

The effects of Japanese Knotweed (*Reynoutria japonica*) on riparian lands in Otsego County, New York

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INTRODUCTION

Japanese knotweed (*Reynoutria japonica*) is a native of Japan, Taiwan and northern China. It is a member of the family Polygonaceae with closely related species including giant knotweed (*Fallopia sachalinensis*, syn. *Polygonum sachalinense*) and Russian vine (*Fallopia baldschuanica*, syn. *Polygonum aubertii*) (USDA 2008). It was introduced to the United Kingdom (UK) in 1825 where it was grown as an ornamental plant. It was eventually exported to the United States of America (USA) for the same reason. The lack of biological control in the western hemisphere has led to an explosion in knotweed growth both in the UK and the USA. Once a clump of knotweed is established, it spreads clonally via rhizomes, forming virtual monocultures that displace native plant species and reduce available habitat for birds, mammals and other organisms (Forman and Kesseli 2003). The established underground system makes knotweed hard if not impossible to remove. Knotweed growth is, however, limited by availability of sunlight; hence, the majority of knotweed growth is limited to roadsides and riparian lands (Beerling 1990).

In this study we examined the effect of knotweed growth on stream bank erosion in riparian lands. The streams chosen include tributaries of the Susquehanna River and are all located in Otsego County. Soil erosion along these streams will directly affect physical properties of the river. The roots of Japanese knotweed are composed of rhizomes which are not strong enough to hold the bank soil down firmly. The knotweed root growth is more shallow than native riparian trees and shrubs and so banks dominated by knotweed growth experience instability (Talmage and Kiviat 2002). Also, since knotweed dies back in the fall, banks are exposed during periods of spring run off. Therefore, it is hypothesized that knotweed growth on streams contributes to soil erosion, affecting not only the ecology of the area but also the physical properties of the stream.

METHODS AND RATIONALE

In order to determine the effects of knotweed on stream bank stability we chose four sites with significant knotweed growth along stream banks. These site locations, along with GPS coordinates, the lengths of knotweed stands and stem densities are displayed in Table 1. Figure 1 provides a map showing site locations. Our sites were limited due to reasons such as accessibility and suitability for sampling (at many potential

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sites, the streams were too shallow to sample and would not have yielded accurate results). All sites except Silver Creek (displayed in Table 1 as SC) had a designated control site immediately upstream of reaches colonized by knotweed, providing us with a comparison in erosion trends of the stream.

Stream name	Site name/abbreviation	GPS coordinates	Knotweed patch length(meters)	Knotweed patch density(per sq meter)
Otego Creek	Hartwick site 1/HW1	N 42 39.869' W 075 02.986'	37.94	15
Otego Creek	Hartwick site 2/HW2	N 42 39.912 W 075 03.009'	56.5	11
Otego creek	Hartwick control site/HWN	n/a	n/a	n/a
Cherry valley Creek	Cherry Valley/CV	N 42 43.093 W 74 55.582	12.75	8
Cherry Valley creek	Cherry valley control site/CVN	n/a	n/a	n/a
Silver creek	Silver creek site/SC	N 42 41.326' W 075 03.747'	38.9	13

Table 1. Summary of creek name and site designation. GPS co-ordinates are locations of knotweed patches at the sites. Length and density are listed in meters and plants per square meter respectively.

To determine sediment load in the streams we divided the stream into three parts, namely the left, middle and right, then took three water samples at each part. Water samples were taken by immersing whirl bags below the surface in the stream and when the bag was full it was removed, secured, placed in a cooler and taken back to the lab. The sampling was done upstream and downstream of the knotweed patch so as to determine the knotweed's contribution to the sediment load. Bed load samples were also taken at the three parts using a bed load sampler. Once sampling was completed, a meter tape was run across the stream and stream velocity and depth were recorded at half meter intervals. These data were used to determine stream discharge. We also measured the length and the density of the knotweed patches. We measured length by running a meter tape from one end to another and measured density by counting the number of plants in a square meter; we did this at three different spots in the patch and took an average of them to determine the patch density. These methods are illustrated below in Figure 2.

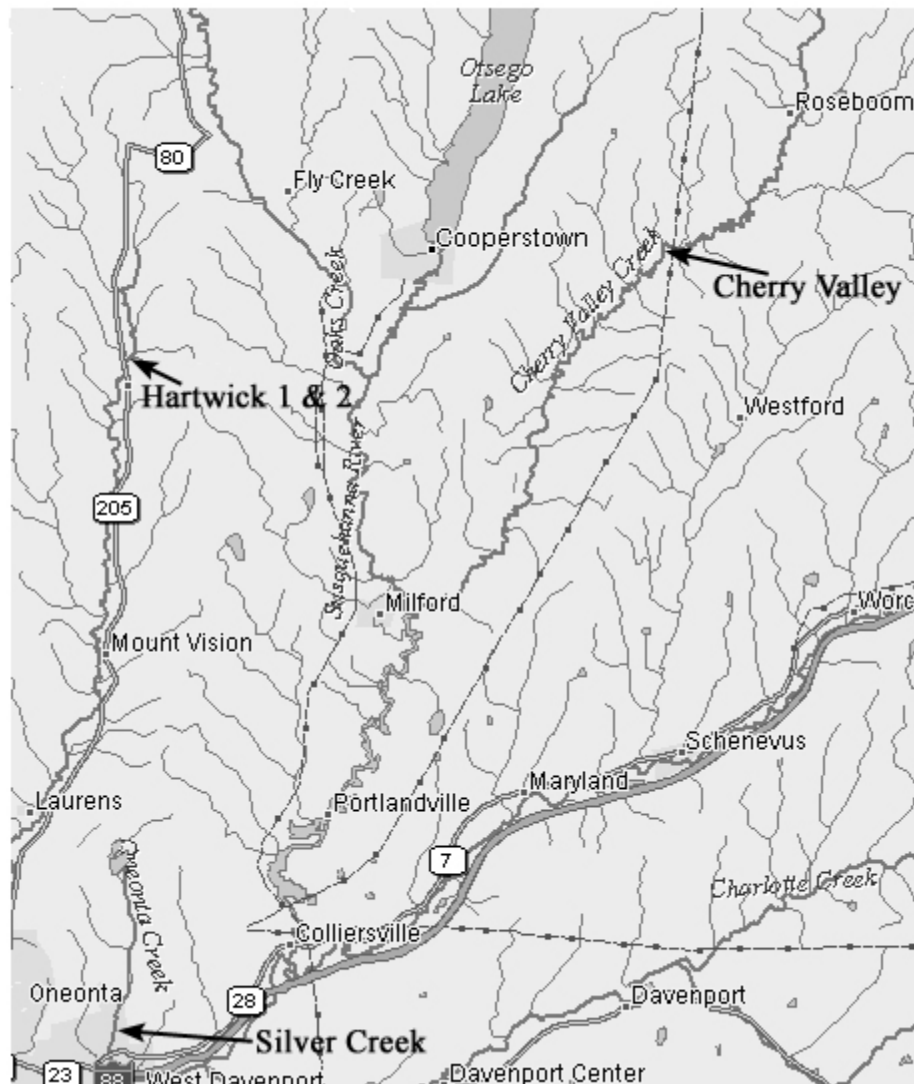


Figure 1. Map showing knotweed sampling sites at Hartwick, Cherry Valley and Silver Creek.

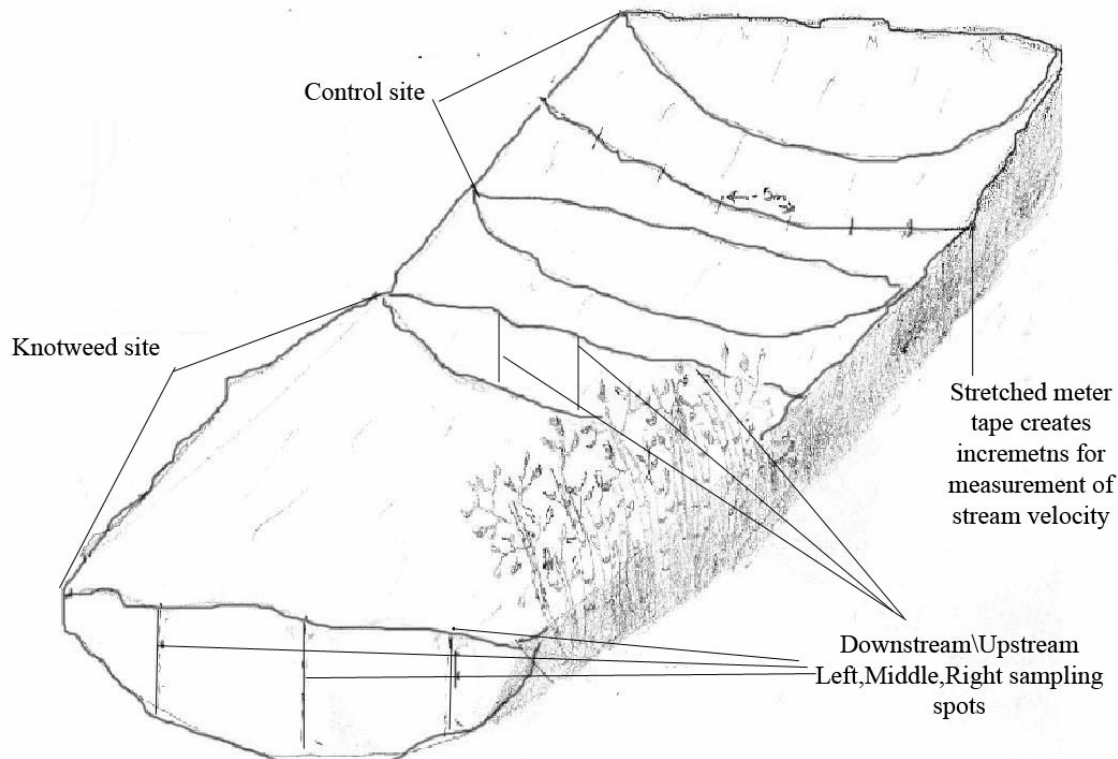


Figure 2. Illustration of a typical sampling site. Samples were collected upstream and downstream of the knotweed site as well as on the control site.

Prior to sample processing, Whatman GF/C 47mm filters were prepared by placing them in a numbered aluminum container in which they were pre-heated at a temperature of 550 °C for an hour. This removed any extra weight contributed by moisture or organic contamination. After cooling to room temperature, the filter weight was recorded. Water samples were passed through the filters and volume of water filtered was recorded. The filters were then dried in an oven at 105 °C for 24 hrs before they were removed, cooled and weighed; this weight subtracted from the weight of the filter paper gave dry weight. Next the filters were once again heated for an hour at 550 °C to rid the sediment of any organic matter. The filters were once again weighed after they cooled down; this weight subtracted from the filter weight gave us the inorganic sediment load on each paper. The data were sorted for each site based on upstream and downstream inorganic sediment load. Discharge was determined for each interval by multiplying the average of depths with the average of velocities and interval length (i.e., 0.5 meters).

We also sampled streams after rain events to study the coupled effect of knotweed patches and rain on stream bank erosion. These dates were 5, 10 and 23 July for the Hartwick sites and 12, 18 and 25 July for Cherry Valley and Silver Creek sites. Data were pooled by upstream and downstream and then averaged the data for each categories for each site on every date. We calculated values in mg/L by dividing sediment load by

amount of water filtered. These values were then grouped together based on criteria mentioned above and the mean and standard error were computed for each data set.

RESULTS

Table 2 shows downstream sediment load versus upstream sediment load. Under site name the first few letters abbreviate the site name, the middle letters determine up stream (up) or downstream (dn), the third set of letters determine left, middle or right part of the stream as “l,m,r” respectively. The sediment amounts were not consistently higher either downstream or upstream across the sites. The control sites typically had more sediment upstream than downstream. These data are illustrated in Figure 2. Also graphed are the dry mass values for each site so as to distinguish between organic and sediment versus pure sediment load in the streams. This is displayed in Figure 3.

SITE NAME	DOWNSTREAM (mg/l)	UPSTREAM (mg/l)
Hartwick 1 (HW1)	8.34	7.46
Hartwick 2 (HW2)	9.15	7.72
Hartwick Control (HC)	5.60	9.34
Cherry Valley (CV)	9.62	9.34
Cherry Valley Control (CVC)	10.13	10.35
Silver Creek	4.05	3.75

Table 2. Inorganic sediment load of streams at various sites sorted by upstream and downstream and displayed in milligrams per liter.

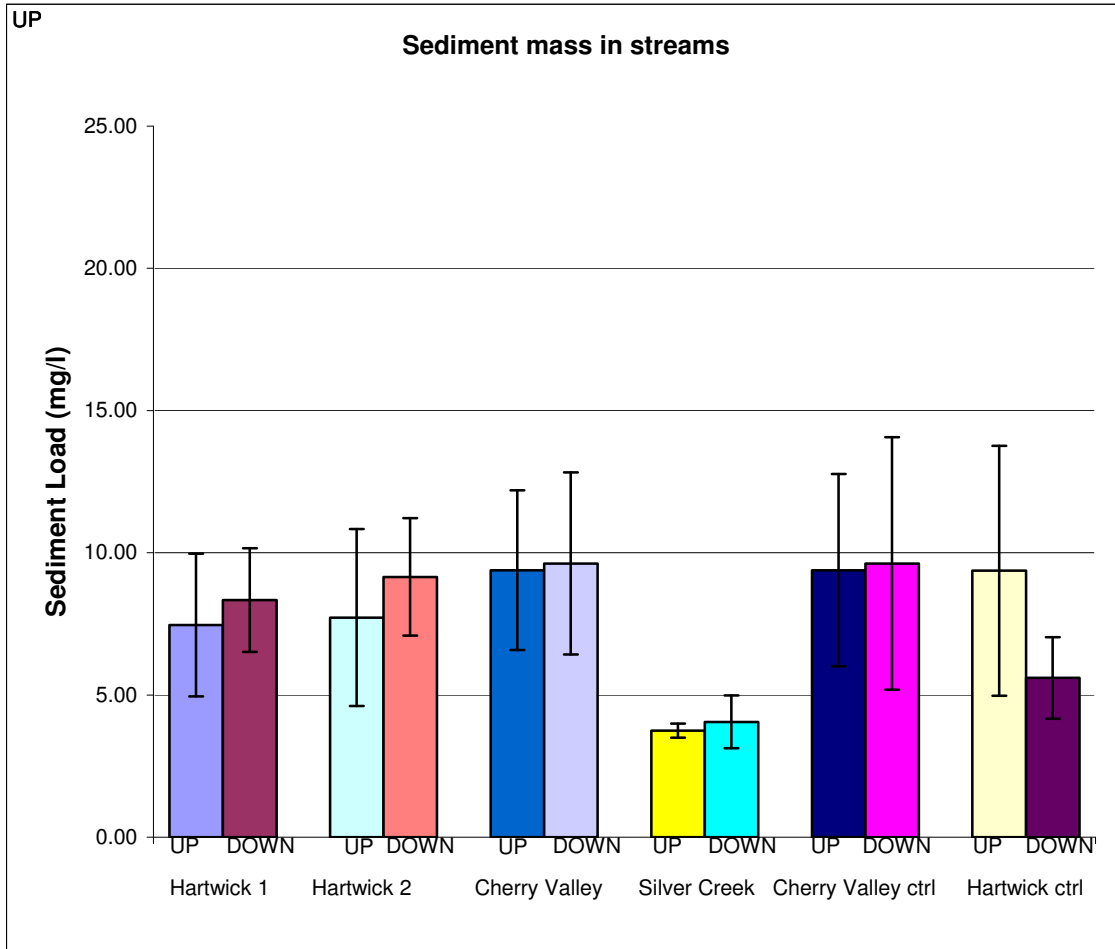


Figure 2. Illustration of Downstream vs. Upstream inorganic sediment load for study sites. Y axis represents sediment load in stream in milligrams per liter and X axis represents study sites and downstream and upstream criteria. Error bars have been calculated for each value with a 95% confidence interval.

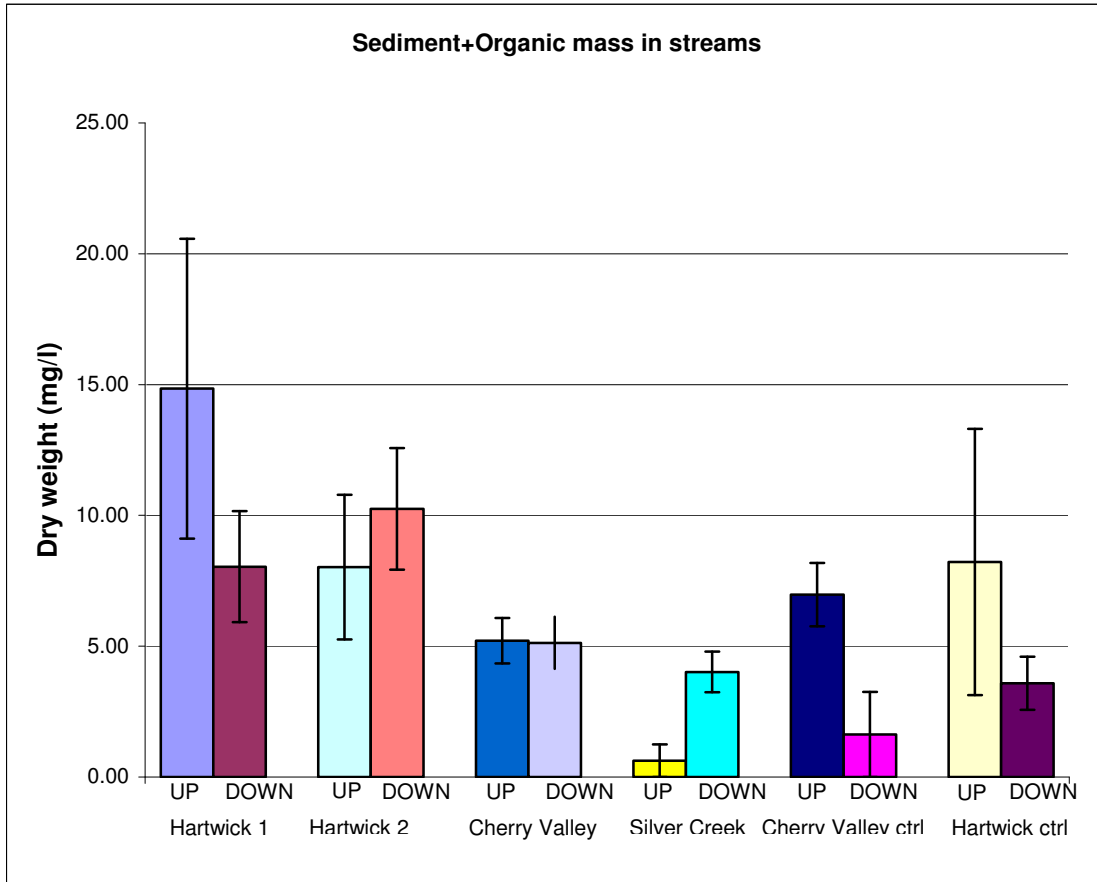


Figure 3. Illustration of sediment + organic (dry weight) load in streams at different study sites. Y axis represents dry weight in milligrams per liter and X axis represents study sites and the upstream and downstream criteria. Error bars are displayed for each value and were computed at a 95% confidence interval.

DISCUSSION

During the course of this research there were times when stream samples had greater upstream sediment load than downstream sediment load. However, data collected after rain events have all shown that the downstream sediment load is greater than the upstream sediment load. These data are displayed in Figure 4.

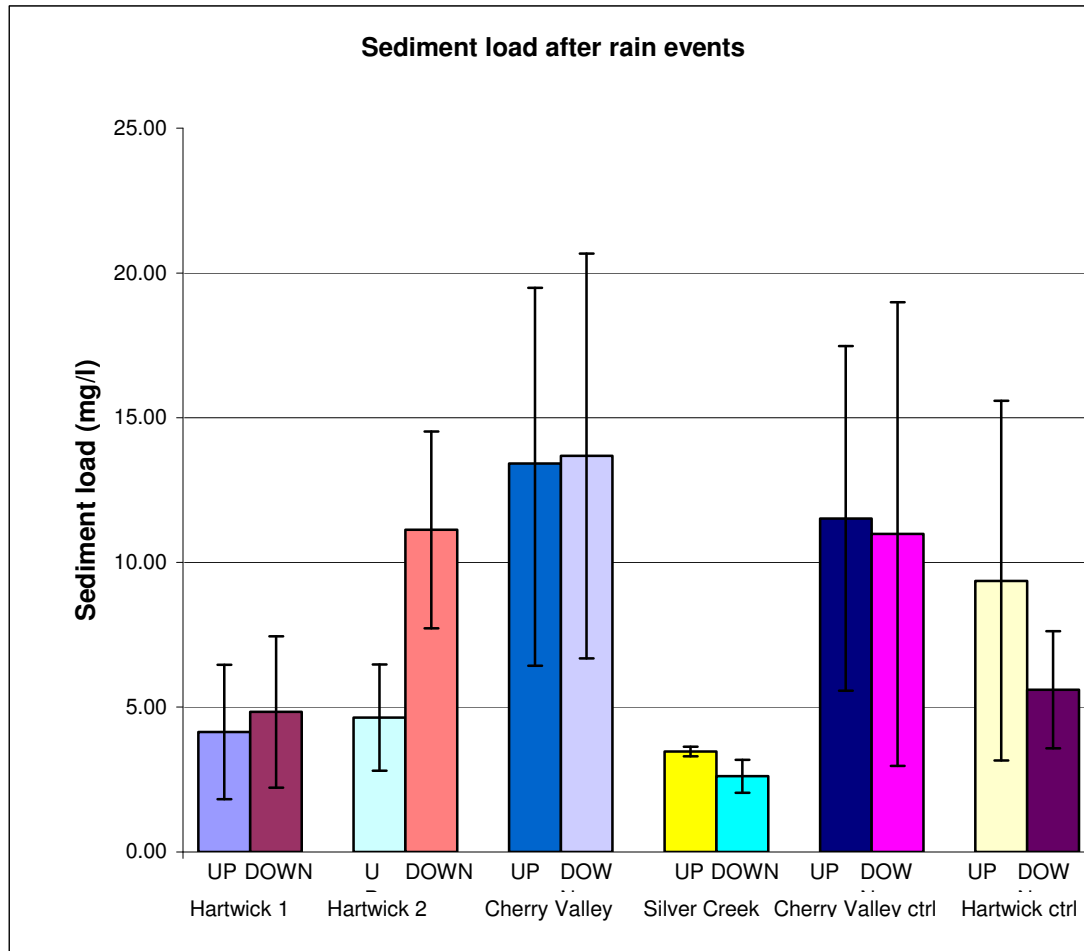


Figure 3. Inorganic sediment load in streams after rain events. Illustration of inorganic sediment load in streams at the sites after rain events. Y axis represents sediment load in milligrams per liter and X axis represents study sites and the upstream and downstream criteria. Error bars were calculated for each value with a 95% confidence interval.

Unfortunately, data collected after rain events were not sufficient to evaluate whether or not increased flows would increase erosion proximal to knotweed patches. Unfortunately the part of the bank that was eroded away contained rhizomes from the knotweed; once that soil is deposited it is possible that a knotweed will grow from it. Further studies should be done on knotweed so as to determine how we can check its growth. This research was limited due to the lack of precipitation and hence low levels in the streams.

During the process of data collection we had to enter the knotweed patch to determine its density. In the middle of the patch we found many knotweed plants dead. This is likely due to central die back which is a process initiated by the knotweed as an adaptive trait (Adachi, Terashima and Takahashi. 1996). The central die back depends

mostly on the rhizome branching angle; the value of the angle affects the density of the knotweed patch and in turn determines the knotweeds monopoly in the soil. For example, a rhizome branching angle of 60 degrees would result in a hexagonal arrangement of rhizomes allowing for maximum density. This would give the knotweed patch an upper hand over native species in deriving nutrients from the soil (Adachi, Terashima and Takahashi 1996). Also, this central dieback tendency would reduce density of knotweed plants at the center of the patch and increase it along the edges and in case of riparian lands along the stream bank, as already discussed this would increase bank erosion.

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