Northeast Ohio Regional Sewer District

Plum Creek Aquatic Life Restoration by Native Fish Translocation

Water Quality and Industrial Surveillance

Environmental Assessment Group

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Abstract

Improvements in regional wastewater collection and treatment in the Rocky River watershed have resulted in water quality improvements and biological Water Quality Standards (WQS) attainment in >90% of the watershed. A series of natural falls in Plum Creek isolate the headwaters from fish recolonization and limit WQS attainment for the fish community component. In 2020, the Northeast Ohio Regional Sewer District (NEORSD) initiated a fish translocation project with a goal to restore full WQS attainment in Plum Creek. Nine candidate species were collected from the Rocky River watershed, tagged using a visual implant elastomer, and introduced into Plum Creek at two different seed locations. Annual follow-up surveys have shown seven species still inhabiting the lower 3.20 miles of Plum Creek, with six species displaying natural reproduction. With the data collected so far, Plum Creek may be able to meet full biological attainment within the next few years.

Introduction

Plum Creek is a small headwater stream tributary to the West Branch of the Rocky River in Cuyahoga and Lorain counties. Plum Creek is currently designated an aquatic life use (ALU) as a warmwater habitat (WWH) under the Ohio Environmental Protection Agency (EPA) WQS. Historically, this stream has experienced biological impairment dating back to the first Ohio EPA water quality assessment in 1981. Gross organic enrichment from multiple publicly owned treatment works (POTWs) were identified as the primary cause of impairment in Plum Creek prior to the 1990s (Ohio EPA 2020). Biological impairment due to organic enrichment was a common occurrence in the greater Cleveland area and led to the regionalization of wastewater treatment and the expansion of the NEORSD.

Large interceptor sewers were constructed to address widespread water quality issues based on the results of an Environmental Impact Statement (USEPA 1983). The NEORSD Southwest Interceptor (SWI) eliminated nine POTWs from discharging into the Rocky River watershed through the late 1990s, three of which discharged directly into Plum Creek. Wastewater flows are now treated at the NEORSD Southerly Wastewater Treatment Center, discharging treated effluent into the Cuyahoga River. The elimination of these POTWs from the Rocky River watershed vastly improved water quality in the impacted reaches. The Ohio EPA's most recent 2014-2015 Rocky River Biological and Water Quality Study of the Rocky River Watershed (2020) showed that biological communities are in full attainment for the ALU WQS in >90% of the watershed (Figure 1).

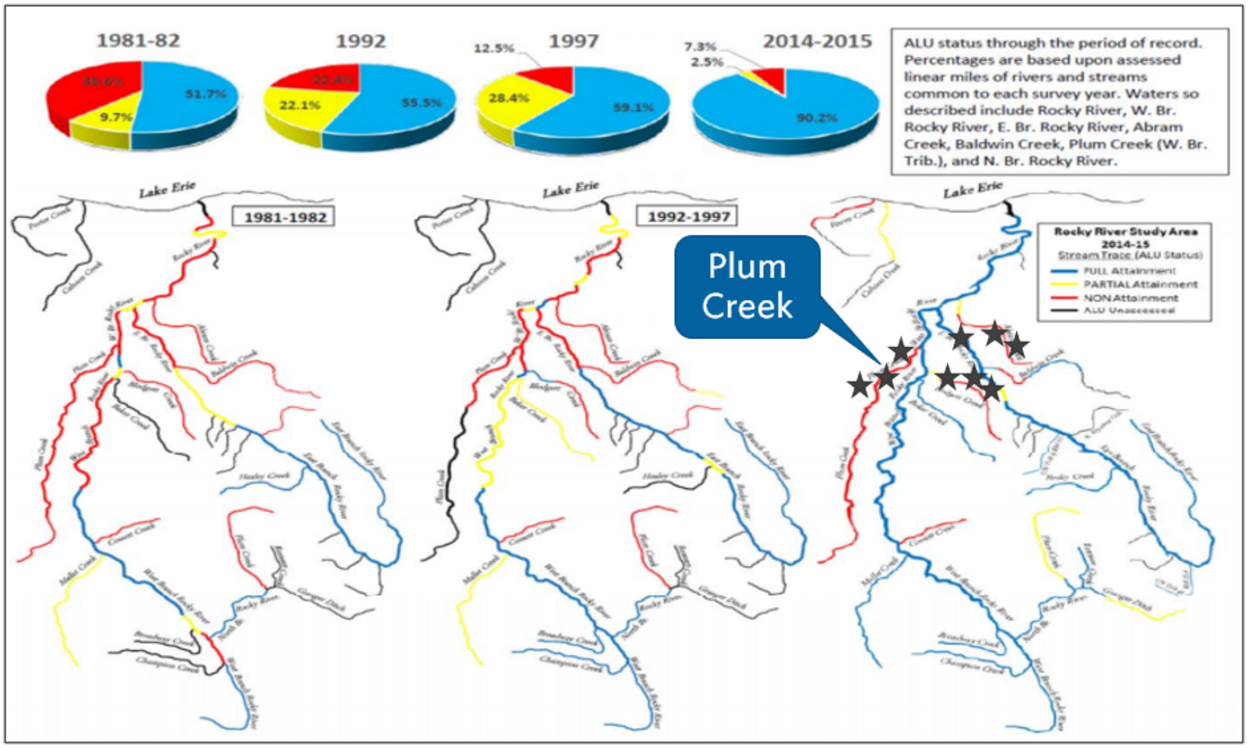

Figure 1. Rocky River watershed ALU WQS attainment status (Ohio EPA 2020). The stars represent the approximate location of the nine POTWs removed by the construction of the NEORSD SWI.

Nutrient enrichment has also historically impacted water quality in Plum Creek. A total maximum daily load (TMDL) for Plum Creek was implemented by the Ohio EPA in 2001. More recent water chemistry data has shown reduced in-stream nutrient concentrations that now consistently meet the water quality target criteria. The recovery of the middle and lower Rocky River watershed was evident as wastewater loading was removed from the watershed and nutrient enrichment issues were minimized. However, artificial and natural barriers limit the fish community biology recovery of a few select streams and therefore are the leading cause of ALU WQS impairment.

The Ohio EPA recognizes the limitations to biological recovery in Plum Creek due to the historical pollution from POTWs and the natural waterfalls posing as a fish passage barrier at the confluence with the Rocky River West Branch (Figure 2). Before considering Plum Creek eligible for an ALU redesignation to a lower water quality goal, the Ohio EPA proposed a seeding of upper Plum Creek with a representative collection of native headwater fish species to restore the ALU. Biologists at the NEORSD reviewed this proposed project and decided to implement a fish translocation project to restore the ALU in Plum Creek. The Ohio EPA has noted this project in the *Loading Analysis Plan and Supporting Data Acquisition Needed for the Rocky River Watershed total maximum daily load development* (2021) as a way to address the current biological impairment.

Figure 2. Plum Creek Gorge (The Waterfall Record)

Methods

The Ohio ALU WQS are based on standard biological assessments (fish and macroinvertebrates) and supplemented by chemical water quality and stream habitat assessments. Methods for performing biological surveys for Aquatic Life Use, and some of those used for this study, are outlined in *Biological Criteria for the Protection of Aquatic Life volumes II and III* (Ohio EPA 1987). All methods detailed in this report follow the *Study Plan for the Upper Plum Creek Native Fish Translocation to Support Fish Community Biology Attainment* (NEORSD 2021).

Nine candidate fish species (Table 1) were selected for translocation into Plum Creek based on numerous factors. The primary goal of this project was to introduce fish species that will increase the fish Index of Biotic Integrity (IBI) score, which is used to determine attainment of the ALU WQS in Ohio. Secondly, these candidate species had never been collected within Plum Creek based on historical data and are abundant within the Rocky River West Branch watershed. A review of in-stream habitat components at the two Plum Creek seed locations using the Ohio EPA Qualitative Habitat Evaluation Index (QHEI; 2006) were compared to individual species needs. QHEI substrate and riffle quality were also compared to reproductive needs for each of the candidate species (Lane et al. 1996; Rice and Zimmerman 2019).

Table 1. Candidate species
Northern Hogsucker
Blacknose Dace
Striped Shiner
Silverjaw Minnow
Sand Shiner
Rainbow Darter
Greenside Darter
Blackside Darter
Fantail Darter

Source locations for the candidate fish species were selected from within the Rocky River watershed. Specific source locations were selected based on historical collections from the Ohio EPA and the NEORSD within the last 10 years. A combination of a low-voltage backpack electroshocker (Smith Root LR24) and a 10-foot weighted seine net were used to collect candidate fish. To target darter and other benthic dwelling species, the seine net would be deployed perpendicular to flows, while a backpack operator effectively shocked a small upstream reach while disturbing benthic substrates with their feet. Stunned fish would flow into the seine net for collection and identification. For cyprinid and pool-dwelling species, the substrate would be disturbed first to increase turbidity flowing downstream. The seine net would then be pulled swiftly downstream, faster than the current, which usually ended with the seine netters pinning fish against a bank. Once collected, the candidate species were selected and placed into buckets until enough fish were collected for the day. This process was repeated until an estimated 100-800 candidate species were collected. Collection of fish occurred between March and June of each year to translocate fish prior to their prime spawning period. Darter species were targeted first due to their earlier preferred spawning period than shiners. A goal of 200 fish per species per year was set based on a literature review of similar projects (Hornick et al. 2017; McManamay et al. 2016, Cochran-Biederman et al. 2014; Cuyahoga Soil and Water Conservation District 2020).

Candidate fish were then sorted by species, counted, and documented on a field sheet. Non-targeted species were released to the stream when they were collected. Every one of the candidate species collected for the day was tagged with a colored *Northwest Marine Technology, Inc.* visual implant elastomer (VIE) on the side of their body, above the lateral line, and between the posterior end of the dorsal fin and the head (Figure 3). The only exception to this was the Northern Hogsucker, which was tagged on the ventral side of their jaw due to the skin being too opaque. Tagging colors were dependent on the year introduced (pink=2021; yellow=2022; red=2023), and the side of body the tag was placed depended on the location that the fish were released into Plum Creek (right=RM 2.85, left=RM 1.50). The color and location of the VIE tag allowed biologists to track survivability, in-stream movement, and reproduction of the introduced species in Plum Creek.

Figure 3. From left to right; Blackside Darter with 2023 red tag; Greenside Darter with 2022 yellow tag; Sand Shiners with 2021 pink tag.

An aerated cooler was used during the tagging process and transport to keep fish alive, and ice was used on an as-needed basis depending on weather conditions. Tagged fish were then released into the appropriate Plum Creek stream location at the end of the day. A map of Plum Creek seed locations is shown in Figure 4.

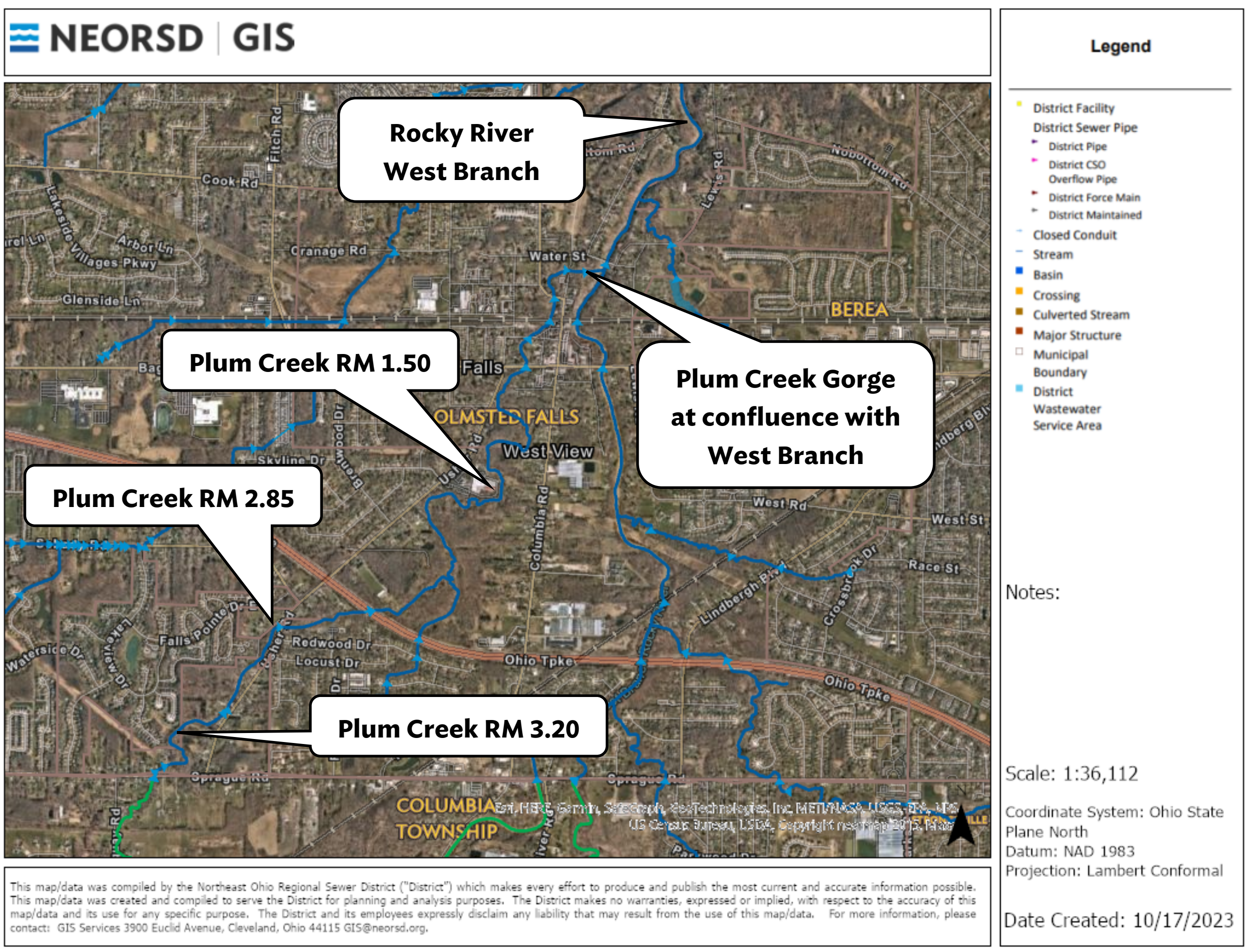

Figure 4. Plum Creek seed location map.

Results and Discussion

Between 2021 and 2023, a total of 10,304 fish were collected from the Rocky River watershed, tagged with a VIE, and introduced into Plum Creek at two different seed locations. The goal of 200 fish translocated per species was met for seven of the nine species. Table 2 below lists annual totals of fish introduced into Plum Creek.

Table 2. Annual Totals of Fish Introduced to Plum Creek

Year	2021		2022		2023	
Species / Location	RM 2.84	RM 1.50	RM 2.84	RM 1.50	RM 2.84	RM 1.50
Northern Hogsucker	2	2	3	3	51	40
Blacknose dace	500	0	205	0	368	0
Striped shiner	79	184	31	66	186	62
Silverjaw minnow	10	46	21	44	200	121
Sand shiner	412	758	399	915	754	327
Rainbow darter	890	39	741	30	904	108
Greenside darter	250	6	148	89	621	124
Blackside darter	3	0	2	0	6	0
Fantail darter	186	0	94	0	258	16
Annual totals	3,367		2,791		4,146	

Annual fall "check-ins" at the two Plum Creek seed locations were used to track reproduction, movement, and survivability. In 2023, one additional location on Plum Creek at RM 3.20 was selected to determine if fish were moving upstream of the seed locations. With fish health being a high priority, electrofishing was not utilized during this post-translocation sampling. A seine net was used while either kicking substrates to allow riffle species to flow into the net or moved swiftly through run and pool habitats.

The number of candidate fish collected from Plum Creek increased from 40 individual fish in 2021, to 446 fish in 2023 (Figure 5). The number of un-tagged fish increased from one individual fish in 2021 to 237 in 2023, indicating that the species that are reproducing in Plum Creek are doing so at a substantial rate. Figure 6 displays the abundance of species collected with either a tag or un-tagged from all three sample years. Six of the candidate species have been collected in Plum Creek without a tag and are assumed to be naturally reproduced within the stream. The total number of un-tagged fish in Plum Creek outnumbered those of tagged fish for three species: Blacknose Dace, Greenside Darter, and Rainbow Darter.

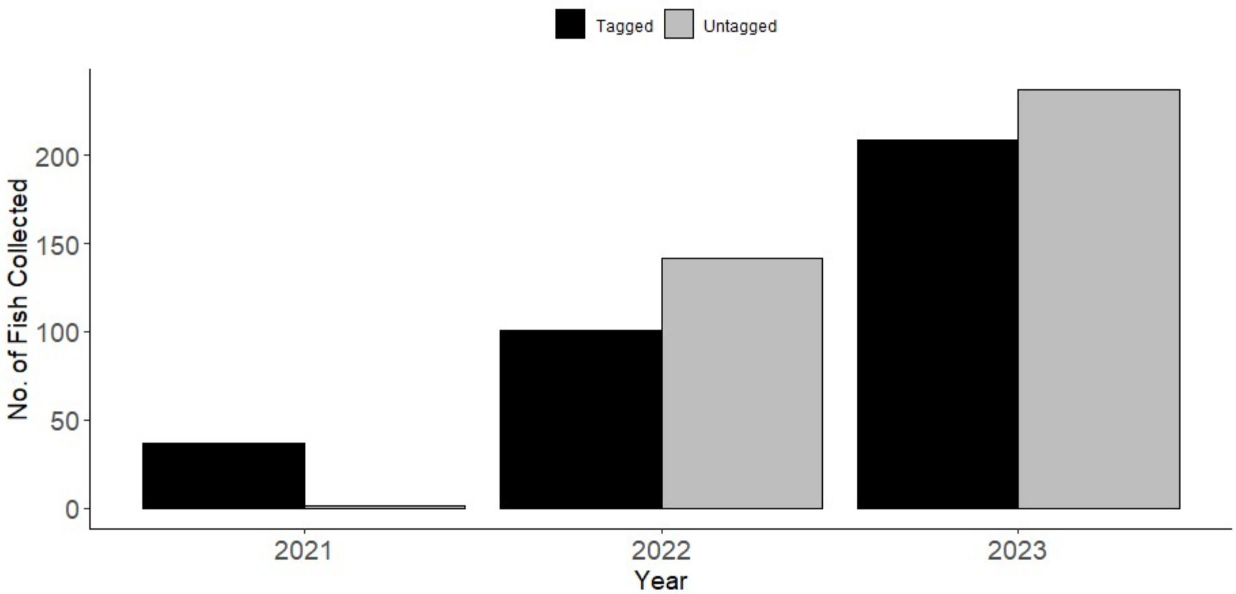

Figure 5. Number of tagged and untagged candidate fish collected in Plum Creek by year.

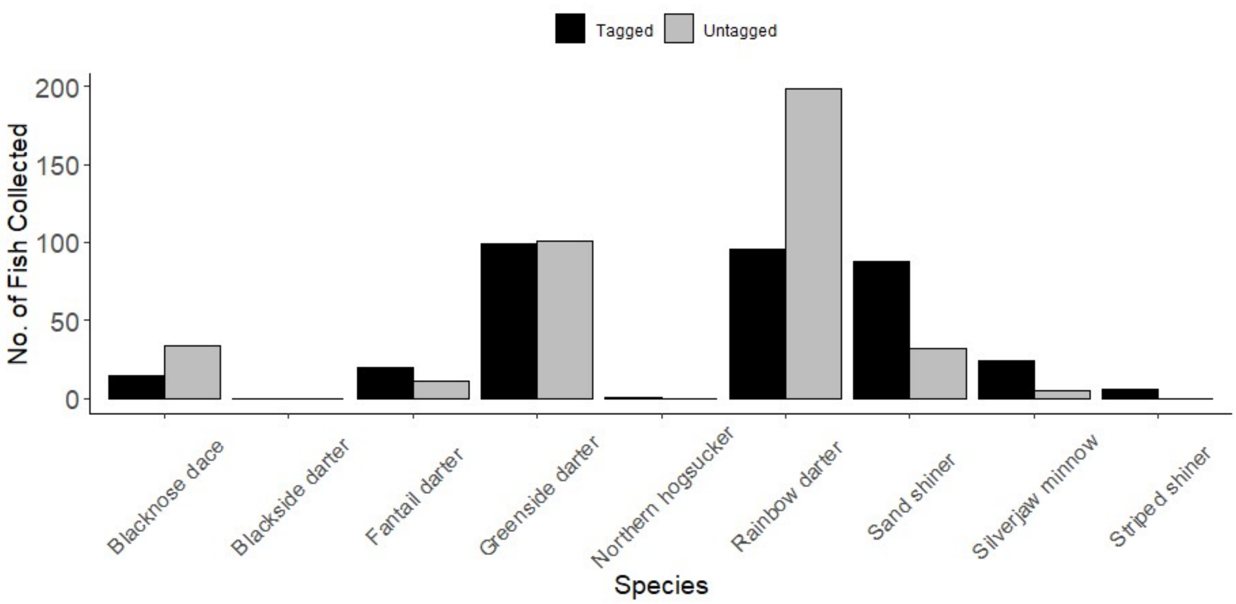

Figure 6. Number of tagged and untagged candidate fish collected in Plum Creek by species.

Population estimates were calculated from mark-and-recapture data using the Chapman – Petersen method (Lockwood and Schneider 2000). Population estimates of the nine candidate species collected in Plum Creek are shown in Figure 7. Recapture data was only used for 2023 data to avoid any duplicate recaptures from previous years. Figure 7 also displays the 68% confidence intervals which are commonly used in fisheries management.

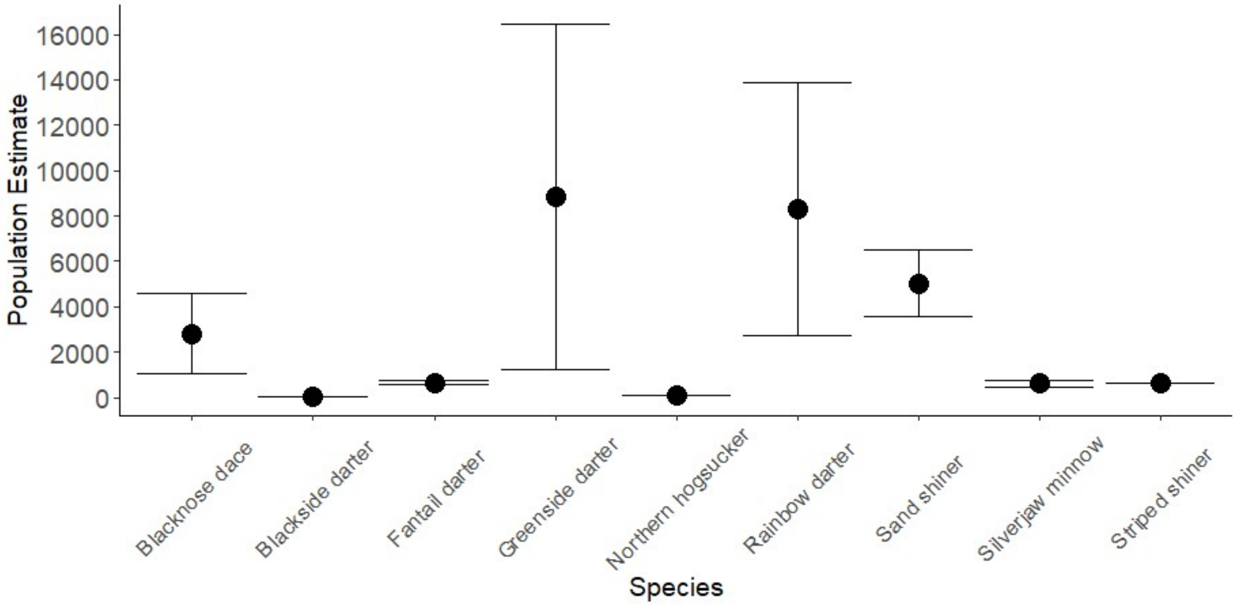

Figure 7. Chapman-Petersen mark-and-recapture estimates with 68% confidence intervals.

Based on estimates, the populations of the Northern Hogsucker, Striped Shiner, and Blackside Darter do not appear to be viable. However, the sampling method of using only a seine net may skew data towards lower collection rates for these species. When these species were collected in the spring, they are typically exhibiting spawning behavior, congregated, and are therefore easier to collect. Utilizing electrofishing equipment in future biological assessments may result in a higher collection rate of these three species. All other species are estimated to have a population of 90-5,539 more fish than the number of individuals introduced. The highest population estimates in order are the Rainbow Darter (8,251), Sand Shiner (4,848), Blacknose Dace (3,356), Greenside Darter (2,490), and Fantail Darter (846).

The survivability of the introduced species can be determined by examining how long the color-coded tagged individuals have survived in Plum Creek. Fish with pink tags were introduced in 2021, yellow in 2022, and red in 2023. Pink tagged fish were recovered in each of the three annual fall sampling dates, with numbers remaining steady, between 15-39 (Figure 8). Yellow tagged fish had a higher overall recapture rate, and the 2023 red tagged fish consisted of the highest number of recaptures. The lifespan on the introduced fish is relatively short (3-6 years) with the exception being the Northern Hogsucker, which can have a lifespan of 11 years. Nearly all fish were introduced as mature adults. The first cohort of introduced fish have now demonstrated survival of >2.5 years and may be nearing the end of their lifespan causing the number of recaptured fish to decline. Natural fish movement throughout Plum Creek has been documented as 39 individuals were collected approximately 0.5 miles upstream of the RM 2.85 seed location. Only seven of these fish were found to be tagged. Tagged fish have also been collected at the opposite seed location during the last two fall sampling events. Fish moving throughout Plum Creek may also be causing a decline in overall species abundance at the seed locations.

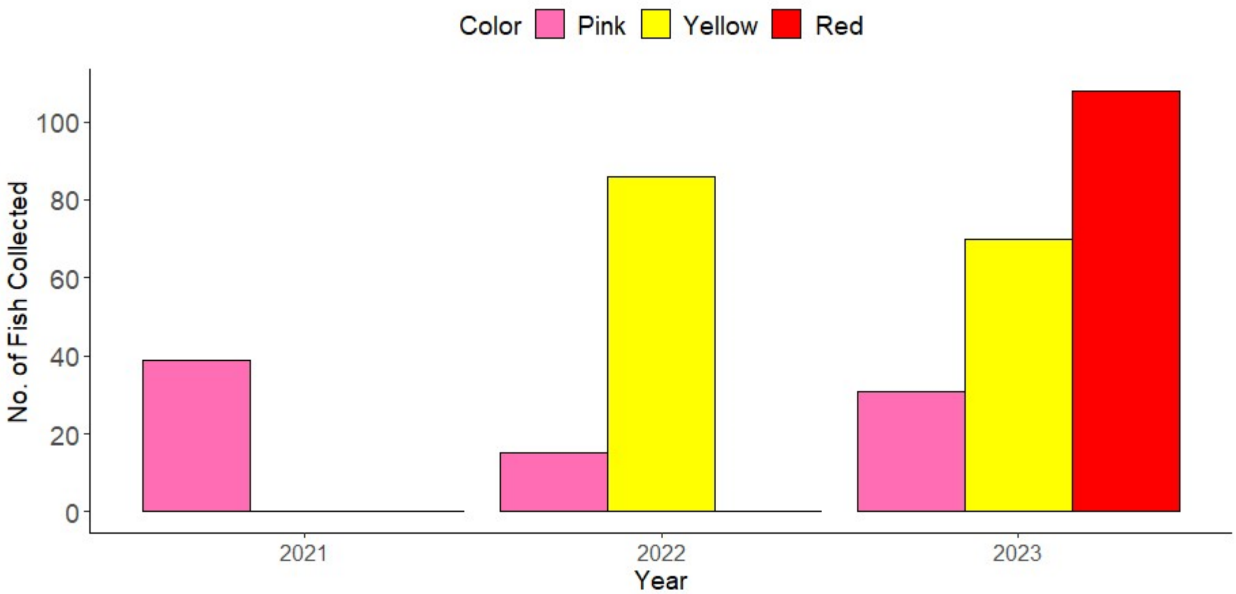

Figure 8. Plum Creek recovered tagged fish abundance by year. Fish with pink tags were introduced in 2021, yellow in 2022, and red in 2023.

Conclusions

All fish introduced into Plum Creek were specifically chosen to have a positive effect on the overall IBI score. Nearly all 12 of the individual IBI metrics have the potential to increase in score with the introduction of these nine fish species. The total number of species, darter species, headwater species, minnow species, and sensitive species have all increased based on the data collected so far. The proportion metrics of the IBI are likely to shift from the historically high proportion of pioneering, tolerant, and omnivorous feeding species, to a higher proportion of pollution neutral or sensitive community with more specialized feeding and spawning guilds.

Results from 2021-2023 have shown an increased population and natural reproduction for several of the species introduced into Plum Creek. Chemical water quality and in-stream habitat do not appear to be limitations to six of the nine species. The three species that were not recollected at a high rate do not appear to have established a self-sustaining population. Habitat may be limiting the Northern Hogsucker and Striped Shiners, as they are generally found in slightly larger streams. Only eleven Blackside Darters were collected and introduced into Plum Creek. It is not likely that this is enough fish to propagate a self-sustaining population.

Figure 5 demonstrates the benefits of adding multiple years of fish translocation to one project. These continued efforts have increased the total number of translocated fish and genetic diversity among species, resulting in true natural reproduction from six species so far. The number of un-tagged fish, or those that have naturally reproduced within Plum Creek, has increased each fall and have outnumbered the number of tagged fish the last two fall sampling dates. The spring of 2023 marked the end of the three-year fish translocation project. Fall sampling on Plum Creek will continue to document natural reproduction rates and overall abundance of the introduced species.

A full biological and water quality assessment is planned on Plum Creek for 2026, as a part of the NEORSD Rocky River watershed water quality assessment. This assessment will be the benchmark for whether this project is successful or not, depending on the improvements to the fish IBI score. If successful, Plum Creek will meet the WWH designated use for the first time ever and eliminate the need to redesignate Plum Creek to a lower water quality goal.

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