

Suspended Sediment in the St. Croix River



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Introduction

- The overarching objective of this study was to determine how suspended sediment affects mussels species on the St. Croix River.
- The goal of this project was to assess how location and discharge affect suspended sediment loads along the St. Croix river.
- Suspended sediment load consists of sand, silt, and clay in transport in the water column.
- The size of the suspended sediment load is determined by water's turbulence and viscosity.
- Suspended sediment load is essential for river ecosystems: too much suspended sediment can block light, too little can increase erosion.

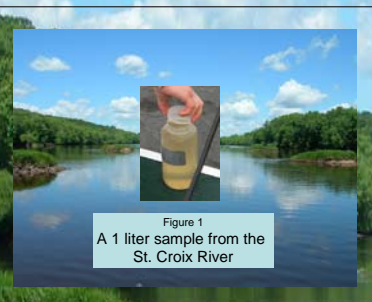


Figure 1
A 1 liter sample from the St. Croix River

Methods

- Surface water samples were collected bi-weekly at four sites: two above and two below the St. Croix Falls dam
- During high flows water was collected more frequently.
- The water was pumped through filters to separate out suspended sediment.
- The filters were dried at 105°F for 1 1/2 hours and weighed.
- The filters were burned at 500°F for 1 hour to remove organic material and weighed again.

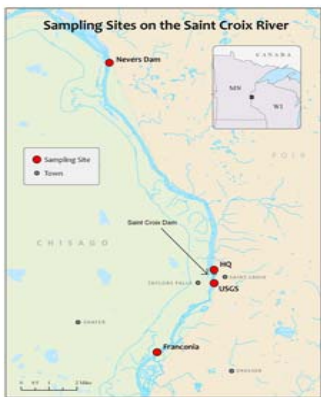


Figure 2

The Nevers Dam and NPS Headquarter (HQ) sites are located upstream of the St. Croix Dam. Nevers Dam is approximately 6 miles above the reservoir while the HQ sampling site is located in the reservoir. The USGS sampling site is directly below the dam and Franconia is approximately 3 miles further downstream.

Results

- At all four sites there was a strong correlation between discharge and suspended sediment (Fig. 4).
- Base flow for the spring of 2008 was ~2000 cfs.
- The peak flow occurred in early April and was ~24,100 cfs.
- At all four sites, discharge above 5600 cfs was positively correlated with suspended sediment concentration.
- Below 5600 cfs, suspended sediment concentrations are low and are not correlated with discharge.
- Increased discharge in the spring caused hysteresis, with higher SSC during increasing peak annual discharge (Fig. 3).

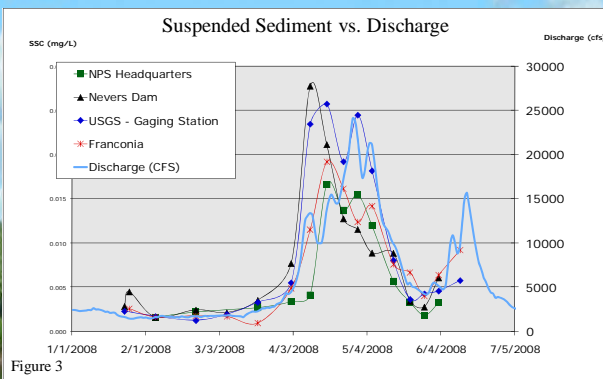


Figure 3

Hysteresis

In the early spring increased discharge dislodged sediment and the suspended load peaked before discharge reached its peak (Fig. 3). This relationship is called hysteresis- the new surge of water from snow melt and increased precipitation frees a maximum amount of sediment and suspended sediment load peaks before discharge. The greatest hysteresis occurred at Nevers Dam (above the St. Croix Dam) and the USGS (right below the dam). In comparison, during the height of hysteresis on 4/10, the location with the largest hysteresis, Nevers Dam, had 15% more suspended sediment (mg/L) than at the location with the smallest hysteresis, NPS headquarters.

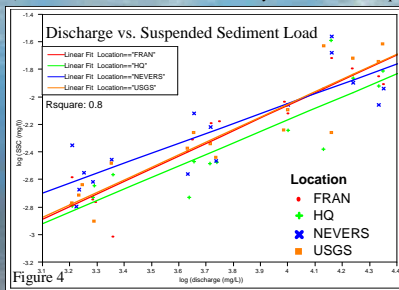


Figure 4

Rating Curve

As this rating curve shows, there is a strong positive correlation between discharge and suspended sediment load (Fig. 4). The two sites below the dam (Franconia and USGS) show a similar relationship with discharge, while Nevers Dam has more suspended sediment at low flows and less suspended sediment at high flows. At HQ suspended sediment concentration is consistently lower at all water discharges.

Figure 5



Carolyn Loeb measures water velocity in the St. Croix River

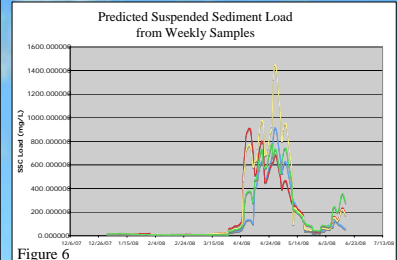


Figure 6

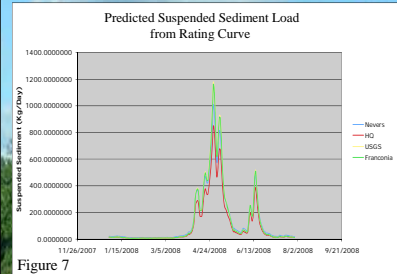


Figure 7

Predicting Suspended Sediment Load

- The two graphs above (Fig. 6 and 7) demonstrate the two methods with which daily suspended sediment loads are estimated: 1) in relation to the weekly samples (Fig. 6) and 2) using the relationship between discharge and suspended sediment load from the rating curve (Fig. 7).
- The predicted suspended sediment concentrations from the weekly samples reflects the observed hysteresis at each site (Fig. 6).
- The predicted suspended sediment load from the rating curve shows how the suspended load correlates with the river's discharge (Fig. 7).
- While the suspended sediment load is the same in both plots, the highest sediment flux peak (at USGS) from the weekly samples predicts a peak sediment load 25% higher than the rating curve's highest predicted flux.

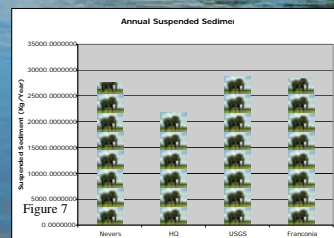


Figure 7

How much sediment is it really?

- At Nevers Dam, USGS and Franconia sites over 28 tons of suspended sediment go through the river annually.
- That is over 7 African Elephants (4 tons each), floating down the river each year (Fig. 7).
- In the reservoir above the dam 20% less suspended sediment flows through the river.

Discussion

- At all four locations discharge controlled the size of the suspended sediment load.
- The St. Croix Falls Dam has a significant effect on suspended sediment concentration, especially at high flows.
- Hysteresis in SSC was especially strong at Nevers Dam (well upstream of the dam).
- Annual suspended sediment load in the reservoir (HQ) above the dam is approximately 8 tons less than in the zone above the reservoir (Nevers Dam). This raises two questions- where is the suspended sediment settling in the reservoir, and where does the increased suspended sediment concentration at USGS come from?

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