Analysis of loadings

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The next block prints a table of the proportion of total phosphorus loading due to each class of event at each site

	snowmelt-driven	early post-snow	late post-snow
eagle	27.0%	29.1%	43.9%
joosvalley	26.9%	20.5%	52.6%
otter	35.4%	20.5%	44.1%
brewery	32.8%	4.5%	62.7%

Table 1 – Proportion of total suspended solids loading contributed by each type of event

	snowmelt-driven	early post-snow	late post-snow
eagle	32.8%	22.9%	44.2%
joosvalley	36.4%	16.9%	46.7%
otter	46.5%	16.6%	36.9%
brewery	49.6%	4.5%	45.9%

Table 2 – Proportion of total phosphorus loading contributed by each type of event

Produce plots of the proportion of the suspended solids and phosphorus (both total loading and stormflow loading) that is contributed by each class of event at each stream site:

Figure out what proportion of total sediment loading is contributed by the top 10% of storms:

1 Data

Description The data in this report comes from four Wisconsin streams that were monitored (with some gaps in data collection) between 1989 and 2007. The streams and the period during which each was monitored are:

Stream	**Monitored**
Eagle	1991-1994, 2003-2007
Joos Valley	1990-1994, 2002-2007
Otter	1990-1997, 2000-2002
Brewery	1989, 1994-2002, 2004-2005

Each entry in our data set represents one "loading event", which is defined based on the hydrograph - the event begins when the loading rises from a base level toward a peak, and ends when the loading falls back to its new base level. Two kinds of load are measured for each event - the sediment load and the phosphorus load. There are two typical ways that sediment and phosphorus get into streams - they can be carried either by runoff during a rainstorm or by melting snow.

Not all of the data can be collected for each event. For instance, rainfall is measured only when the ground is free of snow because snow interferes with the rain gauges. And the amount of snowmelt is estimated by multiplying the water content of the snow by the change in snow depth a warm snap, which is inaccurate when additional snow falls during that event. Broadly, there is one set of measurements that are made during rainfall-driven events and a different set of measurements that are made during snowmelt-driven events. Because of this, the two types of event are modeled separately.

Within the category of events that are driven by rainfall, we investigate making a further split (on May 15 each year) between "early post-snow" and "late post-snow" events. Erosion may be more common early in the spring, before most of the summer's vegetation appears, which would alter the relationship between our inputs and outputs. See the Modeling section for further discussion of this split.

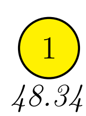
Exploratory Analysis Our anaysis targets the phosphorus and sediment loads carried by each stream. Using "Rainmaker" software, each load can be broken into two parts: base load and storm load. We will consider models of the storm load and of the total load.

Over the course of the monitoring period, the majority of the total load (both of sediment and of phosphorus) was carried during just a few major events. Just 10% of the events carried between 0% (at Eagle) and 0% (at Eagle) of the total sediment load and 0% (at Eagle) and 0% (at Eagle) of the total phosphorus load.

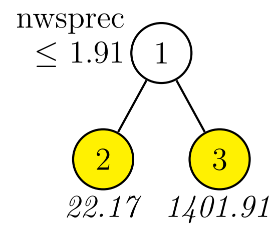
Table 3 shows that the major loading events that produce the majority of the loading can be occur during each of the three annual periods. However, the events caused by snowmelt produced a smaller proportion of major events than their proportion of all events, and their relative contribution to the total sediment load was smaller than their proportion of loading events. So while snowmelt *can* cause a major loading event, a snowmelt-driven event is less likely to be a major event than is one driven by rainfall.

	Snowmelt		Early post-snow		Late post-snow	
Creek	All	Major	All	Major	All	Major
Eagle	42%	30%	13%	19%	45%	51%
Otter	41%	42%	11%	19%	48%	40%
Joos	46%	31%	11%	17%	43%	52%
Brewery	56%	52%	6%	6%	38%	42%

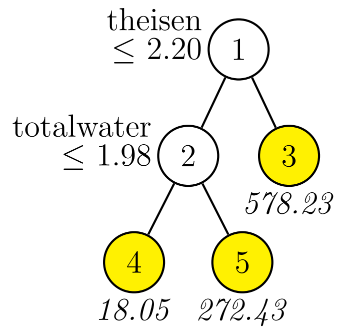
Table 3 – Each pair of columns represents one of the three annual periods. The column on the left of each pair is the proportion of all events in the study that occured during this period; the column on the right is the proportion of major events that occured during this period.



GUIDE piecewise constant least-squares regression tree model. At each intermediate node, a case goes to the left branch if and only if the condition is satisfied. Number in italics beneath leaf node is sample mean of stottot.



GUIDE piecewise constant least-squares regression tree model. At each intermediate node, a case goes to the left branch if and only if the condition is satisfied. Number in italics beneath leaf node is sample mean of stottot.



GUIDE piecewise constant least-squares regression tree model. At each intermediate node, a case goes to the left branch if and only if the condition is satisfied. Number in italics beneath leaf node is sample mean of stottot.

2 Analysis

Variable selection In order to make a model of the load carried by the stream, we need to select the predictor variables that have explanatory power. We use stepwise regression with the Bayesian Information Criterion (BIC) to screen the potential predictor variables.

References

[1] M.E. Danz, S.R. Corsi, D.J. Graczyk, and R.T. Bannerman. Characterization of suspended solids and total phosphorus loadings from small watersheds in wisconsin. Scientific Investigations Report 2010-5039, United States Geological Survey, 2010.

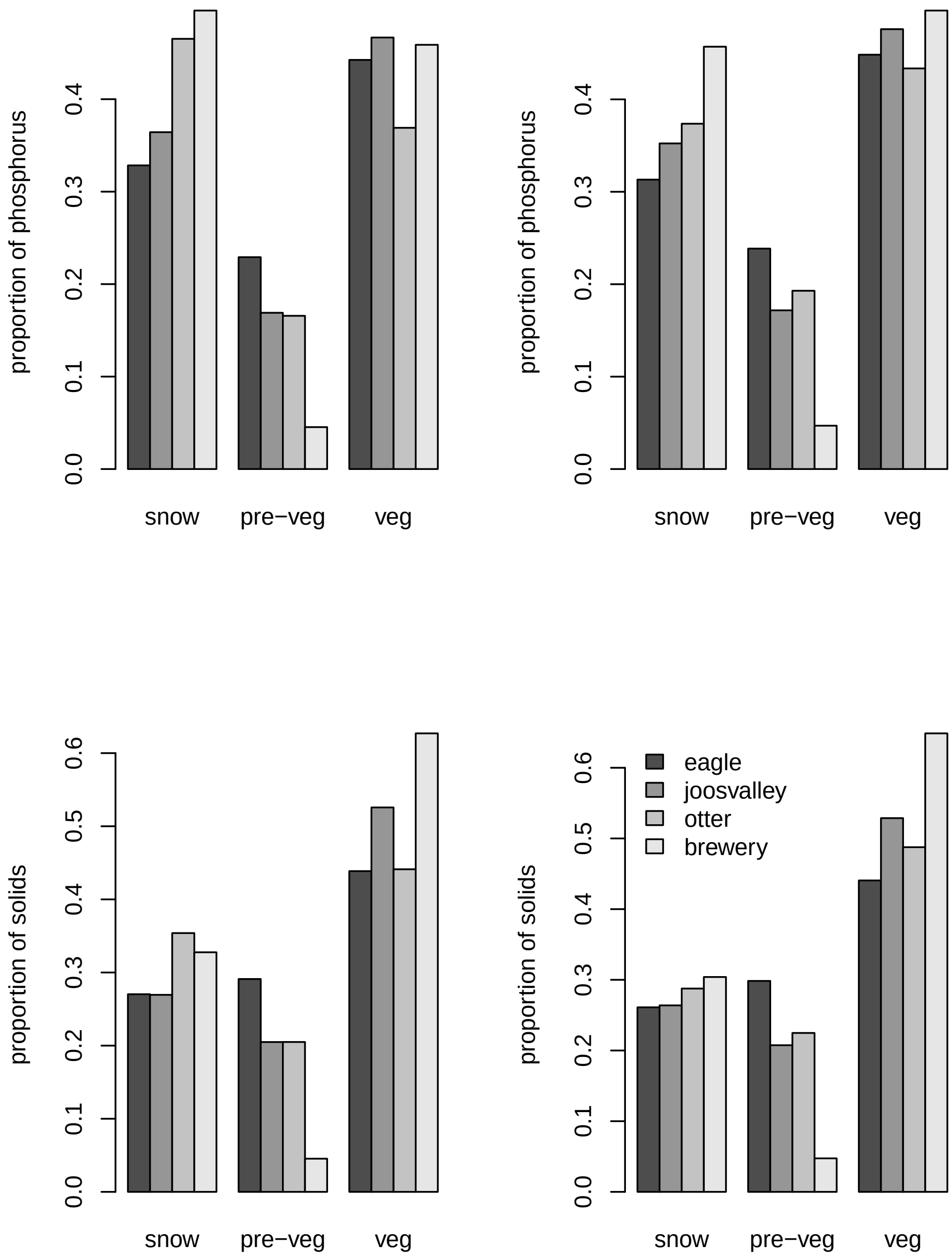
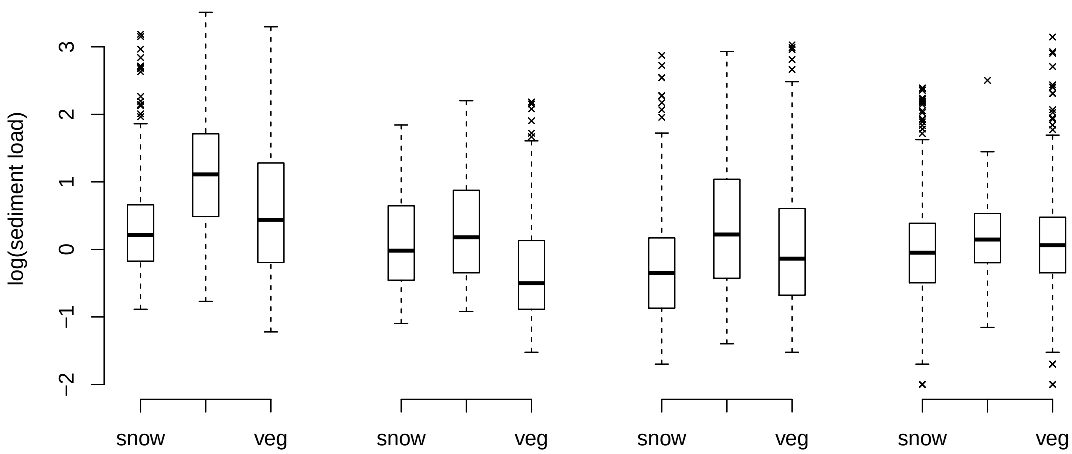


Figure 1 – Cumulative storm loadings at the four creeks.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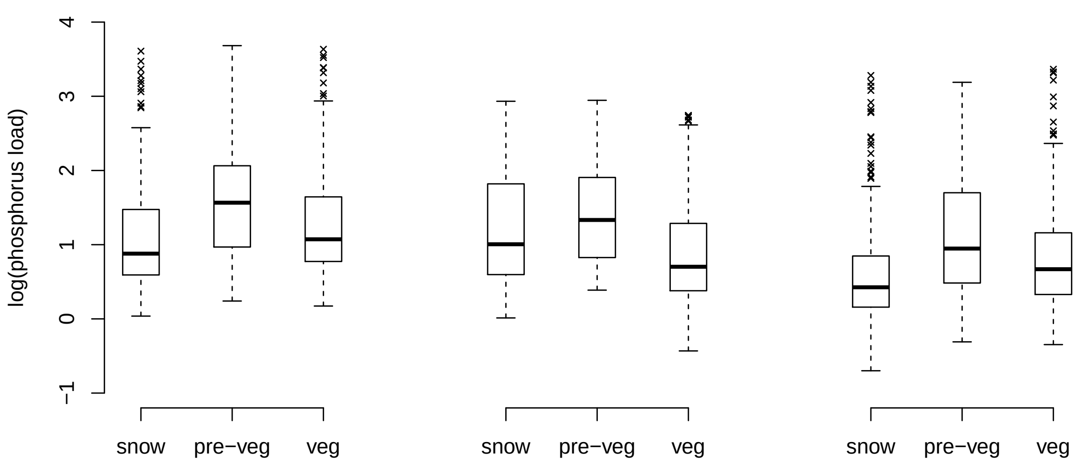
veg
snow
veg
snow
veg
snow
veg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pre−veg
veg
snow
pre−veg
veg
snow
pre−veg
veg

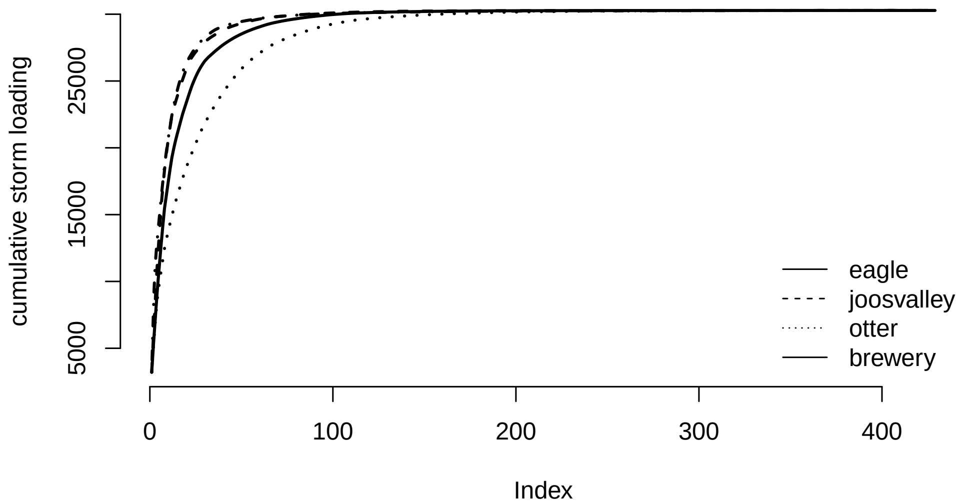

FIGURE 2 – Cumulative storm loadings at the three creeks.

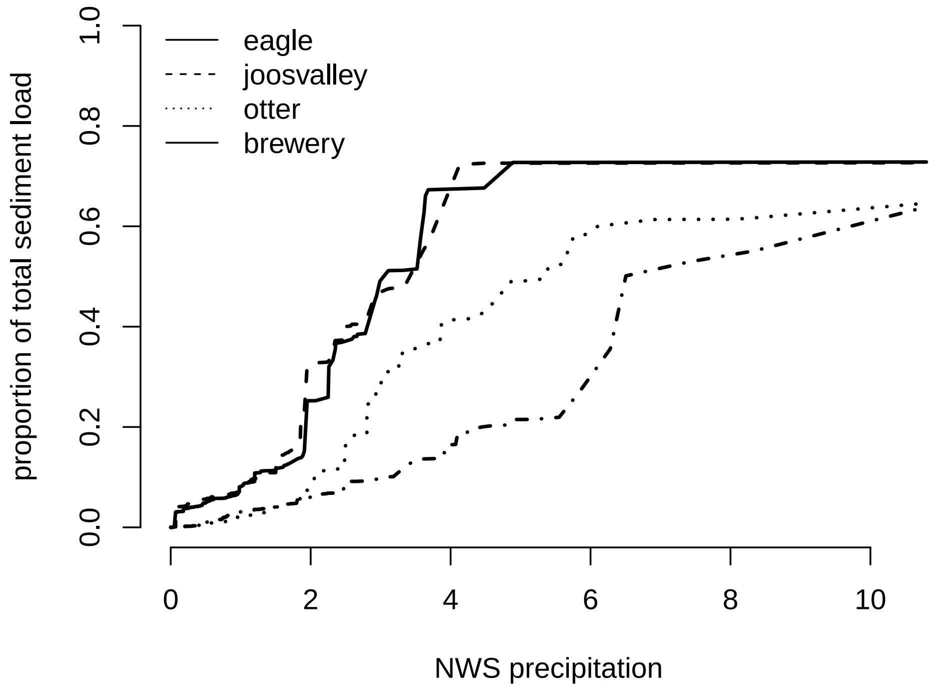

FIGURE 3 – Proportion of the total sediment load contributed by rainfall events up to the size shown. Snowmelt-driven events are excluded.

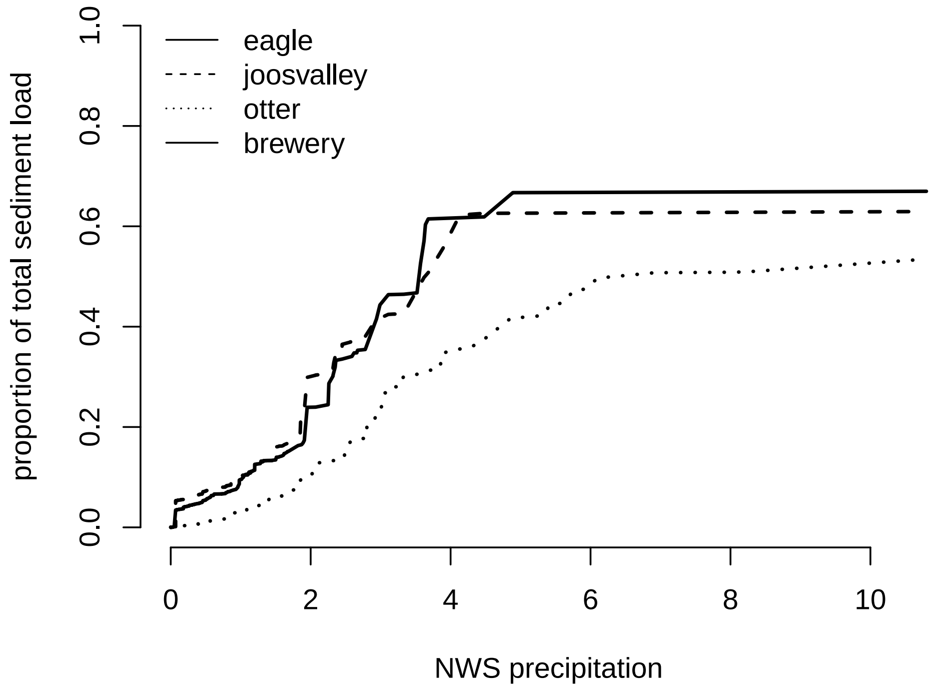

FIGURE 4 – Proportion of the total phosphorus load contributed by rainfall events up to the size shown. Snowmelt-driven events are excluded.

Sediment	R^2	Model terms
Eagle	0.503	theisen
	0.755	theisen + antecedent_qbase
	0.767	theisen + antecedent_qbase + p15max
	0.773	theisen + antecedent_qbase + p15max + p60max
Joos		
	0.49	theisen
	0.665	theisen + antecedent_qbase
	0.692	theisen + antecedent_qbase + p15max
	0.713	theisen + antecedent_qbase + p15max + ap_2day
Otter		
	0.486	theisen
	0.738	theisen + antecedent_qbase
	0.764	theisen + antecedent_qbase + antecedent_tmean
	0.773	theisen + antecedent_qbase + antecedent_tmean + julian
Brewery		
	0.433	theisen
	0.459	theisen + p30max
	0.51	theisen + p30max + tmean

Phosphorus	R^2	Model terms
Eagle	0.579	theisen
	0.783	theisen + antecedent_qbase
	0.784	theisen + antecedent_qbase + tmean
	0.793	theisen + antecedent_qbase + tmean + tmax
Joos		
	0.543	theisen
	0.715	theisen + antecedent_qbase
	0.733	theisen + antecedent_qbase + p15max
	0.755	theisen + antecedent_qbase + p15max + ap_2day
Otter		
	0.483	theisen
	0.737	theisen + antecedent_qbase
	0.762	theisen + antecedent_qbase + tmean
	0.77	theisen + antecedent_qbase + tmean + julian
Brewery		
	0.602	theisen
	0.641	theisen + p30max
	0.674	theisen + p30max + tmean

Creek	Period	All events	Sediment Major events	Sediment Loading	Phosphorus Major events	Phosphorus Loading
Aggregated	Snowmelt	48%	28%	40%	39%	48%
	Early post-snow	10%	23%	14%	17%	13%
	Late post-snow	43%	49%	46%	44%	39%
Eagle	Snowmelt	42%	27%	30%	33%	37%
	Early post-snow	13%	29%	19%	23%	21%
	Late post-snow	45%	44%	51%	44%	42%
Joos	Snowmelt	46%	27%	31%	36%	35%
	Early post-snow	11%	20%	17%	17%	19%
	Late post-snow	43%	53%	52%	47%	46%
Otter	Snowmelt	41%	35%	42%	47%	58%
	Early post-snow	11%	20%	19%	17%	12%
	Late post-snow	48%	44%	40%	37%	30%
Brewery	Snowmelt	56%	33%	52%	50%	60%
	Early post-snow	6%	5%	6%	5%	4%
	Late post-snow	38%	63%	42%	46%	37%

Solids

- Eagle: theisen, antecedent_qbase, p15max, p60max
- Joos: theisen, antecedent_qbase, p15max, ap_2day
- Otter: theisen, antecedent_qbase, antecedent_tmean, julian
- Brewery: theisen, p30max, tmean

Phosphorus

- Eagle: theisen, antecedent_qbase, tmean, tmax, p15max, p30max
- Joos: theisen, antecedent_qbase, p15max, ap_2day
- Otter: theisen, antecedent_qbase, tmean, julian
- Brewery: theisen, p30max, tmean, ap_3day