



Fisheries Sampling at Palgrave, on the Humber River

Trout Unlimited Canada Technical Report
No. ON-016

2006



 **TORONTO AND REGION
Conservation**
for The Living City

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Background

The Humber River watershed covers 908 square kilometres and is the largest watershed in the Toronto region. The Main branch of the river flows more than 120 kilometres from the source on the Oak Ridges Moraine south to Lake Ontario. The East Humber originates in the kettle lakes region of Richmond Hill and King Township. The West Humber begins in Caledon in the rolling hills of the South Slope and flows over the Peel Plain in Brampton before joining the Main Humber in Toronto.

The section of the Humber River which the Palgrave Dam intercepts is designated as a cold water stream and capable of supporting resident populations of brook and brown trout. The Palgrave Mill Dam was built in 1850 to provide a local source of hydro electric power and was in use between 1850 and 1960. Although no longer in operation, the dam and the pond have remained intact to preserve the dam for its local historical and heritage values.

The dam poses a number of potential environmental impacts for both aquatic and terrestrial ecosystems within the Humber River watershed. These impacts relate to physical, chemical and biological processes which must exist for a healthy watershed. The mill pond above the dam increases water temperature above 28°C and then discharges this warm water downstream. (Ontario Streams, 2002). This significantly high water temperature can seriously affect survival of cold and cool water fish species. Brook trout have an upper water temperature threshold of 24°C (Power 1985) while brown trout have an upper water temperature threshold of 26°C. However, neither of these species can survive these temperatures for sustained periods. In addition to temperature stress, the warmer water typically contains low levels of dissolved oxygen due to excessive algal growth and nutrient enrichment. This can further stress fish populations. Physically, ponds can act as sediment traps allowing fine silt particles to accumulate which increases thermal retention, reduces riverine habitat and potentially stores nutrients and pollutants. River systems need to transport sediment and this transport is being impeded by the dam. This disruption of sediment transport de-stabilizes the river and results in increased erosion of the river and its floodplain downstream. Lastly, the dam creates a physical barrier to fish movement both upstream and downstream, isolating populations of fish and impeding movement to critical habitats.

In an effort to increase fish movement through the area, a fishway was installed in 2001, allowing access around the Mill Dam. The fishway was designed to maintain the dam and pond while allowing movement of a variety of species of fish. At the request of the community, a public viewing window was installed at the midpoint of the fishway. The resulting fishway is a series of step pools at a 4% grade from the mouth to a large pool with a viewing window and then a second series of step pools at a 6% grade to a level box culvert leading into the headpond.

There has been great debate concerning the effectiveness of this fishway in both attracting and passing fish. To date, electrofishing surveys have identified fish within the fishway but these data do not identify movement and/or origin of these fish. Understanding the effectiveness of this fishway involves an understanding and identification of potential limiting factors to attraction and passage of fish. Attraction efficiency at this site could potentially be affected by the water quality coming out of the pond. Passage efficiency may be affected by a variety of factors including slope of the fishway, jump height and water velocities over the jumps. Each species will be affected by each of these variables in different ways and at different life stages.

This report documents fish sampling completed in support of a movement study assessing the effectiveness of the fishway at this site in passing salmonids, centrarcids (including bass, perch and sunfish), catostomids (suckers) and cyprinids (shiners, dace, sculpin and chub). Sampling was conducted in an effort to capture various species of fish of appropriate size for tagging with 23mm Passive Integrated Transponder (PIT) tags. Secondly, sampling was conducted to identify species and sizes of individuals in each pool of the fishway. These data help support movement data in the fishway and assess limiting factors in fish movement like length and velocity limitations through various portions of the fishway. The overarching goal is to identify what species utilize the fishway in addition to identifying size limitations in movement, increasing our knowledge of fish movement patterns and abilities. Ultimately, it is hoped that these data will provide useful information in assessing the effectiveness of the fishway and refining its design to increase its effectiveness as well as providing information for potential projects in the future.

Methods

The study area included approximately 800m of the Humber River downstream of Highway 50, which comprised the downstream portion of sampling. The Fishway was sampled by pool, numbered from bottom to top 1 through 8 (Figure 1). Lastly, the mill pond was sampled in a random fashion based on depths.

Sampling of the river and the fishway was conducted between 8am and 3pm on June 6, October 5 and November 18, 2008. Sampling of the mill pond was conducted between 8am and 3pm on June 28, 2008. Electrofishing was utilized to sample fish within each of the identified reaches. Riverine and fishway electrofishing crews included one leader with the shocking unit and two netters at all times. An additional netter was added at the base of the fishway where higher escapement was expected. In the case of the mill pond, depth of water and soft sediment required the use of an electrofishing boat with a crew of three.

All fish were identified, weighed, measured and recorded with capture location for further reference. Where individuals of a given species numbered over 50 individuals in a given sampling site, individuals over $n=50$ were binned by similar length and a bulk weight was taken. All fish were housed in in-stream holding tanks until sampling was complete to avoid recapture within the same sampling day. All fish captured in the river and fishway were released approximately 500m below the fishway. 17 of the 124 fish caught within the head pond were also released below the fishway, the remainder were released into the pond.

Due to the difference in grade between the two portions of the fishway, data was compared among all sampling sites as well as between four and six percent grades. Pools 1 through 4 comprise the 4% grade, while 5 through 8 comprise the 6% grade (Figure 1). Individual species were compared as well as family groups. Length and weight data were used to develop predictive calculations to identify lengths of bulk fish. Data comparisons included species numbers, lengths and biomass.



Figure 1: Sampling sites.

Data and Results

The number of species identified is highest below the fishway with 16 species (Table 1). The number of species identified decreases in the bottom half of the fishway (4% grade, pools 1-4) to 10 species and further decreases in the upper portion of the fishway (6% grade, pools 5-8) to 5 species (Table 1). As the total area within each sampling reach (river, 4% and 6%) decreases upstream, so does the number of species identified (Figure 2). While these cumulative trends hold true, individual pools within each reach have variable results (Figure 3). Interestingly, the largest pool does display a significantly higher number of species than other pools (Figure 3). The number of species per square meter varies from reach to reach. The fishway displays higher species/m² than the river with the lower (4%) reach of the fishway displaying the highest number of species/m² (Figure 4). The number of species/m² increases from the river through pool 1, 2 and 3, but decreases dramatically in pool 4 and is variable through pool 8 (Figure 5).

The most common species sampled throughout all reaches were brown trout (N=40), common shiner (N=73), mottled sculpin (N=7), rock bass (N=39) and white sucker (N=156). The numbers of species caught within each sampling site is identified in Figure 6. Interestingly, brown trout represented the only family found throughout in all sampling sites (Figure 6). Mottled sculpin only appear in the river, pool 1, 4 and 7 (Figure 6). Pool 4 displays the highest numbers of the commonly represented species within the fishway, followed by pools 1 and 5 (Figure 6). The lowest numbers are found within pools 6 and 8 (Figure 6). The distribution of these prominent species within sampling reaches shows a decrease in numbers of brown trout, common shiner and mottled sculpin from the river through the fishway (Figure 7). Both white sucker and rock bass increase from the river to the 4% reach and decrease in the 6% reach (Figure 7).

Proportionally, species grouped by families shows an increase in trout from river to pool 1 through 3 (Figure 8). The proportion of trout caught is low in pools 4 and 5, but are relatively high again in pool 6 and 7 (Figure 8). Minnows and centrarcids were only found up to pool 5 (Figure 8). The river reach sampled was clearly dominated by minnows, while the 4% reach was a reasonable mix of families (Figure 8). The upper reach of the fishway was dominated by trout and centrarcids (Figure 9). The mill pond is clearly dominated by suckers (Figure 9). Interestingly centrarcids and minnows were only found in the lower most pool in the 6% reach (Figure 8). If pool 5 is reassigned

to the 4% reach, the distribution of families changes dramatically, mainly due to the distribution of minnows and centrarcids (Figure 10).

The total length of the most prominent species indicate that brown trout and common shiners found in the fishway are generally larger than those found in the river (Figure 11). In addition, common shiners are significantly larger in the 6% grade than the 4% (Figure 11). Rock bass and mottled sculpin show little difference, while white suckers tend to be smaller in the fishway in comparison to the river (Figure 11).

The total biomass for each sampling reach shows great variability (Figure 12). Pools 1, 4 and 5 display higher biomass estimates than the river (Figure 12). Pools 3, 6, 7 and 8 display the lowest biomass estimates of all sampling sites (Figure 12). The total biomass collection of prominent species within each reach indicates that biomass levels are higher in the fishway than in the river (Figure 13). Within the fishway biomass decreases for all species with the exception of rock bass which increase from the 4% to 6% grade (Figure 13). Interestingly, brown trout show the smallest difference in biomass estimates between the 4% and 6% grades (Figure 13). Biomass estimates by individual sites indicate that the majority of the biomass observed in the 6% grade is represented by pool 5 (Figure 12 and 14). Pools 6, 7 and 8 are strongly dominated by brown trout with little contribution by mottled sculpin and white suckers (Figure 14). Within the 4% grade of the fishway, pool 3 displays little biomass in comparison with pools 1, 4 and to a lesser extent 2 (Figure 14). Total biomass in the 6% grade is skewed greatly by pool 5 which displays a dominance of rock bass and common shiner, whereas pools 6 through 8 display dominance of brown trout (Figure 12 and 14). If pool 5 is reassigned to the 4% reach, the distribution of biomass within reaches changes dramatically (Figure 15)

Sampling of the Mill Pond revealed only 5 species, which was dominated by white suckers (Table 1 and Figure 7).

Summary Plots

	river	4%	6%	Pond
blacknose dace	130	2		
bluntnose minnow	1			
brook lamprey	3			
brown bullhead	4			7
brown trout	16	14	9	1
common shiner	38	32	3	
creek chub	11			
fantail darter	18			
fathead minnow	3			
golden shiner				1
hognose sucker	7			
johnny darter	4			
largemouth bass		1		
mottled sculpin	4	2	1	
northern redbelly dace	1			
pumpkinseed	3	1		5
rock bass	11	18	10	
sunfish		1		
white sucker	20	24	2	110
yellow perch		2		

Table 1: Individuals collected by reach. (Grey shading represents no individuals of that species within the collection within that reach.)

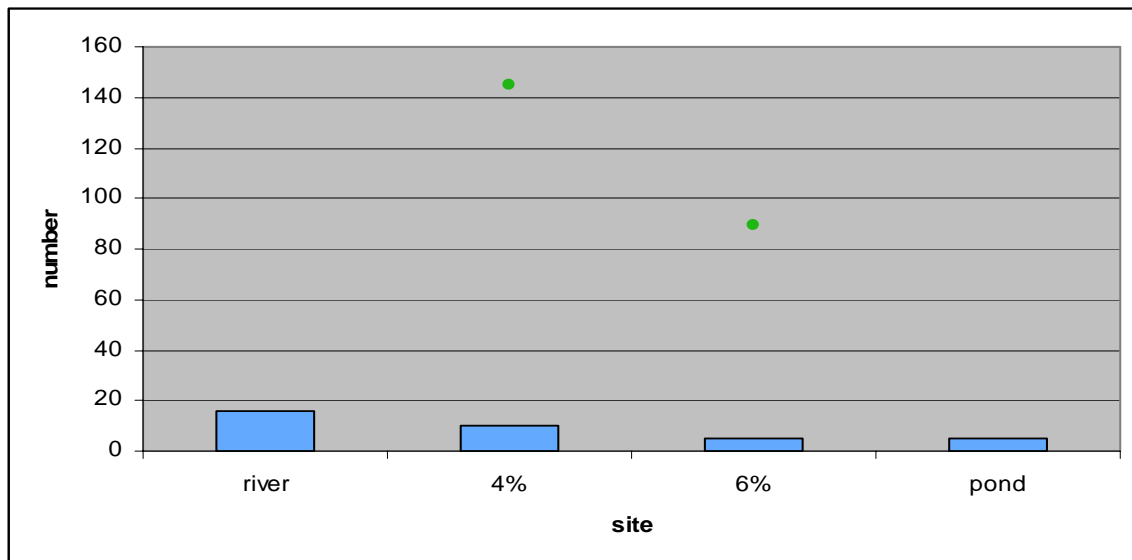


Figure 2: Number of species found within each reach. Green dots represent area of each reach (>800m² for river site).

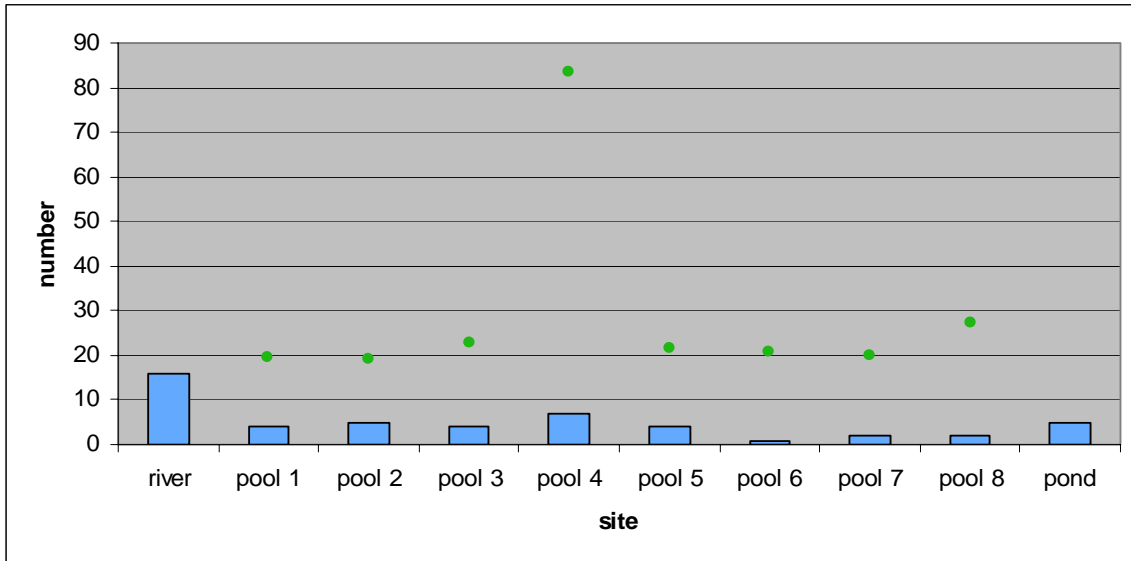


Figure 3: Number of species found at each site. (Green dots represent area of each reach (>800m² for river site).

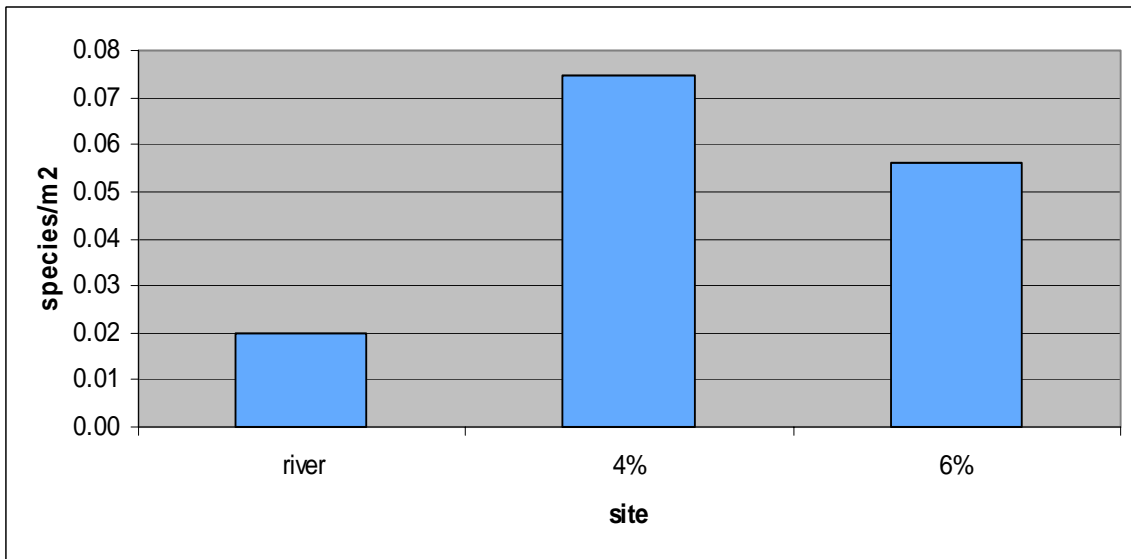


Figure 4: Number of species found per m² within each reach.

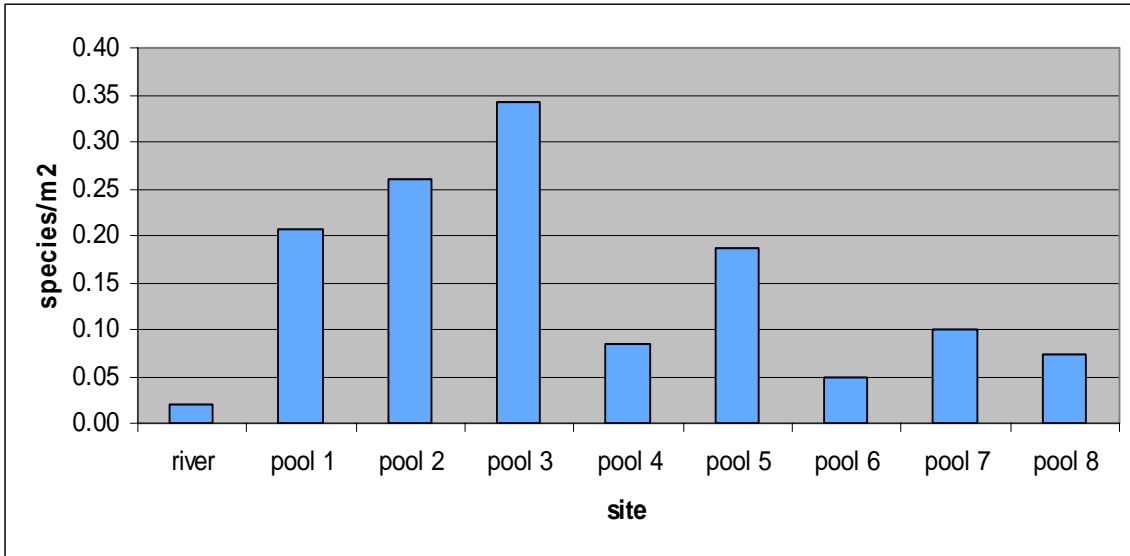


Figure 5: Number of species found per m² at each site.

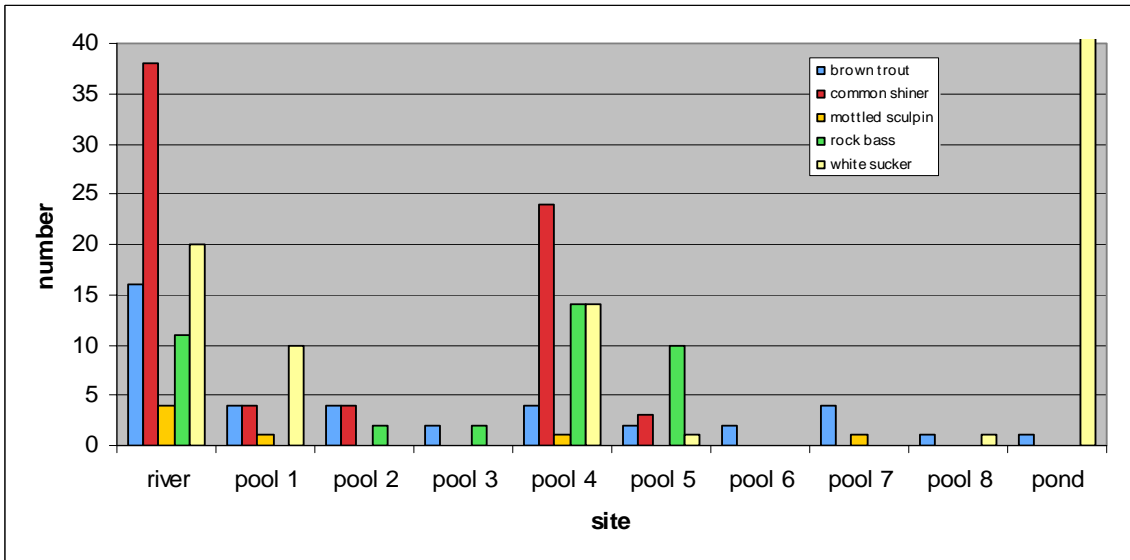


Figure 6: Family distribution, represented total catch at each site.

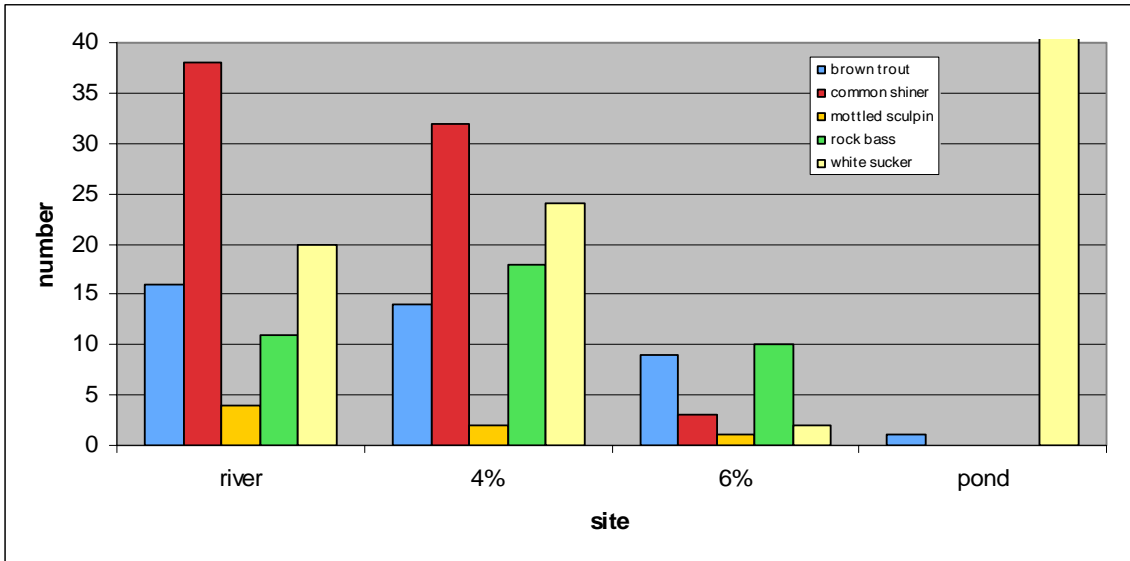


Figure 7: Distribution of prominent species across reaches, represented as total catch.

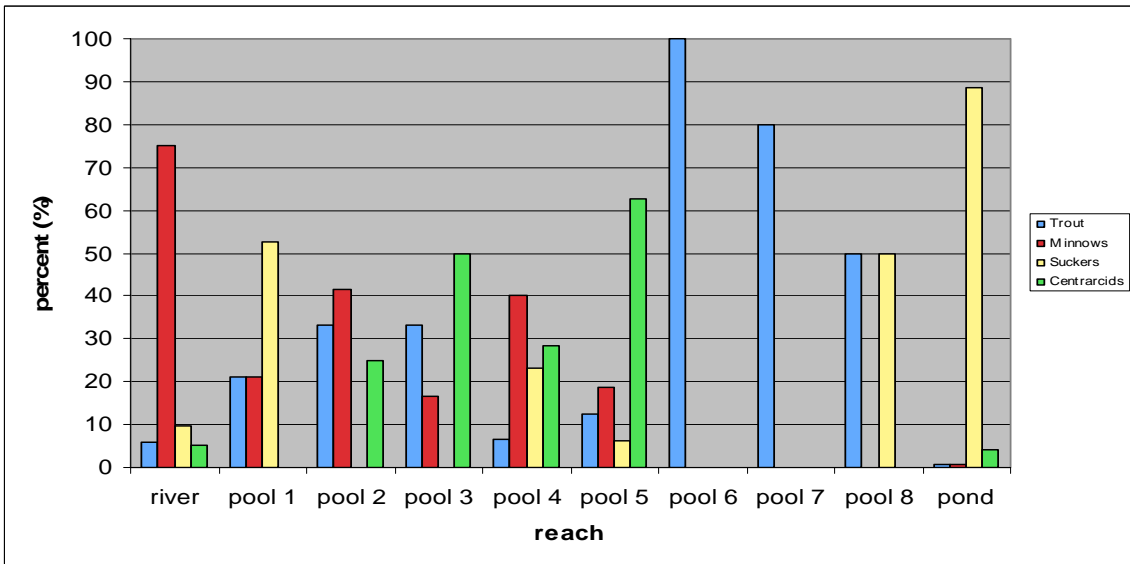


Figure 8: Family distribution, represented as % of total catch at each site.

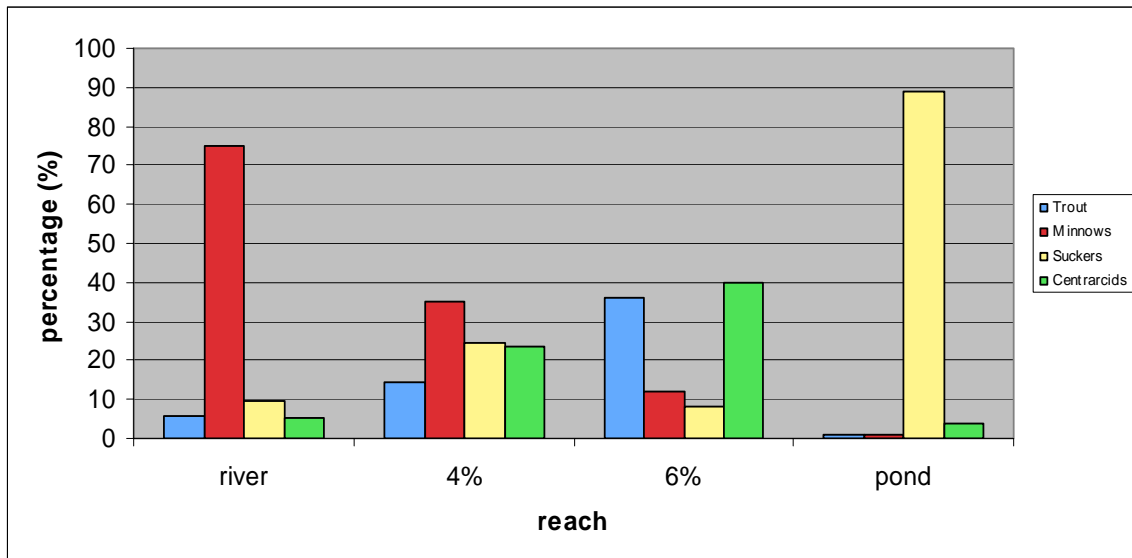


Figure 9: Family distribution within each reach, represented as % of total catch.

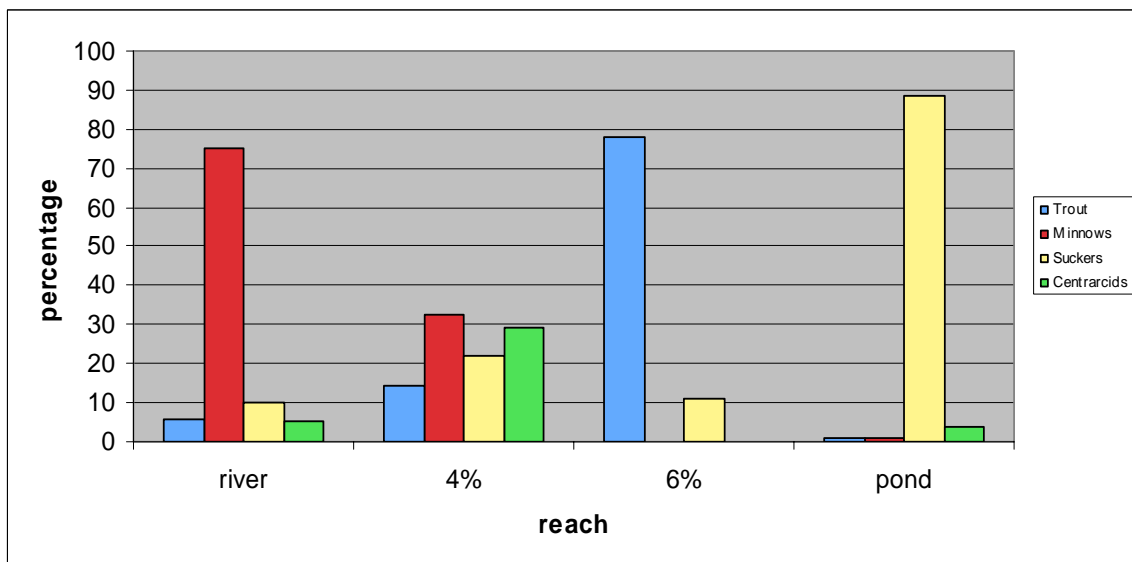


Figure 10: Family distribution within each modified reach, represented as % of total catch. The 4% reach is modified to include pool 5 and the 6% reach excludes pool 5.

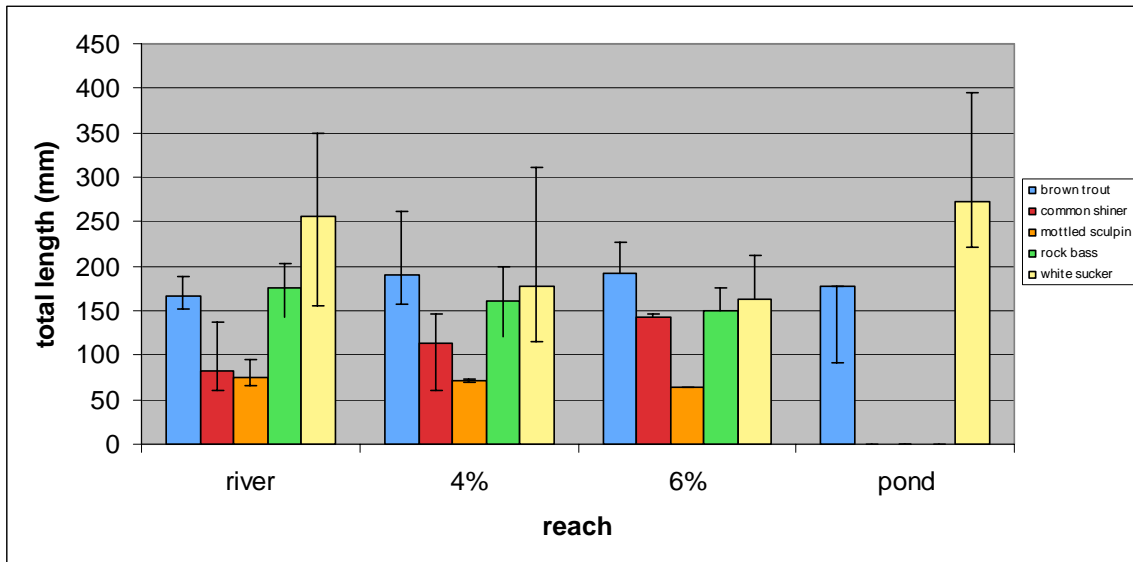


Figure 11: Size distribution of prominent species by reach. (Lines indicate range of sizes observed, bars represent average values.)

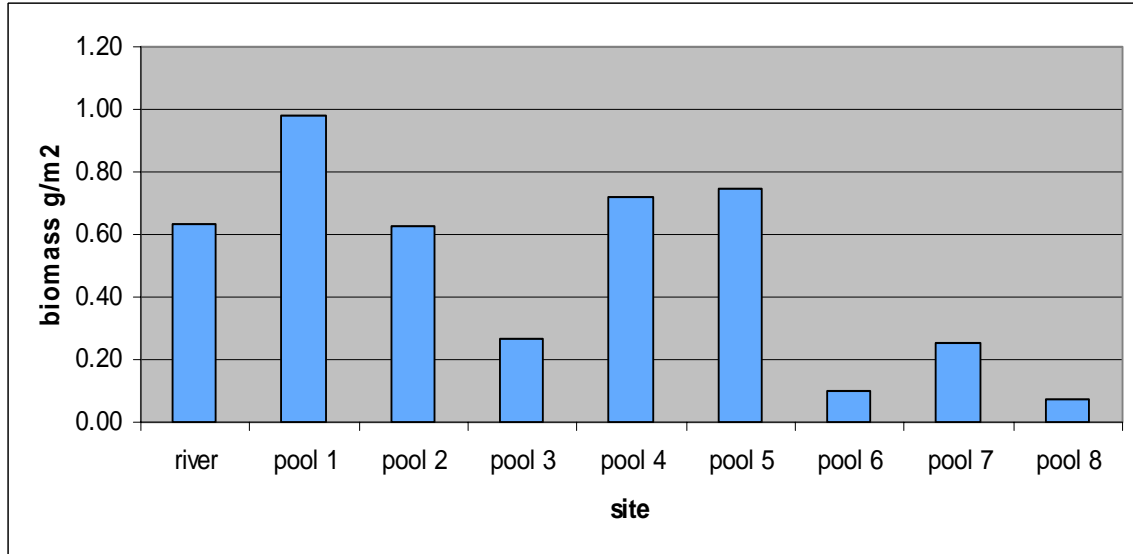


Figure 12: Total biomass collected at each site.

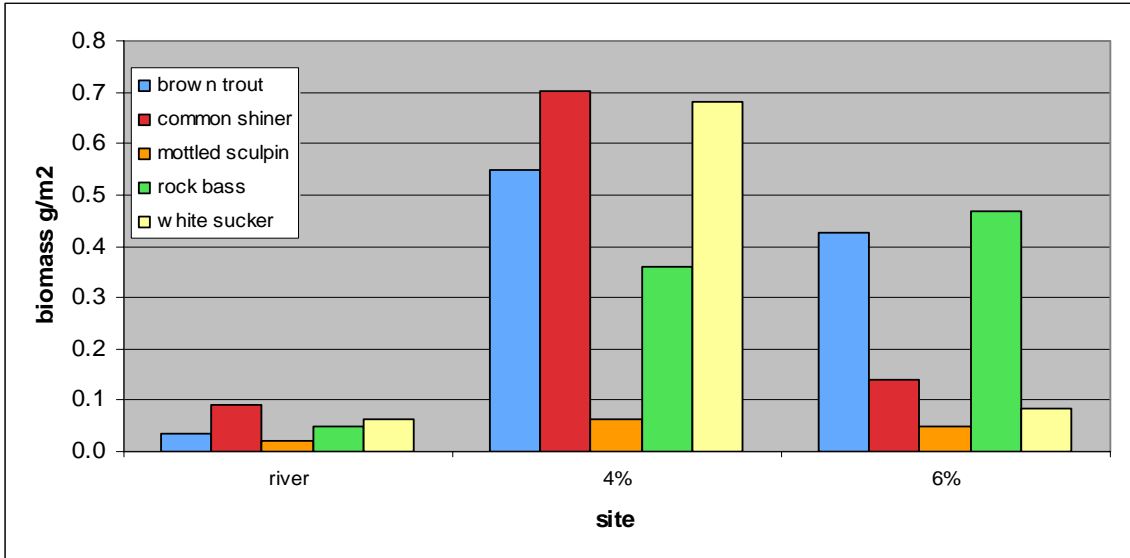


Figure 13: Total biomass of prominent species collected by reach.

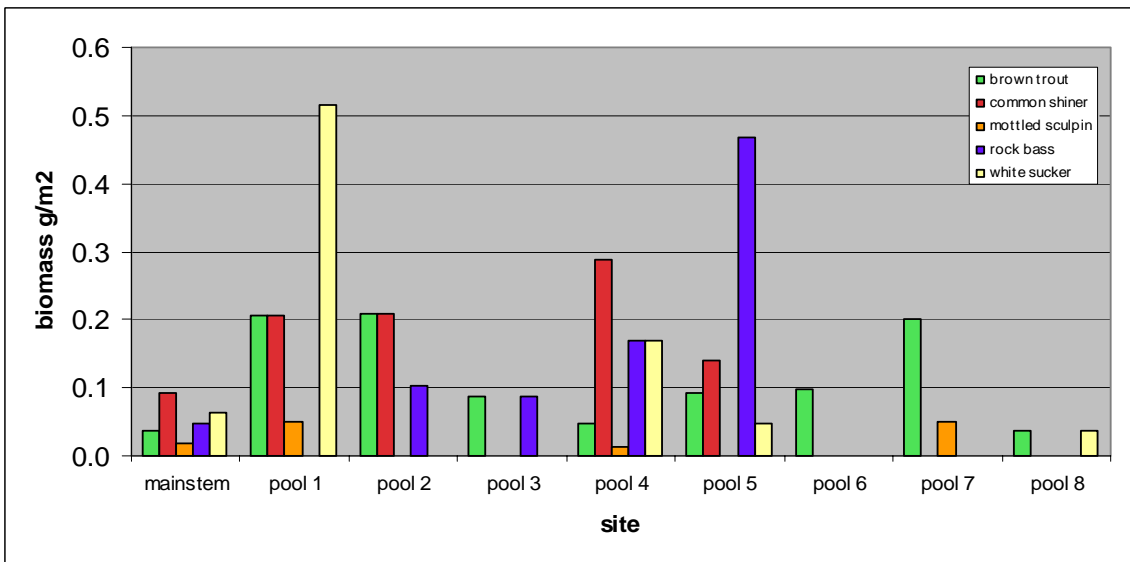


Figure 14: Total biomass of prominent species collected by site.

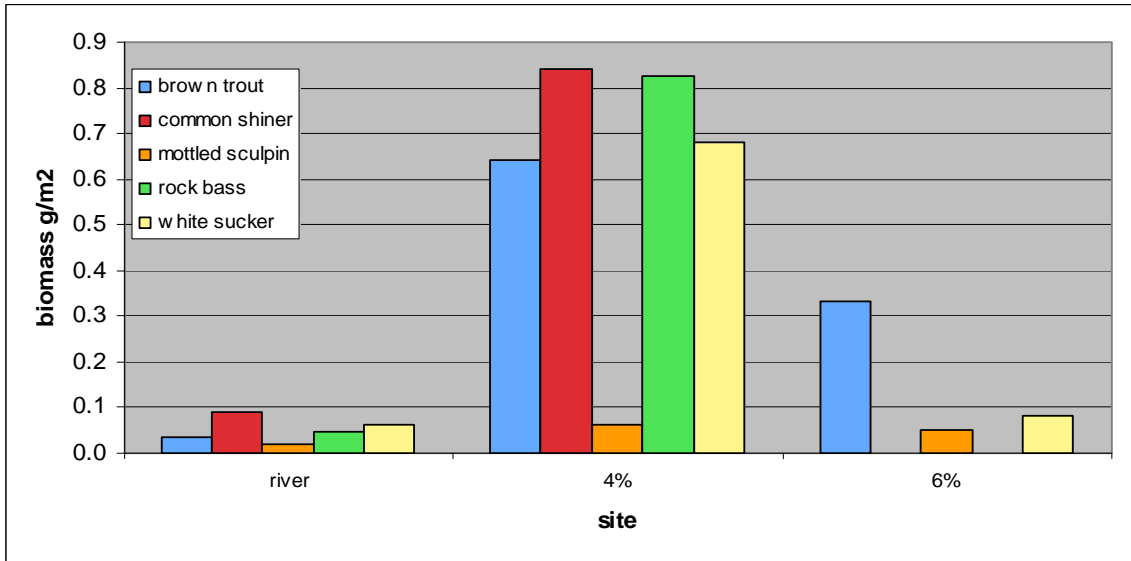


Figure 15: Total biomass of prominent species collected at each modified reach. The 4% reach is modified to include pool 5 and the 6% reach excludes pool 5.

Implications

The identification of multiple species of fish within the fishway is evidence that the fishway does attract some species of fish and that many of these species seem capable of traversing at least some of the jumps within the fishway. The species composition within the fishway is similar to the river and both are distinctly different from the head pond. This suggests that, while direction of movement is not known (i.e. from the head pond down or from the river up); the similarities in species composition indicate that it is likely many of these species are moving up from the river. The significant difference between the species composition in the fishway and the head pond also suggests that movement through the entirety of the fishway from the river is non-existent, not significant, or individuals moving into the head pond do not survive.

It is difficult to determine the efficiency of this fishway in passing fish, but the difference in sizes of shiners between the fishway and river may indicate that not all age classes of these fish are able to traverse the entire fishway. Interestingly, the largest white suckers are not found in the fishway and therefore may be moving downstream from the head pond to the river.

Analysis of the data collected assumed that the fishway increased in grade from 4% to 6% after pool 4. However, the distribution of species and biomass suggests that the jump from pool 4 to pool 5 is not significantly more difficult than those lower.

A disproportionately large number of trout within the fishway indicates that it is highly attractive to trout. Pools 6, 7 and 8 only held trout and few white suckers (which could have moved down from the mill pond) suggesting limitations in movement of some species in the upper reaches of the fishway.

The data collected to date indicate that fish are attracted to the fishway and most species are capable of traversing the jumps from the river to pool 5. The upper reaches seem to be more difficult as they are only found to contain trout and white suckers. This data cannot speak to the ability of fish to pass through the entire fishway and monitoring of movement through Passive Integrated Transponders (PIT) tags is ongoing.

Further analysis and monitoring should include water quality monitoring including dissolved oxygen and temperature which may assist with the analysis of fish movements. Lastly, data collection should continue to include multiyear data. These data will help eliminate cyclical trends in and environmental effects on population dynamics.

References

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Power, G. 1980. The brook charr, *Salvelinus fontinalis*. In Charrs: salmonids fishes of the genus *Salvelinus*. Kluwer Boston Inc., Boston, U.S.A. pp. 141-203.