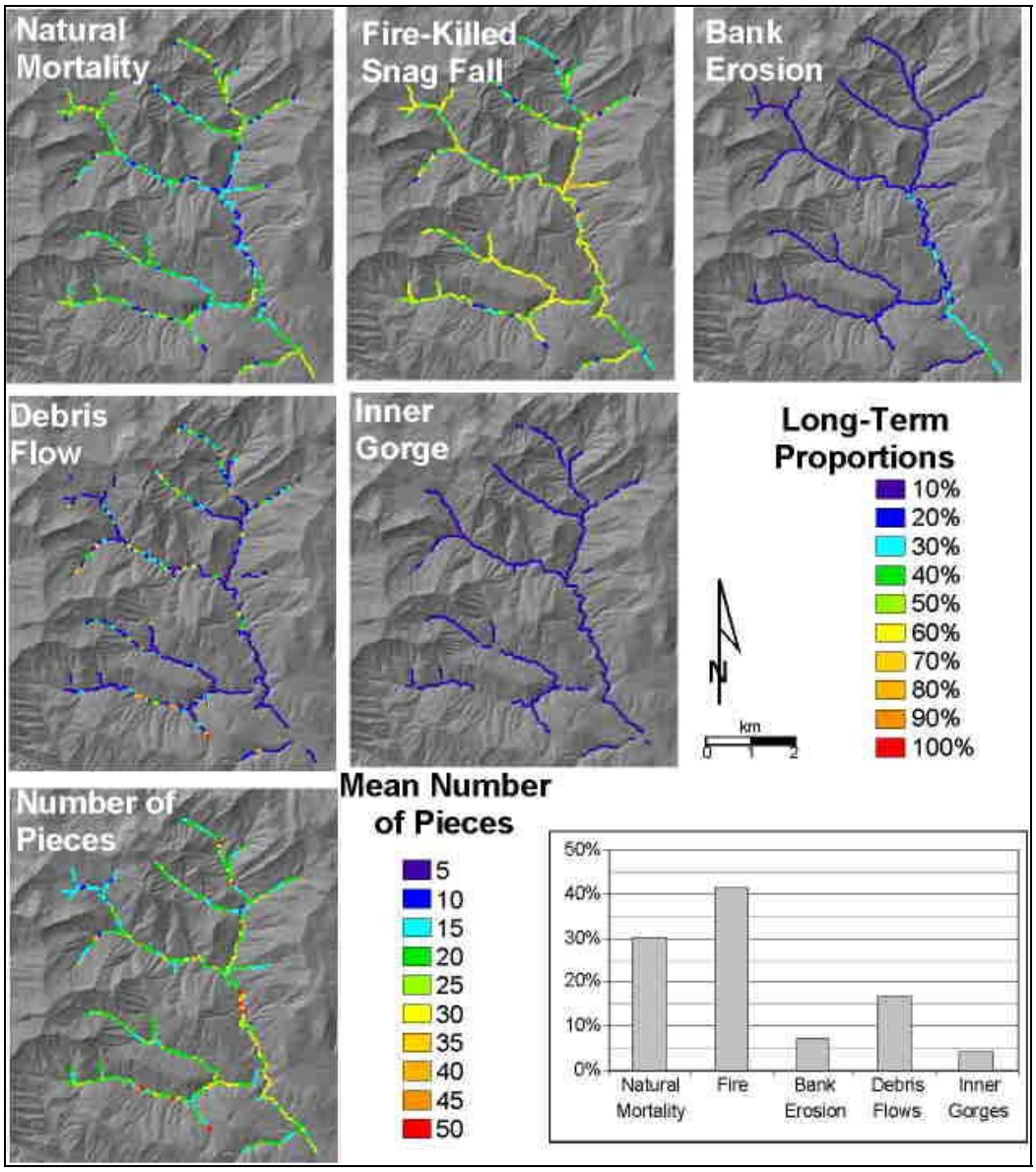


Figure A-9. Predicted long-term patterns of wood recruitment to the 3rd– and higher-order network in a 200-km^2 watershed in southwest Washington show the relative importance and spatial locations of different wood recruitment processes. Post-fire toppling of trees is predicted to be the most important wood recruitment agent (42%) followed by natural mortality (30%). Debris flows from first-and second-order channels are predicted to deliver up to 17% of the total wood supply to fish-bearing streams. Adapted from Benda et al. 2003.

APPENDIX B

Riparian Assessment Supplemental Information

Appendix B
Riparian Assessment Supplemental Information

Riparian Field Verification Surveys

Field Verification Studies

Riparian ground-truthing to confirm general riparian stand characteristics (i.e., stand composition, tree-size and density) as mapped on the existing riparian coverages or photo-based interpretation of additional stream segments occurred March 14 – 18, 2005. Survey sites for verification were selected based on the percent distribution of vegetative condition types in the watershed. Surveys were chosen for riparian stand codes comprising more than 10 percent of the stream mileage of fish-bearing streams in the basin. Vegetative condition types with high frequencies received correspondingly more field effort.

Methods

At each survey site, a lineal distance of approximately 20 times the bankfull channel width or 1,000 feet as measured with a laser range finder was assessed (Smith 1998). As a result of relatively small channel sizes, a typical survey length ranged between 400 and 800 feet. Within each survey reach, channel and riparian condition measurements and observations were recorded a minimum of four times at locations evenly distributed throughout the survey reach. Channel and riparian data were averaged for each reach. The channel measurements included (1) wetted width, (2) bankfull width and (3) valley width. Riparian measurements and observations included: (1) Angle and distance from mid-channel to the height of riparian vegetation providing shade; (2) inner riparian zone (RA1) width and composition [OWEB three-digit riparian condition code, see *Background*]; (3) outer riparian zone (RA2) width and composition [OWEB three-digit riparian condition code, see *Background*] out to a distance of 150 feet on either side of the channel.

As a form of further verification, riparian tree species, density, diameters and heights were measured in a standard 30m x 30m (100 ft x 100 ft) sample plot. Plot surveys were based on Riparian Stand Survey methods (Smith 1998). Plots were delineated using a compass and tape measure. Within the sample plot, the number of trees were enumerated by species and size class (4-8 in., 8-12 in., 12-16 in., 16-20 in., 20-24 in., 24-36 in.) using a standard diameter tape. A minimum of 5 trees of each species was measured to obtain an average tree height using a laser rangefinder when the visibility to tree crown allowed.

Results

The results of the field verification occurring March 14 – 18, 2005 are provided in Appendix B Tables 1-4. The appendix includes the overall reach assessment of stand characteristics as well as subplot measurements of individual trees, density in trees per acre (tpa), and measured diameters.

In general, the field verification along samples of small, medium and large channel sizes in the upper watershed indicated good agreement with riparian site conditions and the 1995 aerial photo assessment. The only exceptions were: (1) instances where tree growth in the riparian stand over the intervening 10-year period may have altered a call from a small diameter size class to an average overall medium size class, (2) where harvest since the 1995 photos may have reduced either the overall density or size class of the stand, (3) where a channel may have shifted or (4) stands considered dense as a result of closed canopies noted in the photo assessment may, in fact, have been sparse due to an underlying road. The instances where the field effort did not confirm the photo assessment were few (<10%). The watershed analysts were confident the original photo-based assessment was adequate to characterize the existing riparian conditions relative to their potential to contribute large wood to stream channels.

Table B-1 Nehalem Riparian Vegetation Assessment Verification.

Reach #	Stream name	Mngmt. Basin	Riparian Type				Channel	Wetted Width	Bankfull Width	Valley Width	View to Sky				Comments
											Left Bank		Right Bank		
			Mapped		Observed		Size[1/]	(ft)	(ft)	(ft)	Dist (ft)	Angle (°)	Dist (ft)	Angle (°)	
1-Lousignont	Lousignont Cr	Wheeler	LB	RB	LB	RB	L	16	26	164	43	68	33	78	RB had recent clearcut
2-Carlson	Carlson Cr	Wheeler	HMD	HMD	HMD	HMD	M	10	20	58	53	63	51	50	
3-Unnamed trib	Unnamed trib to Lousignont Cr	Wheeler	MMD	CMD	MMD	CMS	M	8	20	70	49	63	31	75	
4-Nehalem	Nehalem River	Wheeler	CMD	CMD	MMD	CMD	L	20	42	126	40	75	51	71	
5-Unnamed trib	Unnamed trib to Wolf Cr	Wheeler	CMD	MMD	MMD	MMD	M	9	24	51	30	75	26	77	
6-Walker Cr	Walker Cr	Buster	CMD	CMD	CMD	CMD	M	14	21	122	42	75	44	62	LB sparse due to road – may have been considered dense with photo assessment
7-Buster Cr	Buster Cr	Buster	HMD	HMD	HMD	HMD	L	31	41	282	42	70	34	76	
8-Nettle Cr	Nettle Cr	Buster	HMD	MMD	HMS	MMD	M	6	15	54	28	75	24	82	
9-Buster Cr	Buster Cr	Buster	MMD	MMD	CMD	CMD	L	28	47	140	31	78	43	77	RB Dense – meandering channel hugged valley wall for most of reach (valley slopes mostly dense conifer) Small hardwoods outside

Table B-1 Nehalem Riparian Vegetation Assessment Verification.

Reach #	Stream name	Mngmt. Basin	Riparian Type				Channel	Wetted Width	Bankfull Width	Valley Width	View to Sky				Comments
											Left Bank		Right Bank		
			Mapped		Observed		Size[1/]	(ft)	(ft)	(ft)	Dist (ft)	Angle (°)	Dist (ft)	Angle (°)	
															channel
10-Northrup Cr	Northrup Cr	Northrup	MSD	MSD	MSD	MMD	L	19	31	350	49	52	37	76	
11-Northrup Cr	Northrup Cr	Northrup	MMS	MMS	MMS	MMD	L	17	38	185	34	75	50	66	
12-Unnamed trib	Unnamed trib to Northrup Cr	Northrup	HSD	HSD	HMD	HMD	M	7	17	60	37	72	37	77	RB was clearcut, so mapped and observed are similar
13-Unnamed trib	Unnamed trib to Northrup Cr	Northrup	HSD	MMD	HMD	MMD	M	9	19	40	43	78	43	78	LB was recently clearcut
14-Unnamed trib	Unnamed trib to Northrup Cr	Northrup	HSD	CRD	MMS	HMS	U	5	12	35	28	74	28	83	LB was recently clearcut
15-Unnamed trib	Unnamed trib to Northrup Cr	Northrup	MSD	MSD	MMS	MMD	U	4	11	31	36	78	40	75	
16-Unnamed trib	Unnamed trib to Northrup Cr	Northrup	MSD	CSD	MMS	MMD	S	5	10	56	19	84	23	84	
17-Nehalem	Nehalem River		CSD	CSD	CMD	MMD	L	111	128		100	42	77	42	

1) S = Small; M = Medium; L = Large U = Unknown ODFW stream channel sizes

Table B-2. Nehalem Riparian Vegetation Field Plot Data by Management Basin

Grand Total for Wheeler Management Basin

Size-Class Distribution per Species

DBH Size-class	Conifer	Hardwd	Extn	
4 - 8"	7	6	78	
8 - 12"	11	5	160	
12 - 16"	13	20	462	Mode
16 - 20"	10	19	522	Median/Mean
20 - 24"	15	15	660	
>24"	6	2	240	
Stems (#)	62	67	2122	48% Conifer
7 Plot Size (ft^2)	70000	70000		MMD
mean dbh (in.)			16.4	
TPA	39	42		
Total Stand Density (tpa):		80		

Grand Total for Northrup Management Basin

Size-Class Distribution per Species

DBH Size-class	Conifer	Hardwd	Extn	
4 - 8"	7	7	84	
8 - 12"	4	27	310	
12 - 16"	8	28	504	Mode/Median/Mean
16 - 20"	4	10	252	
20 - 24"	10	2	264	
>24"	6	1	210	
Stems (#)	39	75	1624	34% Conifer
5 Plot Size (ft^2)	50000	50000		MMD
mean dbh (in.)			14.2	
TPA	34	65		
Total Stand Density (tpa):		99		

Grand Total for Buster Management Basin

Size-Class Distribution per Species

	DBH Size-class	Conifer	Hardwd	Extn		
	4 - 8"	8	16	144		
	8 - 12"	12	13	250	Mode	
	12 - 16"	2	20	308	Median/Mean	
	16 - 20"	6	15	378		
	20 - 24"	4	8	264		
	>24"	1	5	180		
	Stems (#)	33	77	1524	30%	Conifer
4	Plot Size (ft^2)	40000	40000			HMD
	mean dbh (in.)			13.9		
	TPA	36	84			
	Total Stand Density (tpa):		120			

Grand Total of Plots (Nehalem ODF lands)

Size-Class Distribution per Species

	DBH Size-class	Conifer	Hardwd	Extn		
	4 - 8"	30	33	378		
	8 - 12"	21	47	680		
	12 - 16"	30	67	1358	Mode/Median/Mean	
	16 - 20"	15	45	1080		
	20 - 24"	31	30	1342		
	>24"	24	9	990		
	Stems (#)	151	231	5828	40%	Conifer
16	Plot Size (ft^2)	160000	160000			MMD
	mean dbh (in.)			15.3		
	TPA	41	63			
	Total Stand Density (tpa):		104			

APPENDIX C

Existing Riparian Conditions per 6th Field HUC in Each Management Basin

Astoria District

Beneke						
171002020302						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.1	0.1	1%	L
SHR	0.0	0.0	0.1	0.1	1%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	2.5	4.2	1.0	7.7	41%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.2	0.3	0.5	2%	L
MMS	0.0	0.8	0.0	0.8	4%	M
MMD	2.0	3.7	2.5	8.2	44%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.2	0.1	0.3	1%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.1	0.2	0.6	0.8	4%	H
RD	0.0	0.1	0.0	0.1	1%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	4.7	9.3	4.7	18.7	100%	H

Buster						
171002020105						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.1	0.5	0.1	0.6	18%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.3	0.1	0.4	0.8	23%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.1	0.1	2%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.3	0.3	9%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.2	0.8	0.7	1.7	47%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.6	1.4	1.6	3.6	100%	H

Buster						
171002020106						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.8	0.8	48%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.0	0.0	0%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.3	0.3	15%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.6	0.6	37%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.0	1.7	1.7	100%	L

Buster						
171002020107						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.0	0.0	0%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.6	0.6	100%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.0	0.6	0.6	100%	H

Buster						
171002020304						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.1	0.1	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.1	0.1	0.3	1%	L
HMS	0.3	0.0	0.3	0.6	2%	L
HMD	2.1	1.6	1.0	4.6	15%	M
MSS	0.0	0.6	0.0	0.6	2%	L
MSD	0.4	0.0	0.2	0.5	2%	L
MMS	0.1	0.5	0.6	1.3	4%	M
MMD	2.4	4.2	5.7	12.3	41%	H
CRS	0.0	0.1	0.0	0.1	0%	L
CRD	0.0	0.4	0.2	0.7	2%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.3	0.3	1%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	1.1	0.9	6.4	8.4	28%	H
RD	0.0	0.1	0.0	0.1	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	6.5	8.5	15.1	30.0	100%	H

Buster						
171002020305						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.4	0.0	0.0	0.4	5%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.8	1.2	0.4	2.4	28%	M
MSS	0.1	0.0	0.0	0.1	1%	L
MSD	0.1	0.0	0.0	0.1	1%	L
MMS	0.1	0.1	0.0	0.2	2%	M
MMD	1.2	2.4	0.7	4.3	51%	H
CRS	0.0	0.0	0.1	0.1	1%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.1	0.4	0.3	0.8	10%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	2.8	4.1	1.6	8.4	100%	H

Crawford						
171002020301						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.1	0.1	1%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.1	0.1	0.2	4%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.1	0.0	0.1	2%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.4	0.0	0.4	7%	L
MMS	0.0	0.1	0.0	0.1	2%	M
MMD	0.2	1.7	0.6	2.5	47%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.9	0.3	1.2	23%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.2	0.4	0.6	11%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.1	0.1	2%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.2	3.5	1.6	5.2	100%	H

Crawford						
171002020302						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.2	0.2	100%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.0	0.0	0%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.0	0.0	0%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.0	0.2	0.2	100%	H

Crawford						
171002020304						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.1	0.1	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.1	0.1	0.3	1%	L
HMS	0.3	0.0	0.3	0.6	2%	L
HMD	2.1	1.6	1.0	4.6	15%	M
MSS	0.0	0.6	0.0	0.6	2%	L
MSD	0.4	0.0	0.2	0.5	2%	L
MMS	0.1	0.5	0.6	1.3	4%	M
MMD	2.4	4.2	5.7	12.3	41%	H
CRS	0.0	0.1	0.0	0.1	0%	L
CRD	0.0	0.4	0.2	0.7	2%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.3	0.3	1%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	1.1	0.9	6.4	8.4	28%	H
RD	0.0	0.1	0.0	0.1	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	6.5	8.5	15.1	30.0	100%	L

Fishhawk						
171002020205						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.6	0.0	0.1	0.6	6%	M
MSS	0.0	0.0	0.3	0.3	3%	L
MSD	0.0	0.2	0.0	0.2	2%	L
MMS	0.0	0.6	0.3	0.8	8%	M
MMD	1.0	2.3	0.8	4.1	39%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.1	0.8	0.9	9%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.3	0.3	3%	L
CMS	0.0	0.2	0.0	0.2	2%	M
CMD	0.1	0.6	2.4	3.0	29%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	1.6	4.0	5.0	10.6	100%	H

Hamilton						
171002020303						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.1	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.2	0.0	0.0	0.2	1%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	2.0	2.5	0.5	4.9	30%	M
MSS	0.0	0.0	0.2	0.2	1%	L
MSD	0.0	0.0	0.3	0.3	2%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	3.3	1.8	2.0	7.1	43%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.1	0.1	0.3	0.5	3%	L
CSS	0.1	0.0	0.0	0.1	1%	L
CSD	0.2	0.3	0.5	1.0	6%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.4	1.8	2.2	13%	H
RD	0.0	0.0	0.0	0.1	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	5.9	5.2	5.6	16.6	100%	H

Hamilton						
Young's Bay						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.1	0.1	0.2	12%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.0	0.0	0%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.2	0.2	14%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.3	0.3	21%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.1	0.8	0.9	52%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.1	1.5	1.6	100%	H

Lousignont						
171002020205						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.3	0.5	0.0	0.8	63%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	3%	L
MMS	0.0	0.0	0.0	0.0	1%	M
MMD	0.0	0.0	0.0	0.0	3%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.2	0.2	20%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.1	0.1	9%	H
RD	0.0	0.0	0.0	0.0	1%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.3	0.5	0.4	1.2	100%	M

Lousignont						
171002020208						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.1	0.5	0.0	0.6	10%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.2	0.0	0.2	4%	L
MSD	0.0	0.5	0.0	0.5	9%	L
MMS	0.2	0.0	0.0	0.2	4%	M
MMD	0.5	0.0	0.2	0.7	12%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.6	0.6	10%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	1.0	0.2	1.2	20%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.2	1.8	1.9	31%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.8	2.6	2.8	6.2	100%	L

Northrup						
171002020208						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.2	0.0	0.0	0.2	2%	L
SHR	0.1	0.0	0.0	0.0	0%	L
HSS	0.6	0.0	0.0	0.6	5%	L
HSD	0.8	0.6	0.0	1.4	10%	L
HMS	0.0	0.0	0.0	0.1	1%	L
HMD	0.8	0.0	0.0	0.8	6%	M
MSS	0.1	0.0	0.0	0.2	1%	L
MSD	3.0	0.7	0.3	3.9	30%	L
MMS	1.1	0.1	0.0	1.1	9%	M
MMD	0.7	0.1	0.1	0.9	7%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.1	0.5	0.1	0.6	4%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.1	1.8	0.8	2.7	20%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.5	0.2	0.7	5%	H
RD	0.0	0.0	0.0	0.1	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	7.7	4.4	1.4	13.3	100%	L

Northrup						
171002020302						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.1	0.0	0.0	0.1	18%	M
MMD	0.2	0.0	0.0	0.2	60%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	8%	L
CSS	0.0	0.0	0.0	0.0	14%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.0	0.0	0%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.3	0.0	0.0	0.3	100%	H

Quartz						
171002020105						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.6	0.2	0.0	0.7	13%	L
SHR	0.3	0.3	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.4	0.4	0.3	1.1	19%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	1%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.1	0.0	0.1	0.1	2%	M
MMD	0.0	0.0	0.0	0.0	1%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.1	1.1	2.3	3.5	63%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	1.4	2.0	2.7	5.6	100%	H

Quartz						
171002020305						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	1%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.8	0.2	0.0	1.0	39%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.6	0.2	0.3	1.2	44%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.1	0.3	0.4	16%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	1%	L
Total	1.5	0.5	0.7	2.7	100%	H

Quartz						
171002020307						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	1%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.1	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.3	1.0	0.0	1.3	28%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.2	0.2	5%	M
MMD	0.2	1.4	0.2	1.9	40%	H
CRS	0.0	0.0	0.2	0.2	5%	L
CRD	0.0	0.0	0.0	0.1	1%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	1%	M
CMD	0.2	0.4	0.3	0.9	19%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.8	2.9	1.0	4.6	100%	H

Quartz						
171002020402						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	7%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.1	0.1	36%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.0	0.0	0%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.0	0.0	0%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.0	0.1	0.1	100%	H

Sager						
171002020206						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	1.7	1.0	2.8	30%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	1.0	1.1	12%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.2	0.3	3%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.3	0.9	3.7	4.9	54%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.3	2.8	6.1	9.1	100%	H

Sager						
171002020208						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.1	0.0	0.1	1%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.4	1.0	0.2	1.7	23%	L
HSD	0.1	0.7	0.6	1.4	19%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.3	0.2	0.5	7%	L
MSD	0.0	0.0	0.5	0.6	8%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.2	0.3	4%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.6	0.9	1.5	21%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.1	0.1	0.3	0.5	7%	L
CMS	0.0	0.0	0.1	0.1	1%	M
CMD	0.0	0.4	0.3	0.7	10%	H
RD	0.0	0.0	0.0	0.0	1%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.7	3.2	3.3	7.2	100%	H

Sager						
171002020301						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.2	0.3	11%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.4	0.4	15%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.3	0.8	1.1	45%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.6	0.6	24%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.1	0.1	3%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.0	0.0	2%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.3	2.1	2.4	100%	H

Scattered Parcels						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0	0.0	0.0	0%	L
GRA	0.0	0.0	0.0	0.0	0%	L
SHR	0.0	0.0	0.0	0.0	0%	L
HSS	0.0	0.0	0.0	0.0	0%	L
HSD	0.0	0.0	0.0	0.0	0%	L
HMS	0.0	0.0	0.0	0.0	0%	L
HMD	0.0	0.0	0.0	0.0	0%	M
MSS	0.0	0.0	0.0	0.0	0%	L
MSD	0.0	0.0	0.0	0.0	0%	L
MMS	0.0	0.0	0.0	0.0	0%	M
MMD	0.0	0.0	0.1	0.1	100%	H
CRS	0.0	0.0	0.0	0.0	0%	L
CRD	0.0	0.0	0.0	0.0	0%	L
CSS	0.0	0.0	0.0	0.0	0%	L
CSD	0.0	0.0	0.0	0.0	0%	L
CMS	0.0	0.0	0.0	0.0	0%	M
CMD	0.0	0.0	0.0	0.0	0%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK	0.0	0.0	0.0	0.0	0%	L
Total	0.0	0.0	0.1	0.1	100%	H

McGregor						
171002020102						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG				0.0	0%	L
GRA				0.0	0%	L
SHR	0.0	0.0	0.0	0.1	1%	L
HSS				0.0	0%	L
HSD	2.9	1.3	0.9	5.1	37%	L
HMS				0.0	0%	L
HMD				0.0	0%	M
MSS		0.1	0.0	0.1	1%	L
MSD			0.2	0.2	1%	L
MMS				0.0	0%	M
MMD		0.1	0.4	0.5	3%	H
CRS			0.3	0.3	2%	L
CRD				0.0	0%	L
CSS				0.0	0%	L
CSD				0.0	0%	L
CMS	0.0	0.0	0.5	0.6	4%	M
CMD	0.3	2.5	4.1	6.9	50%	H
RD		0.0	0.0	0.0	0%	L
UNK						
Total	3.3	4.0	6.5	13.9	100%	H

McGregor						
171002020103						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG				0.0	0%	L
GRA				0.0	0%	L
SHR		0.0		0.0	0%	L
HSS		0.0	0.0	0.1	1%	L
HSD		0.3	0.5	0.8	18%	L
HMS				0.0	0%	L
HMD		0.3	0.0	0.3	8%	M
MSS				0.0	0%	L
MSD				0.0	0%	L
MMS		0.0		0.0	1%	M
MMD		0.4	0.5	0.9	20%	H
CRS				0.0	0%	L
CRD			0.3	0.3	7%	L
CSS				0.0	0%	L
CSD				0.0	0%	L
CMS			0.0	0.0	1%	M
CMD		0.3	1.4	1.7	38%	H
RD				0.0	0%	L
UNK		0.1	0.2	0.3	6%	
Total	0.0	1.6	2.9	4.5	100%	H

McGregor						
171002020105						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG				0.0	0%	L
GRA				0.0	0%	L
SHR			0.0	0.0	0%	L
HSS				0.0	0%	L
HSD	0.5	0.3	0.3	1.2	27%	L
HMS				0.0	0%	L
HMD	0.0			0.0	1%	M
MSS				0.0	0%	L
MSD		0.0		0.0	0%	L
MMS			0.1	0.1	2%	M
MMD	0.0		1.3	1.3	30%	H
CRS				0.0	0%	L
CRD				0.0	0%	L
CSS				0.0	0%	L
CSD				0.0	0%	L
CMS				0.0	0%	M
CMD		0.4	1.2	1.6	37%	H
RD		0.0	0.0	0.0	0%	L
UNK			0.1	0.1	3%	
Total	0.6	0.8	2.9	4.2	100%	H

McGregor						
171002020106						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG			0.0	0.0	0%	L
GRA				0.0	0%	L
SHR			0.0	0.0	0%	L
HSS				0.0	0%	L
HSD	0.7	0.9	0.8	2.4	26%	L
HMS				0.0	0%	L
HMD				0.0	0%	M
MSS				0.0	0%	L
MSD				0.0	0%	L
MMS				0.0	0%	M
MMD			0.1	0.1	1%	H
CRS				0.0	0%	L
CRD		0.1		0.1	1%	L
CSS			0.2	0.2	3%	L
CSD				0.0	0%	L
CMS		0.3	0.2	0.5	5%	M
CMD	0.0	0.5	5.3	5.9	64%	H
RD	0.0		0.0	0.0	0%	L
UNK		0.1		0.1	1%	
Total	0.7	1.8	6.7	9.3	100%	H

Wheeler						
171002020101						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG	0.0	0.0		0.0	0%	L
GRA		0.1	0.0	0.1	0%	L
SHR	0.4	0.4	0.1	0.8	2%	L
HSS	0.0	0.1	0.0	0.1	0%	L
HSD	0.5	0.8	0.3	1.6	4%	L
HMS				0.0	0%	L
HMD	5.2	2.7	2.2	10.2	28%	M
MSS		0.3	0.5	0.7	2%	L
MSD	0.2	0.4	0.4	1.0	3%	L
MMS	0.1	0.2	0.1	0.4	1%	M
MMD	1.6	3.5	1.7	6.9	19%	H
CRS			0.2	0.2	0%	L
CRD	0.0	0.0	1.1	1.2	3%	L
CSS		0.0	0.2	0.2	1%	L
CSD	0.0	0.1	0.1	0.1	0%	L
CMS	0.0	0.0	0.8	0.8	2%	M
CMD	0.6	3.4	7.1	11.2	30%	H
RD	0.0	0.0	0.0	0.1	0%	L
UNK		0.4	0.7	1.1	3%	
Total	8.8	12.3	15.7	36.8	100%	H

Wheeler						
171002020102						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG				0.0	0%	L
GRA				0.0	0%	L
SHR				0.0	0%	L
HSS				0.0	0%	L
HSD	0.1	0.1	0.0	0.2	4%	L
HMS				0.0	0%	L
HMD				0.0	0%	M
MSS				0.0	0%	L
MSD				0.0	0%	L
MMS				0.0	0%	M
MMD				0.0	0%	H
CRS				0.0	0%	L
CRD			0.4	0.4	8%	L
CSS				0.0	0%	L
CSD				0.0	0%	L
CMS				0.0	0%	M
CMD	0.2	1.9	3.0	5.1	88%	H
RD			0.0	0.0	0%	L
UNK			0.1	0.1	1%	
Total	0.3	2.0	3.6	5.9	100%	H

Wheeler						
171002020105						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG				0.0	0%	L
GRA	0.0			0.0	0%	L
SHR	0.0	0.0		0.0	0%	L
HSS		0.0		0.0	0%	L
HSD	0.4	0.9	0.3	1.7	28%	L
HMS				0.0	0%	L
HMD				0.0	0%	M
MSS				0.0	0%	L
MSD	1.6	0.2		1.8	31%	L
MMS				0.0	0%	M
MMD	0.1	0.0		0.1	2%	H
CRS				0.0	0%	L
CRD			0.4	0.4	8%	L
CSS			0.1	0.1	1%	L
CSD			0.1	0.1	2%	L
CMS			0.2	0.2	3%	M
CMD	0.0	1.0	2.4	3.3	57%	H
RD	0.0	0.0	0.0	0.0	0%	L
UNK				0.0	0%	
Total	2.2	2.1	3.5	7.8	133%	L

Wilark						
171002020203						
Riparian Condition Code	Stream miles per Channel Size				Frequency (%)	L. Wood Recruitment Potential
	Large	Medium	Small	Total		
BG				0.0	0%	L
GRA				0.0	0%	L
SHR			0.1	0.1	2%	L
HSS				0.0	0%	L
HSD	0.1	0.1	0.0	0.3	5%	M
HMS				0.0	0%	L
HMD			0.1	0.1	1%	L
MSS		0.2	0.0	0.2	3%	M
MSD	0.4	1.0	0.3	1.8	28%	H
MMS				0.0	0%	L
MMD		0.2	1.2	1.4	23%	L
CRS				0.0	0%	L
CRD			0.4	0.4	6%	L
CSS		0.2		0.2	3%	M
CSD		0.4	1.4	1.8	29%	H
CMS		0.0	0.0	0.0	1%	L
CMD				0.0	0%	
RD						
UNK						
Total	0.5	2.1	3.6	6.2	100%	H