Harry and Laura Nohr Chapter of Trout Unlimited

Scott Ladd Memorial Internship Report (2004-2005)

McPherson Branch and the upper Blue River

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Abstract - The short term impacts of reach scale restoration activities on habitat, macroinvertebrates, and fish were studied in the McPherson Branch and upper Blue River of southwestern Wisconsin. Field surveys were conducted upstream, at, and downstream of restoration sites. Restored sites in both streams had higher numbers of brown trout than the unrestored sites. Although other variables also differed among sites, a few clearly distinguished restored from unrestored reaches in each stream. While restoration activities influence stream habitat and communities in the short term, such changes may not necessarily be as extensive as expected.

INTRODUCTION

Stream restoration activities not only affect the physical stream characteristics, but also the diversity and abundance of fish (Gorman and Karr 1978, Schlosser 1982, Meffe and Sheldon 1998) and macroinvertebrates (Allan 1975, Minshall 1984, Gore et al. 1998). Although the intention of such restoration is to benefit the ecosystem, actual monitoring and evaluation of stream restoration projects have been rare (NRC 1992, Kershner 1997) and assessed restorations indicated mixed responses (Frissell and Nawa 1992). Consequently, more studies are needed to ensure that the long-term outcomes of stream restoration activities match the initial objectives.

This study examined effects of reach-scale restoration on habitat, macroinvertebrates, and fish in the McPherson Branch and upper Blue River in Southwest Wisconsin. Restoration activities in both streams were administered by The Harry and Laura Nohr Chapter of Trout Unlimited to increase biodiversity and enhance trout habitat. The two systems were expected to provide unique perspectives on restoration activities because they differed with respect to size and time since restoration. The McPherson Branch was a smaller system restored nearly five years ago, while the upper Blue River was a larger system with ongoing restoration.

The overall objective of this study was to determine if there were differences in habitat, macroinvertebrates, and fish between restored and unrestored reaches within each stream. If differences occurred, a secondary objective was to quantify the magnitude of those differences. We hypothesized that restored reaches in both systems would have greater abundance and diversity of both fish and macroinvertebrates than unrestored reaches. We also expected the habitat in restored reaches to be significantly different from unrestored reaches. In particular, sediment depth, erosion, channel width, and riparian cover were predicted to be greater in the unrestored reaches than the restored reaches.

METHODS

Study Areas

McPherson Branch

The McPherson Branch stream was located 15km northwest of Platteville, WI and drains a 6.4km^2 watershed into the Platte River (42°47.009N, 90°37.019W). The McPherson Branch had minor habitat modifications in the 1970's and more significant habitat modifications (i.e. bank stabilization and lunker structures) in 2001-02. The 1400m of stream immediately up from the Platte River were divided into four 350m study sites (Figure 1). Sites 2 and 3 were restored, sites 1 and 4 were unrestored.

Upper Blue River

The upper Blue River (43°00.087N, 90°25.583W) was located 32km north of Platteville, WI flowing west-northwest, eventually draining into the Wisconsin River. This stream continues to undergo major restoration (i.e. riparian, bank, and in-stream modifications) that began in 2004. This study considered 3600m of stream spanning three properties (Addison, Wolenec, and Zoha) where County Highway I crosses the Blue River (Figure 2). In each of the three properties, a single 400m sampling site was randomly selected (Figure 2). Site 1 was unrestored, site 2 was completely restored in late summer 2004, and site 3 was targeted for restoration following the 2005 sampling period.

Sampling

All 2005 data were collected in summer with the McPherson Branch sampled in June and the Blue River sampled in August. In addition, the Blue River was surveyed in June 2004 prior to any restoration activities and in August 2004 immediately after restoration on site 2 by

Amanda Lederer the 2004 Scott Ladd Memorial Intern. Sampling locations were determined by evenly dividing each study site into 12 transects that spanned the width of the stream. Sampling protocols were the same for both streams.

Habitat

Habitat surveys on all sites were conducted using the Wisconsin Department of Natural Resources Habitat Survey Protocols. The following measurements were taken from four points along each transect: river width, river depth, bank erosion, coverage, substrate compostition (including macrophytes), fine substrate depth/embeddedness, dissolved oxygen, pH, water temperature, and water conductivity. Coverage, substrate, and embeddedness were estimated percentages.

Macroinvertebrates

Macroinvertebrates were collected from six randomly selected transects within each site. One sample was collected at each transect; in-channel positions altered among left, center and right from one transect to the next. The samples were collected using a 250µm mesh Surber sampler and preserved in 75% ethanol. All aquatic macroinverebrates were identified down to either family or genera.

Fish

The fish were sampled using a backpack electro-fisher at three randomly-selected locations in each sampling site. Fish were surveyed throughout the 30m immediately upstream of each location (resulting in a total of 90m per site). All fish were counted and identified down to species. Total lengths (TL) of all brown trout (*Salmo trutta*) and white suckers (*Catostomus commersonii*) also were measured. All fish were released.

Analyses

Average values for habitat, macroinvertebrate and fish were compared among all four sites on the McPherson Branch. Additional comparisons considered the restored sites (2 and 3) versus the unrestored sites (1 and 4). For the upper Blue River, among-site and between-year comparisons were made using data from 2004 (both pre and post site 2 restoration) and 2005 (1 yr post site 2 restoration). One-way ANOVA and paired-t tests were used to determine significance at the 0.05 level.

RESULTS

McPherson Branch

Habitat

All sites on the McPherson Branch had similar channel width, ranging from an average of 3.1m (site 4) to 3.9m at (site 2), and all sites also had similar amounts of gravel substrate (averaging 10.9%). Overall, restored sites averaged less bank erosion (0.17m) and lower fine substrate depths (2.89cm) than the unrestored sites (averages = 0.59m and 7.65cm respectively). Although there were no significant differences among any other habitat variable comparing unrestored sites to restored sites, significant differences did exist among the four individual sites. The average depth of restored site 2 (0.42m) was more than 11cm greater than at the three other sites (which ranged from 0.26m to 0.31m). Site 2 also had 60.6% of the channel bottom covered by macrophytes which was 20% more than unrestored site 1 with the next most at 40.6%. Restored site 3 averaged over 15% more cobble substrate (40.63%) than the other sites (unrestored site 1 had the next most cobble with 24.6%). Unrestored site 4 had the highest average degree of bank erosion (0.7m), over 48% more fine substrates (68.7%) than the other sites, and had the least amount of macrophyte growth (2.3% of the channel bottom).

Macroinvertebrates

There were a total of 11 macroinvertebrate families identified throughout the four sites. Over 80% of the macroinvertebrate community at each site was composed of chironomid midges, isopods, and amphipods (scuds). There were no significant differences between restored and unrestored sites regarding macroinvertebrate abundance or diversity. Restored site 2 had the highest total abundance of macroinvertebrates and sites 3 and 4 had the fewest.

Fish

A total of eight fish species were identified with brown trout (*Salmo trutta*), johnny darter (*Etheostoma nigrum*), and white sucker (*Catostomus commersonii*) representing 69%, 11%, and 11% of the overall fish community respectively. Although restored sites 2 and 3 had fewer different species than the unrestored sites (5 vs. 10) they had over 15% more total fish than the unrestored sites. Brown trout were significantly more abundant in restored sites than unrestored sites (Figure 3). Restored sites 2 and 3 also had higher numbers of all brown trout size classes, especially small juveniles (Figure 4).

Upper Blue River

Habitat

A year after restoration activities, channel substrate composition changed significantly at all sampling sites and all three sites had significant decreases in channel depth. By August 2005, downstream site 1 had significantly more riparian coverage, channel width, gravel and sand substrates, and less depth than sites 2 and 3. Site 1 experienced the least change in overall habitat from 2004 to 2005, although there was an 11% decrease in silt and a 15% increase in cobble.

In 2005, the only habitat characteristic that distinguished restored site 2 from the other sites was that it had 80% less bank erosion. Site 2 experienced the most changes in physical habitat from 2004 to 2005, including a 35% increase in macrophytes, a 19% loss of gravel substrates, and a 13% loss of cobble substrates. There were no significant changes in riparian coverage, channel width, silt, or sand.

Among the three sites in 2005, site 3 had the least riparian cover, greatest channel depth, second highest bank erosion, and most abundant macrophytes. From 2004 to 2005, site 3 had an 85% increase in bank erosion, an 11% increase in silt substrate, and a 14% decrease in gravel substrate. There were no significant changes in riparian coverage, channel width, cobble, or sand.

Macroinvertebrates

Although 17 different macroinvertebrate families were identified in 2005, chironomid midges and amphipods dominated the macroinvertebrate community at all sites in 2005. There were no significant differences among sites regarding macroinvertebrate abundance or diversity.

Overall macroinvertebrate abundance decreased nearly 85% across all sites from 2004 to 2005; however, most of the decrease occurred in sites 2 and 3, as site 1 experienced no significant changes in macroinvertebrate abundance or diversity. Site 2 had the greatest reduction of macroinvertebrate abundance and diversity from 2004 to 2005.

Fish

Six different fish species were identified in 2005 (10 were found in 2004); brown trout, white sucker, mottled sculpin (*Cottis bairdi*) and slimy sculpin (*Cottus cognatus*) remained the most abundant fish across all sites (Figure 5). There were no significant differences among the three sites in 2005 regarding fish species richness and abundance.

Although overall brown trout abundance decreased slightly from 2004 to 2005, the number in restored site 2 increased 22% (Figure 6). In contrast, brown trout decreased 38% in site 1 (Figure 6). The greatest change in size distribution from 2004 to 2005 occurred in site 1; within a year the site's proportion of brown trout ranging from 50-99mm decreased from 33% to only 5% (Figure 7). The size distribution in site 2 was relatively the same from year to year aside from an increase of 100-149mm fish and a decrease in 150-199mm fish (Figure 7). Site 3 changed the least from year to year and maintained the fewest number of brown trout among the sites. (Figures 6 & 7).

DISCUSSION

We observed among-site variability in habitat, macroinvertebrates, and fish in two streams that differed with respect to size and time since restoration. This study supports the notion that stream restoration activities affect a spectrum of biotic and abiotic characteristics (Allan 1975, Gorman and Karr 1978, Schlosser 1982, Minshall 1984, Gore et al. 1998, Meffe and Sheldon 1998). As expected, differences did exist between restored and unrestored reaches within each stream; however, in both systems we also observed characteristics that either did not differ among sites or were not associated with restoration patterns.

McPherson Branch

Evidence of potential restoration effects in the McPherson Branch was most apparent from the fish surveys; consistent habitat or macroinvertebrate differences between restored and unrestored sites were minimal. Nevertheless, despite few consistent differences, it does appear habitat within restored sites provides more cover, larger substrates, and less bank erosion than the unrestored sites. In addition, unrestored site 4 clearly has habitat less conducive to fish (particularly brown trout) than the other 3 sites downstream. The lack of difference between restored and unrestored sites regarding macroinvertebrates and the overwhelming abundance of tolerant species, suggests modifications to streams targeted for particular fish species, may not necessarily translate to all aspects of stream form and function.

The higher diversity of fish in unrestored areas may be due to both overall habitat and low brown trout numbers. Fewer brown trout in these sites reduces the threat of predation to prey species; whereas in the restored areas larger brown trout likely forage heavily on the other fish. The most dramatic difference between restored and unrestored sites in the McPherson Branch was the abundance of all sizes of brown trout. Observations suggest the restorations have clearly benefited brown trout in this system. High numbers of fingerlings in the restored sites suggest the environment has been favorable for reproduction.

The outlook for brown trout in this stream is very positive. The relatively small McPherson watershed has little agriculture use, which may aid in restoration. Although site 4 appeared in poor condition compared to the other sites, it had three times more brown trout than sites surveyed in other trout streams of SW Wisconsin.

Upper Blue River

There were 2 external factors/events that could have significantly influenced conditions in the upper Blue River during the summer of 2005. First, it was a low-water year and flows were down compared to 2004. Second, there were 2 incidental stockings of thousands of brown trout fingerlings during the summer. Our observations suggest that the low-water year had a more universal and dramatic impact on the system; we found little direct evidence of the trout stockings. Time since restoration activities (a single year) was another critical consideration on the upper Blue River. Unlike the typically rapid recovery of streams after natural disturbances

(Yount and Niemi 1990), recovery after severe, human-induced modifications varies and may often be incomplete (Niemi et al. 1990, Detenbeck et al. 1992).

Like the McPherson Branch, differences between restored and unrestored sites in the upper Blue River were limited to a few specific variables. High bank stability and an abundance of adult brown trout clearly distinguished restored site 2 from the unrestored sites in 2005, suggesting, in the short term, restoration modifications were effective for particular goals.

Significant changes to the habitat took place since restoration one year ago, especially within the restored site 2. Low water seems a primary factor here. Reduction in water flow would have affected the ability to move fine sediments through the sites. Deposition of silt and macrophyte growth flourishes in such conditions, as witnessed in the changes within site 2. Such changes would then be translated into the stream organisms. Macrophytes and silt reduce algal growth and cover larger substrates, which in turn limit macroinvertebrates. A reduction in the abundance of macroinvertebrates may have ultimately placed greater predation pressure on smaller fish by larger fish (i.e. adult brown trout). Such a scenario is supported by the observations of this study. In contrast, the highly complex unrestored site 1 had the most resilient habitat and macroinvertebrate community during the low water period, and the changes that did occur from 2004 to 2005 were often opposite of those seen in the upper sites. The riparian cover and complex channel likely mitigated many of the processes mentioned above.

Two groups of fish experienced dramatic losses in the upper Blue River: sculpins and young brown trout. Both may be due, in part, to the decline in macroinvertebrate abundance and potential increase in predation by large brown trout. Low water levels and higher temperatures could also have concentrated fish into smaller areas, increasing stress and competition. For the bottom-dwelling sculpins, another likely factor was the change in substrates. Most mysterious is the reduction of smaller brown trout (particularly in site 1), especially given the stocking events that occurred during the summer. Site 1 also continued to have favorable spawning and rearing habitat, yet still experienced low fingerling numbers.

Conclusions

As expected these two systems provided unique perspectives on stream restoration activities. However, together they also illustrate three considerations for determining the success of reach-scale stream restoration activities:

1) Size of the system

The upper Blue River watershed is at least 2.5X bigger than the McPherson Branch watershed. Sites in larger systems simply have more potentially confounding variables that may influence evidence of recovery.

2) Land-use activities within the watershed

Type and extent of land-use activity in the watershed will certainly impact a system's ability to recover.

3) Time

Ecological systems take many, many years to develop, so although significant changes can occur in a system from year to year, it may take several years for everything to work out.

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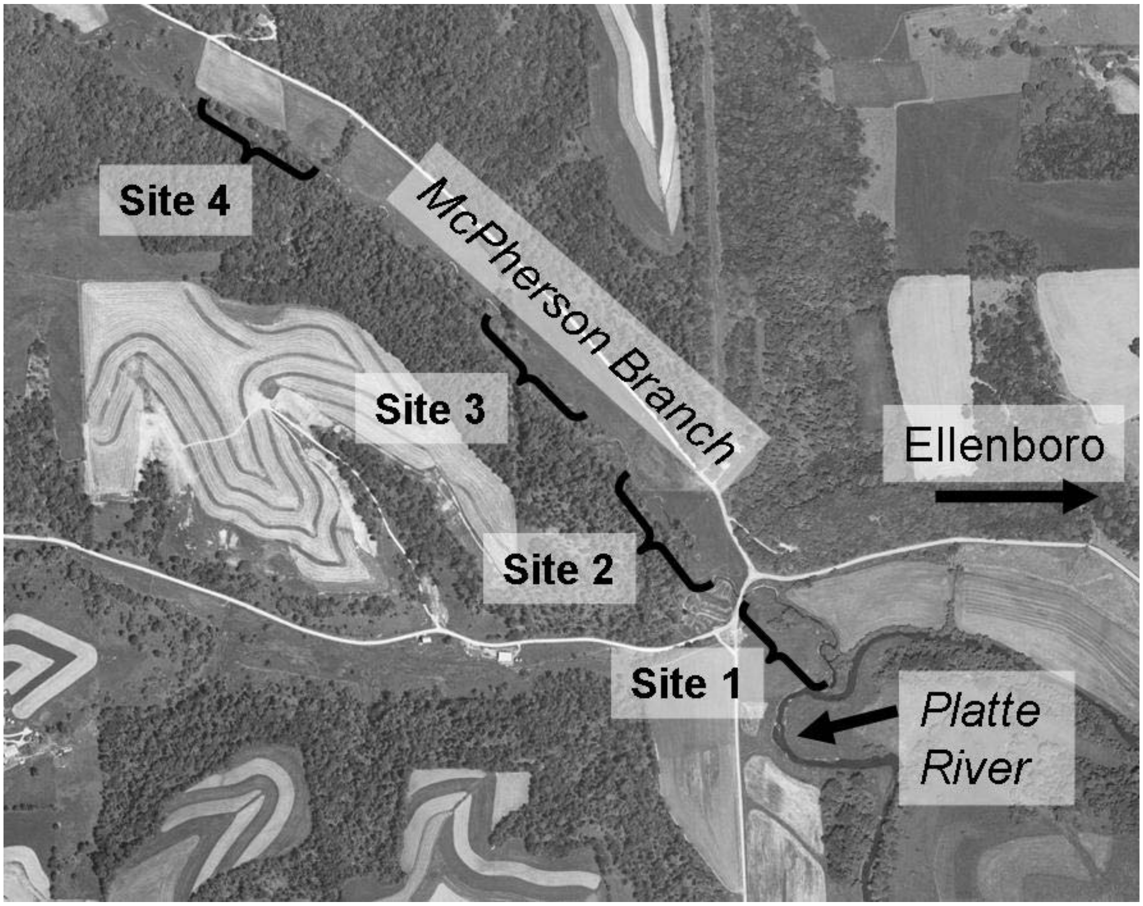

Figure 1. Study area and sampling sites on the McPherson Branch for summer 2005. Sites 2 and 3 were restored, sites 1 and 4 were unrestored. Site 1 is downstream. (1 inch ≈ 400meters)

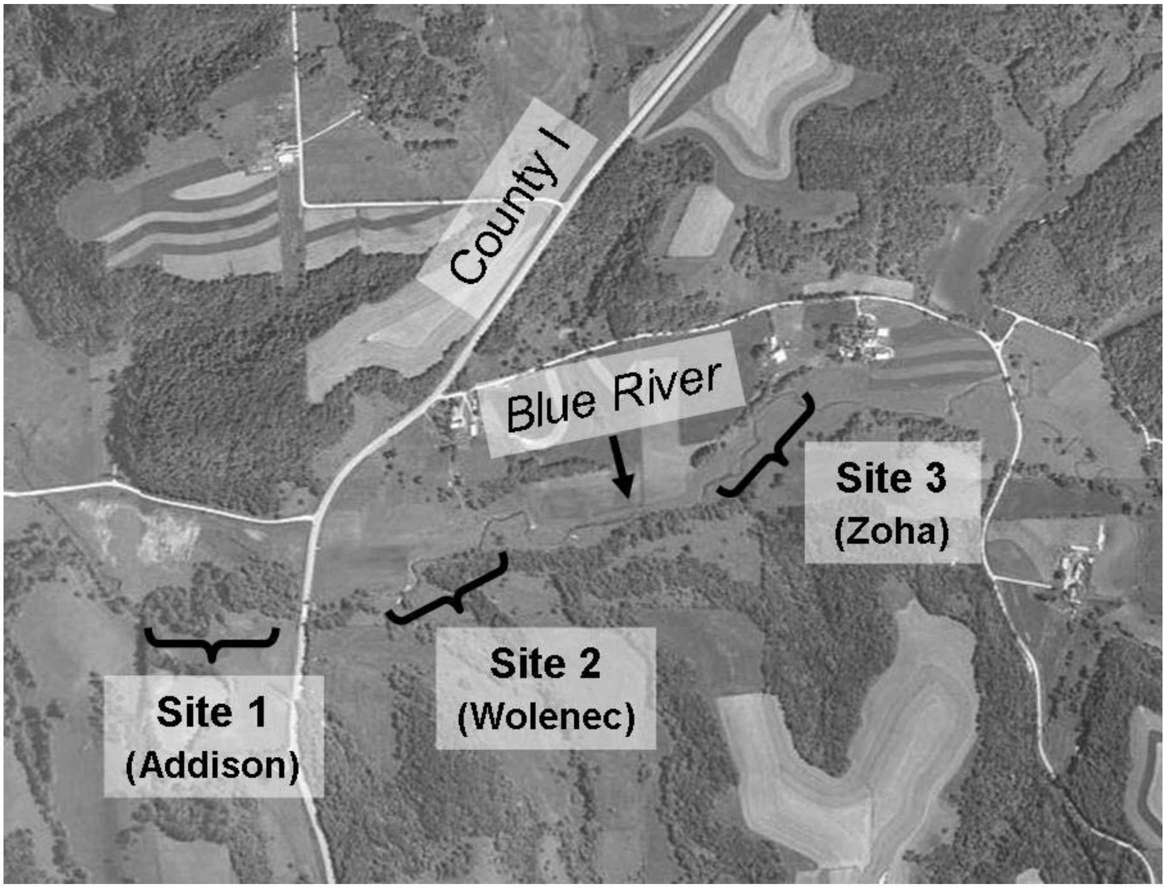

Figure 2. Study area and sampling sites on the upper Blue River 2004 and 2005. Site 2 was restored in August 2004, sites 1 and 3 were unrestored. Site 1 is downstream. (1 inch ≈ 500meters)

Figure 3. Comparison of brown trout abundance among the four McPherson Branch sites in summer 2005. Site 1 is downstream.

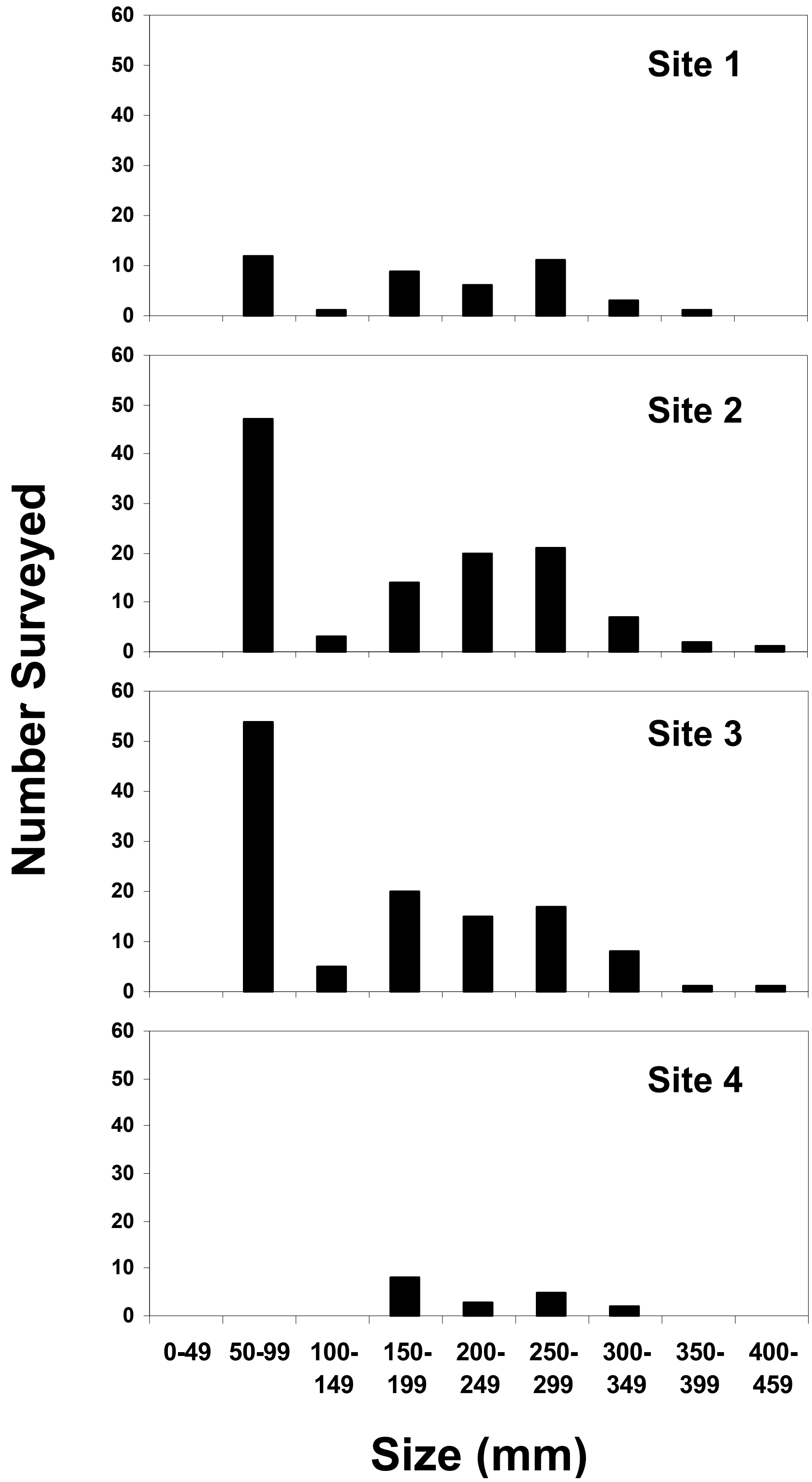

Figure 4. Comparison of brown trout size distributions among the four McPherson Branch sites in summer 2005. Site 1 was downstream. Sites 2 and 3 were restored.

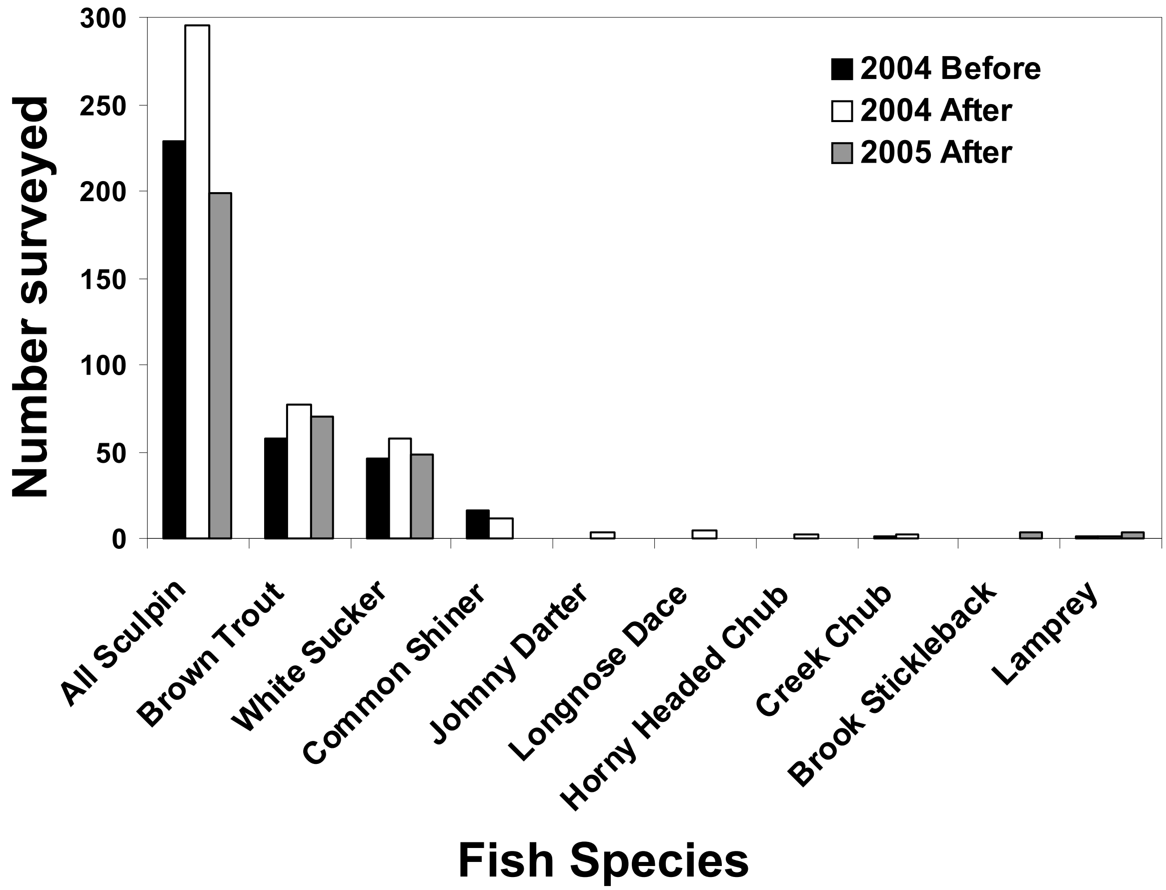

Figure 5. Comparison of abundance and diversity for all fish surveyed in the Blue River before restoration in 2004, immediately after restoration in 2004, and 1 year after restoration in 2005. Site 2 is where restoration occurred. “All Sculpins” is a combination of all mottled, slimy, and unidentified sculpins.

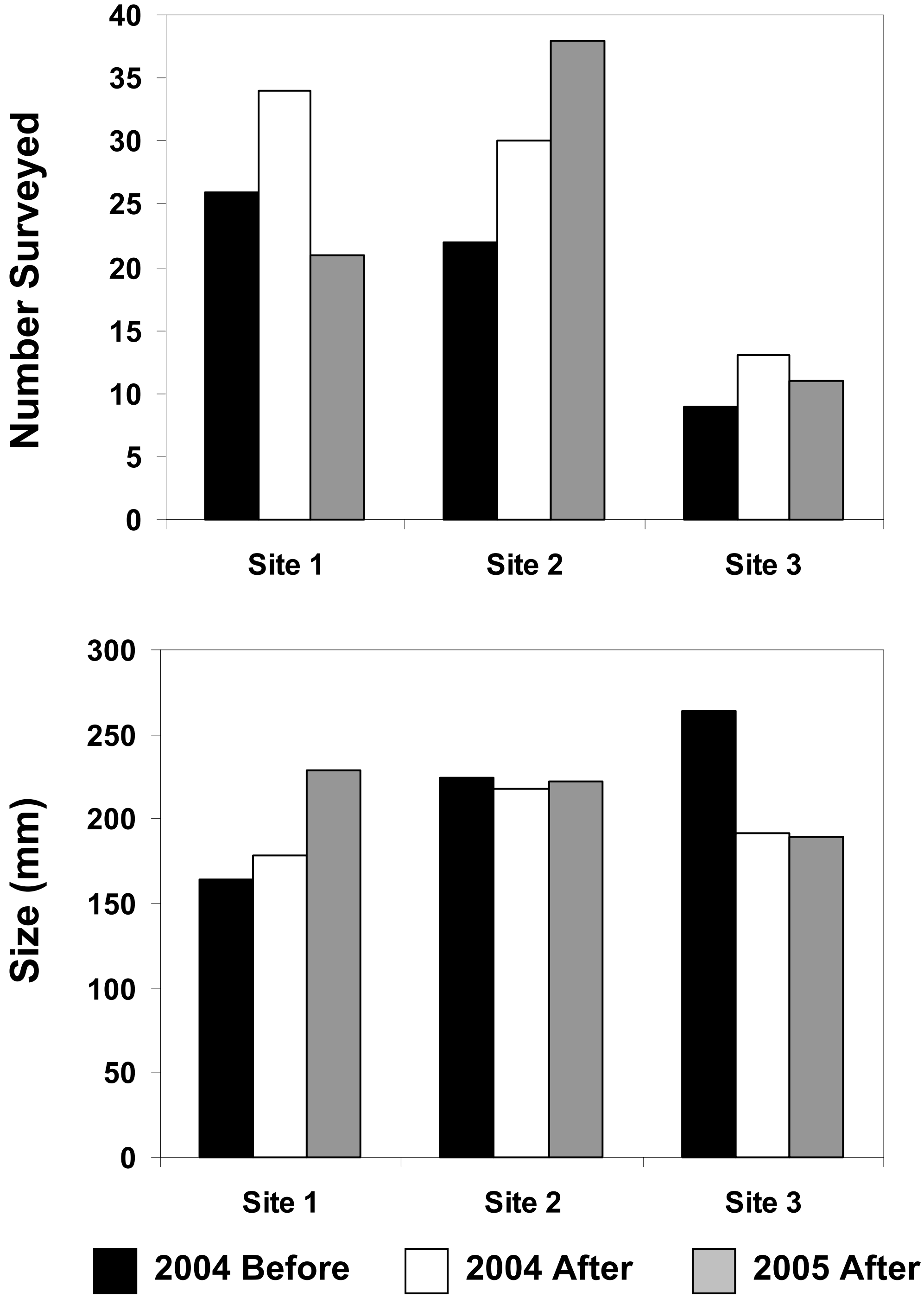

Figure 6. Comparisons of abundance and average size of brown trout among the three Blue River sites before restoration in 2004, immediately after restoration in 2004, and 1 year after restoration in 2005. Site 2 is where restoration occurred; Site 1 is downstream.

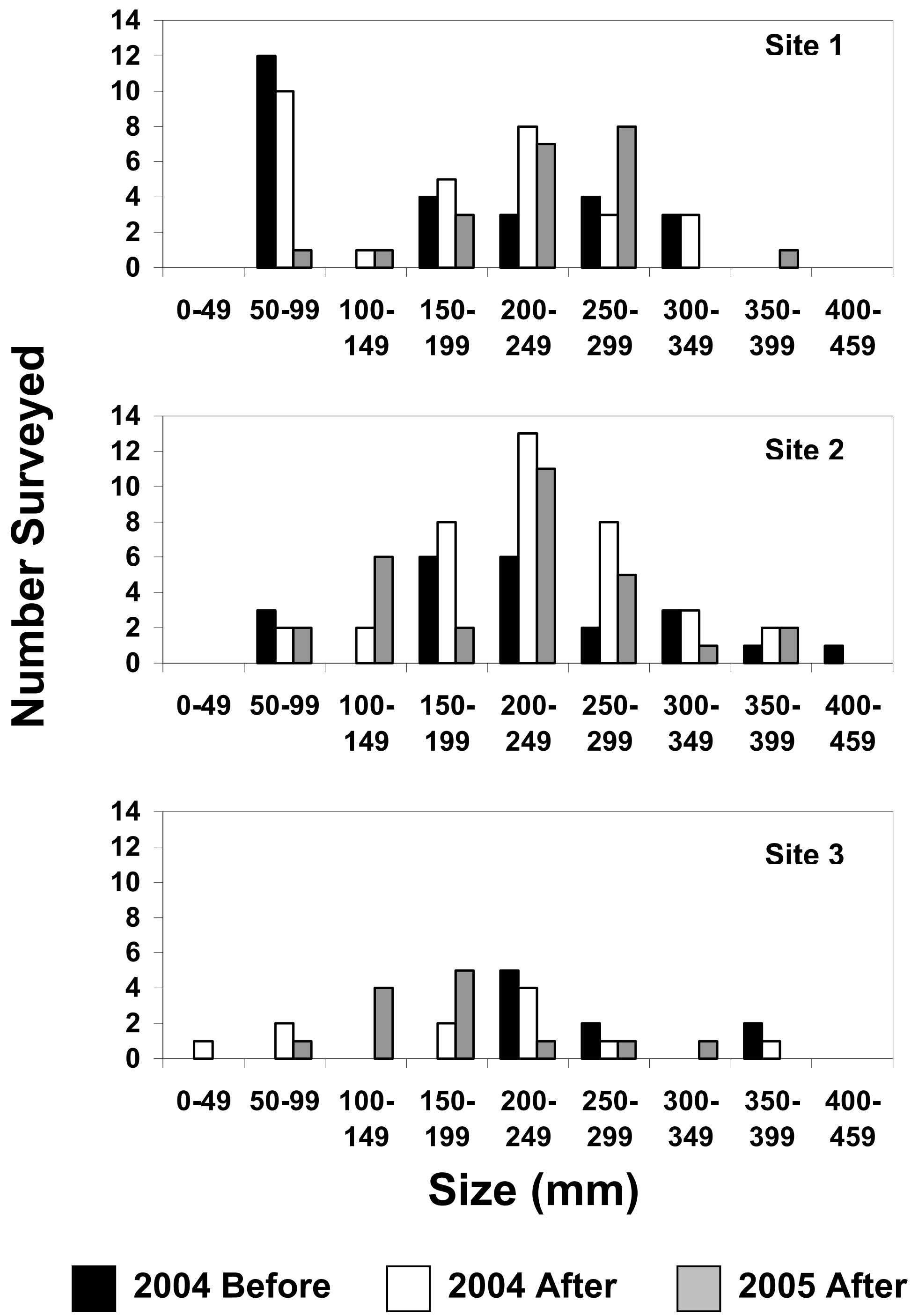

Figure 7. Comparisons of size of brown trout among the three Blue River sites before restoration in 2004, immediately after restoration in 2004, and 1 year after restoration in 2005. Site 2 (middle graph)is where restoration occurred; Site 1 (top graph) is downstream.