WOODY DEBRIS TRANSPORT THROUGH LOW-ORDER STREAM CHANNELS OF NORTHWEST CALIFORNIA – IMPLICATIONS FOR ROAD-STREAM CROSSING FAILURE

by

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A Thesis

Presented to
The Faculty of Humboldt State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

In Environmental Systems: Geology

August, 2004

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ABSTRACT

WOODY DEBRIS TRANSPORT THROUGH LOW-ORDER STREAM CHANNELS OF NORTHWEST CALIFORNIA – IMPLICATIONS FOR ROAD-STREAM CROSSING FAILURE

By, Sam A. Flanagan
M.S. Geology

Where culverts are installed to allow roads to cross streams, debris plugging may occur. Plugged culverts can trigger severe erosional consequences with impacts on downstream aquatic and riparian environments sensitive to sediment inputs. This study examines the fluvial transport of woody debris and the interactions of woody debris with road-stream crossings in northwest California.

Fluvially transported wood was captured in fences built across twenty-three channels in three study watersheds in northwest California. For stream flows of less than 12 year recurrence interval, 99% of the pieces (n=3,114) were less than or equal to the channel bed width, the zone of average annual scour. Therefore, to reduce debris plugging hazard, culverts should be sized in relation to the channel width. To further minimize debris plugging hazard stream crossing design should maintain the natural channel planform and cross section. Channels should not widen as they approach the inlet. The culvert should not be placed at an angle to the stream channel. Road-stream crossings should not be allowed to pond water.

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INTRODUCTION

Roads significantly impact aquatic and riparian environments. Numerous studies have documented both chronic and catastrophic delivery of sediment from roads to streams (*e.g.*, Furniss *et al.* 1991). Road-stream crossings often are principal sites for the generation and catastrophic delivery of sediment into stream channels (Best *et al.* 1995, Weaver *et al.* 1995). However, the triggering mechanisms for catastrophic sediment production from road-stream crossings are less well understood.

Road-stream crossings represent a significant and widespread risk to downstream aquatic and riparian environments. On federally managed lands in the Pacific Northwest, the Forest Ecosystem Management Assessment Team (FEMAT 1993) estimated 250,000 road-stream crossings exist. This figure is considerably larger when non-federally owned lands are considered.

Culverts are the most common means of conveying streamflow through road fills. Within a channel, a culvert presents a potential debris obstacle, often restricting the channel width at the inlet. This restriction provides a favorable location for debris lodgment (Braudrick *et al.* 1997). When the capacity of this aperture is exceeded, significant erosional consequences often result. Culvert plugging is cited as a common road-stream crossing "failure mechanism" (Best *et al.* 1995, Weaver *et al.* 1995, Furniss *et al.* 1998).

Traditionally, culverts are hydraulically sized. An appropriate diameter is chosen to pass a design flow. Recent culvert sizing regulations implemented in the Pacific Northwest, however, mandate that road-stream crossings be sized not only for hydraulic capacity, but associated debris and sediment as well (USDA, USDI ROD 1994). However, those responsible for designing or upgrading road-stream crossings to meet these regulations are faced with a dearth of information on accommodating debris and sediment.

This study examined the size distribution of wood transported through low order stream channels and the characteristics of wood lodgment at culvert inlets. Specific objectives were to (1) relate the length of fluvially transported wood to channel widths, (2) describe the process of wood lodgment at culvert inlets, (3) describe the size distributions of wood lodged across culvert inlets, and (4) develop design criteria to reduce the hazard of debris plugging at road-stream crossings.

BACKGROUND

I examine three topics here. First, I discuss the environmental risk posed by road stream crossings in order to portray the magnitude and relevance of the problem. Second, I describe previous work on road-stream crossing failure with emphasis on the mechanisms and processes of failure. Finally, I review relevant work examining characteristics of woody debris in stream channels.

The environmental risk of road-stream crossings

Stream crossings are sites of enhanced environmental risk to aquatic and riparian communities sensitive to sediment inputs. Stream crossings are presented with watershed products produced upstream and upslope including water, organic debris and sediment. When the capacity of the structure to pass these watershed products is exceeded, the crossing and downstream channel are subject to a variety of erosional and depositional consequences. The consequences of road-stream crossing failure can have impacts on aquatic and riparian communities far removed from the initial failure site (*e.g.*, Furniss *et al.* 1991). The environmental risk of road-stream crossings is considered as a four component model consisting of inputs, capacity, erosional consequences and endpoints. These components are individually described below.

Inputs

As stated above, culverts are presented with a variety of watershed products composed of water, organic debris, and sediment. Typically, the delivery of these materials is greatest during large precipitation or snowmelt events. Estimating these flood flows involves large errors and the delivery of organic debris and sediment are not included in these estimates. For example, regional regression equations developed by Waananen and Crippen (1978) for the North Coast region of California have standard errors (in log10 units) of 0.24 to 0.26 (Table 1). Furthermore, typical drainage areas above road-stream crossings in the same region are commonly smaller than the areas used to develop the regional estimators (Figure 1), making their applicability uncertain.

Table 1. Errors associated with estimating peak flows in ungaged basins can be large. The example here is for a 1 km^2 basin in the North Coast region of California using the relations of Waananen and Crippen (1978). Mean annual precipitation is 1775 mm and mean basin elevation is 1,000 m.

Recurrence interval (years)	Q (m^3/sec)	Standard error (m^3/sec)
5	1.98	±1.19
10	2.94	±1.75
25	4.25	±2.55
50	5.72	±3.62
100	7.02	±4.64

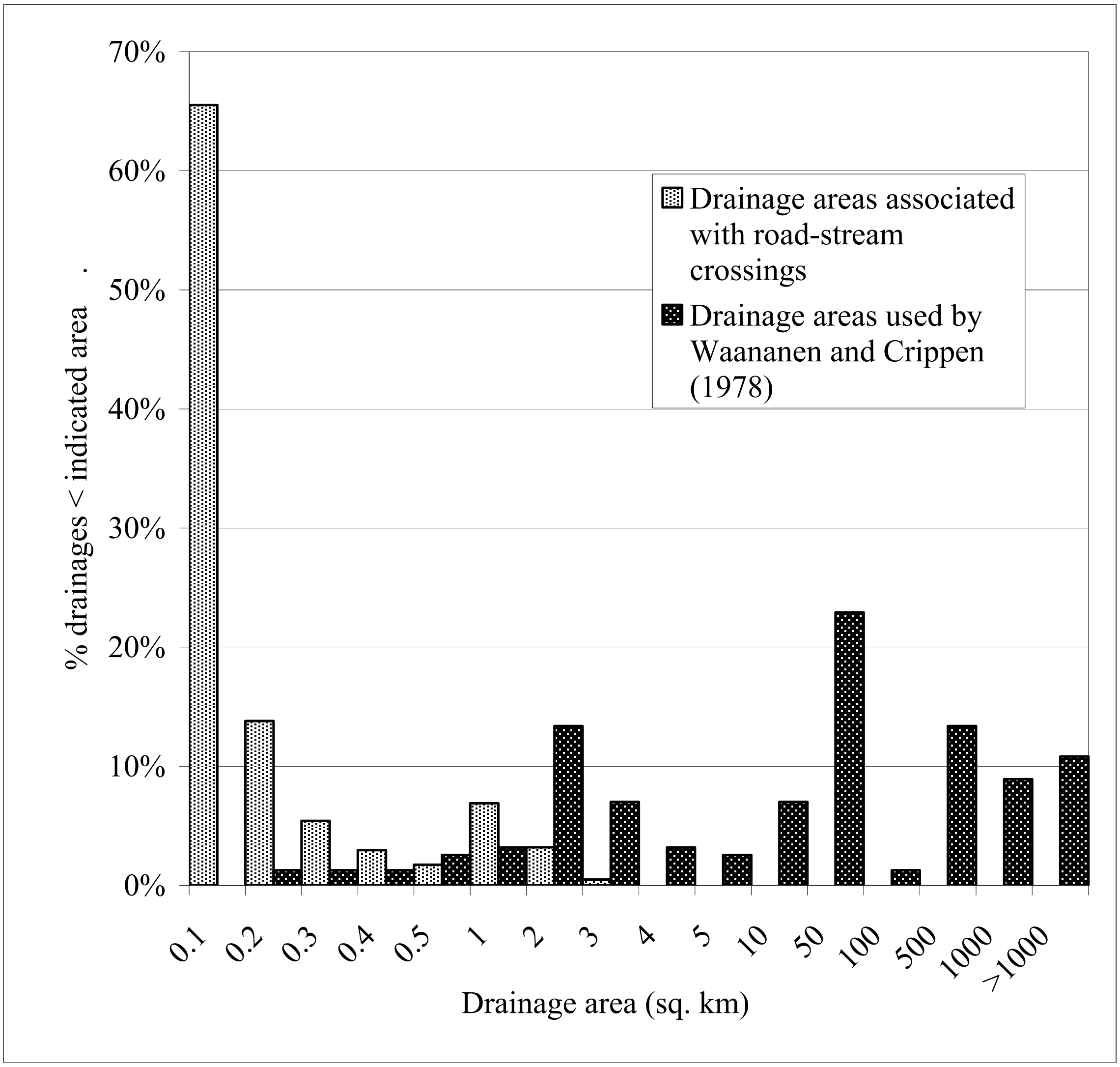

Figure 1. Comparison of drainage areas associated with road-stream crossings and drainage areas used in developing regional flood-frequency relations. Regional flood estimators such as those developed by Waananen and Crippen (1978) often do not encompass smaller drainages where most culverts are located (unpublished data from U.S. Forest Service).

Capacity

Culvert capacity is typically expressed as the design flow the structure will pass without exceeding a predetermined headwater depth (water depth at the culvert inlet). Note that this design flow is typically a "design water flow" and does not account for debris and sediment.

Traditional methods for sizing culverts require computing a design flow (*e.g.*, a 100 year flood), determining a maximum acceptable headwater depth, and computing the necessary culvert diameter to accommodate the calculated peak flow without exceeding the headwater depth (*e.g.*, AISI 1980, Campbell *et al.* 1982, Normann 1985). The capacity of *existing* installations is expressed as a design flow capacity for a given headwater depth to culvert diameter ratio (HW/d) as described by Piehl and colleagues (1988) (Figure 2).

Few design and construction methods exist for accommodating woody debris loads (Pyles *et al.* 1989). Normann (1985) suggests that straight channel approaches promote debris passage. For ditch relief culverts, minimizing the skew angle between the culvert and the stream or ditch is important in minimizing debris plugging (Garland 1983 and Piehl *et al.* 1988). Currently, sizing culverts for debris passage is site-specific and subjective (Piehl *et al.* 1988) often using a "bulking factor" to account for added debris and sediment. This factor increases clear-water discharge estimates by accounting for transported solids. Debris capacity has also been addressed by sizing the culvert for a design flow (*e.g.*, 100 year event) and increasing the diameter one size increment (corrugated metal culverts are typically available in 15 cm increments) (Furniss, personal communication).

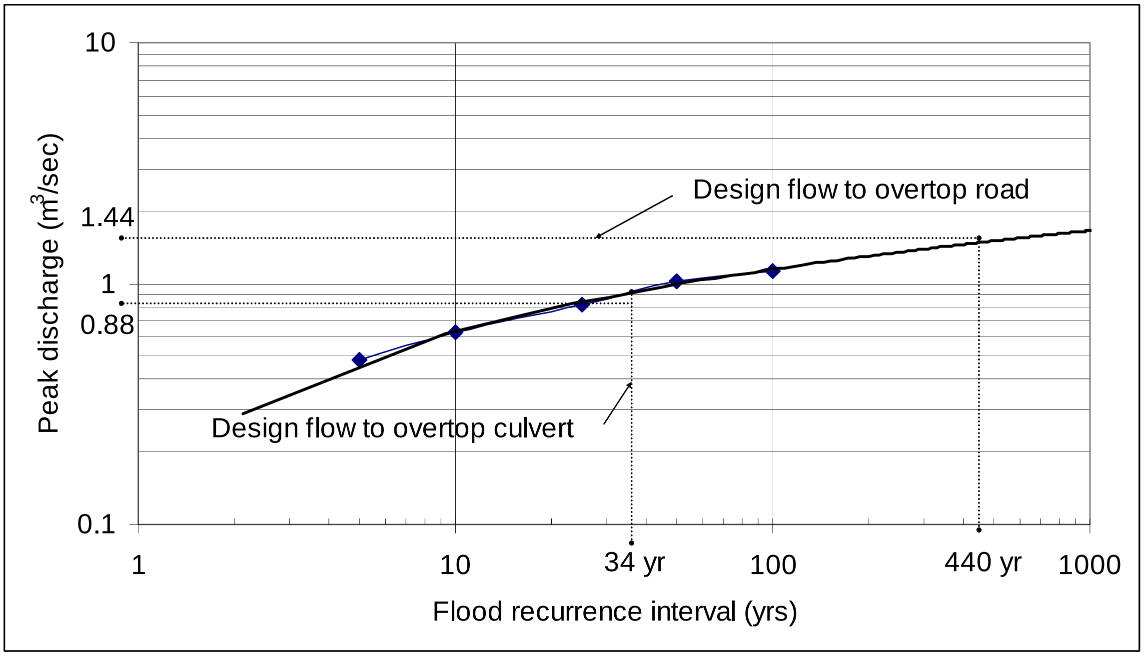

Figure 2. Example of flood-frequency relations used in culvert design. Culvert hydraulic capacity can be expressed as a recurrence interval (T). In this example, two design discharges are calculated for a 90 cm pipe. The discharge at HW/d = 1 is assigned a recurrence interval of 34 years (exceedence probability = 0.029). The discharge necessary to overtop the road is assigned a recurrence interval of 440 years (exceedence probability = 0.0023). In this case, the fill height above the inlet invert is 1.5 m. The flood frequency curve was generated using a regional flood estimator for the northcoast region of California (Waananen and Crippen 1978).

Erosional and depositional consequences

During ponded conditions, when the headwater depth exceeds the culvert diameter (HW/d > 1), several erosional and/or depositional consequences are possible. Saturation of the road fill enhances the likelihood of a fill failure. Deposition of debris and sediment may occur in the ponded area, often requiring costly excavation. If flow sufficiently exceeds capacity, water will overtop the roadway. If the road slopes down and away from the crossing in at least one direction, the overtopping streamflow will be diverted along the road or ditch to an adjacent drainage or onto unchanneled hillslopes. This potential for diversion is increased when the road is insloped with an inboard ditch (Best *et al.* 1995).

Diversion potential is common at road-stream crossings (Figure 3). In the absence of diversion, the overtopping streamflow will simply spill over the fill and reenter the channel near the culvert outlet. Thus, the amount of material eroded is limited by the amount of fill spanning the channel. However, when stream flows are diverted out of the channel, the erosional consequences are often much greater (Furniss *et al.* 1997, Weaver *et al.* 1995). Diverted streams can enlarge the receiving ditch(es) and channels, erode the road surface, create gullies on unchanneled hillslopes and initiate landslides and debris flows (Furniss *et al.* 1997).

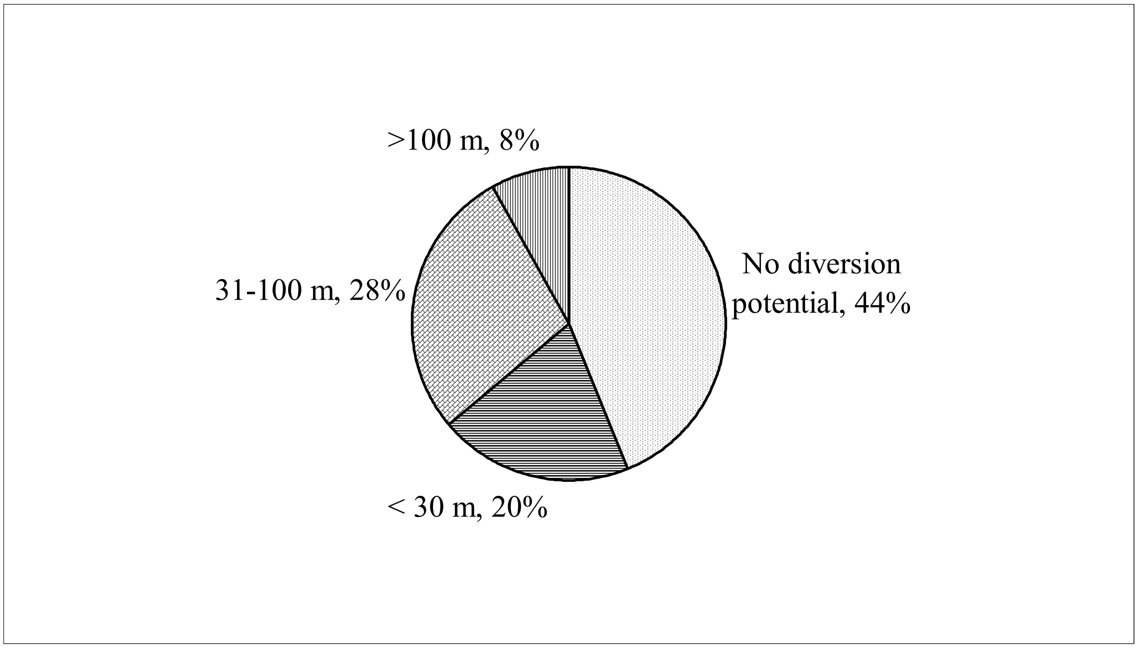

Figure 3. Potential diversion distance along the road and/or ditch for 1,992 road-stream crossings in the Pacific Northwest. When the capacity of a stream crossing is exceeded water may overtop the road surface. Where the road slopes down and away from the crossing in at least one direction, the water may be diverted along the road and/or ditch before entering an adjacent drainage or flowing onto unchanneled hillslopes (U.S.D.A. Forest Service unpublished data).

Endpoints

Endpoints are the downstream resources sensitive to sediment inputs. These include, but are not limited to, fish, amphibians, aquatic invertebrates, and domestic water supplies. In certain areas, road-stream crossing failure can eliminate vehicle access, imposing significant social concerns as well. Thus, the risk of road stream crossings is the composite of all four components.

Previous work investigating stream crossing failure

Zander (1993) cited culvert plugging as a common cause for stream diversions and eroded road fills in the Stillaguamish River watershed of Washington. Weaver and others (1995) observed that gullies produced by stream diversions were the largest fluvial erosion features in a basin. Those culverts plugged by debris and sediment with consequent diversion of streamflows out of the natural channel accounted for the greatest volume of gully-derived sediment in the Copper Creek drainage of northwest California (Weaver *et al.* 1995). In nearby Garret Creek basin, Best and others (1995) observed that stream diversions caused by plugged culverts initiated 68 percent of road-related fluvial erosion. Following large flood events in the Pacific Northwest and northern California in 1996-1998, Furniss *et al.* (1998) found that crossing failures were initiated by various combinations of water, wood and sediment (Figure 4).

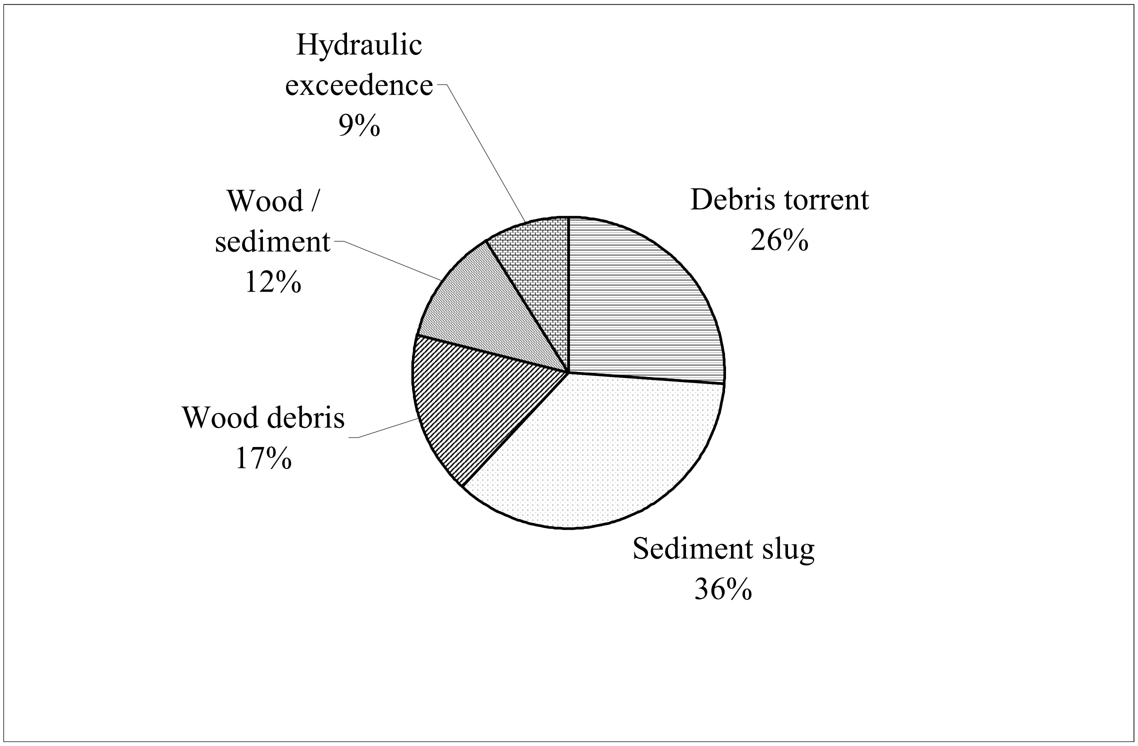

Figure 4. Causes of road-stream crossing failures. Road-stream crossing failures during large floods in the Pacific Northwest and California are often initiated by some combination of wood and/or sediment. "Sediment slug" refers to catastrophic delivery of sediment to the culvert inlet by non-fluvial or debris flow-driven processes. The "wood / sediment" category refers to sites where burial of the inlet precluded identification of a specific mechanism (data from Furniss et al. 1998).

Lodgment of woody debris at culvert inlets

Lodgment of fluvially transported woody debris at culvert inlets has been implicated in crossing failure (*e.g.*, Swanson *et al.* 1984, Normann 1985, Piehl *et al.* 1988b, Gillilan 1989). Considerable time and money are spent each year removing debris accumulations at culvert inlets in forested watersheds.

Detailed descriptions of culvert plugging are limited. Following the December 1964 and January 1965 storms in the Pacific Northwest, the U.S. Forest Service observed that "debris which plugged drainage channels and structures was the major contributor to fill and culvert losses" (Dyson *et al.* 1966, as cited in Piehl 1986). In a survey of 143 stream crossings, Piehl (1986) found organic debris blocking 9 percent of the sites. He also noted that reductions in culvert cross sectional area at the inlet were greater for woody debris than for denting or sediment accumulations. However, Piehl (1986) concluded that debris accumulations were "highly likely" removed by maintenance crews prior to his site visits and, thus, 9% was an underestimate. Over a 24 year study period, 48 of 111 (43%) road-stream crossings in the Garret Creek watershed clogged and failed (Best *et al.* 1995). However, the authors did not describe the specific materials clogging the culverts. Furniss *et al.* (1998) found that 29% of observed failed crossings following large storm events were due to woody debris lodged across the inlet or some combination of wood and sediment (Figure 4).

<u>Woody debris in stream channels</u>

Many studies have examined the characteristics and functions of woody debris in stream channels. Much of this work focuses on large woody debris (LWD), pieces generally greater than 1 m long and 10 cm diameter. Also, much of the existing literature describes LWD in streams that is substantially larger than those where culverts are commonly encountered (Tables 2 and 3).

Fluvial transport of woody debris has been described by several authors (Table 2). Size distribution of pieces transported depends on channel width (Table 4) and therefore is transport-limited in low-order channels where pieces supplied to the channel are often longer than the channel width (Nakamura and Swanson 1993). Braudrick and colleagues (1997) characterize wood transport as a dimensionless ratio; the relative log length, which is the log length divided by the channel width (L_{log}/w_c). Abbe *et al.* (1993) note deposition of wood when $L_{log}/w_c > 0.5$ in wide, unconfined reaches, and Lienkaemper and Swanson (1987) observe few mobile pieces with $L_{log}/w_c > 1$ in narrow, confined reaches.

Woody debris is also moved through stream channels by mass-wasting processes. In steep, low-order channels, infrequent debris flows often entrain large quantities of woody debris (Swanson and Lienkaemper 1978, Nakamura and Swanson 1993). Extent of debris flow influence depends on channel slope, drainage area and the angle at which the delivering channel enters larger channels (Benda 1985).

Table 2. Summary of channel sizes for published studies examining the characteristics of woody debris in stream channels. Mean values in parentheses.

Author(s)	drainage areas (km^2)	channel width (m)	gradient (%)	location
Keller and Swanson 1979	0.2 - 1024.0 (218.3)	1.0 - 40.0 (15.9)	0.6 - 40 (16.5)	McKenzie R. basin, W. OR
Keller and Tally 1979	1.1 - 19.8 (8.6)	6.4 - 18.5 (10.4)	0.5 - 4.8 (2.1)	Prairie Creek, NW CA
Bilby 1981	n/a	2.8	8	Hubbard Brook Experimental Forest, New Hampshire
Swanson *et al.* 1984	n/a	1.4 - 7.0 (3.6)	1 - 7 (4)	SE AK
Lienkaemper and Swanson 1987	0.1 - 60.5 (15.8)	3.5 - 24.0 (12.0)	3 - 37 (17)	Lookout Creek, W. OR
Lisle 1986	36	12	0.014 - 0.006	Jacoby Cr. NW CA
Bilby and Ward 1989	0.4 - 68.0 (13.7)	3.6 - 19.7 (9.7)	1 - 18 (8)	W. WA
Gillilan 1989		3.8-5.6 (4.5)	1.0-2.2 (1.5)	SE AK
Murphy and Koski 1989	n/a	8.2 - 31.4 (15.8)	0.4 - 2.9 (1.4)	SE AK
Robison and Beschta 1990	0.72 - 55.4 (14.8)	4.6 - 25.9 (11.4)	0.8 - 2.5 (1.7)	SE AK
Van Sickle and Gregory 1990	n/a	12	13	Mack Creek, W. OR

Table 3. Channel widths upstream of culverted road-stream crossings in the Pacific Northwest.

State	Physiographic province	n	mean channel width (m)	standard deviation (m)
WA[1]	Blue Mountains	76	3.23	2.84
WA[1]	Western Cascades	50	1.32	0.85
OR[2]	WA/OR Coast Range	18	1.10	0.79
CA[1]	Franciscan	201	0.71	0.51
OR[1]	Western Cascades	13	1.08	0.48

[1] Unpublished data from USDA Forest Service
[2] Unpublished data from USDI Bureau of Land Management

Table 4. Previous studies observing the role of channel width in regulating the length of transportable debris.

Location	Mean channel width (m)	Largest storm event during study period	Percent of pieces transported > channel width	Source
Bonnie Creek - Prince of Wales Island, Alaska	9.7	n/a	"Pieces up to 8m long have been transported downstream at high flows"	Swanson *et al.* 1984
Salmon Creek - Tributary to Chehalis River in W. Washington	11.5	7 year recurrence interval	13%[1]	Bilby 1985
Mack Creek - H.J. Andrews Experimental Forest - central Oregon Cascades	11.9	4th highest discharge for period of record (1950-1984) =10-year flood (as cited in Braudrick *et al.* 1997)	7%[2]	Lienkaemper and Swanson 1987
Lookout Creek - H.J. Andrews Experimental Forest - central Oregon Cascades	23	n/a	"Virtually all transported pieces were shorter than mean bankfull width..."	Nakamura and Swanson 1994
Flume experiment	n/a	n/a	Deposition or lodging occurs where channel width is less than the piece length	Braudrick *et al.* 1997

[1] Data are reported as % of pieces moved >10 m length. Thus, this value is likely an overestimate.
[2] The two pieces transported "pivoted". Total transport distance was less than 10m.

STUDY SITES

Three watersheds were chosen for assessing the transport of woody debris following peak flows: Coyote Creek, Pilot Creek, and Bull Creek (Figure 5). These watersheds were generally accessible during the winter months and the roads and culverts unmaintained. Twenty three stream channels were chosen within these three watersheds for debris transport monitoring (Table 5) based on ease of access and high road-stream crossing densities. Descriptions of each watershed are given in the text following Figure 5 and Table 5.

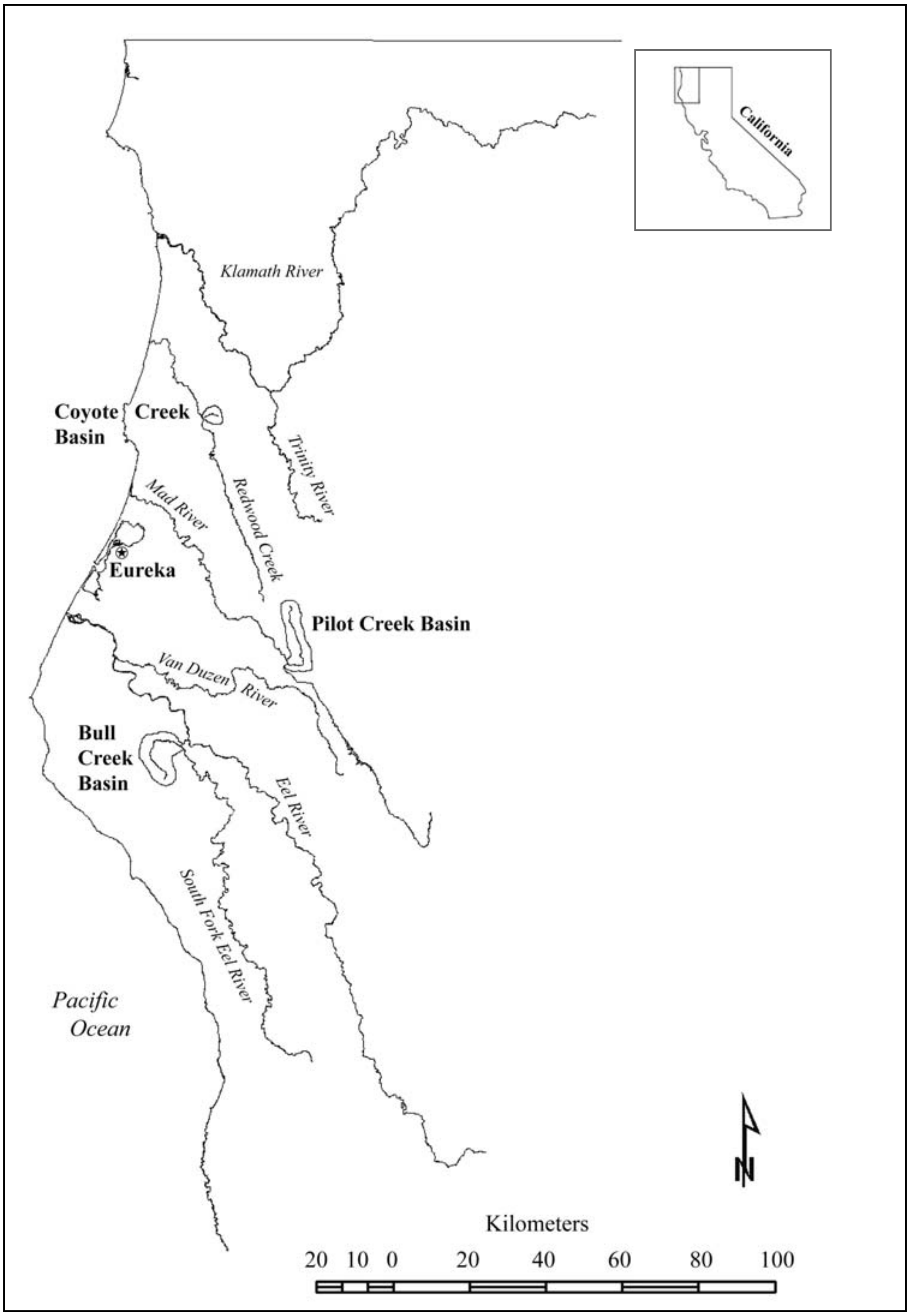

Figure 5. Location map of study sites. Study sites were located in three watersheds of northwest California: Bull Creek, Pilot Creek, and Coyote Creek.

Table 5. Culvert and channel characteristics for 23 study sites in three watersheds. T is the design flow capacity at HW/d = 1 expressed as a recurrence interval (refer to Figure 2 for further explanation). CMP refers to corrugated metal pipe (i.e. culvert). Mean annual precipitation was determined from Rantz (1968). Channel slope was determined from a 7.5 minute topographic map using the average channel slope immediately upstream of the road crossing.

Site	CMP diameter (cm)	Drainage Area (km^2)	Mean Bed Width (m)	Mean Annual Precip. (mm)	Channel slope	T (years)
Pilot Creek						
2n14-11	150	0.491	3.32	1780	0.30	57
2n14-19	150	0.299	2.48	1780	0.35	345
2n17-1	90	0.111	0.95	1780	0.30	60
2n17b-3	45	0.015	0.49	1780	0.24	62
3n06-12	60	0.037	1.02	1780	0.41	50
3n06-21	90	0.264	1.37	1780	0.35	10
3n06-24	90	0.179	0.98	1780	0.52	19
3n06-26	90	0.037	1.01	1780	0.28	12,958
3n06-30	60	0.030	0.58	1780	0.45	94
3n06-31	150	0.264	2.42	1780	0.41	622
Bull Creek						
BC 23	60	0.060	0.74	2670	0.34	5
BC 24	75	0.180	1.58	2670	0.29	3
BC 26	75	0.100	1.06	2670	0.32	6
BC 27b	75	0.080	1.25	2670	0.30	8
BC 36	120	0.830	2.72	2670	0.19	2
BC 59	75	0.310	1.56	2670	0.32	2
BC 65	105	0.570	2.66	2670	0.22	2

Table 5. (continued).

Site	CMP diameter (cm)	Drainage Area (km^2)	Mean Bed Width (m)	Mean Annual Precip. (mm)	Channel slope	T (years)
Coyote Creek						
CC 517	45	0.047	0.88	2160	0.21	6
CC 520	75	0.070	1.30	2160	0.20	29
CC 1721	75	0.044	1.29	2160	0.10	108
CC 1725	60	0.067	1.33	2160	0.22	10
CC 1728	90	0.163	1.32	2160	0.19	15
CC 1731	90	0.174	1.86	2160	0.18	13
Mean		0.185	1.46		0.29	23
St. dev		0.202	0.74		0.10	39

Coyote Creek

Coyote Creek is a 20.4 km^2 tributary to Redwood Creek (Figure 5). The Coyote Creek basin is underlain primarily by unmetamorphosed, folded and sheared siltstone and sandstone of the Incoherent Unit of Coyote Creek, part of the Franciscan Complex (Harden *et al.* 1982). This unit is compositionally similar to the better known "Central Belt Franciscan" as described by Berkland *et al.* (1972). Precipitation ranges from 2,030 mm to 2,285 mm (Rantz 1968) and occurs mostly during the winter. Snow is common along the highest ridges, although accumulations rarely last for more than a week. Vegetation is dominated by Douglas-fir (Pseudotsuga menziesii), Oregon white oak (Quercus garryana) and prairie grasslands in the upper portion of the basin where the study sites were located (Weaver at al. 1995).

Pilot Creek

Pilot Creek is a 103 km^2 tributary to the Mad River (Figure 5). All sites except 2n17b-3, 2n14-11 and 2n14-19 are underlain by South Fork Mountain Schist (Aalto *et al.* 1988). The remaining sites are underlain by a relatively coherent unit of the Franciscan Complex (Aalto *et al.* 1988). The climate is warm with dry summers and wet winters. The basin lies in the "transitional snow zone", receiving a mixture of snow and rain in the winter. Approximately one third of the basin lies above the mean winter snowline (Six Rivers National Forest 1994). Mean annual precipitation ranges from

1,780 mm near the mouth to 2,285 mm at the higher elevations (Rantz 1968). Vegetative patterns reflect elevation and aspect. Red fir (Abies magnifica var. Shastensis) is at the highest elevations, white fir (Abies concolor), at lower elevations, and Douglas fir, oak woodlands, and grasslands in the lowest areas (Six Rivers National Forest 1994).

Bull Creek

Bull Creek is a 133 km^2 tributary to the South Fork Eel River (Figure 5). Precipitation ranges from 1,525 mm at the mouth to 2,670 mm at the highest and westernmost portions of the basin (Rantz 1968). Snow is uncommon except along the highest ridges. Vegetation is dominated by mixed stands of Douglas fir, redwood (Sequoia sempervirens), and madrone (Arbutus menziesii). The geology of the basin is composed entirely of the Yager and Franciscan formations, consisting of mudstone, shale, siltstone, greywacke, and conglomerate of Upper Jurassic to Late Cretaceous Age (Ogle 1953, LaVen 1987).

METHODOLOGY

Site selection

Sites were chosen based on culvert diameter and evidence of annual scour and/or deposition upstream of the crossing, indicating the potential for wood transport. Based on culvert diameter distributions from the U.S. Forest Service (unpublished data) and Pyles *et al.* (1989), only culverts less than or equal to 150 cm in diameter were chosen because these are most common. Selection of individual sites from the above criteria was based on safe vehicle access and proximity to other sites. I monitored wood transport though these channels beginning in Fall 1992 and ending in Spring 1995.

Characteristics of fluvially transported woody debris

At each site, 15.2 cm square mesh fencing was strung across the channel 5 – 10 m below the culvert outlet. The fencing was secured by three or more fence posts pounded into the bed and banks. These "debris screens" captured a portion of fluvially transported woody debris (Figure 6).

Figure 6. Debris screens consisted of 15 cm square mesh fencing secured by three or more metal fence posts. Accumulation of redwood limbs can be seen on this screen in Bull Creek.

During debris screen installation, mean bed width (Lisle 1986), was determined by measuring the bed width upstream of the culvert inlet at five meter intervals. In the field, bed width was the zone of actively scoured sediment, typically absent any vegetation. Ten bed width measurements were recorded at each site to adequately describe the channel width which may influence debris transport.

After each runoff event, woody debris was gathered from the debris screens, except for Pilot Creek sites which were visited annually since snow prohibited winter access. Only pieces greater than 30 cm long were measured. From preliminary assessment of plugging data collected during the winter of 1992-1993, 30 cm was chosen as an approximate minimum piece length capable of lodging across culvert inlets ≥ 45 cm. Thirty centimeters was also the minimum length studied by Gillilan (1989). Length and diameter of pieces were recorded. Piece length was recorded as an "effective length"; the greatest linear span of a piece including branches and irregularities (Figure 7). This is the maximum length a piece presents to the culvert inlet during transport. No attempt was made to quantify the degree of branching or state of decay of each piece.

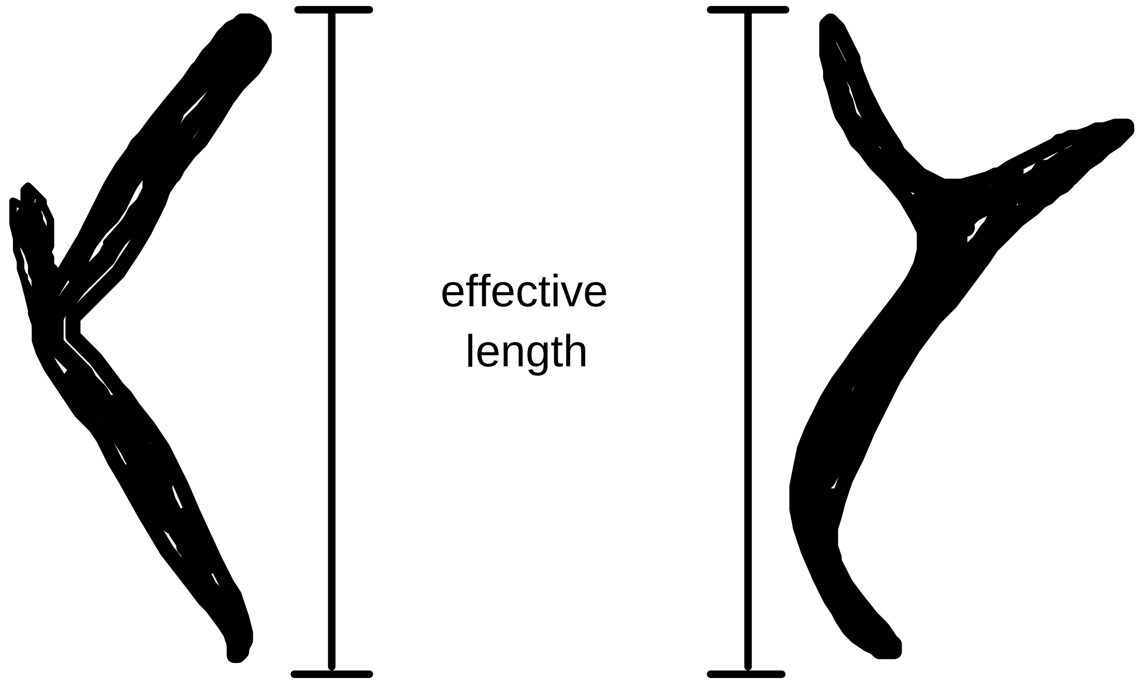

Figure 7. Piece length was recorded as the maximum linear span, or “effective length”.

To characterize the lengths of woody debris transported relative to the channel size, wood length was divided by mean bed width to produce a dimensionless ratio, the relative log length (L_{log}/w_c)(Braudrick *et al.* 1997). A cumulative percent plot of this ratio was constructed for each site. From each site, the ninety-fifth and ninety-ninth percentile relative log lengths were determined. Ninety-fifth percentile length is plotted versus mean bed width. These data are presented in the results section.

Assessment of wood lodged across culvert inlets

I located plugged culverts during site visits to the study watersheds and by examining accessible culverts in other areas after periods of high runoff. The culvert was considered plugged if one or more pieces were lodged across the culvert inlet. Other debris supported by these "initiator" pieces or lodged near the inlet but not contacting the culvert inlet were not counted (Figure 8).

At the site, the following data were recorded: culvert diameter, a description of the area within approximately five culvert diameters upstream of the inlet, and the length and diameter of piece(s) lodged across the culvert inlet.

Data for wood lodged at culvert inlets are presented as a dimensionless ratio of wood length to culvert diameter (L_{log} /d). Additionally, mean and median lengths lodged across inlets are shown. Raw plug data are provided in Appendix A.

Figure 8. Criteria for culvert plugging. A culvert was considered plugged if one or more pieces were lodged across and in contact with culvert inlet at one or more places. Piece "a" satisfies this criteria by contacting the inlet lip at two points. Piece "b", although in contact with the pipe, is <u>not</u> counted because it does not contact the inlet.

RESULTS

Fifty-four instances of wood lodged across culvert inlets were described. Pieces do not have to be longer than the culvert diameter to lodge across the inlet (Figure 9). However, on average, pieces were 175% (± 94%, = 1 s.d.) of the culvert diameter (Table 6). Mean and median lengths increased with increasing culvert diameter (Figure 10). At 23 sites, bed width was recorded and allowed evaluation of Llog/Wc for pieces lodged across the inlet (Figure 11). At 23 sites, bed width was recorded and allowed an evaluation of the relative log lengths of pieces initiating plugging (Figure 11).

Debris screens captured 3,114 pieces of woody debris ≥ 30 cm length (Table 7). Size distributions of transported debris among the three basins are similar among the three basins (Figures 12 and 13). On average, 99% of fluvially transported woody debris greater than 30 cm long which passed through the culverts was less than or equal to the mean stream bed width (Figure 14). Over the range of channel widths observed, the 95th percentile length did not increase as fast as bed width (Figure 15). However, when only the five largest pieces are considered, piece length shows a much better relationship with bed width (Figure 16).

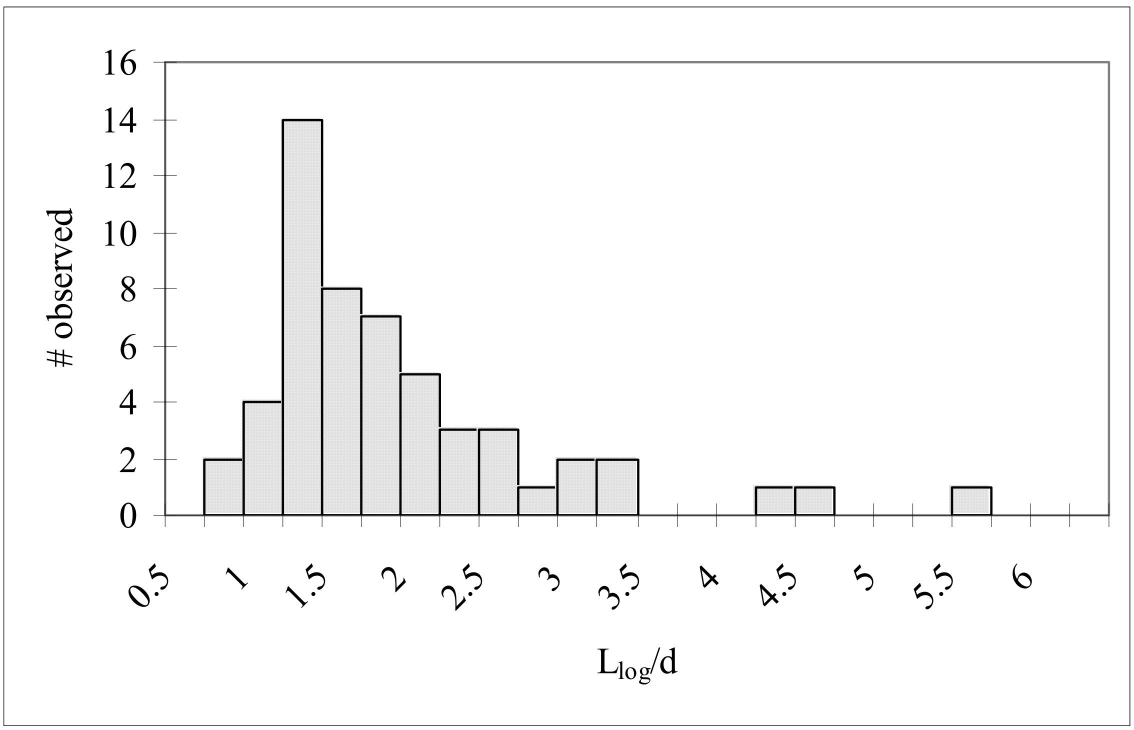

Figure 9. Wood lodged across culvert inlets can be less than the culvert diameter (n=54). Wood length is expressed as piece length divided by culvert diameter (Llog/d).

Table 6. Summary statistics of woody debris lodged across culvert inlets (n = number of culverts).

Culvert dia. (cm)	n	Mean length (cm)	Median length (cm)	st.dev. (cm)	s.e. mean	min (cm)	max (cm)
45	19	91	72	54	17	28	247
60	17	109	81	64	18	56	262
75	11	116	103	38	20	77	193
90	8	133	141	36	13	67	182

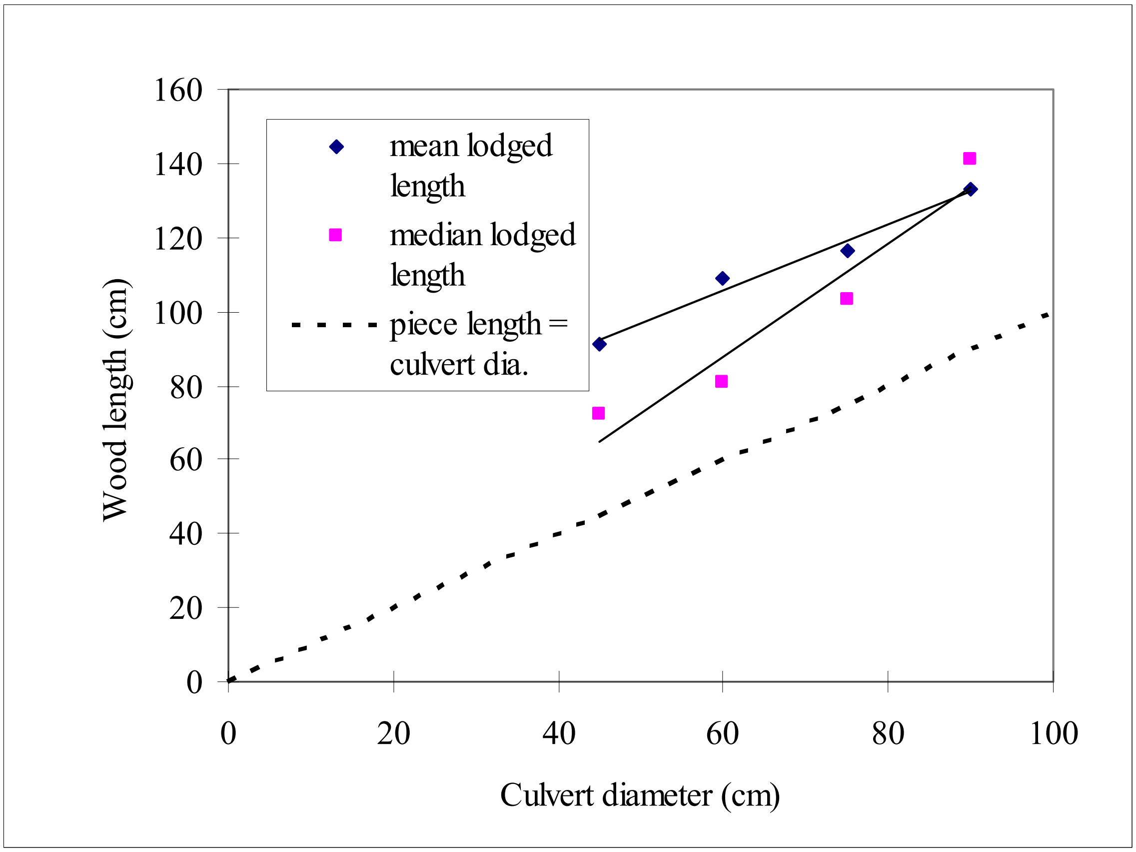

Figure 10. Mean and median lengths of wood lodged across culvert inlets increases with culvert diameter.

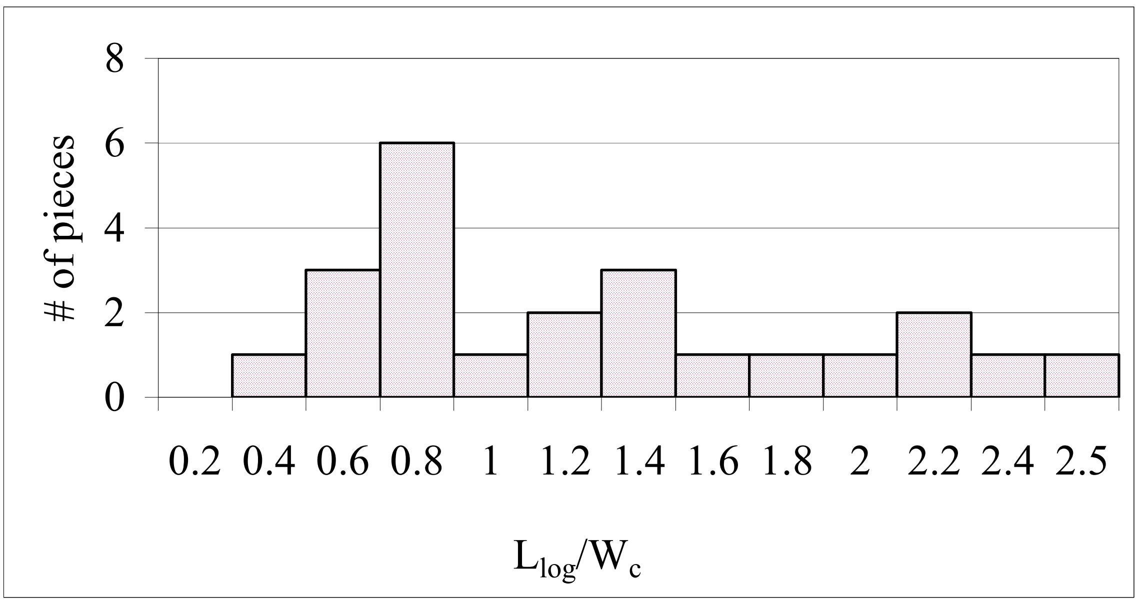

Figure 11. Relative log length for pieces lodged across culvert inlets (n=23).

Table 7. Summary statistics for woody debris captured in debris screens. Minimum length for all sites is 30 cm.

Site	n	mean length (cm)	geometric mean length (cm)	standard deviation (cm)	maximum length (cm)	%pieces ≤ bed width	95th %ile L_{log}/w_c	99th %ile L_{log}/w_c
Pilot Creek								
2n14-11	136	54	48	42	409	99	0.32	0.72
2n14-19	146	46	44	18	135	100	0.34	0.54
2n17-1	34	43	42	11	72	100	0.75	0.75
2n17b-3	49	40	40	9	73	89	1.10	1.49
3n06-12	28	44	42	12	85	100	0.61	0.61
3n06-21	86	41	39	10	75	100	0.48	0.54
3n06-24	127	52	48	22	150	95	0.98	1.40
3n06-26	108	45	44	15	95	100	0.84	0.95
3n06-30	127	42	41	13	100	91	1.19	1.73
3n06-31	272	50	46	19	148	100	0.35	0.54
Bull Creek								
BC 23	12	42	41	12	65	100	0.88	0.88
BC 24	122	49	46	21	129	100	0.62	0.82
BC 26	26	40	39	10	66	99	0.54	0.63
BC 27b	93	45	43	13	88	100	0.61	0.71
BC 36	258	52	49	25	169	100	0.38	0.58
BC 59	402	52	49	29	424	99	0.62	0.88
BC 65	265	51	46	27	218	100	0.40	0.67

Table 7 (continued).

Site	n	mean (cm)	geometric mean (cm)	standard deviation (cm)	maximum length (cm)	%pieces ≤ bed width	95th %ile L_{log}/w_c	99th %ile L_{log}/w_c
Coyote Creek								
CC 517	197	42	41	13	90	99	0.79	1.02
CC 520	91	45	42	18	110	100	0.77	0.83
CC 1721	147	45	43	16	125	100	0.59	0.86
CC 1725	137	46	43	19	126	100	0.70	0.91
CC 1728	133	44	42	15	103	100	0.63	0.75
CC 1731	118	43	41	13	105	100	0.36	0.46
mean						98.8	0.65	0.84
standard deviation						2.9	0.24	0.32

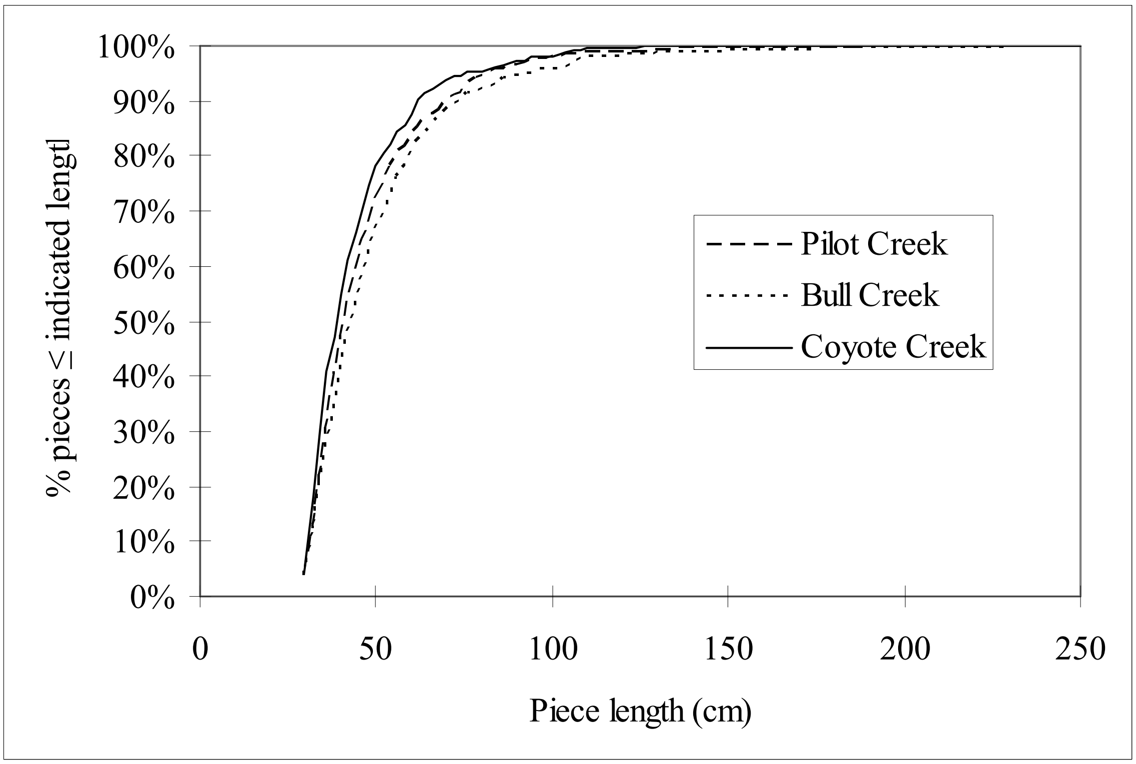

Figure 12. Distribution of wood lengths captured in 24 debris screens in three watersheds (n = 3,114). Figure does not encompass two pieces > 250 cm that were recovered from the screens.

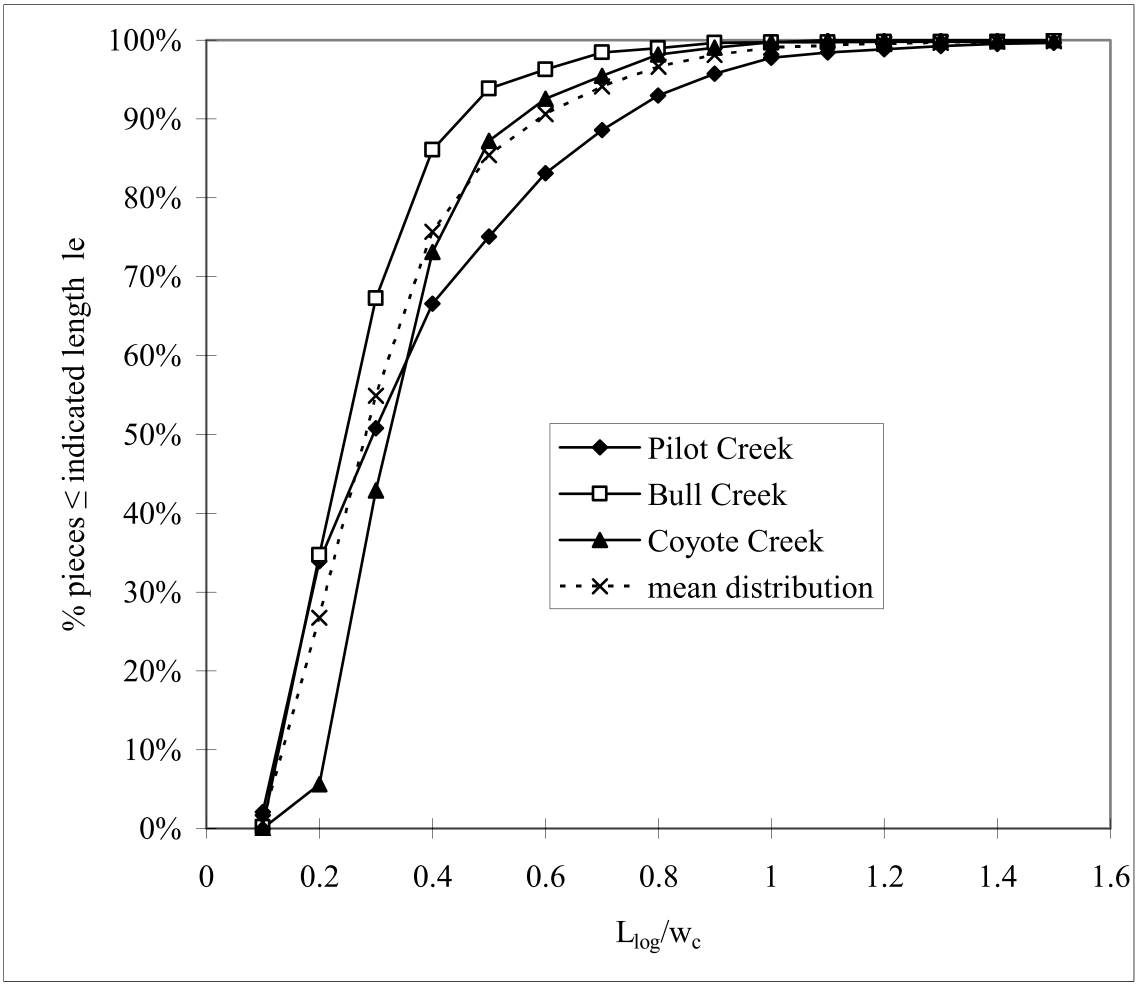

Figure 13. Size distribution of fluvially transported wood, by basin. Piece lengths are expressed as the ratio to bed width (L_{log}/w_c).

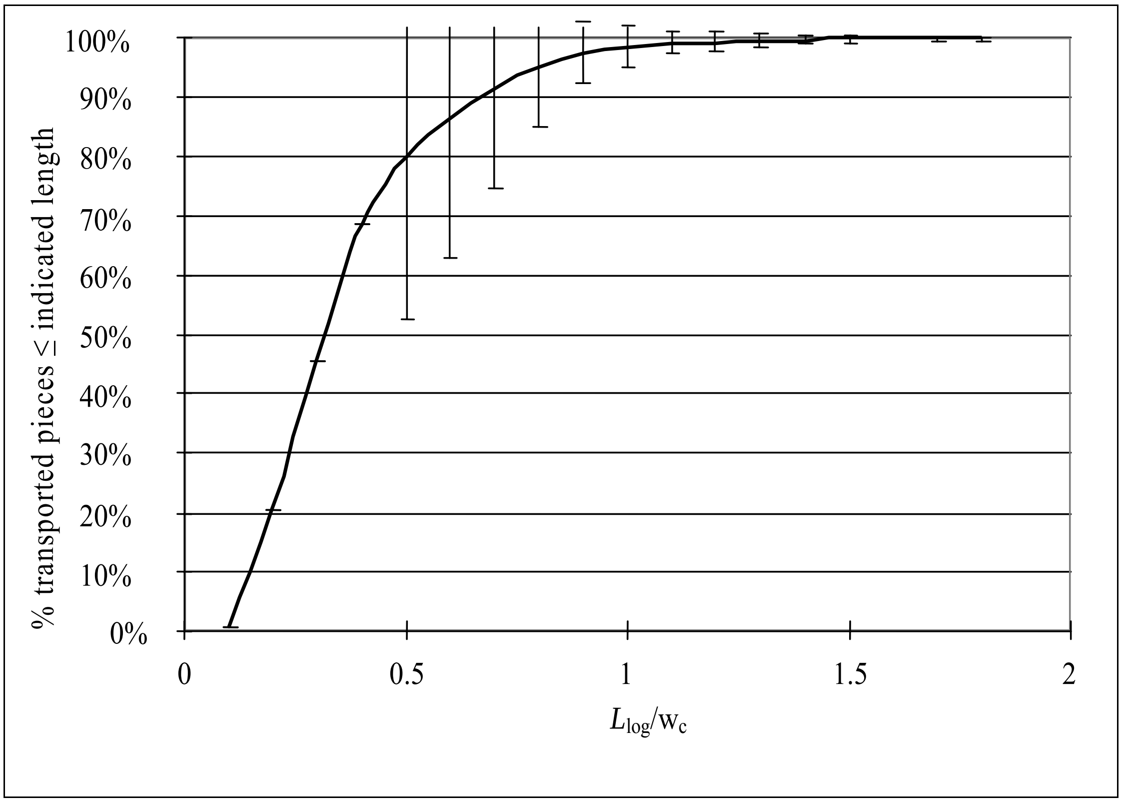

Figure 14. Pooled size distribution of wood lengths. The data from 25 sites (3,114 pieces) are expressed as a ratio to channel width (L_{log}/w_c). Error bars are one standard deviation.

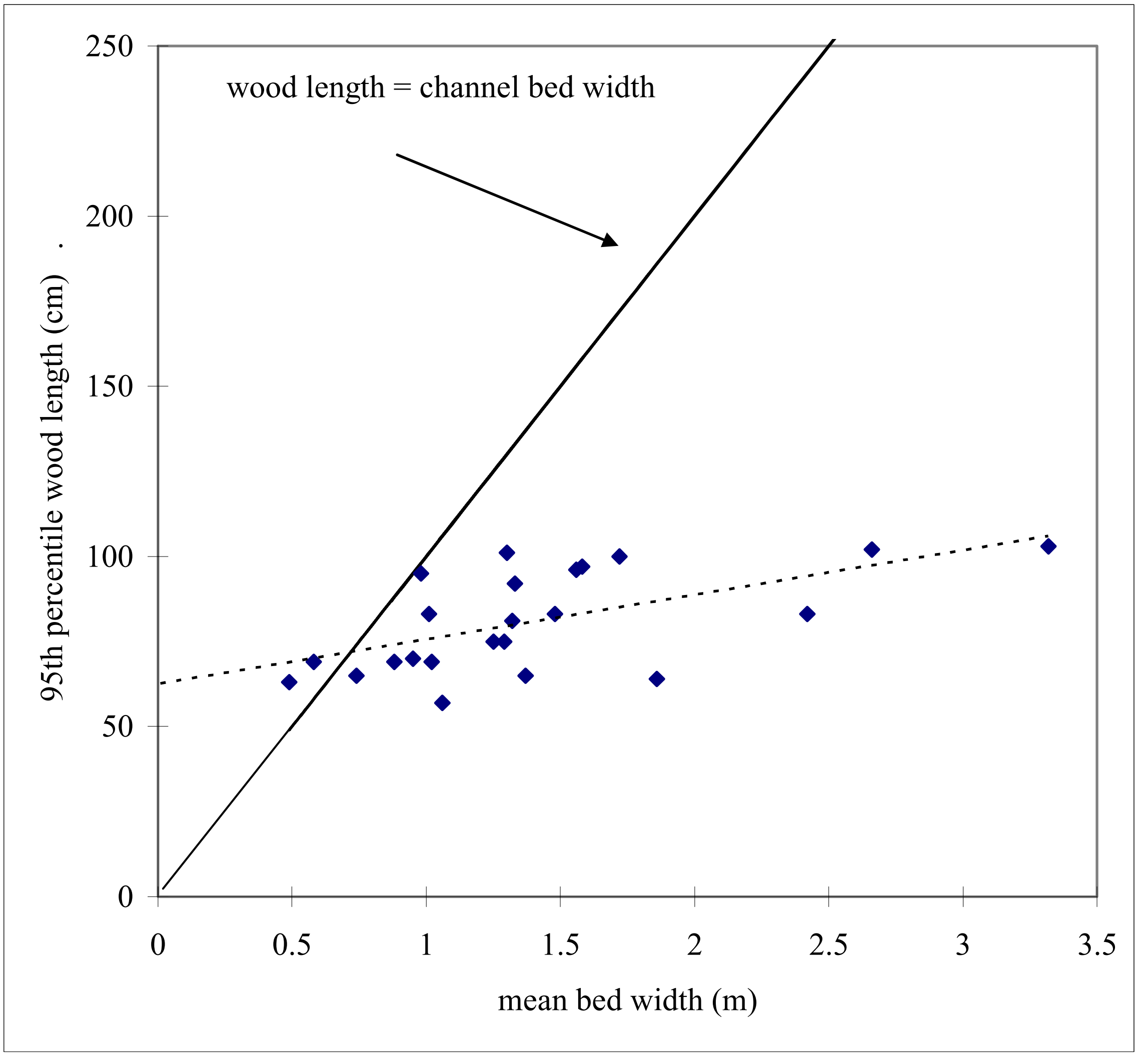

Figure 15. Except for the smallest channels, the 95th percentile wood length is less than the channel bed width.

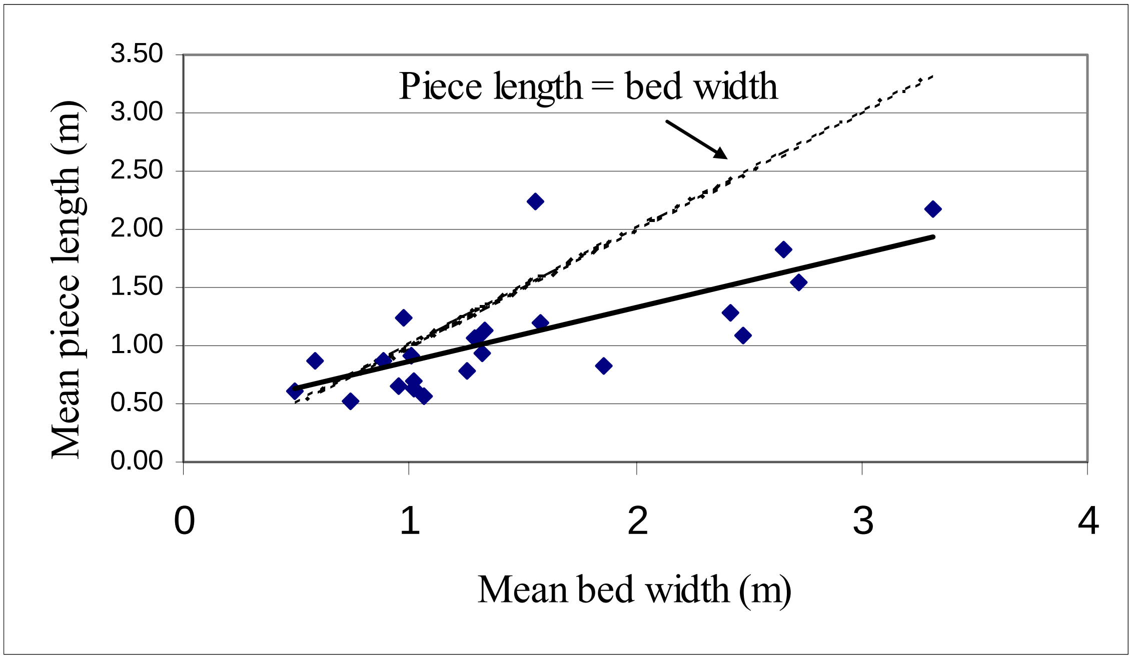

Figure 16. Mean piece length when only the five largest pieces in the sample are considered.

DISCUSSION

Characteristics of wood lodged across culvert inlets

Culvert plugging is typically initiated by one or more pieces of woody debris lodging across the inlet. Once lodged at the inlet, the piece becomes a locus for the further accumulation of wood and sediment, reducing part or all of the inlet aperture (Figure 17). These "initiator pieces" typically span the culvert inlet and have two contact points along the pipe edge. Initiator pieces do not have to be longer than the culvert diameter to lodge when a piece lodges near the top or bottom of a circular pipe (Table 6).

With lack of post–storm maintenance, I witnessed the plugging process continuing over several storms with a gradual reduction in the capacity of the culvert to transport water, wood and sediment. Post–storm culvert cleaning can reduce the potential erosional consequences of debris plugging. Therefore, road managers should ensure culvert inlet inspections on a regular basis. Where possible, inlets should be inspected after each peak flow event.

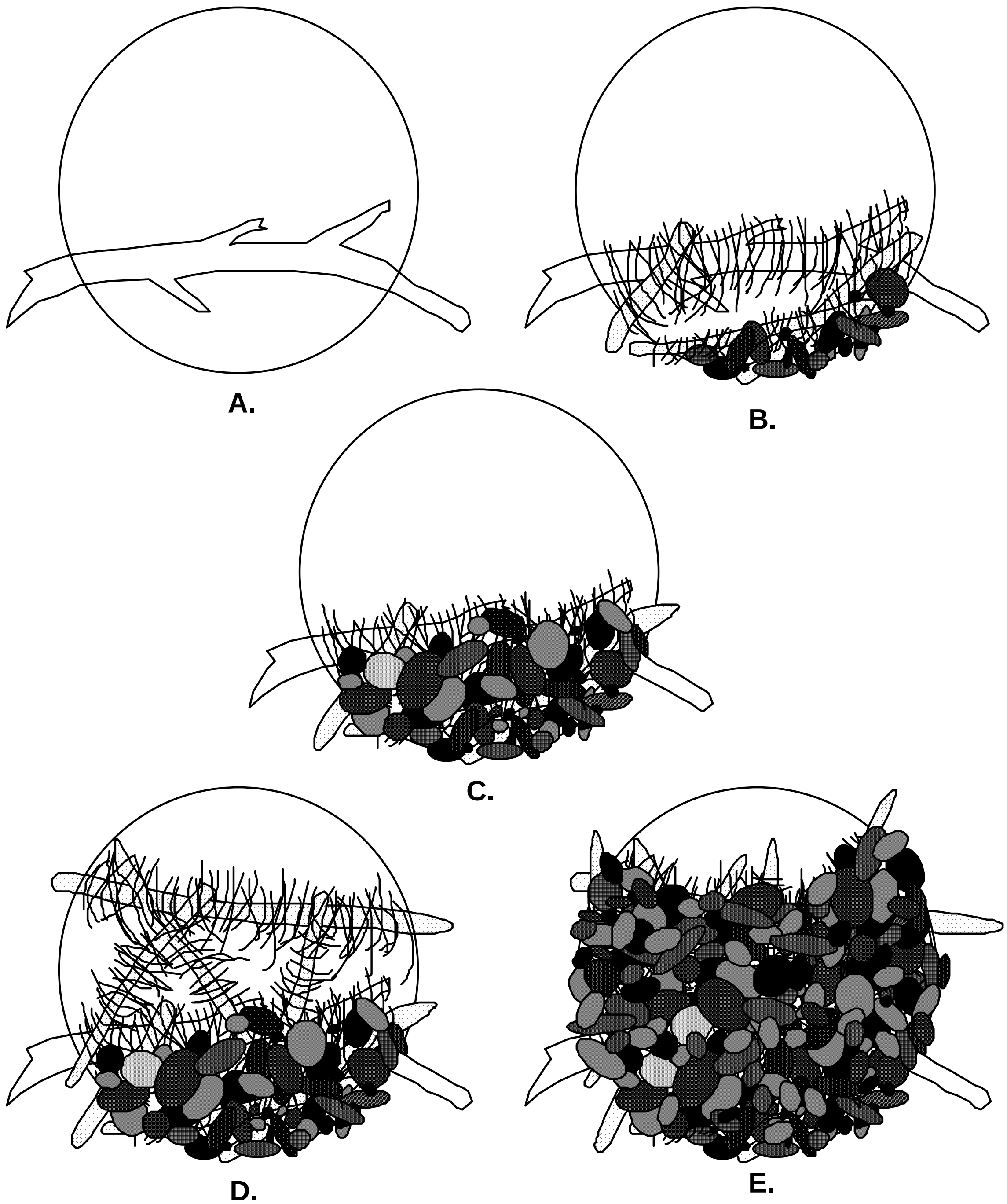

Figure 17. Plugging of culverts by woody debris is typically initiated by a single piece lodging across the inlet (a). This piece serves a locus for the accumulation of detritus and sediment (b). As the plug grows, sediment and detritus seal off a portion of the inlet (c). The initiation process may be repeated with a second piece, allowing the plug to grow upwards (d). Fully plugged inlets can become buried in a wood / sediment matrix (e).

The size distribution of initiator pieces shown in Figure 9 is the result of the size distribution of fluvially transported woody debris (Table 7 and Figure 14) and the "filtering" effects of the culvert inlet. Lodging will occur when the orientation of the piece presents a length greater than the water surface width at the culvert inlet. As a piece rotates, it presents an effective length to the culvert inlet. This length is maximized when a piece is oriented perpendicular to the culvert inlet. The abundant smaller pieces are too short to lodge across the inlet. Conversely, the largest pieces are transported so infrequently that they are rarely presented to the culvert inlet. The effect is that a given culvert diameter will have an optimal piece size where lodgment is most likely. This is suggested in Figure 9 and 10 where the length of lodged pieces increases with culvert diameter. Therefore, for a fixed channel size and debris load, larger culverts will pass longer pieces of debris.

Characteristics of fluvially transported woody debris

The results indicate that channel width influences length of debris transported (Table 7 and Figures 15 and 16). Distribution of debris lengths show abundant smaller pieces with larger pieces decreasing in abundance. This distribution was also observed by Bilby (1985) and Murphy and Koski (1989) for LWD. When the lengths of the five largest pieces captured for each debris screen site were averaged, a much better relationship was observed relative to channel width (Figure 16). The largest piece collected during the study was 4.2 m long, recovered from the Bull Creek watershed, site no. 59 (Table 7), following a twelve year peak flow. Prior to transport, the piece was oriented parallel to the channel pproximately 5 m upstream of the culvert inlet and was secured in by a small (< 1 m high) debris jam. When the debris jam collapsed, the piece was in a favorable orientation for transport and passed through the culvert and was captured in the debris screen. This is evident in Figure 16. Coho (1993) notes that such remobilized wood jams are most common in first– and second–order streams. Also, Hogan (1985) has pointed out the relative instability of pieces aligned parallel to the channel.

I used Lisle's (1986) definition of "bed width," the zone of average annual bedload transport to measure channel width (w_c). Channel bed width was chosen for two reasons. First, bankfull channel width, a traditional measure of channel size, is often difficult to define on low order stream channels (Keller and Tally, 1979). Confinement often precludes development of banks and terraces used in determining the dimensions of bankfull discharge. Second, the bed width is typically an easily defined area of perennial scour. Barren, freshly scoured gravel is easily distinguishable from the surrounding forest floor. At the study sites, I found this width relatively easy to identify and measure – the distinction between channel bed and forest floor was typically sharply defined in these small, high gradient channels.

Visually, bed width did not appear to change over the study period, and thus, served as a relatively stable feature for characterizing the channels. However, I did not re-measure the channels at the conclusion of this study. In these small channels, the confined setting appears to limit any potential increases in channel width. However, no extreme storm event occurred during the study (the largest event was estimated as a 12 year recurrence interval) and the utility of using bed width as a relatively stable, long–term feature has yet to be tested.

As stated previously, when the data from the 23 sites are pooled, 99% of the pieces passed are less than the channel bed width (Figure 14). I chose the 95th and 99th percentile of L_{log}/w_c to characterize differences among channels because measures of central tendency do not reveal differences among the sites (Table 7). However, given the abundance of finer material in the channel, even these extreme values do not reveal a clear relation to channel bed width. When I considered the mean length of the five longest pieces in each debris screen, the resulting plot suggests channel width is influencing the size distribution of fluvially transported debris (Figure 16).

Sampling only pieces greater than 30cm long at all sites results in relatively larger 95th percentile values of L_{log}/w_c for the smaller channels (Figure 18). This is likely due to the fixed maximum piece size used across all channel sizes. An alternative approach not employed in this study would be to establish a minimum L_{log}/w_c value for measurement. This would have eliminated the bias described above but potentially missed shorter pieces capable of lodging across a relatively small culvert on a large channel.

If the supply of wood recruited to stream channels is similar among sites and the larger channels do not receive longer wood, the 95th percentile L_{log}/w_c would be greater in smaller channels. This hypothesis could be tested by measuring all pieces in the channel prior to transport.

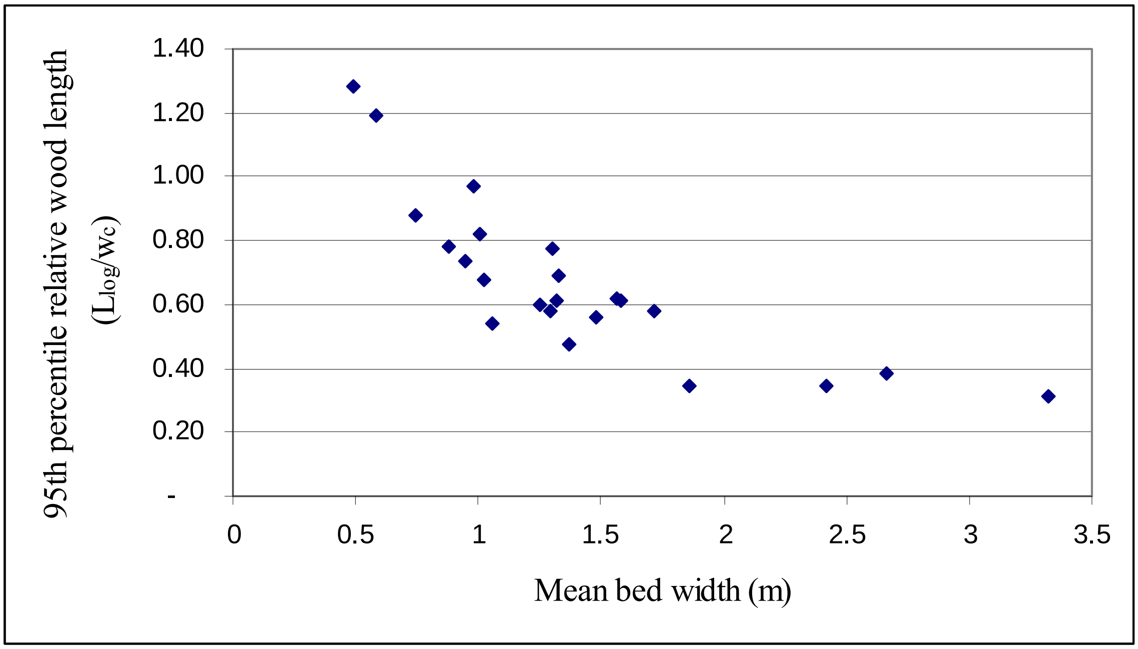

Figure 18. When only pieces greater than 30 cm long were measured at all sites, the smaller channels had relatively larger values of L_{log}/w_c.

Another interpretation for the differences in 95th percentile lengths among channel sizes and, hence, the apparent ability of smaller channels to transport relatively longer pieces, is underestimation of bed width. This likely explains the abundance of transported pieces in excess of the bed width for Pilot Creek 2N17b-3 (Table 5 and Table 7). Using the strict definition of bed width as the zone of perennial scour, I may have underestimated the width. The channel at 2N17b-3 possesses a narrow zone of litter free bed material (49 cm wide) but adjacent to this is an area of alluvial material covered with moss and not considered as part of the "bed". Given the small size of the contributing watershed (0.015 km^2), common peak flows may not be capable of removing this moss layer. If the channel width is increased to encompass the moss-covered portion, the 95th percentile distribution of L_{log}/w_c decreases.

Interpretation of the results must also consider the magnitude of flows observed during the study period. The largest flow observed occurred on January 9, 1995 in Bull Creek. The 164 cms (5,800 cfs) peak at the gage had an estimated recurrence interval of 12 years. This flow transported large quantities of debris to the debris screens. At site number 23, wood transport occurred for the first time since the onset of the study delivering 7 pieces to the screen. Peak flows in excess of a 12 year recurrence interval may transport pieces longer than the channel width. However, in confined channels the increase in length may be slight simply because the wetted channel is unable to appreciably widen as flows increase. Because of a lack of large events during the study period, the role of large events on the size distribution of fluvially transported woody debris is lacking.

Wood may be delivered to culvert inlets by processes other than fluvial transport. Debris flows can transport large volumes of debris and sediment (Lienkaemper and Swanson 1978). Blown down overhead limbs can also fall across the inlet. I observed very long lodged pieces that were relatively unabraded and possessed many smaller limbs. Presumably, these pieces underwent little, if any, fluvial transport and the overhead canopy was the likely source. The condition of the pieces and their length relative to the channel width suggested that fluvial transport was unlikely. However, the probabilistic nature of debris transport does not exclude the transport of very long pieces such as that observed at BC 59. Debris hazard cannot be eliminated, but consideration of the processes affecting debris lodgment during culvert design and assessment can insure a reduction in the hazard imposed by woody debris. Figure 11 indicates that 10 of 23 pieces lodged across culvert inlets are less that the bed width, suggesting a simple strategy of sizing culverts equal to the bed width could reduce plugging hazard by nearly half. Potential design criteria to address woody debris hazard are discussed below.

Design considerations for debris passage through culverts

Culvert design for optimal debris passage must strive to; 1) avoid ponding at the inlet, 2) maintain the natural channel cross section, and 3) maintain channel planform. Debris lodgment cannot be eliminated, but consideration of the factors influencing debris lodgment can reduce the hazard. Wood supply should be considered unlimited and the assessment and design of debris hazard should focus on how the road-stream crossing processes the debris that is presented rather than on the quantity of debris. This section addresses the above three issues for sizing culverts as well as the concept of sizing culverts using channel width.

Ponding at the culvert inlet

Note that for $HW/d \geq 1.0$, debris passage is effectively eliminated. During ponded conditions, wood accumulates above the inlet (Figure 19 and Figure 20). During receding flows, the wood converges on the inlet in a large mass. I observed several instances where a short duration, high intensity rainfall submerged the inlet. A floating mass of wood rapidly accumulated in the pond. When the inlet crown was exposed during the receding flows, the interlocking mass of wood plugged the culvert. As the flow dropped further, floating pieces of wood continued to lodge and some pieces lodged above dropped to lower points on the inlet. At one site, where ponding had occurred, the inlet was 80% plugged with debris and sediment when the flow had fully receded. Culvert designs that reduce the probability of ponding also reduce plugging hazard.

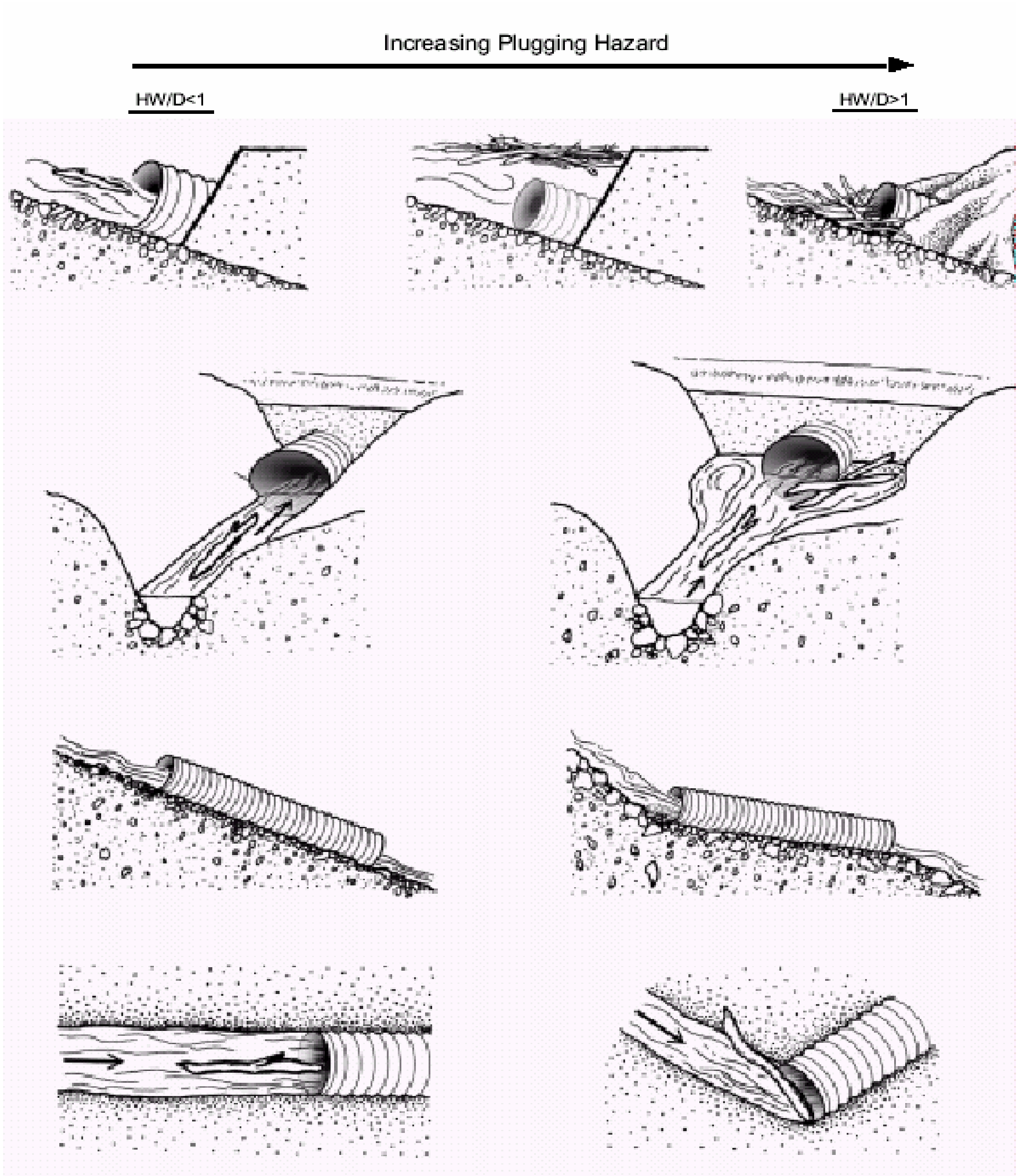

Figure 19. The orientation of the culvert with respect to the natural channel influences the potential for wood lodgment at the culvert inlet. First row, culverts should not pond water at the inlet, allowing the inlet to become submerged ($HW/d \geq 1$). Second row, flows should not widen as they approach the culvert inlet. Third row, culverts should be set at a grade similar to the natural channel slope, avoiding areas where deposition of wood is likely to occur. Finally, culverts should be aligned with the natural channel and avoid abrupt changes in direction. This is a common scenario for cross drains. Figure from Furniss et al. (1998).

Figure 20. When water is ponded over the inlet crown (HW/d > 1), wood accumulates in the inlet basin enhancing the chance of plugging during receding flows. This photo is from the central Cascades of Oregon following a peak flow event in the early winter of 1997.

Channel cross section

Fluvially transported wood is likely to lodge at channel constrictions (Braudrick *et al.* 1997) or irregularities (Bilby and Likens 1980). Culvert inlets are often narrower than the channel width and represent a "debris roughness" feature as described by Braudrick *et al.* (1997). When sizing culverts for woody debris passage, or assessing the hazard of existing installations, consideration must be given to the culvert diameter relative to the channel width. This can be expressed as a dimensionless ratio of culvert diameter divided by channel width (d/w_c) and I discuss the implications for this further in this section.

Also, the debris passage potential of a circular culvert is optimized when HW/d = 0.5. This is the point at which the flow through the culvert enters at the widest point (equal to the culvert diameter). Installing multiple pipes of similar diameters will not increase debris capacity. Transported pieces must still pass through a single, limited aperture (Normann 1985).

The circular inlet of a culvert is different than typical stream cross sections. Alternative inlet shapes will change the debris passage characteristics of a site. For example, a corrugated pipe arch may be a solution because the greatest width is nearer the stream bed. The lower HW/d of optimal debris passage provided by a pipe arch will pass debris during more frequent peak flows. At higher peaks, when HW/d is above the maximum inlet width, debris lodging may be temporary as receding flows allow the wood to fall to the wider portion of the inlet. A square or rectangular culvert would provide the best design solution because wood passage is optimized over all values of HW/d < 1.0.

Channel planform

When I observed wood in transport during peak flows, I noticed that longer pieces tended to remain parallel to the channel during transport through straight, narrow reaches. However, where the channel width increased, pieces rotated in the eddies due to flow separation. Rotation resulted in piece presentation perpendicular to the inlet rather than a more favorable parallel orientation. Unfortunately, many stream crossings are constructed with enlarged inlet basins which allow peak flows to spread laterally. This is because roads are often located on natural benches where channel confinement is less or material was excavated to construct the road fill. Abbe *et al.* (1993) observed increased deposition of LWD in wider, shallower river reaches. Lodgment is virtually ensured when a piece is delivered to the inlet in a perpendicular orientation. Constructing crossings with a restricting channel planform to the inlet may facilitate debris passage by maintaining or promoting a parallel alignment of the transported debris (Figure 19).

The angle the culvert makes with the channel is termed skew angle. Where skew angles are high, debris lodgment is increased (Garland 1983, Piehl *et al.* 1988a). When a piece in transport reaches the inlet, it must rotate in order to pass through the culvert. Often, though, the momentum of the piece and/or lack of turning room carries it beyond the inlet lip and lodgment occurs (Piehl 1988a). Cross drains are especially susceptible to this because they typically have skew angles at or near 90 degrees. I observed several plugs where channels were intercepted by the roadside ditch and rerouted to the culvert at high skew angles. Minimizing culvert skew angle is another means of reducing debris hazard (Figure 19).

Sizing culverts using channel width - implications for hydraulic capacity

Larger values of d/w_c reduce debris plugging hazard by reducing the degree to which the culvert constricts the overall channel width. I examined the effects of installing circular culverts equal to the channel width ($d/w_c = 1.0$) on the hydraulic capacity of the installation. For each of the twenty three study sites, I calculated the design flow the culvert would pass at $HW/d = 1.0$ assuming a corrugated metal pipe with a diameter equal to the bed width (Figure 21). Except for the smallest channels, the culverts were able to pass peak flows in excess of a 100 year design discharge. For the smallest channels, an additional increase of one or two standard culvert diameter increments (15 cm) is needed to pass the 100 year design discharge (Figure 22). For the smallest channels, the cost of upgrading one or two pipe diameters may be relatively insignificant when compared to the cost of the overall crossing and the cost of repairing a site after failure. Therefore, both hydraulic capacity and the culvert size relative to channel width should be checked when installing new culverts or assessing existing sites.

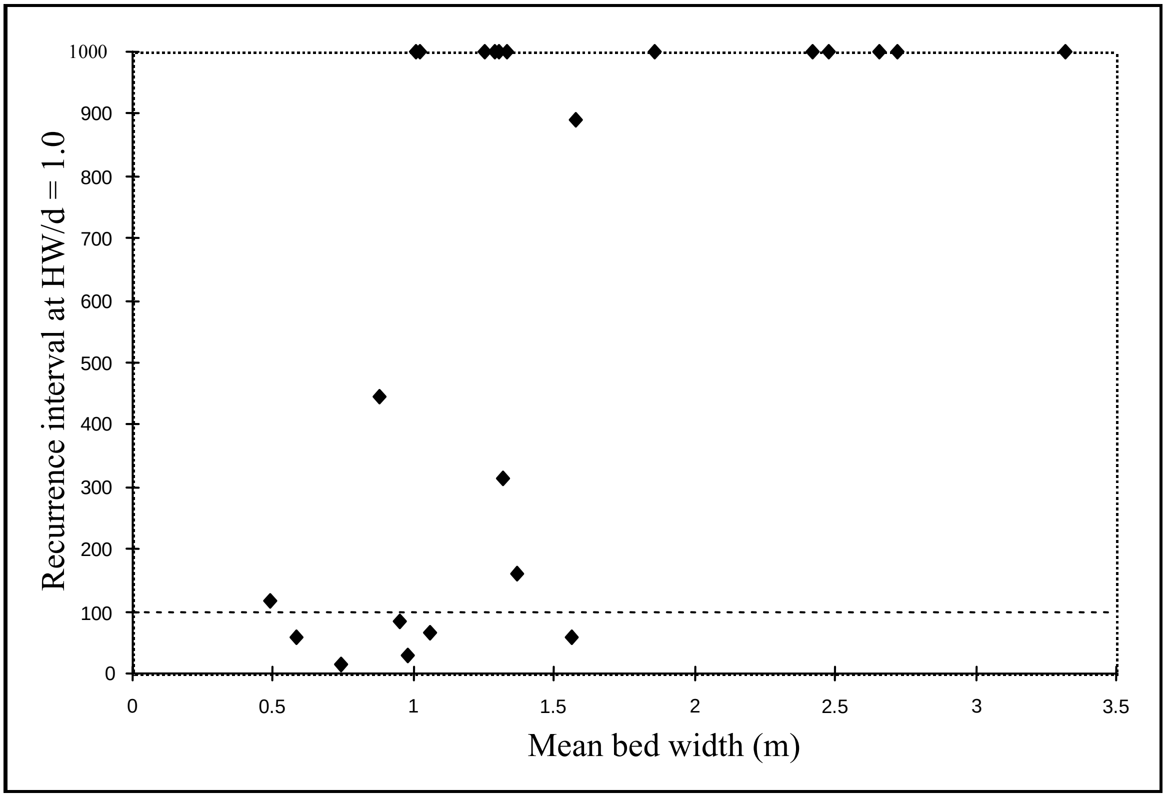

Figure 21. Sizing culverts equal to the bed width does not always satisfy hydraulic capacity requirements. The culvert diameters used here are equal to the bed width and are not rounded to the nearest actual culvert diameter. The 100 year design flow is used to illustrate those pipes lacking adequate hydraulic capacity (USDA, USDI ROD 1994). Recurrence intervals greater than 1,000 years are assigned a value of 1,000.

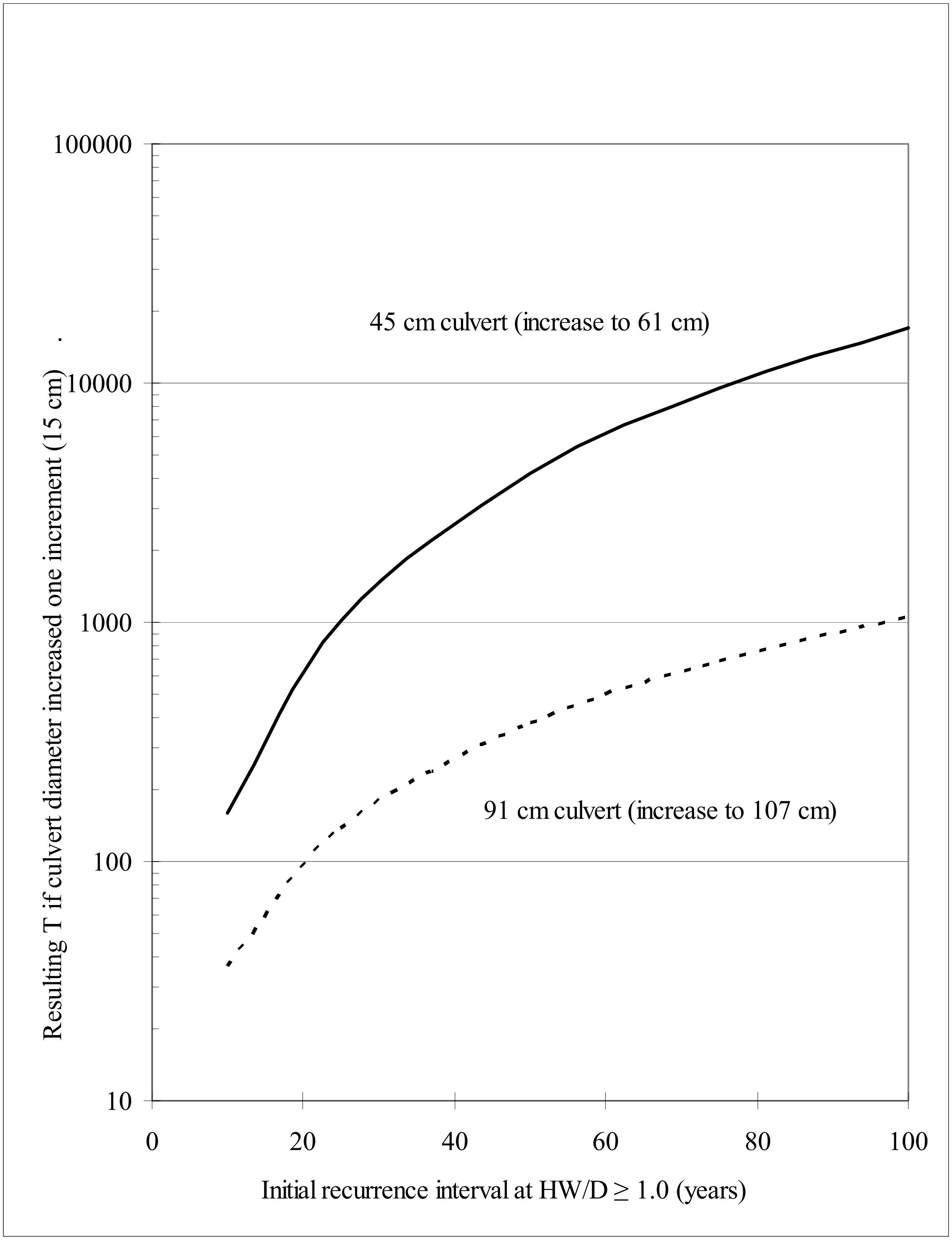

Figure 22. For pipes lacking adequate hydraulic capacity (e.g. cannot pass the 100 year design storm), increasing the diameter by one standard culvert size (15 cm) will often satisfy hydraulic capacity. However, pipes with severe hydraulic capacity limitations (e.g., T < 10 years) may require an increase of two culvert sizes.

CONCLUSIONS

Woody debris is abundant in low–order forested channels of the Pacific Northwest. Where roads cross these channels, woody debris may trigger catastrophic erosional consequences by plugging culverts. In forested settings, debris hazard is present at **all** culverts. Assessing the hazard of debris plugging at existing installations or designing new crossings in forested settings should consider how the road-stream crossing processes woody debris delivered to the inlet.

The results presented here support previous studies noting the role of channel width in regulating the size distribution of fluvially transported woody debris. In northwest California, culverts on channels less than 1.5 m wide should be carefully designed to account for greater relative wood lengths while ensuring adequate hydraulic capacity. In these smaller channels, a culvert diameter equal to the channel bed width would provide for optimal debris passage over a wide range of stream flows. The cost for appropriately sizing a culvert for debris passage will often be insignificant when compared with the overall construction cost.

Debris lodgment at culvert inlets can be minimized by maintaining channel planform and cross section. Culverts sizes and shapes that approximate the channel cross section will minimize debris plugging hazard. For this reason, circular culverts may not be the optimal shape for passing debris. Corrugated pipe arches, with the maximum inlet aperture near the base, may pass wood more readily during "frequent" peak flows. At higher peaks, lodged wood may fall down into the wider section and pass through the culvert. Box shaped culverts allow equal passage of woody debris for all flows less than HW/d = 1.0.

Channels should not widen as they approach the inlet. Rotation of pieces is promoted in the back-eddies of the widening flow. Also, the loss of water depth as a result of increased width may promote debris lodgment. Culverts should not be installed at an angle to the channel. Wood in transport cannot turn into the culvert before it is carried across the inlet and lodges. Ponded conditions, when the inlet is submerged, is undesirable. Wood accumulates in the pond. When flows recede and expose the inlet, the wood converges on the inlet en masse, virtually assuring plugging.

Finally I note that debris plugging hazard at culverts cannot be eliminated. However, consideration of the processes influencing debris plugging can be incorporated into the design of road-stream crossings to minimize the hazard.

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APPENDIX A

Length of woody debris (cm) lodged at two points across culvert inlets by culvert diameter. Also presented are corresponding active channel widths (m) where such data were collected.

#	46 cm (18 ")	Chan. width (m)	61 cm (24")	Chan. width (m)	76 cm (30")	Chan. width (m)	91 cm (36")	Chan. width (m)
1	54		66		193	1.65	137	
2	28		117	0.61	78		147	
3	47		65		87		67	
4	67	0.65	81		132		161	
5	46		57		110	1.56	123	0.88
6	134	0.65	70		77[1]	1.58[1]	145	
7	69	1.05	101		103[1]	1.58[1]	103	0.69
8	48		65		89		182	0.74
9	147	0.65	136		160	1.29		
10	146		262		154	1.95		
11	247		249		98	3.68		
12	91		69					
13	43	0.88	177	1.18				
14	107[1]	0.78[1]	64					
15	75[1]	0.78[1]	98	1.33				
16	65		56					
17	108	0.50	118	2.00				
18	115	0.65						
19	80	0.61						
n	19	10	17	4	11	7	8	3
mean	90.9	0.73	108.9	1.28	116.5	1.90	133.1	0.77
median	72.0	0.65	81.0	1.26	103.0	1.58	141.0	0.74
s.d.	53.6	0.16	64.2	0.57	38.2	0.81	35.7	0.10

[1] There were two instances where two pieces were independently lodged across the same culvert inlet. These were treated as separate data points with identical active channel widths.

APPENDIX B

Raw data for woody debris captured in debris screens.

Pilot Creek Watershed

Site: Pilot Creek 2n14-11

Dates screens were cleaned:
June 26, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
79	4.2	48	0.7	122	2.5
56	4.1	70	0.4	52	2.2
62	0.4	53	0.6	32	1.3
48	0.7	37	0.5	37	1.6
97	0.5	35	2.3	30	0.8
45	0.5	47	2.3	44	0.8
30	1.2	44	0.4	36	5
44	0.6	34	1	32	2.5
42	1	39	0.3	34	12
71	6.5	79	0.7	36	1.5
82	6.3	60	0.4	37	3.2
84	16.5	60	0.6	133	12
50	8.3	33	0.4	48	3.8
49	0.5	38	1.8	38	2.4
69	0.4	33	0.9	34	1
80	1	52	4	98	0.9
50	0.5	31	0.7	52	6.8
57	3.5	69	0.5	34	3
67	25	35	0.6	41	1.2
71	0.8	73	0.6	64	12.6
45	0.9	52	0.6	31	4.4
32	1.9	32	1.3	42	0.8
42	1.6	32	0.9	33	2
34	1.1	46	0.5	44	2.1
34	0.4	44	1.5	35	1.1
49	7	48	0.7	44	0.4
39	1	38	1.7	32	0.7
30	1.1	35	2.9	47	0.5
58	0.5	44	1.5	39	0.4
75	0.8	44	3	44	0.3
36	0.3	42	6.8	39	0.2
34	0.4	35	0.4	36	0.4
43	0.5	30	0.5	34	0.5
97	9.5	108	0.8	31	0.3
88	11	40	0.3	188	2
77	0.9	70	7.8	239	1.4
63	0.6	70	2.5	409	10.5
33	1	103	4.8	31	4.2
40	0.6	40	3.7	36	0.9
32	0.2	51	10.2	33	2.8

Site: Pilot Creek 2n14-11, June 26, 1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
35	0.3	51	1.4	36	1
37	0.8	46	3.4	30	0.8
42	0.9	41	2	38	0.5
68	0.6	38	1		

Site: Pilot Creek 2n14-19

Dates screens were cleaned:
June 26, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
30	1.3	32	1	32	3.4
36	0.4	82	1	31	0.4
37	0.4	74	1.4	39	0.7
52	0.8	32	0.8	41	0.8
90	1.2	33	0.6	38	0.4
40	0.4	37	2.1	34	0.5
65	1.1	51	0.8	37	0.6
45	1.8	30	0.8	36	0.6
43	0.6	44	1.1	62	0.4
38	0.7	32	0.2	30	0.4
39	0.4	92	0.5	38	0.5
76	0.8	37	0.5	50	0.8
58	0.5	135	1.8	52	1.2
42	0.3	30	2.1	35	0.7
30	0.3	39	0.6	40	0.4
46	0.6	42	2.3	37	0.2
49	0.7	50	0.7	36	0.4
49	0.6	33	0.4	44	0.3
35	1.5	32	1.5	45	0.3
63	0.9	38	0.6	32	0.5
70	0.8	39	0.2	33	0.5
77	0.8	36	2.2	36	0.5
38	0.5	48	0.2	52	0.6
37	0.6	49	0.4	30	0.4
49	2.6	31	0.2	62	0.3
31	0.6	31	0.4	32	0.4
133	1.5	32	2.8	46	0.6
63	0.8	33	0.4	43	0.6
43	5	31	0.4	33	1
93	1.4	30	0.3	30	0.4
60	4.6	55	2	32	0.4

Site: Pilot Creek 2n14-19, June 26, 1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
55	1.8	34	0.5	36	0.5
30	0.6	30	0.4	36	0.3
40	0.6	39	0.8	30	0.6
44	0.8	36	0.6	31	0.7
49	1.8	53	0.6	34	0.7
42	0.4	37	1	61	3
51	1.3	75	4.2	49	0.4
36	0.5	36	0.3	53	0.5
77	4	82	0.9	49	0.6
31	1.7	43	0.4	34	0.5
47	1.7	37	0.5	46	0.4
34	0.6	57	0.7	39	0.6
48	0.6	87	1.3	37	0.7
36	0.5	41	2.4	46	0.7
35	0.6	37	0.6	35	3.5
44	1.1	48	2.4	55	0.6
76	1.2	56	0.6	77	4.6
60	1.9	60	1.4		

Site: Pilot Creek 2n17-1

Dates screens were cleaned:

June 26, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
42	4.5	37	0.6	45	7.5
33	2	41	2.8	58	3.4
63	10.4	59	3.8	47	1.7
34	0.3	31	0.5	39	1.9
43	0.4	50	2.5	37	6.5
32	0.3	42	2.3	30	0.8
33	0.2	35	3	36	0.3
55	0.4	44	5.8	31	0.3
30	0.3	39	2.8	39	0.3
39	0.5	30	0.5	39	0.4
49	0.6	51	0.4	72	1.9
71	4				

Site: Pilot Creek 2n17b-3

Dates screens were cleaned:

June 26, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
53	0.7	40	0.9	35	1.1
43	0.6	34	0.6	40	0.7
37	0.6	41	4.2	38	0.4
64	0.9	34	0.4	63	0.8

Site: Pilot Creek 3n06-12

Dates screens were cleaned:

June 26, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
50	0.8	39	0.4	45	0.3
85	1.3	35	0.7	36	0.7
35	1	31	0.5	55	0.5
31	0.4	33	0.7	37	1.4

June 17, 1993

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
44	4.7	48	0.5	47	1.3
59	1.5	48	1.1	42.5	1.7
33	0.7	57	1.1	52	0.6
52	1.2	62	0.8	34	1.1
34	0.5	35	1.1	31	0.4
32.5	0.8				

Site: Pilot Creek 3n06-21

Dates screens were cleaned:

June 27,1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
43	5.5	48	1.4	45	1.9
38	1.2	61	2.7	32	0.5
67	0.6	48	0.8	30	0.6
38	0.5	30	0.5	31	0.9
30	0.6	45	4.6	39	1.3
75	0.8	35	1.1	37	0.6
33	0.7	65	3.5	35	0.3
56	1.1	36	6	39	0.2
70	1.4	30	0.8	33	0.7
43	0.9	31	0.4	41	0.6
38	0.8	33	0.4	41	0.6
60	1.3	38	0.5	44	0.4
36	2.4	37	0.6	38	0.4
34	5.3	30	1.4	31	0.5
44	0.8	30	0.5	34	1.4
38	0.6	44	0.5	42	4.5
62	1.8	48	0.8	33	0.7
36	6.5	39	0.5	32	2.3
32	0.3	37	0.7	56	0.5
38	1	42	0.6	42	1.8
36	0.7	75	0.7	31	3.2
45	0.4	48	0.6	34	0.4
53	0.6	30	0.5	35	0.5
31	13	39	0.3	36	0.3
40	2.2	40	0.5	35	0.6
45	3.8	42	2	32	0.9
34	1.2	30	0.9	32	2.6
41	1.7	44	0.5	36	1
37	1.5	37	0.6		

Site: Pilot Creek 3n06-24

Dates screens were cleaned:
June 27,1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
35	2	37	0.5	46	0.5
50	0.6	44	0.3	35	0.6
53	1	37	0.4	33	0.6
33	0.5	39	0.6	65	0.7
89	0.5	43	0.5	42	0.6
38	0.6	64	0.8	43	0.8
48	0.8	31	0.6	30	0.7
32	0.4	50	0.8	42	1.2
90	0.4	42	0.4	31	0.4
31	2.4	39	0.7	122	4.7
73	0.5	64	0.8	76	0.9
41	0.4	32	0.6	96	10.4
92	0.6	54	0.6	43	0.6
35	0.4	84	0.8	36	1.2
47	0.3	34	0.7	82	1
75	1.9	54	0.3	61	0.5
38	0.9	150	0.6	49	0.6
70	0.6	54	1.2	40	0.4
70	0.4	62	1	77	0.8
36	0.8	36	0.5	32	0.4
38	0.5	49	2.1	39	0.5
69	0.7	75	1.8	37	0.4
103	1.9	38	4.2	45	0.3
52	0.4	44	0.7	32	0.7
35	0.6	60	1.2	40	0.5
35	0.5	44	0.4	34	0.3
35	0.7	38	3.6	39	0.2
33	1.2	34	0.4	49	0.4
32	1.4	51	0.6	33	0.5
44	0.6	35	0.6	31	0.4
50	0.7	40	0.8	32	0.5
51	0.4	72	0.8	30	0.3
31	0.5	50	0.4	44	0.6
42	0.5	33	0.5	56	0.6
41	0.7	46	0.5	38	0.5
70	0.8	41	0.8	44	0.4
65	0.4	62	0.5	109	0.4
72	0.9	137	3.6	67	0.6
40	1	50	0.4	105	0.7
46	0.5	56	0.6	67	0.5

Site: Pilot Creek 3n06-24, June 27,1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
44	0.5	37	1	69	0.7
36	0.4	36	2.5	88	0.6
36	0.8				

Site: Pilot Creek 3n06-26

Dates screens were cleaned:
June 27,1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
37	2	46	1.4	50	3.5
50	0.9	81	1.4	69	0.7
30	1.5	37	0.4	48	0.6
44	0.7	39	0.5	41	0.7
31	0.8	34	2.3	34	0.9
40	6.2	60	2.7	39	0.4
52	0.7	31	1	37	1.1
48	3.3	49	0.9	45	1.8
40	3.5	91	1.1	38	1.9
35	7.3	78	1.2	34	3.9
33	8.3	51	3.4	46	2.3
30	0.6	35	1.3	46	0.4
36	0.8	41	0.5	95	1.9
53	1.1	46	0.7	72	1.3
45	0.7	39	1.3	84	0.9
84	1.5	43	2.2	34	0.3
59	2.1	61	2.3	38	0.7
95	1.2	53	2.8	45	0.7
43	0.6	39	2.8	42	0.8
32	0.8	31	0.9	38	0.5
39	0.5	42	0.5	41	1.4
41	4.3	34	1.3	33	1.7
31	0.4	32	0.7	46	0.7
55	2.4	39	0.5	46	0.9
60	3.8	56	0.6	31	0.9
36	1	30	0.4	53	0.8
42	5	32	0.8	36	0.6
70	1.1	50	0.3	44	0.7
33	0.6	44	11	35	0.9
38	1.2	41	0.5	45	0.6
33	0.5	39	0.2	37	0.8
50	1.2	34	0.6	35	0.7

Site: Pilot Creek 3n06-26, June 27,1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
60	4.7	33	2.2	33	0.6
35	0.6	47	0.8	41	0.8
56	0.9	88	1.3	38	0.8
44	0.7	42	6	33	0.6

Site: Pilot Creek 3n06-30

Dates screens were cleaned:

June 27,1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
56	5	41	0.7	57	0.5
41	0.8	32	1.1	70	0.9
100	0.6	30	0.6	45	3
49	1.5	37	0.6	41	0.6
73	4.6	67	0.7	38	1.5
56	1.4	45	1.4	34	1.8
30	0.4	38	0.4	42	0.7
88	1.3	30	0.3	56	0.9
53	2.4	31	0.2	50	1.8
32	1.3	31	0.4	37	3.2
50	4.5	37	0.5	37	0.5
52	0.4	76	0.8	40	0.9
45	0.3	32	7.6	34	0.9
40	0.9	54	0.7	37	0.8
38	0.5	34	2	33	0.9
50	0.4	66	0.8	41	0.9
39	1.3	32	0.5	49	0.7
34	0.3	30	0.5	37	0.6
40	0.6	34	0.6	36	0.6
45	1	36	0.4	38	0.9
54	0.8	57	2.3	43	0.8
45	0.4	31	0.3	39	0.5
38	2	30	3.6	40	0.4
36	0.5	41	0.5	55	0.7
33	0.3	52	1	31	0.5
30	0.4	46	0.3	34	0.6
33	1.4	69	0.4	36	0.5
52	0.4	30	0.4	40	0.2
35	0.4	37	0.6	42	0.4
40	0.8	57	1.6	33	0.4

Site: Pilot Creek 3n06-30, June 27,1995, cont'd

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
61	0.8	30	0.5	31	0.2
42	1.3	51	0.7	40	0.2
30	0.2	30	0.4	30	0.3
41	0.6	30	0.2	50	1.1
30	0.5	31	0.4	56	2.8
32	0.4	31	0.4	45	0.5
46	0.5	34	0.4	35	1.1
34	0.5	32	0.4	30	0.3
38	0.7	33	0.5	33	0.3
55	0.6	38	0.6	53	0.7
33	9.7	38	0.5	61	0.6
94	0.8	31	0.4	33	0.3
33	0.9				

Site: Pilot Creek 3n06-31

Dates screens were cleaned:

June 27,1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
44	0.4	76	1.2	75	1
38	0.7	30	0.4	77	2.6
42	0.6	38	0.3	70	0.9
47	0.6	77	1.1	47	0.9
46	0.7	104	3.5	33	0.5
40	4	57	1.3	30	1.6
37	4.7	54	0.5	76	2
52	0.6	148	1	62	0.9
55	0.4	80	3.2	32	1.3
71	0.7	55	0.4	57	0.6
37	0.7	46	0.3	83	0.7
35	0.4	50	0.3	41	1.6
41	0.6	36	1.1	41	0.5
36	0.6	52	3.9	45	0.5
70	0.5	54	0.6	34	0.5
90	0.6	52	0.6	40	4.4
53	0.6	40	0.3	36	0.3
32	1.4	53	0.6	59	1.2
33	0.7	50	8.4	76	0.4
63	0.6	45	0.6	84	0.8
36	0.9	64	0.6	43	0.6
38	0.8	51	0.7	39	1.9
49	0.6	63	0.7	52	0.6
39	2.8	35	0.4	38	0.2
53	0.6	43	0.5	62	0.6
48	0.5	35	0.5	64	0.4
46	0.9	54	0.4	105	0.7
67	0.7	31	0.4	45	1
53	0.5	79	0.5	54	0.7
32	0.9	43	0.5	65	0.8
40	0.4	41	0.5	103	0.7
42	0.3	34	3.1	52	3.2
43	0.3	56	0.4	42	1.1
40	0.5	38	0.3	46	1.6
33	2.7	33	1.4	41	0.9
35	1.3	36	0.5	85	7.5
65	2	45	0.7	42	0.8
87	1.9	64	0.5	50	2

Site: Pilot Creek 3n06-31, June 27,1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
34	0.5	40	0.7	65	0.8
33	0.4	69	0.6	34	0.2
34	1.7	87	1	63	0.6
36	0.4	47	0.8	42	0.2
58	0.6	47	0.6	96	1
46	0.4	37	0.3	52	0.4
76	0.9	34	0.9	60	0.4
46	0.4	52	0.5	31	0.6
35	0.7	129	1.3	40	0.8
44	0.2	31	1	38	0.5
38	0.6	62	0.9	77	0.6
41	0.8	41	0.5	40	0.4
34	0.5	72	1.1	49	1
36	0.3	58	1.4	36	0.4
38	0.5	34	0.2	69	0.6
46	0.3	35	1.1	44	0.4
34	0.8	45	0.4	56	0.7
30	0.6	43	1.4	42	0.6
42	0.6	40	0.5	43	0.5
40	0.5	34	2.3	36	0.2
31	0.2	35	0.4	36	0.5
76	0.5	45	0.4	57	0.4
34	1.5	63	0.5	59	0.4
50	0.3	51	0.9	36	0.4
46	0.4	31	0.3	30	0.7
52	1.6	38	0.5	37	0.3
48	0.3	57	0.9	51	0.8
51	0.4	84	2.1	32	0.8
42	0.6	38	1.5	37	0.6
39	0.4	44	0.9	50	1.4
50	1.3	36	3	36	0.9
30	0.4	66	3	34	0.8
35	0.5	109	0.8	44	0.8
40	0.5	49	1.1	52	0.5
45	0.4	32	0.7	36	0.4
46	2.1	61	1.7	45	0.5
59	0.9	30	0.2	32	0.6
59	0.5	57	0.8	41	1
32	3.5	47	0.3	34	0.2
37	0.8	60	0.6	50	0.6
69	0.5	37	0.4	37	0.9
34	1.1	40	0.4	35	3.2

Site: Pilot Creek 3n06-31, June 27,1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
71	0.9	59	0.7	40	1.6
75	0.7	46	0.9	62	1.2
133	0.7	36	0.7	48	0.4
45	0.4	42	0.8	49	0.8
31	0.8	51	0.5	37	0.5
31	0.8	68	0.8	33	1.3
46	0.4	50	0.8	38	2.6
39	0.5	30	0.7	33	1.2
40	0.4	35	0.4	47	1.3
31	2	45	0.4	128	1.2
52	0.6	63	0.7		

APPENDIX C

Raw data for woody debris captured in debris screens.

Bull Creek Watershed

Site: Bull Creek BC 23

Dates screens were cleaned:

January 29, 1994
No wood collected in screen

February 12, 1994
No wood collected in screen

November 20, 1994
No wood collected in screen

January 16, 1995

Length (cm)	Dia. (cm)
32	0.4
33	0.6
65	0.5
58	0.6
56	0.6
45	0.4
39	0.3

February 11, 1995
No wood collected in screen

April 10, 1995

Length (cm)	Dia. (cm)
32	0.2
32	0.3
40	0.3
35	0.3
36	0.3

Site: Bull Creek BC 24

Dates screens were cleaned:

January 29, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
80	0.5	42	0.6	38	0.6
72	0.5	41	0.7	38	0.8
59	0.5	39	0.7	37	0.5
54	0.5	39	1.4	34	0.5
51	0.9	31.5	1	34	0.6

February 12, 1994
No wood collected in screen

February 20, 1994
No wood collected in screen

November 20, 1994
No wood collected in screen

January 17, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
56	3	74	3.9	69	0.5
96	4	48	0.6	30	0.5
128	13.8	44	0.6	31	4.5
76	3.8	33	0.4	42	0.4
97	7	33	0.5	43	0.4
55	2.8	37	2.2	42	0.5
29.5	1.6	56	0.6	38	0.8
37	4.9	56	4.1	60	0.5
49	18.4	53	1.5	41	0.5
36	0.6	32	0.6	48	0.4
46	3.5	41	0.4	45	2.5
40	0.4	31	0.4	34	1
63	8	110	0.8	33	0.5
34	0.9	34	0.4	34	0.4
61	3.4	36	0.8	34	0.4
46	0.4	47	4.8	38	0.5
48	2.1	52	2.4	44	0.5
42	0.4	34	2.2	30	0.7
35	0.3	36	0.6	38	0.7
40	0.4				

Site: Bull Creek BC 24 (cont'd)

February 11, 1995

Length (cm)	Dia. (cm)
49	0.4
41	0.6
37	0.5
47	0.4
55	0.4
30	1.6

April 10, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
49	5	106	1.5	42	0.5
109	1.1	39	0.5	32	0.4
80	0.6	47	0.7	35	0.5
38	0.6	46	0.4	30	0.4
32	0.3				

December 17, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
35	1.5	55	0.8	49	0.5
76	0.7	56	0.6	75	0.7
36	0.9	58	0.5	52	0.6
24	0.8	42	0.5	57	0.4
73	1.1	127	1.3	41	3
39	0.5	57	8.5	35	0.4
39	0.5	44	0.8	31	0.7
49	0.4	67	0.8	48	0.6
45	0.4	30	1.8	41	0.9
129	1.3	38	1.4	37	0.7

Site: Bull Creek BC 26

Dates screens were cleaned:

January 29, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
66	2.2	42	1	34.5	0.9
57	0.6	41	0.5	34	1.1
55	0.8	40	0.5	33	1.5
48	0.9	37.5	1.3	33	0.6
47	0.6	36	0.5	31	1.9
46	0.5	36	0.7	31	1.7
30	1.2	34.5	0.6	30.5	1.2
27	0.4				

February 12, 1994

Length (cm)	Dia. (cm)
43	1.7
48	1.1
32	0.7
32	0.4
34	0.4
56	0.8
39	0.6

November 20, 1994

Length (cm)	Dia. (cm)
38	0.5
32.5	0.4
51	0.2
54.5	0.5

Site: Bull Creek BC 26 (cont'd)

January 17, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
70	3.4	53	0.6	60	0.4
62	0.7	39	0.8	57	1.3
18.4	0.6	30	1.4	69	0.8
39	0.7	45	0.8	38	0.4
39	0.8	57	0.7	31	0.7
122	1.8	35	0.5	36	1.7
49	1	40	10	31	0.5
97	2.8	32	0.6	44	0.5
46	0.9	30	7.5	71	0.7
52	0.8	41	2.4	37	0.4
80	0.6	51	0.5	32	2.3
28	0.4	44	1.7	39	1.3
35	0.9	47	1.4	37	0.4
43	1.4	41	1.7	54	0.6
44	4.2	72	0.7	49	0.6
64	14.7	38	0.4	31	0.5
69	1.8	84	4.8	31	0.9
30	0.6	37	1	31	0.7
41	0.9	35	0.5	39	1.7
44	1.1	62	5.6	38	1.6
35	0.5	40	4.4	54	1.3
38	1	46	0.8	33	0.4
50	0.6	44	0.3	30	0.6
94	1.3	56	0.6	38	0.5
33	0.4	30	0.5	37	0.5
51	0.4	30	0.4	41	0.3
32	0.5	47	0.5	52	1.6
31	0.6	30	1.9	58	0.9
49	0.7	44	1.5	31	1
62	0.7	33	1.4	41	0.3
39	0.3	37	0.3	53	3
39	0.9	34	0.9	32	10.5
69	0.5	31	0.3		

February 11, 1995

Length (cm)	Dia. (cm)
73	0.6

Site: Bull Creek BC 26 (cont'd)

April 10, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
52	0.7	32	0.3	33	0.5
91	1.3	46	0.4	55	0.9
89	1.3	86	0.8	34	16.5

December 17, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
41	0.6	32	0.6	44	0.7
52	0.4	36	0.4	89	0.8
30	0.4	32	0.5	33	0.5
57	6.6	46	0.6	39	0.5
34	2.7	38	1.1	36	0.6
62	0.7	75	0.8	98	0.8

Site: Bull Creek BC 27b

Dates screens were cleaned:

January 29, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
77	3.9	39.5	0.5	53	0.5
75	0.4	39	0.6	53	0.5
75	0.7	36	0.3	51.5	1
61	0.4	34.5	0.7	43.5	0.5
56	0.5	34	1.8	39.5	0.9
55	4.5	34	1	31	1.1

February 12, 1994

Length (cm)	Dia. (cm)
43	0.5
35	1.5
34	0.3

February 20, 1994

Length (cm)	Dia. (cm)
46.5	0.3

January 16, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
49	0.7	40	2.9	51	0.4
80	1.4	34	1.3	65	0.4
48	1.3	57	0.6	37	2.6
51	0.5	39	2.2	30	0.5
39	1.1	30	0.9	46	2
50	0.6	39	0.6	40	0.4
30	0.6	37	0.3	30	0.3
33	1.1	31	0.7	50	0.5
37	0.6	88	0.5	31	9.8
58	0.5	45	0.9	61	0.4
47	0.8	34	0.4	41	0.4
68	2.1	60	0.8	32	0.6
59	1.1	38	0.3	34	0.6
66	0.4	42	0.4	33	0.6
67	0.4	54	0.4	31	0.5
37	1.3	38	0.4	38	0.4
33	0.5	44	0.3	58	0.7
30	0.4	45	0.6	53	0.5
36	0.4	31	0.4	37	0.6

Site: Bull Creek BC 27b (cont'd)

February 11, 1995

Length (cm)	Dia. (cm)
41	1.5
38	0.4
35	0.6

April 10, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
32	0.7	35	12	54	0.4
59	0.8	45	0.7	32	0.7
71	0.5	37	0.4	35	12
62	0.4	33	0.3	45	0.7
35	8.5	33	0.3	37	0.4

Site: Bull Creek BC 36

Dates screens were cleaned:

November 20, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
68	1	32	3.5	44	3
135	5	35	2.5	35	4
47	4	55	2	39	6
45	3	70	5	54	1
77	4.5	66	2.5	54	1
37	5	50	1.5	47	2
50	2.5	35	2	50	3
34	2.5				

January 16, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
89.5	1.1	33.6	6.4	33.5	3.3
82.6	2	36.1	8.3	69	2.4
64.5	0.8	30.5	1.7	43	6
75	1.1	31.4	2.9	64	1.6
45.6	1.3	31.7	8.5	46	1.3
52.9	0.5	37.7	0.6	1	1.2
148	1.5	40.8	1.4	43	1
33.5	1	71.2	8	62	1
44	1.4	35.7	3	91	5
72.7	2	87	0.8	89	14.2
45.1	4.7	32.9	2	40	3.7
54	1.3	62	1	31	7.5
56	1.8	169	1.5	75	8.6
39	0.9	94	1.7	41	10.5
36	6	130	1.4	85	6.4
46	3.2	30	0.7	74	1.1
44	2.9	47	0.8	43	3.6
49	2.6	41	1.2	35	0.9
64	0.8	73	1.1	51	0.5
38	0.8	39	1.5	43	4
30	0.7	60	1.3	39	1
39	1.4	53	0.7	32	0.4
30	2.3	35	0.6		

Site: Bull Creek BC 36 (cont'd)

February 11, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
35	17.5	39	0.8	39	0.4
161	0.7	31	3	33	1.2
55	1.6	99	0.5	42	0.7
43	1.5	38	0.9	32	0.6
33	0.5	63	1	45	0.8
34	1.2	38	0.5	37	0.7
56	0.8	35	0.8	56	0.5
62	2	30	1.3	49	1.7
34	13	30	4	95	1.8
47	1.3	39	0.5	72	5.3
52	0.6	59	0.4	74	1.2
62	1.5	42	0.4	84	1.1
128	3.4	39	0.9	53	1.2
61	0.9	46	0.3	37	4.8
107	0.8	33	0.4	39	8.5
46	0.8	52	0.6	42	0.9
46	2.4	34	0.4	30	0.5
35	0.7	31	0.4	46	0.8
31	1.1	34	1.2	30	0.8

April 10, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
45	12.5	46	0.6	52	1.6
58	30	42	4	116	0.9
60	3.4	111	0.8	102	0.5
42	3	39	0.7	38	7.5
120	1.1	30	0.9	69	0.8
125	0.8	37	0.5	43	0.3
63	2.1	46	1.2	33	0.8
32	0.7	32	0.5	65	1.2
39	0.8	46	0.3	84	0.4
40	0.7	53	0.6	43	2.4
72	1.7	47	0.6	101	0.6
58	0.4	36	2	36	0.6
39	1.1	45	0.5	42	0.5
99	0.6	34	0.7	87	1.2
49	0.7	35	0.6	45	0.3
38	1.1	31	7.5	46	0.6
36	1.2	30	8.5	49	0.6

Site: Bull Creek BC 36, April 10, 1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
49	0.6	30	1.8	76	0.8
59	0.6	43	2.4	49	0.5
31	1.6	30	1	38	0.6
32	5.4	39	0.5	39	0.5
36	2.3	40	0.4	32	0.9
30	0.7	52	0.4	31	0.8
36	0.9	37	7.8	33	0.4
157	0.9	33	1	39	1.2
42	11	34	0.8	30	0.9
95	0.9	41	0.7	34	1.7
48	0.5	83	0.8	70	0.7
51	2.3	79	0.7	36	0.7
44	0.5	63	0.4	38	1.4
53	0.7	45	0.5	61	1
46	0.5	70	0.9	64	0.7
33	0.5	82	0.6	31	2.3
35	1	46	0.7	48	0.5
52	0.4	40	0.7	94	0.7
35	0.6	53	1.3	48	0.4
30	1.1	31	5.4	62	0.6

Site: Bull Creek BC 59

Dates screens were cleaned:

December 11, 1993

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
71.5	1	46	0.6	32	0.3
39.5	6.6	42	0.5	33	0.3
59	0.5	33	0.3	57	0.3
46	0.4	39	0.5	31.5	4.8
37.5	0.4	34.5	0.5	47	0.4
35	0.4	51	0.6	61	0.6
34	0.3	40.5	0.6	41	0.4
61.5	0.7	51	0.4	44	0.4
33	0.5	43	0.4	57	0.05
52.5	0.4	56	0.5	39	0.4
43	0.5	67	0.4	36	0.4
62	0.4	42	0.4	56	0.5

January 29, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
109	1.4	41	0.4	48.5	0.8
105	0.9	39	1.4	48	1
104	6.6	37.5	1.9	45	0.4
70	0.7	35.5	1.1	43.5	0.8
56	7.8	35	0.5	34.5	3.8
50	0.9				

February 12, 1994
No wood collected in screen

November 20, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
67	3	45	3	65	4
105	3	70	4	40	3.5
50	4	60	5	43	4
37	3.5	72	2	40	3
43	4	66	2	59	5
33	4	54	4.5		

Site: Bull Creek BC 59 (cont'd)

January 17, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
424	4.2	52	15.8	68	0.7
230	11	51	6.5	40	1.4
136	1.6	42	0.4	48	0.8
153	3.1	38	3	39	2.9
176	3.7	32	2.4	41	2
137	4.8	32	0.7	51	0.5
105	2.9	34	0.5	45	0.4
106	1.5	34	0.5	39	0.4
89	0.7	34	0.6	55	0.6
126	0.6	38	1	49	0.4
121	1.9	38	0.5	48	0.6
104	1	34	0.4	48	2.3
102	15.8	39	0.4	47	1.4
91	1	51	5.8	46	0.5
96	10	32	0.7	57	0.6
106	1.1	40	0.6	50	0.7
95	15.7	40	4.7	46	0.5
61	0.6	42	6.5	47	1.1
78	0.7	39	2.2	52	0.5
85	1	31	1.4	39	0.7
85	0.5	34	1.1	61	0.8
68	0.6	38	3.3	34	0.3
56	0.9	32	0.9	46	3.1
71	0.8	35	2	47	7.5
83	0.9	48	0.8	56	2.7
75	5.6	31	1.1	30	0.5
72	2.9	34	0.7	39	2.4
67	2.8	33	2.3	40	6.5
65	0.6	35	0.6	36	0.4
71	1.8	41	5.5	52	0.6
74	0.7	31	9	48	0.6
64	0.7	31	1.4	44	0.8
33	0.6	42	3.4	39	0.5
33	0.5	31	1.2	42	0.5
72	0.4	35	9.4	48	0.5
63	0.6	31	5.5	41	4.5
74	0.7	46	0.7	39	1.3
69	0.5	39	21	30	1.4
66	0.7	31	11.5	49	1
59	1	30	6.5	43	0.4

Site: Bull Creek BC 59, January 17, 1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
71	0.7	31	3.5	31	1.3
59	0.4	59	0.9	58	17.6
56	0.3	59	3.8	52	1.3
60	0.8	48	15	61	0.7
74	2.9	54	0.4	49	0.5
33	0.5	69	0.7	54	5.5
59	0.4	45	0.4	49	3.3
58	0.7	50	0.4	44	0.5
70	3.8	35	0.3	46	0.6
72	6.9	54	0.6	44	0.6
61	0.7	45	0.5	51	0.9
34	0.4	38	0.4	39	0.4
41	0.4	41	0.4	35	0.4
49	0.6	36	0.5	49	0.8
50	1.1	49	0.5	38	0.8
57	0.9	31	0.5	59	1.3
55	0.7	42	0.5	53	0.7
48	0.6	44	0.3	68	1.2
40	0.5	54	0.3	46	0.6
59	0.9	41	0.4	54	1.7
62	3.1	44	0.5	66	11
43	0.4	36	0.4	53	7.5
43	0.6	33	2		

February 11, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
44	0.5	34	2.4	40	0.5
43	0.4	35	0.3	60	0.6
106	0.5	35	0.4	49	0.8
37	8.8	34	0.4	86	0.8
78	10.4	31	0.6	36	2
53	0.5	73	1.7	34	0.8
43	0.6	50	2.8	31	1.3
39	0.5	56	2.2	58	0.6
60	0.6	68	0.7	51	0.6
32	1.3	30	1.2	45	0.6
42	0.4	49	4.7	63	1.9
30	1.4	48	0.4	37	0.4
37	0.4	31	0.5	43	0.5
39	0.6	52	0.5	96	0.7
53	0.7	79	0.6	37	0.6
46	0.7	67	4.3	38	0.6
43	0.5	40	0.4		

Site: Bull Creek BC 59 (cont'd)

April 10, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
30	0.5	36	1.1	43	0.4
47	0.7	66	0.5	39	1.9
44	0.5	55	0.8	42	1
52	0.4	55	0.8	30	0.6
38	0.5	56	0.7	38	0.5
43	0.8	54	0.4	36	0.5
33	0.2	41	0.4	43	0.3
45	0.3	55	0.5	41	0.6
42	0.3	39	0.3	35	0.3
64	0.9	34	0.4	46	0.6
43	0.4	32	0.2	31	3.5
41	0.5	54	0.8	46	0.6
41	0.6	49	0.7	38	0.3
56	0.5	42	0.4	50	0.7
30	0.4	43	7.5	32	0.3
54	0.5	32	3.6	30	0.6
39	0.4	85	0.9	48	0.8
31	0.4	110	1.3	49	0.3
58	0.9	45	0.4	69	0.6
37	0.7	45	2.8	43	0.4
34	0.4	46	0.4	42	0.5
49	0.5	37	0.4	78	1
38	0.5	40	0.5	89	0.8
48	0.6	47	0.3	56	0.5
36	0.8	34	0.5	43	0.4
55	0.5	38	0.4	81	0.9
46	0.5	37	0.5	40	0.4
30	0.4	32	0.4	55	0.6
47	0.3	37	0.5	41	0.4
72	0.7	62	0.6	39	0.3
75	0.8	34	0.4	32	0.3
67	17	37	0.4		

Site: Bull Creek BC 65

Dates screens were cleaned:

January 29, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
218	1.4	34.5	0.6	43	0.8
108	0.8	33.5	0.7	42.5	4.6
105	0.6	32	5.1	42.5	7.9
104.5	1.2	31.5	1.2	40.5	0.8
104	0.9	31	9.8	40.5	1.1
87	0.8	31	1.4	38	0.9
86	0.7	30.5	3.8	36	4.4
85.5	1.2	48	0.9	36	1.3
70.5	1	45	1.1	36	1.1
64	0.5	44	1.1	35	5.3
61	0.6	43.5	0.9	54	0.6
58.5	1.3	43	1.8	51.5	1.2
57	2.3				

February 12, 1994

Length (cm)	Dia. (cm)
60.5	1.6
37	1.1
54	0.8
42.5	0.3
44	0.3

November 20, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
34	0.4	37.8	0.3	38.8	1.2
60.1	0.45	48.2	1.3	39.9	2.2
39	0.6	44.5	0.3	41.6	0.2
32.6	0.3	30.4	2.9	31.2	1.2
44	0.7				

Site: Bull Creek BC 65 (cont'd)
January 17, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
66	4	73	0.8	32	0.9
67	2.2	40	4.4	30	0.6
90	1.7	46	1	34	0.5
69	5.8	105	3.3	31	0.4
31	18.2	59	12.6	40	0.3
48	4.7	9	11.9	46	1
38	1.9	62	16.5	31	1.3
64	0.9	119	29.6	40	1.6
50	8.9	51	1.1	81	0.9
37	6.2	95	5.4	49	1.6
51	3.3	38	3.7	46	2.5
34	5	36	3	45	1.1
34	1.1	33	2.9	86	2.7
45	3.4	79	4.6	112	1.3
32	1.2	39	14.5	178	1
65	1.6	135	7	30	5.2
35	0.7	36	4.3	51	3.4
50	10	36	0.6	32	6.4
58	1.4	35	4.4	33	0.7
31	0.6	49	6.1	35	0.8
30	1.8	32	3.5	57	1.6
94	0.9	37	7.3	42	1.3
38	1.8	37	0.7	45	1.5
32	2.5	33	4.2	46	0.8
32	0.6	32	0.3	49	0.7
85	8	57	0.8	39	0.2
43	2.2	37	0.5	30	0.6
32	3.9	32	1.4	35	0.2
40	2.1	44	1.2	41	2.1
30	3.3	54	0.6	45	0.5
30	1	52	0.5	41	0.4
50	5	31	0.4	66	0.9
43	1.3	35	7.4	42	0.5
41	2.5	40	0.5	38	0.4
40	0.3	33	8.6	150	1.2
33	0.4	67	9.6	32	1.3
33	5.4	82	13	63	2.1
35	0.3	41	8	47	5.5
35	1.2	52	2.5	208	2.2
36	0.2	30	0.5	89	2.7
41	0.4	36	0.6	159	3.1
34	0.4	76	8	39	1.8

Site: Bull Creek BC 65, January 17, 1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
37	0.4	31	0.4	56	4.5
84	0.5	95	9.5	63	0.4
85	3.5	42	7.5		

February 11, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
34	1.4	53	0.7	36	0.5
44	0.8	40	0.8	32	5.4
36	1.6	46	0.2	32	2.5
48	0.6	59	11.2	34	1.2
30	2.3				

April 10, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
67	1.2	102	2.7	54	4.5
69	0.9	45	9.4	38	6.5
37	1.3	62	5	46	12
65	1	62	5.8	40	7.8
48	10	35	5.2	40	1.4
37	3.8	30	1.3	66	0.5
74	1	31	0.9	32	3.2
85	1.6	37	0.4	33	0.4
106	12	39	0.5	30	0.4
34	3.7	34	5.6	41	0.6
31	1.1	36	0.5	44	0.4
41	8	85	2.4	36	0.8
50	0.3	38	2.2	33	5.5
67	0.6	59	1.1	55	1.1
30	1.3	62	1.8	45	0.7
38	0.4	52	3.2	39	3.8
34	0.3	51	6	39	1
50	0.4	31	5.7		

APPENDIX D

Raw data for woody debris captured in debris screens.

Coyote Creek Watershed

Site: Coyote Creek CC 517

Dates screens were cleaned:

January 30, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
49	1	36	0.9	39	0.8
32.5	0.6	35.5	0.5	34	0.5
46	0.9	32.5	0.7	36.5	0.7
33.5	0.6	38.5	0.5	32	0.6
36.5	0.6	41	0.9	40	0.6
31.5	0.4	37	0.4	42	0.4
				31.5	0.4

February 13, 1994

Length (cm)	Dia. (cm)
43	0.6
30	0.5
46	0.6
34	0.6

November 12, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
55.6	0.7	30.2	0.3	36.9	1
64.6	1.3	40.1	1.1	30.9	0.4
65.5	0.8	30.9	0.8	33	0.5
66.9	0.7	32.1	0.7	32.3	0.6
68.7	0.6	34.5	0.3	32.9	0.8
60.5	1.1	32.7	0.5	33.4	0.6
37	0.6	34.8	0.5	40.4	0.8
37.9	0.7	34.3	0.5	35.9	0.4
33.5	0.7	68.1	0.9	35.5	0.6

January 13, 1995
No wood in screen

Site: Coyote Creek CC 517 (cont'd)

February 5, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
35	2.6	35	0.6	35	0.6
50	0.7	41	0.5	32	0.6
43	0.4	45	1.4	70	9
36	0.5	33	0.7	42	5.7
34	0.8	32	0.9	31	4.3
39	1.7	40	0.4	43	0.1
35	0.8	42	1	36	1.4
35	0.7	41	0.8	25	0.2
40	5.5	41	2.6	46	0.6
40	0.5	45	0.5	49	0.7
45	0.6	30	1.3	33	0.5
30	0.6	60	5	47	0.8
43	0.5	35	0.6	51	1
33	1	86	7	51	2.7
55	3.5	33	0.7	31	0.5
32	0.7	34	4	49	1.8
51	4.4	36	1.3	89	0.4
43	1.2	53	1.2	51	0.5
83	0.5	64	9	43	0.7
51	0.8	60	4.4	39	0.8
42	1.7	41	0.4	34	1
36	0.7	31	0.5	34	0.6
38	0.9	57	1.8	48	1.1
47	0.6	45	0.6	43	1.5
33	0.6	37	0.5	30	4.5
46	0.7	34	0.9	50	0.5
73	1.1	33	0.6	32	0.8
69	5.5	30	0.5	37	0.5
72	0.9	37	0.9	61	1
34	0.8	63	0.6	90	4
32	1.6	35	0.7	39	1.2
50	0.6	42	0.4	35	0.5
61	4.5	42	0.6	34	0.5
86	0.4	35	0.8	36	0.5
30	0.6	39	0.8	32	0.5
35	0.4	35	0.6	45	1.3
				46	0.6

Site: Coyote Creek CC 517 (cont'd)

April 2, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
31	0.8	30	0.4	50	0.9
41	1.1	61	1.4	53	0.6
32	1.3	32	0.9	30	0.4
42	0.8	61	1	60	1.1
49	0.4	31	1.1	30	0.8
57	0.7	44	1.8	30	0.4
71	0.9	48	0.7	34	0.9
31	1.4	30	0.5	32	0.5
65	0.5	31	0.7	34	0.4
40	1.7	32	0.4	30	0.7
32	0.8	34	0.8	30	0.8
43	0.3	35	1.1	35	11
41	0.8	41	0.7		

June 9, 1995
No wood in screen

Site: Coyote Creek CC 520

Dates screens were cleaned:

November 12, 1994

Length (cm)	Dia. (cm)
47.3	0.7
30.4	0.6
31.6	0.4
37.1	0.6
34.9	0.7
47.8	1
32.6	1.6

January 13, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
48.5	0.7	45.6	0.6	39	0.6
63.3	1.8	31.2	2.6	37.6	0.6
68.2	0.8	39.1	0.5	44.1	0.6
37.1	0.8	40	2.6	36.4	0.5
36	0.9	30.6	0.7	33.6	0.5
52.1	5.8	33.9	0.7	41.1	1.5
42.5	0.7	49	2.5	52.7	1
32.6	0.5	45.7	0.7	40.1	0.7

Site: Coyote Creek CC 520 (cont'd)

February 5, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
30	5	36	0.9	37	0.8
60	0.8	51	1.1	34	0.8
34	2	51	1	36	0.7
31	0.6	37	0.8	66	0.9
90	2.2	55	0.8	41	2.2
57	2.7	36	2	47	0.8
104	4.8	31	1.2	45	2.3
46	1.2	34	1.3	30	2.1
56	2.4	39	0.7	56	0.6
110	3.4	105	4.8	35	1.2
40	1.8	35	1.3	55	2.2
40	1.8	36	0.8	34	0.6
34	0.5	43	0.5	35	0.6
35	1.6	47	1.2	54	3.6
44	2.2	41	5.4	58	0.6
36	0.8	42	0.7	62	3.4
109	7.6	54	0.8	52	2.4
39	1.2	33	0.8	102	2.8
30	0.8	45	0.8	39	0.8

April 2, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
33	0.4	30	0.8	32	0.7
34	0.7	63	1.2	30	0.9
38	1.1	43	0.9	34	0.7
36	1.7	37	0.8	45	5.7
33	1.2	31	0.7	31	0.6
53	2	37	0.8	30	0.7
40	0.5	31	0.6		

June 10, 1995
No wood collected in screen

Site: Coyote Creek CC 1721

Dates screens were cleaned:

November 12, 1994
No wood collected in screen

January 13, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
39.6	0.3	34.5	0.3	30.9	0.3
48.2	1.5	31.2	0.2	33.3	0.3
35.3	0.6	34.4	0.4	33	0.4
47.9	0.4	33.1	0.5	46.5	0.7
31.7	0.7	39	0.3	33.4	0.3

February 5, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
75	1.7	62	1.1	47	1.3
39	0.6	61	1.1	33	1
75	0.8	35	0.7	34	0.4
39	0.4	31	1.1	35	0.2
33	0.6	46	2	42	0.2
47	1	40	2.1	42	0.2
34	0.3	48	1.3	50	0.2
42	1.3	34	1	41	3
37	1.4	32	1	34	0.5
37	9.8	90	5	100	0.4
35	0.6	49	4	41	0.8
50	1.2	48	6	50	0.6
32	1	60	6	52	1.8
31	3	45	1.1	40	0.6
55	0.4	35	5	67	0.6
41	0.6	50	0.8	60	0.1
50	0.3	62	0.8	40	0.5
31	0.6	43	5	34	0.8
45	0.7	42	2.3	43	0.4
34	0.5	44	1.2	33	0.8
46	0.8	35	1.6	36	1.2
51	1.1	32	0.4	37	0.3
44	1	40	0.6	47	0.5
72	1.1	32	0.6	34	0.7
42	1.4	35	0.4	30	6.5
75	1.1	47	2	55	1
69	1.4	45	4	40	0.8

Site: Coyote Creek CC 1721, February 5, 1995 (cont'd)

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
30	2.4	39	10	42	0.4
103	3.4	62	1.7	40	0.7
58	1.8	94	1.6	41	0.5
54	4.8	110	2	32	0.6
37	5.2	38	2	35	0.4
46	0.7	62	2.6	75	3.5
44	0.9				

April 2, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
47	0.7	32	1.4	30	0.6
34	0.8	50	3.8	33	1.2
35	1.7	38	0.4	32	0.9
33	0.4	34	0.3	32	0.4
34	0.7	42	0.4	53	1
32	0.3	61	0.4	33	0.4
30	0.3	47	0.3	33	0.4
51	16.5	36	0.3	40	0.5
43	1	34	0.4	39	0.2
31	0.5	33	0.3	31	0.3
				125	1.1

June 10, 1995

Length (cm)	Dia. (cm)
35	1.9

Site: Coyote Creek CC 1725

Dates screens were cleaned:

January 20, 1994
No wood collected in screen

January 30, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
43	0.6	39.5	0.5	51	1.6
40.5	0.4	61	0.6	43.5	1.1
30.5	0.5	33.5	0.6	90	1.4
41	0.7	34	1.8	71.5	1.1
32.5	0.4	33	0.7	53.5	0.7
46.5	9.7	31.5	0.5	30.5	0.5
40.5	0.6	39.5	0.8	35	0.4
62	1.6	75	0.4	35	0.7
31.5	0.6	48	0.5	54.5	2.2
32	0.4	31	0.9	58	1.6

February 13, 1994

Length (cm)	Dia. (cm)
40	0.3
62	0.8
35.5	0.6
32.5	8.5
33	1.5

November 12, 1994

Length (cm)	Dia. (cm)
36	0.4
30.4	0.2
38.4	0.4
31.9	0.5

Site: Coyote Creek CC 1725 (cont'd)

January 9, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
104	1.6	50	0.4	31	1
88	5.2	40	0.8	34	0.6
31	6	31	0.6	52	1.4
120	4.5	50	0.8	52	0.8
58	4.6	31.5	0.8	40	0.6
94	5	42	0.8	40	1
59	3	31	0.6	39	0.6
37	3				

January 13, 1995

Length (cm)	Dia. (cm)
39.3	0.8
34.2	1.3
38	0.5
34	0.6

February 5, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
60	0.7	44	1.1	30	0.5
54	4.5	50	0.6	43	0.8
35	0.6	63	3	30	0.5
38	0.9	35	3.4	35	0.7
37	1.1	40	0.8	31	1.1
38	1.6	36	10	35	1.2
31	14	32	15	36	1.2
53	0.4	30	0.4	64	1.6
60	0.6	30	0.4	44	0.4
53	4.5	35	0.6	70	2.8
39	2.2	38	0.3	64	3
39	0.7	39	0.6	30	1.5
40	0.8	35	0.6	43	2.2
42	1.1	50	0.6		

Site: Coyote Creek CC 1725 (cont'd)

April 2, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
45	15.2	93	1.6	33	0.6
44	0.6	76	1.1	53	4.7
32	0.9	50	3	105	1.3
55	1.3	30	1.8	55	1
32	0.3	41	2	36	1.1
33	1.2	31	3.3	126	5.5
34	0.6	52	0.8	77	0.7
110	0.8	38	0.2	48	1.5
31	0.5	45	0.4	64	0.3

June 9 1995

Length (cm)	Dia. (cm)
32	0.7
32	0.8
40	0.3
46	0.5

Site: Coyote Creek CC 1728

Dates screens were cleaned:

November 12, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
35.9	0.7	36.2	0.6	41.6	0.5
42.5	0.6	42.3	0.5	30.2	0.6
43.1	1.8	30.3	0.5	32.4	0.7
33.2	0.9	51.2	0.5	38	0.5
56.8	1.1	34.3	0.4	37.7	0.5
35.7	0.8	30.1	0.7		

January 8,1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
61	3.4	30	1.6	45	0.4
31	0.6	35	0.5	45	1
43	0.4	48	0.4	38	0.5
41.5	0.6	38	0.6	30	0.3

January 13, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
82	5.5	49.6	0.8	70.8	0.5
31.7	1.1	44	0.5	59.3	0.6
44	1.3	81.5	2.8	66	3.7
99	1.2	58	2.4	37.2	2.4
31.1	1.1				

Site: Coyote Creek CC 1728 (cont'd)

February 5, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
60	1.3	31	0.8	30	0.7
30	3.3	35	1.8	39	1
33	1.3	36	1.8	42	0.7
67	1	33	1.3	30	1.7
35	1.3	37	0.9	43	3
30	2.8	36	0.7	34	14.2
38	1.8	30	1.8	50	1.2
66	1	67	0.7	40	2.4
61	1.5	67	3.6	37	4.9
35	0.8	35	0.7	33	0.9
36	1.8	65	0.5	37	1
49	0.4	36	0.4	38	3.8
48	0.8	36	0.8	63	2.7
33	0.7	47	0.8	48	0.4
36	0.8	40	0.8	30	0.5
35	1.4	47	0.7	53	0.5
40	1.1	45	0.8	32	0.9
46	3.4	50	0.5	55	0.7
31	1.5	45	0.4	65	4.4
36	0.4	38	2.7		

April 2, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
103	3	33	0.7	84	6.7
82	1.9	31	0.6	41	4.6
88	1	38	0.3	41	1.3
45	2.3	32	0.8	36	0.6
55	4	32	0.3	41	0.6
51	0.8	38	1.2	44	0.5
94	1	34	0.3	39	0.5
59	0.6	45	0.5	30	0.8
52	1	30	0.5	43	0.9
36	0.5	36	0.4	46	1.8
31	0.4	37	0.6		

June 9 1995
No wood collected in screen

Site: Coyote Creek CC 1731

Dates screens were cleaned:

January 20, 1994

Length (cm)	Dia. (cm)
54.1	0.6
32.6	0.4
32	0.5
31.6	0.4

January 30, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
64	0.6	40	1	42	1
85	1	36.5	0.9	47	1
38.5	1	32	2.5	43	0.6
37.5	0.9	50	0.5	43.5	0.6
62	4.4	35	0.8	30.5	0.8
32	1	34.5	0.6	32	4.7
33	0.4	31.5	0.8	38	1
62	1	30	0.7	42	0.6
32.5	0.6				

February 13, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
55	1.2	45.5	0.6	31.5	0.5
30.5	1	39	0.4	35	0.9
40	0.5	32	0.3		

November 12, 1994

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
60.9	0.8	33.4	0.6	46.2	2.2
43.2	0.6	40.8	1.3	48	1.7
58.2	1	39.3	2	45.8	1.3
38.5	1.8	31.4	1.4	44	0.9
43.5	0.5	40.5	0.3	43.4	0.9

Site: Coyote Creek CC 1731 (cont'd)

January 13, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
49.2	1	51	3	31	1
46.7	1.1	42	6	42	1.2
31	1	71	2.5	83	3.4
62	2	36	2.5		

February 5, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
33	14.5	31	1	39	0.6
41	1.5	47	1.1	31	0.6
62	9.5	32	1.8	33	1.1
34	4.5	30	25	58	0.6
56	0.6	46	0.8	31	0.8
55	0.7	34	0.9	45	0.5
39	1.4	33	0.8	44	1.6
47	4.8	40	2	47	0.9
39	1.3	31	0.5	33	1.2
35	1.4	38	0.4	30	0.5

April 2, 1995

Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)	Length (cm)	Dia. (cm)
31	20.5	30	13.8	34	0.7
56	0.7	49	1.1	30	0.5
48	2	72	1	37	8.4
105	2.1	62	0.7	51	0.7
66	2.6	60	0.9	39	0.4
59	0.7	39	0.8	42	0.5
34	18.5	35	1.5	33	0.6
43	6.9	38	0.4	38	0.4

June 9 1995

Length (cm)	Dia. (cm)
35	2.1