Three concerns about Oak Creek bed-load study

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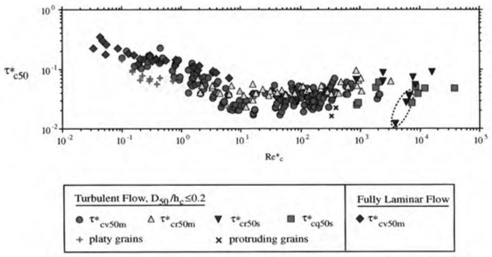
The following figure is from Buffington and Montgomery, 1997, the three points in the dotted oval are from Oak Creek near Corvallis, Oregon. Why are the Oak Creek points an outlier?



Topics in this poster

There are three topics considered in this poster that may help explain why the Oak Creek points in the Buffington and Montgomery figure are an outlier. The two most important are:

1. **Sampling and quantification of bed-surface material (armour) size.**
2. **Specific gravity of Oak Creek bed-material**

The third topic may not be important in the Buffington and Montgomery analysis but could be important in other studies.

3. **Change in median size of armour with time resulting from the discharge time series**

The fourth topic is to put the Oak Creek sampling period in prospective relative to the possible bed-material movement in other years.

4. **Oak Creek sampling period in a long term time series**

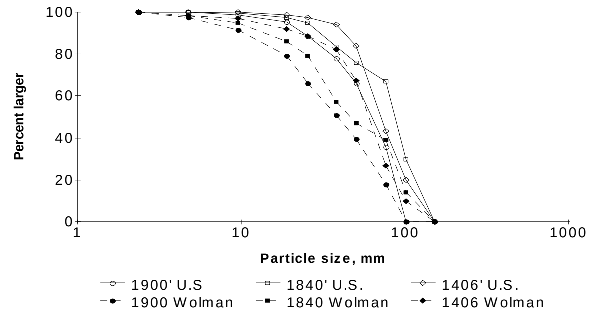
Sampling and size quantification of bed-surface material

The three most common approaches to bed-surface material sampling are the Wolman pebble count, and area sampling where the size distribution is either by counting the particles in a size range or weighing the particles in a size range. Kellerhals and Bray, 1971, presented an argument on the best sampling method to use for a give study and how to convert between the methods. The factors used in the conversion are below. D is the size of the particles. See Kellerhals and Bray for details.

	Conversion to		
Conversion from	Grid by number (pebble count)	Area by weight	Area by number (barrel sample)
Grid by number	1	D	$1/D^2$
Area by weight	1/D	1	$1/D^3$
Area by number	D^2	D^3	1

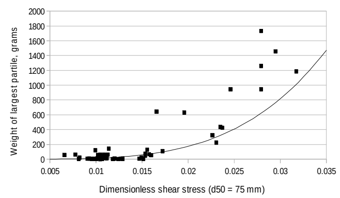
The Oak Creek study used area by weight sampling. It is possible most of the other points on the Buffington and Montgomery figure used an approach that gave results closer to the pebble count than area-by-weight.

A comparison of the original distribution of the sizes of three Oak Creek armour measured using area-by-weight to the distribution after converting to grid-by-number (Wolman pebble count) are in the figure below.

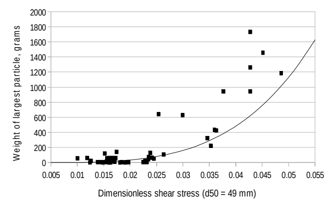


Type	Location			Average
	1900' U.S	1840' U.S.	1406' U.S.	
Area by weight	64	88	72	75
Wolman pebble count	39	47	62	49

Area-by-weight



Wolman pebble count

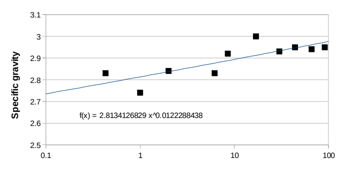


Using the #4 sieve size (4.76 mm) as the lower limit on gravel and assuming sphere the 'critical dimensionless shear stress' is when the gravels start to move, the dimensionless shear stress for area-by-weight is 0.020 and for the Wolman pebble count 0.030. A specific gravity of 2.81 was used in the calculations.

The fall 1971 sample time was about 24 hours. It is possible the length of the sampling period is part of the reason for the Oak Creek anomaly on the Buffington Montgomery diagram.

Specific gravity of Oak Creek bed-material

The bed material is a basaltic material derived from the Tholeiitic Siletz River Volcanics (Snavely et al,1968). Snavely et al analyzed samples collected in the Corvallis area; three of the samples are from areas about equidistant from the Oak Creek watershed. Using the average composition data from Snavely et al and specific gravity information given in Dana's Manual of Mineralogy a theoretical specific gravity of 2.93 to 3.07 was calculated.



The line drawn on the figure is a trend line from 2.98 at 100 mm to 2.74 at 0.1 mm. A better relation is a step function with a break at 8 mm. The specific gravity is 2.95 for particles > 8 mm and 2.81 for 0.1 – 8 mm.

Change in median size of armour

The bed- surface material in Oak Creek did change during the bed-load sampling period. This table is from Milhous, 1973. The representative particle sizes for armour material in Oak Creek near the sediment trap are shown in the following table.

Date	Median size of grouped Samples, cm	Range of Median size of samples, cm	D65, cm	D35,cm	D65/D35
26 October 1969	4.8	4.3-5.0	5.8	4.1	1.42
26 October 1970	5.2	4.6 - 6.3	5.9	4.3	1.37
29 January 1971.	6.3	4.3 - 8.4	7.3	5.2	1.43
27 July 1971	6. 3	4.5-7.6	7.4	5.2	1.42

The time dynamics of bed-surface material size would be worth modeling. There are two possibilities for Oak Creek. One is that the smaller sizes were removed during high water in January leaving the larger particles as the surface material. The second is that larger sizes were transported from upstream into the study reach.

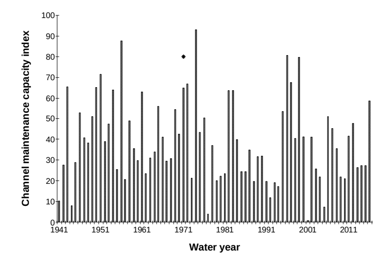
Oak Creek sampling period in a long term time series

An index to the ability of the river to maintain its channel is used to obtain some idea about the annual potential of the river to move the bed-material. The equation used in the present analysis is:

$$CMCI = \sum_{i=1,n} \frac{Qd(i)^{\beta} - Qcrt^{\beta}}{Qref^{\beta}}$$

where CMCI is the Channel Maintince Capacity Index, Qd(i) is the daily discharge in day i, Qcrt is a discharge below which the streamflows contribute little to the maintance of the channel, Qref is an arbrtary reference discharge. The summation is over the n days the daily discharge exceeds the critical discharge.

Streamflow data for the Luckiamute River near Suver, Oregon is used to obtain some idea about the potential of bed material movement in the region close to Oak Creek. The Luckiamute River is found to the north of the Oak Creek watershed. The critical discharge was assumed to be the discharge at which the average channel velocity was 1.5 fps. In the Luckiamute River this is a discharge of 1530 cfs. Shear stress moves the bed, if the river slope and unit weight of water are constant the shear stress is proportional to the depth which is roughly proportional to the $Q^{0.5}$; therefore β in the equation is 0.5. The reference discharge used was 1000 cfs.



The * on the diagram indicates the year with the bed-load samples. The Oak Creek bed-load samples were obtained in a year that probably had higher discharges than average and total potential for movement was much larger than normal. This may have explained why the bed-surface material changed during the year.

Reference

Buffington, John M. and David R. Montgomery. 1997. A systematic analysis of eight decades of incipient motion studies, with special reference to gravel-bedded rivers. Water Resources Research, Vol. 33, No. 8. August 1997. pages 1993–2029.

Kellerhals, Rolf and Dale I, Bray. 1971. Sampling Procedures for Coarse Fluvial Sediments. Journal of the Hydraulics Division. Proceedings of the American Society of Civil Engineers, Vol. 97, No. HY8. August 1971. pages 1165-1179.

Milhous, Robert T. 1973. Sediment Transport in a Gravel-Bottomed Stream. Thesis presented to Oregon State University, at Corvallis, Oregon., in 1973, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.