Relative Abundance of Fish Populations in the Swan River: 2014 – 2022

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Introduction

This report reviews the relative abundance of fish populations in the upper Swan River of Montana (Figure 1). The upper Swan River is defined as the 89 kilometer (55.3 mile) length from Lindbergh Lake to Swan Lake. The primary objective of this work is to evaluate spatial distribution of fish species and determine changes over time, if any. A secondary objective is to monitor gross changes in species abundance.

Native species in this river include Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi,* Bull Trout *Salvelinus confluentus,* Mountain Whitefish *Prosopium williamsnoni,* Finescale Sucker *Catostomus catostomus*, Largescale Sucker *Catostomus macrocheilus*, Northern Pikeminnow, *Ptychocheilus oregonensis*, Redside Shiner, *Richardsonius balteatus* and an undescribed Sculpin species (*Cottidae*). Sculpins are challenging to identify to the species level and a recent range-wide genetic sampling found multiple species are present in the Swan River Valley distribution (Young et al 2022). Given the difficulty in distinguishing the species, even with genetic sampling, snorkelers cannot identify Sculpins beyond the genus level. Non-native species include include Rainbow Trout *Oncorhynchus mykiss*, Brook Trout *Salvelinus fontinalis,* hybridized *Oncorhynchus*, hybridized *Salvelinus* and Brook Stickleback *Culaea inconstans*.

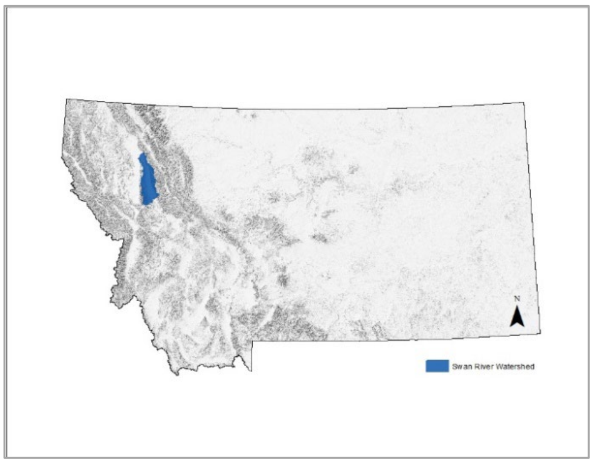

Figure 1. Swan River watershed (blue polygon) location within state of Montana

Methods

Prior to sampling, Forest Service hydrologists delineated the Swan River into "valley segments" and then further divided the valley segments into "reaches" by aerial imagery and GIS modeling. A valley segment distinguishes broad changes in the channel entrenchment, gradient, and/or water temperature. Fish species distribution will likely correlate with valley segments (e.g., Redside Shiner more likely to be found in warm, low gradient valley segments). The Swan River has 7 valley segments, numbered sequentially from the inlet to Swan Lake and going upstream, shown on Figure 2.

Reaches are bound by general channel types of single thread, multiple thread or channel width. A valley segment may have one or more reach. A total of 15 reaches have been identified in the Swan River labeled from A (inlet to Swan Lake) to O (outlet of Cygnet Lake). These delineations have not been ground-truthed.

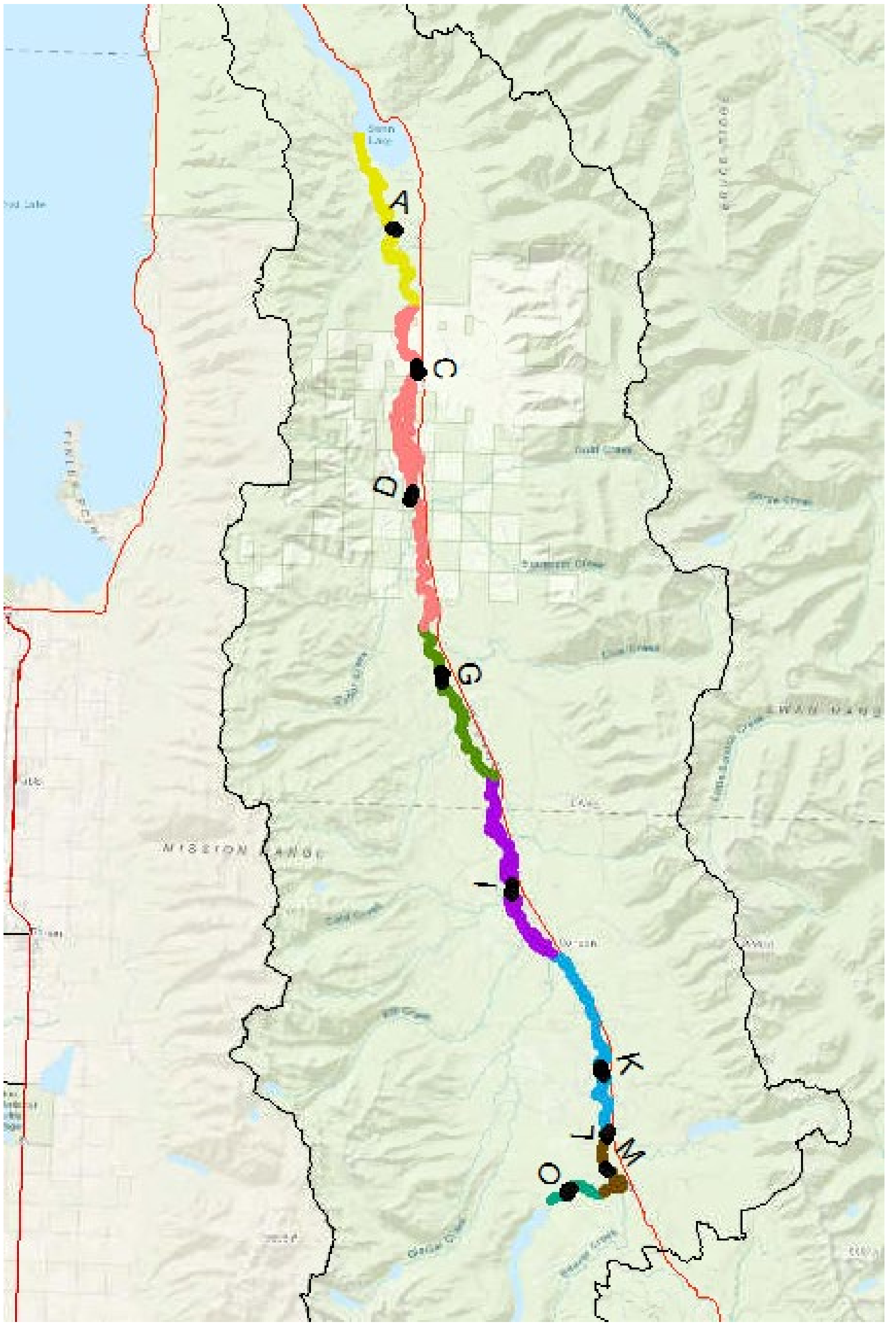

Figure 2. Location of valley segments (colored lines) and sample areas.

A "sample" is a smaller area of a reach that presumably typifies the rest of the reach. Fish distribution in the sample should represent the larger reach and valley segment. Ideally a comprehensive sampling would take place across the reach to confirm the sample is representative. Lacking the resources to conduct such comprehensive work, this work assumes that a single sample represents the entire reach.

Miscellaneous pilot work took place in 2009, 2013, 2014 and 2015. These studies helped select the best sample areas and time periods. Gardner and Stephens (2015) summarized the 2014-2015 work and concluded snorkeling has sufficient efficacy in the Swan River. A collaborative group comprised of Montana FWP, Montana DNRC, Swan Valley Connections, the University of Montana, and the Flathead National Forest then proposed to replicate the 2014-2015 work every 3 years. The group sampled the river in 2019 and 2022. The group assumed that if 9 reaches were sampled within days of each other, data would meet project objectives. However, logistic challenges have not yet allowed all 9 samples to be done in one year. The following table describes the valley segment, reach, and sample years to date.

Table 1. Description of sample areas and effort to date.

Valley Segment	Reach	Sample Area	2014	2015	2019	2022
1	A	Near Porcupine Bridge		X		X
2	C	Point Pleasant CG	X		X	X
2	D	Near Goat Ck Station	X		X	X
3	G	Near Piper Bridge	X	X	X	X
4	I	Near Kaufman Rd	X			X
5	K	Near Jette Road	X		X	X
5	L	Pine Ridge CG	X	X	X	X
6	M	Near Lindbergh Bridge	X		X	
7	O	Near Cygnet Lake	X			X

To minimize variance, all sampling has standardized effort (dive time) between years. All snorkeling is done in daylight during weeks 30-32. Divers practice snorkeling techniques including identification, size categorization, and safety prior to performing surveys. Fish length was sorted into five categories: Young of year (typically less than 3 centimeters), 3 - 10 centimeters, 10 – 20 centimeters, 20 – 30 centimeters, and > 30 centimeters. Fish were only counted when divers had confidence in species or at least genus. Divers could assign a fish to just "*Oncorhynchus*" if the fish appeared to be hybridized or identity was too uncertain. It is acknowledged that correctly identifying *Oncorhynchus* species based on morphology alone is impossible, but that error is assumed to be tolerable for this project. Divers could also use "*Salvelinus*" when uncertain if an individual was a Bull Trout, Brook Trout, or hybridized Bull x Brook, however this proved to be very uncommon and the undetermined *Salvelinus* were ignored. During older samples divers simply lumped all Sucker observations into *Catostomus* but starting in 2022, divers occasionally distinguished *C. catostomus* from *C. macrocheilus*. It is recognized that the divers had unequal experience, but all samples were utilized in this report. Further information on protocols is provided by Gardner (2022).

All fisheries sampling methods have shortcomings and inherent bias. Modeling is needed to transform the snorkel tally into a fish population estimate. Ideally the local snorkel estimates would be contrasted to a different local method, such as electrofishing, but in the Swan River no other method has been robust enough to generate fish population estimates. Therefore, published relevant literature is utilized to transform snorkel tallies into an estimate. The formula used is $N = C + ((1- P)*C)$. Whereas N is the estimated population per species, per size category, per reach. C is the snorkel count per species, per size category, per reach. P is the average efficiency, or probability of observation by snorkeling, per species and size category. Thus if the P of a certain species and size category is 0.75, and the snorkel count was 5, then the equation is $N = 5 + ((1-0.75)*5) = 6.25$. All N values are rounded to the nearest whole number. Estimated N is then converted to density per 1,000 square meters. This allows comparisons across the reaches, which have unequal sample lengths. The gap between the count and N is regarded as the margin of error. Only changes that exceed the margin of error will be considered large enough to be significant changes.

Five published reports were used to estimate P. Thurow (1994) provides literature review of P for juvenile and adult brook, rainbow, bull and cutthroat trout in all habitat conditions. Thurow, Peterson, and Guzevich (2006) provide charts that estimate P for several size categories of bull, cutthroat and rainbow trout based on visibility, water temperature and percent pool composition. Mullner, Hubert and Wesche (1998) estimate P for all trout species based on regression equation that factors large woody debris coverage and percentage of large cobble

(>128mm) coverage. Hagen and Baxter (2005) provide a chart of P for all salmonids based on water visibility. Weaver, Kwak and Pollock (2014) provide single P for shiner and sucker species for all habitat conditions. When multiple studies provided P values for a species, a simple averaging of all studies was used. No P values have been discovered for Sculpins, Brook Stickleback, Northern Pikeminnow, Brook x Bull Trout hybrids or undetermined *Oncorhynchus*. These species counts remain untransformed.

Each sample area had habitat measurements taken during base flows in 2022. Measurements included length, surface area, volume of each pool, riffle, pocket pool and side channel. Wood debris was enumerated, and surface area of debris jams computed. Each sample area had two transects that measured the medial axis of all surface substrates with bankfull perimeter. Gradient was measured with a single representative profile using an engineering level. Further details on habitat measurements are in Gardner (2022). To minimize observer variance, all measurements were collected by the same crew. Snorkel samples prior to 2022 did not have any measurements. This project assumes that habitat conditions have not substantially changed and used 2022 data to extrapolate all older surveys. Table 2 below summarizes habitat conditions at each sample area, except M. Area M has not yet been measured.

Table 2. Habitat descriptions of sample areas. No data available for Sample area M.

Sample	Length (m)	Total Surface area (m2)	% of Surface area w/ Debris Jams	% of Surface area w/ Side Channels	% of volume Pools	% of volume Riffles	Max Depth of Pools (m)	D50 of substrate (mm)	% substrates >128mm	Gradient
A	979	33,254	1.6	1.2	92.1	7.5	3.4	24-32	0	0.07
C	723.1	22,544	2.3	17.4	63.3	34.1	2.9	48-64	0.4	0.39
D	615	18,525	1.2	0	12.3	84.8	0.8	48-64	14.4	0.1
G	752.4	18,800	8.2	4.0	56.3	38.8	2.4	32-48	4.3	2.93
I	713.5	17,461	6.4	33.1	70.0	28.4	0.9	32-48	3.1	0.46
K	841.5	12,765	1.1	0	29.5	64.9	0.3	48-64	16.1	4.01
L	483	6,881	0.9	5.1	58.9	34.8	0.7	32-48	3.8	0.32
O	450.5	8,476	1.7	22.3	9.7	83.3	0.4	64-96	21.5	1.3

Results and Discussion

During the four sample years, a total of 6,809 individuals were observed. To examine gross changes in species composition over time, data from 2014 and 2022 are most useful since these years sampled 8 out of 9 areas. 2015 and 2019 did not sample as many areas. Figures 3 and 4 below provide pie charts that display overall species compositions for all reaches in 2014 and 2022. These figures show the percentage of actual counts (not transformed population estimates) for species. Undetermined *Oncorhynchus* are not shown. Brook Stickleback, Brook x Bull Trout Hybrid, and Sculpins were uncommon and combined into “Other”.

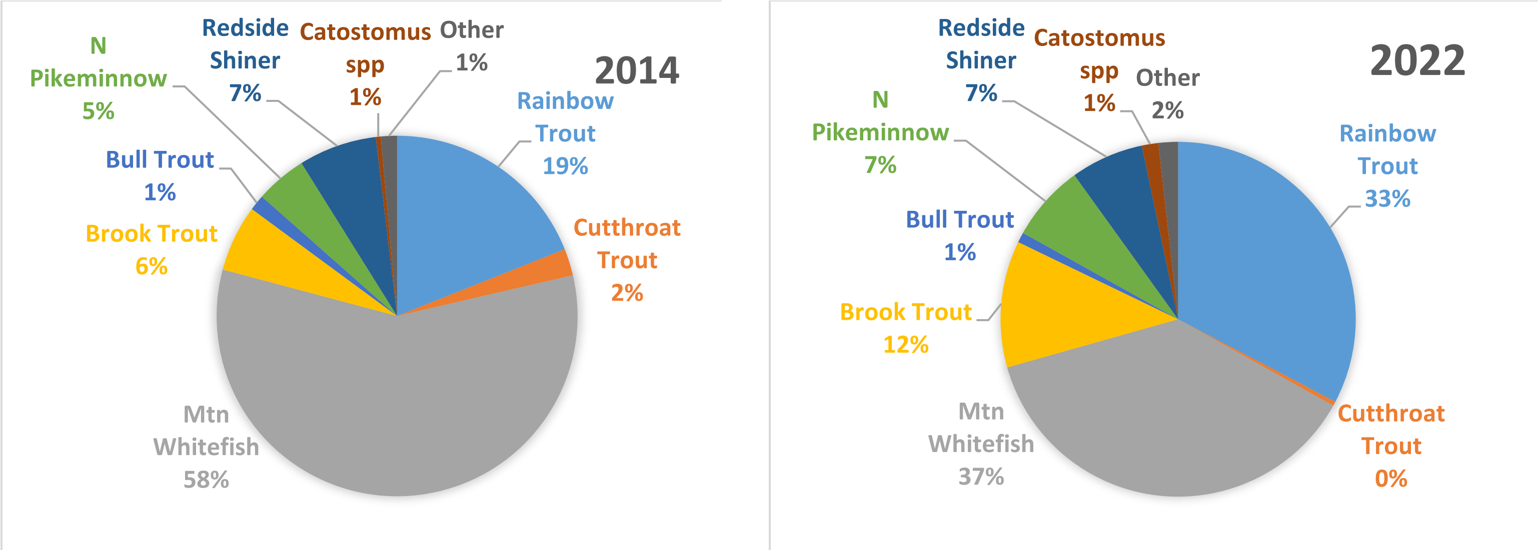

Figure 3 (left) and 4 (right). Percentage of species tallied in 2014 and 2022. To reduce clutter, Brook Stickleback, Brook x Bull Trout Hybrid and Sculpin are combined into "other" category. Percent value rounded to nearest whole number.

The following sections provide more detail for species, in descending order of abundance.

Mountain Whitefish

Mountain Whitefish were the most abundant species in 2014, 2015 and 2022. As shown on Figure 5 below, Mountain Whitefish abundance appears to be decreasing over time but there is overlap in the margin of error between years. This suggests the amount of change is not significant enough for detection. Figure 6 illustrates spatial distribution of Mountain Whitefish across the sampling areas and years. Data indicates that while Mountain Whitefish are present in all reaches of the river, they are less prevalent Reach A, C and D. These reaches are in the lower two valley segments, which have the coldest water temperatures. Divers have no difficulty identifying the species but P is generally low, presumably because of the challenge of correctly counting large schools in deeper water. Substantial numbers of young-of-year Mountain Whitefish were observed in Reach I and O and a few observed in Reach D (none elsewhere). These three reaches have the largest substrates and highest gradients, suggesting they have the most optimal rearing habitats for Mountain Whitefish.

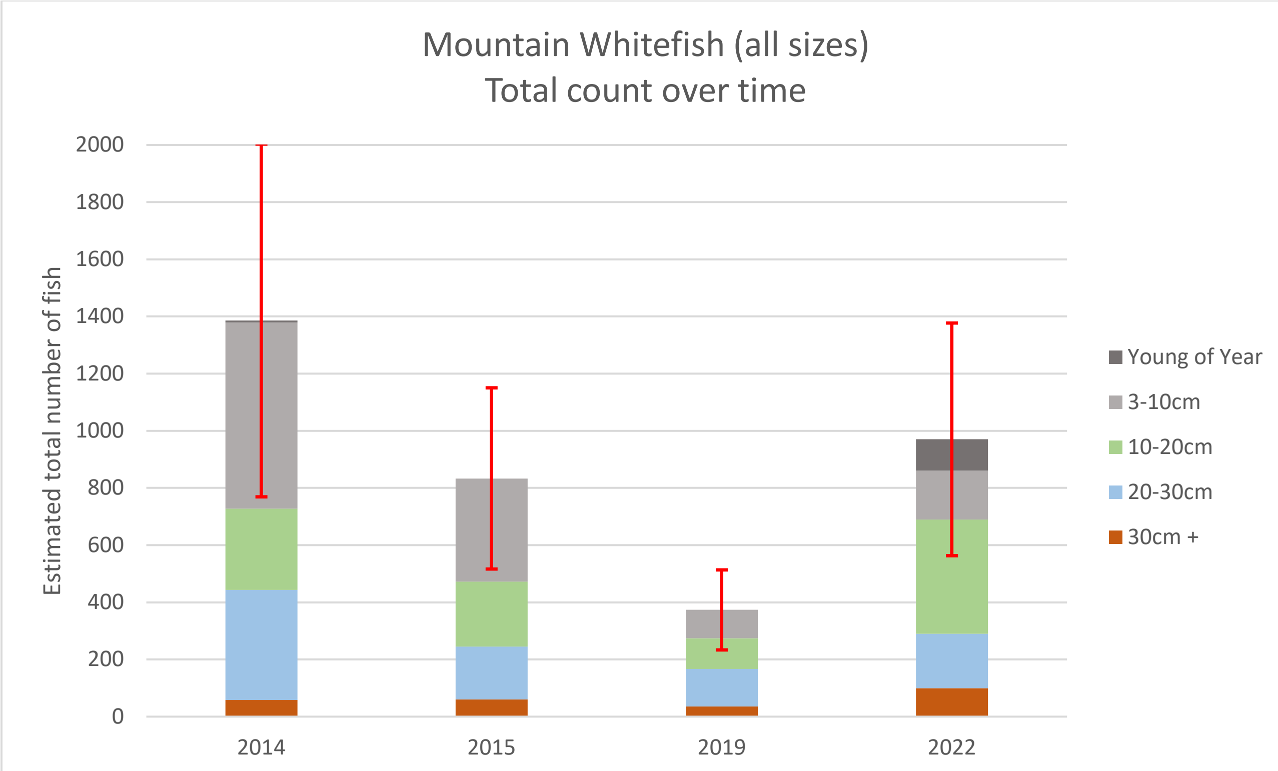

Figure 5. Trend data for all Mountain Whitefish. Each size category is stacked and the entire bar represents the estimated N for that year. Error bars illustrate the margin of error.

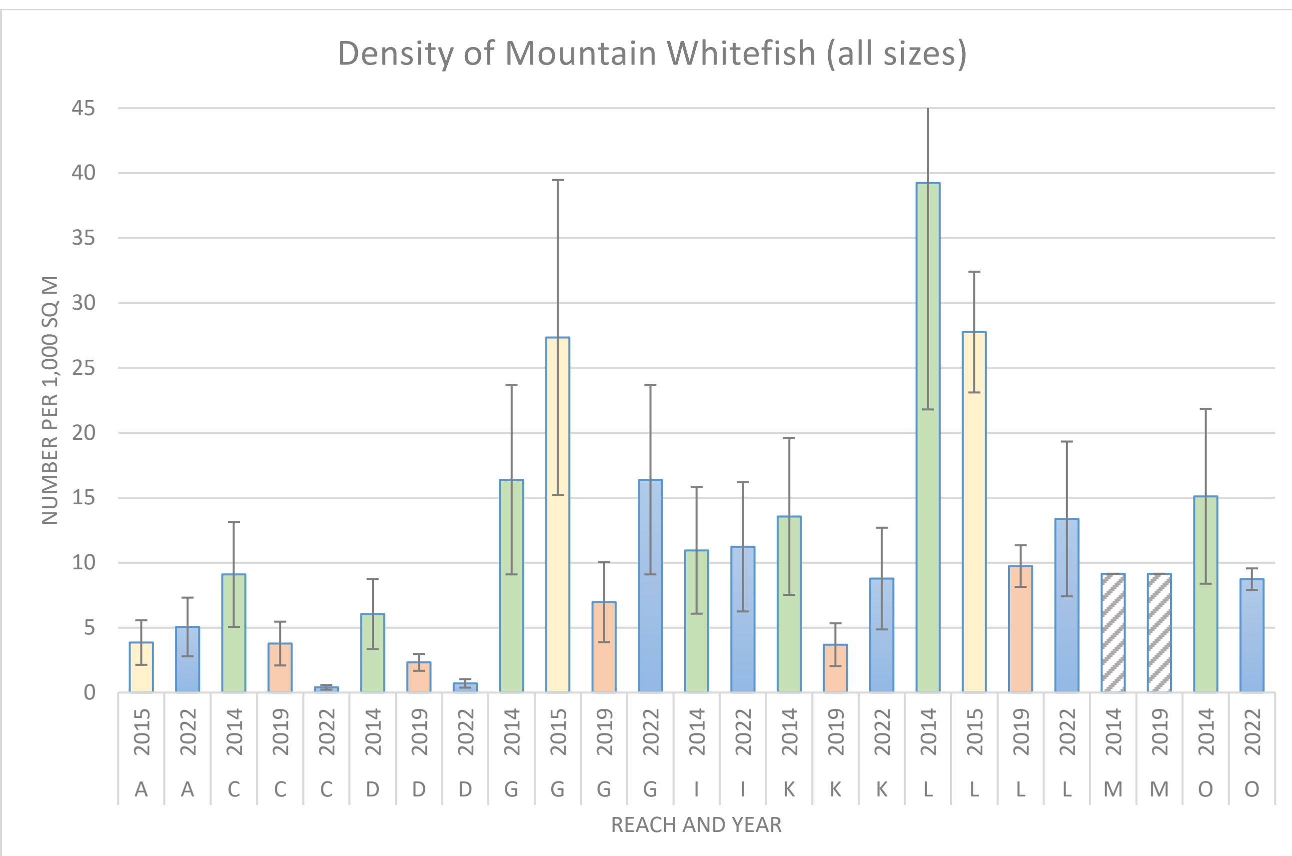

Figure 6. Density of Mountain Whitefish across all reaches and years. Reaches are organized with the most downstream on the left. Years are color coded bars. Error bars represent the margin of error. The upper margin of error for Reach L in 2014 is 56.7. No margin of error is available for Reach M.

Rainbow Trout, Cutthroat Trout, and undetermined Oncorhynchus

Rainbow Trout are abundant throughout the river and presumably the primary recreational fishery. As shown on Figure 7 below, Rainbow Trout numbers may be increasing but given the overlap in margin of error, this is not considered a significant difference. Density gradually increases the further upstream in the river, as illustrated on Figure 8. Divers consistently observed more 10-20cm Rainbow Trout than all other sizes (ranging from 48% to 65% of total). While younger fish were observed, they are underrepresented in the main river. This implies spawning and rearing is not taking place in the main channel of the river. The 2022 sample more intentionally sought to find young-of-year and did notice them in Reach C, I and especially O. These three reaches also had more side channel habitats than others. The work suggests Rainbow Trout reproduction takes place on all suitable side channels throughout the valley.

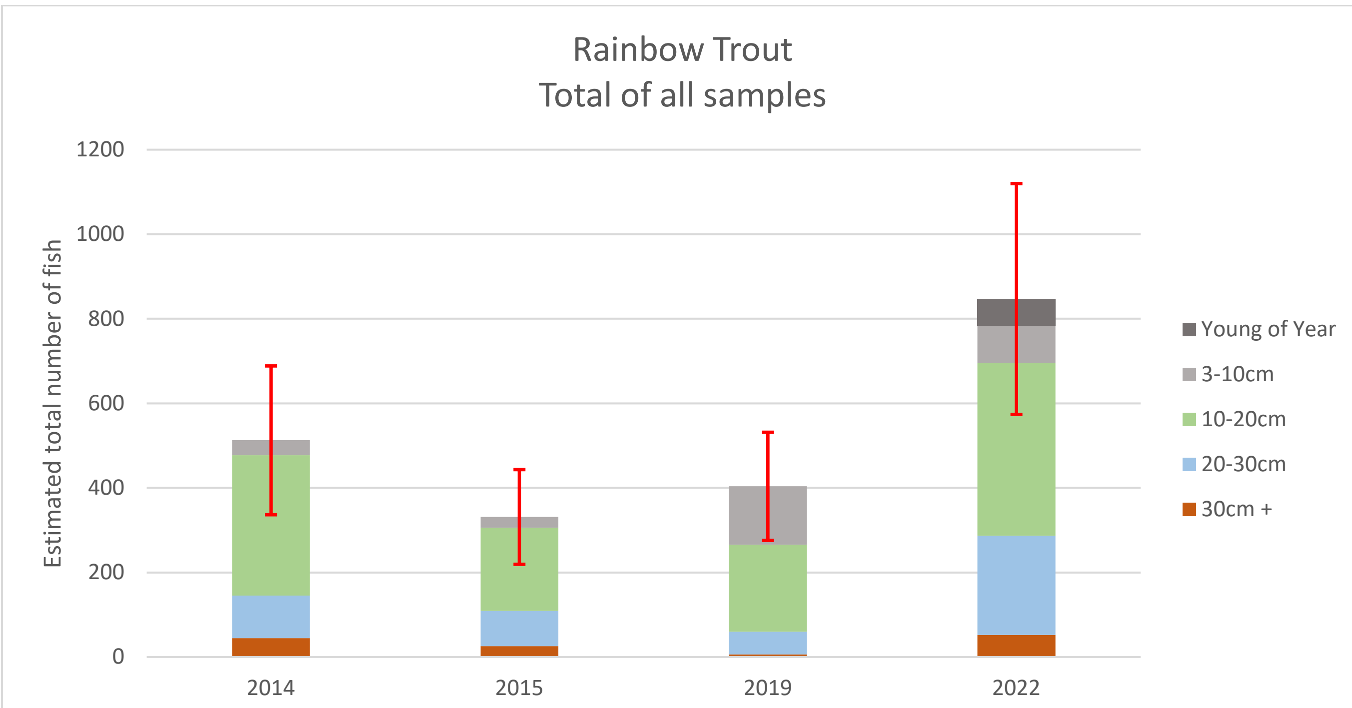

Figure 7. Trend data for Rainbow Trout. Each size category is stacked and the entire bar represents the estimated N for that year. Error bars illustrate the margin of error.

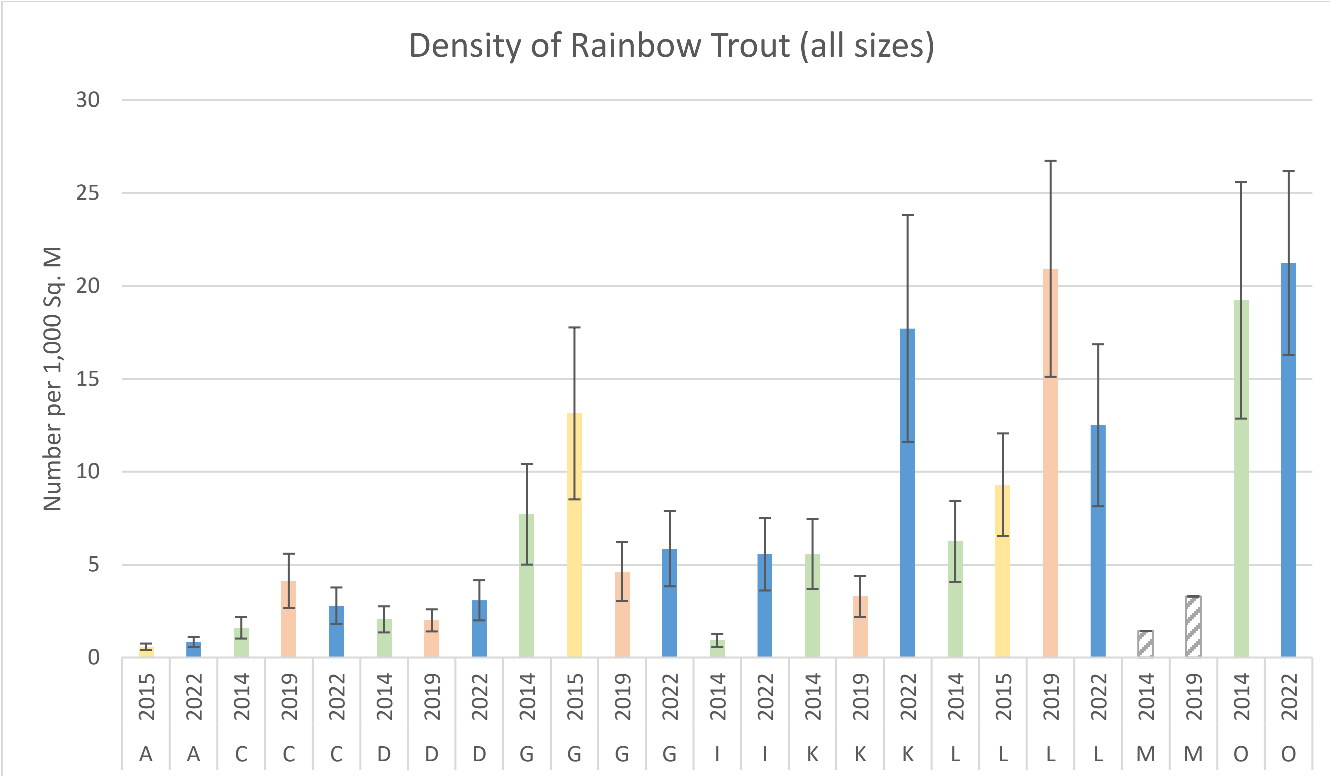

Figure 8. Density of Rainbow Trout across all reaches and years. Reaches are organized with the most downstream on the left. Color coded bars represent sampling years. Error bars represent the margin of error. No margin of error is available for Reach M.

It remains problematic to distinguish actual trends of *Oncorhynchus* species because of difficulty in identifying them by phenotype. Divers generally have more confidence in identifying larger fish, but water clarity and diver experience are likely factors as well. The 2014 samples had the greatest amount of uncertainty, as shown in Figure 9 below. Cutthroat Trout numbers have declined from an estimated total of 65 in 2014 to just 10 fish in 2022. The margin of errors does not overlap, thus indicating this trend is significant. Yet uncertainty remains due to the challenge of identifying species. Cutthroat Trout are still present in tributary streams of the Swan River valley but appear to be functionally extirpated from the river.

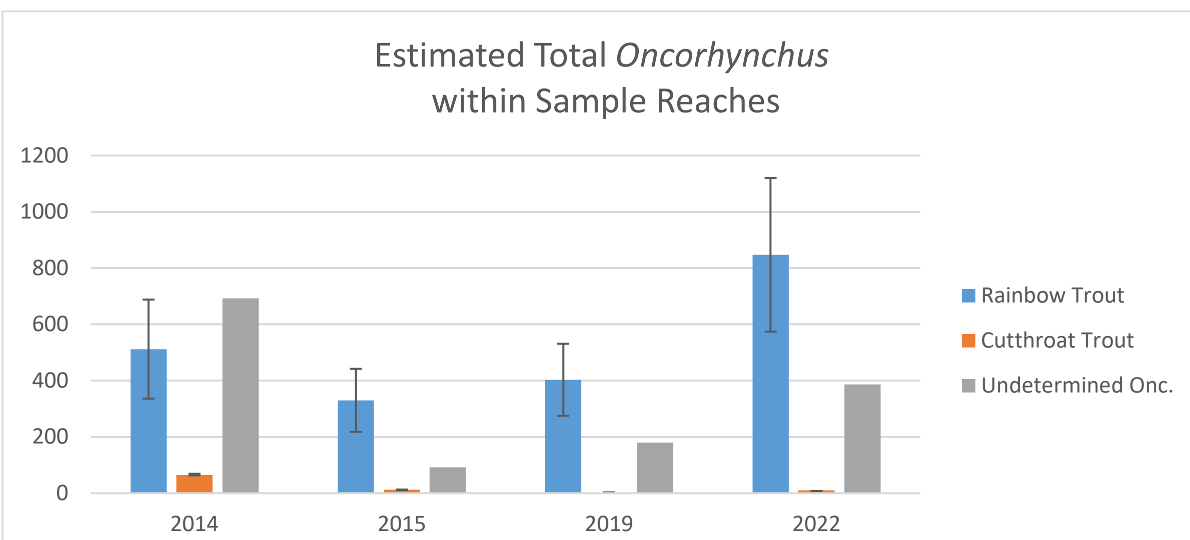

Figure 9. Trends of Rainbow Trout, Cutthroat Trout and undetermined *Oncorhynchus* over time. Margin of error are displayed on Rainbow Trout and Cutthroat Trout (although hard to see at scale). No margin of error is available for undetermined species.

Brook Trout

Brook Trout have the highest P value of all species in the Swan River (e.g., easiest to observe), thus the greatest confidence in trend data. While the 2015 and 2019 found significantly fewer numbers, the 2022 data indicates Brook Trout have fully rebounded, as shown on Figure 10 below. Brook Trout have been observed in every reach, although they are very scarce in Reach A. Relatively few individuals less than 10cm have been observed over the years (ranging from 0% to 30% of total). The 2022 divers recorded young-of-year Brook Trout in the river for the first time, nearly all in Reach O. Large Brook Trout are uncommon. While Brook Trout are the most numerous fish in tributary streams, it appears that only a relatively small percentage of this species utilize the Swan River.

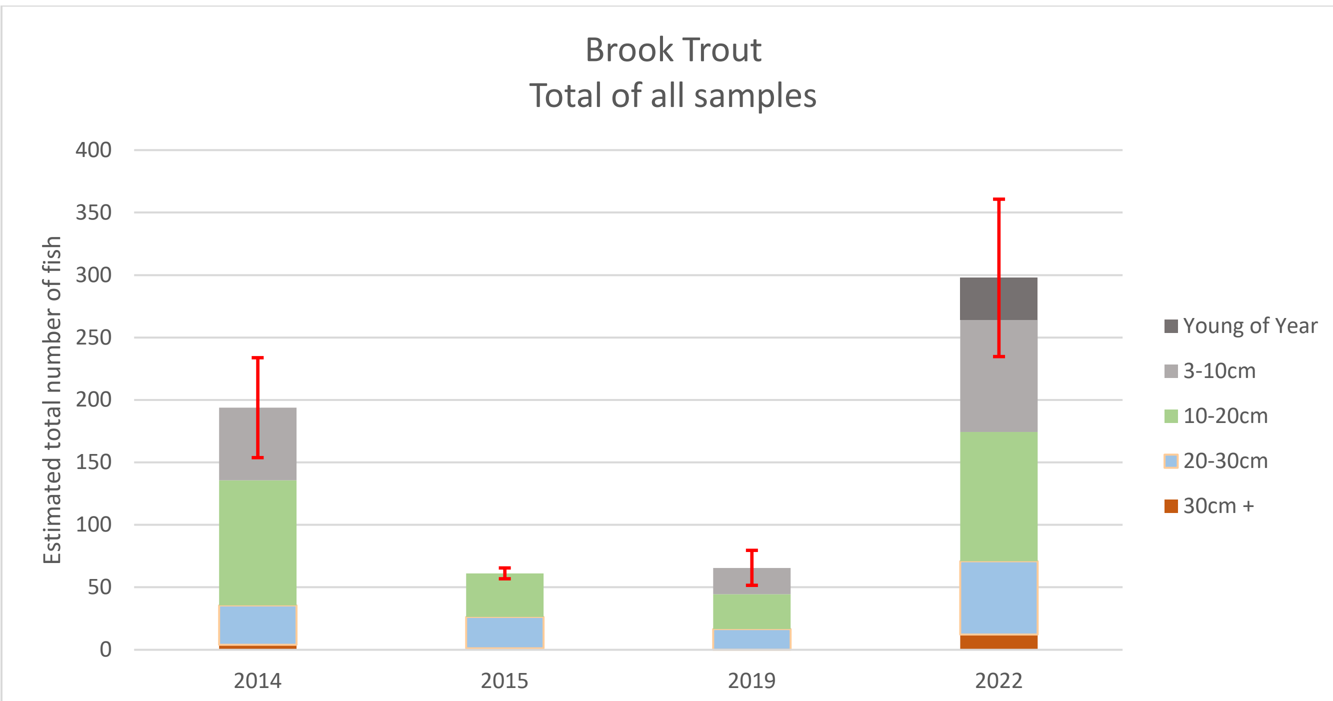

Figure 10. Trend data for Brook Trout. Each size category is stacked and the entire bar represents the estimated N for that year. Error bars illustrate the margin of error.

Bull Trout and hybrids

Bull Trout and Brook x Bull Trout hybrids have remained relatively uncommon but stable in number between the years. Yearly variation is less than the margin of error. Bull Trout occupy 1% to 3% of the total number of observed fish and hybrids occupy less than 1% of total. As displayed on Figure 11 below, Bull Trout are more numerous in Reaches C, D, G (valley segments 2-3). Although the 2014 sample observed low numbers of Bull Trout in the upper valley segments, none have been observed since. Their absence in Reach I is unexpected given that two spawning and rearing streams (Elk Creek and Cold Creek) enter the river in this reach. No juvenile Bull Trout or juvenile hybrids have ever been observed in any reach. Hybrids tend to be large, with 80 percent of all fish ever observed greater than 30cm.

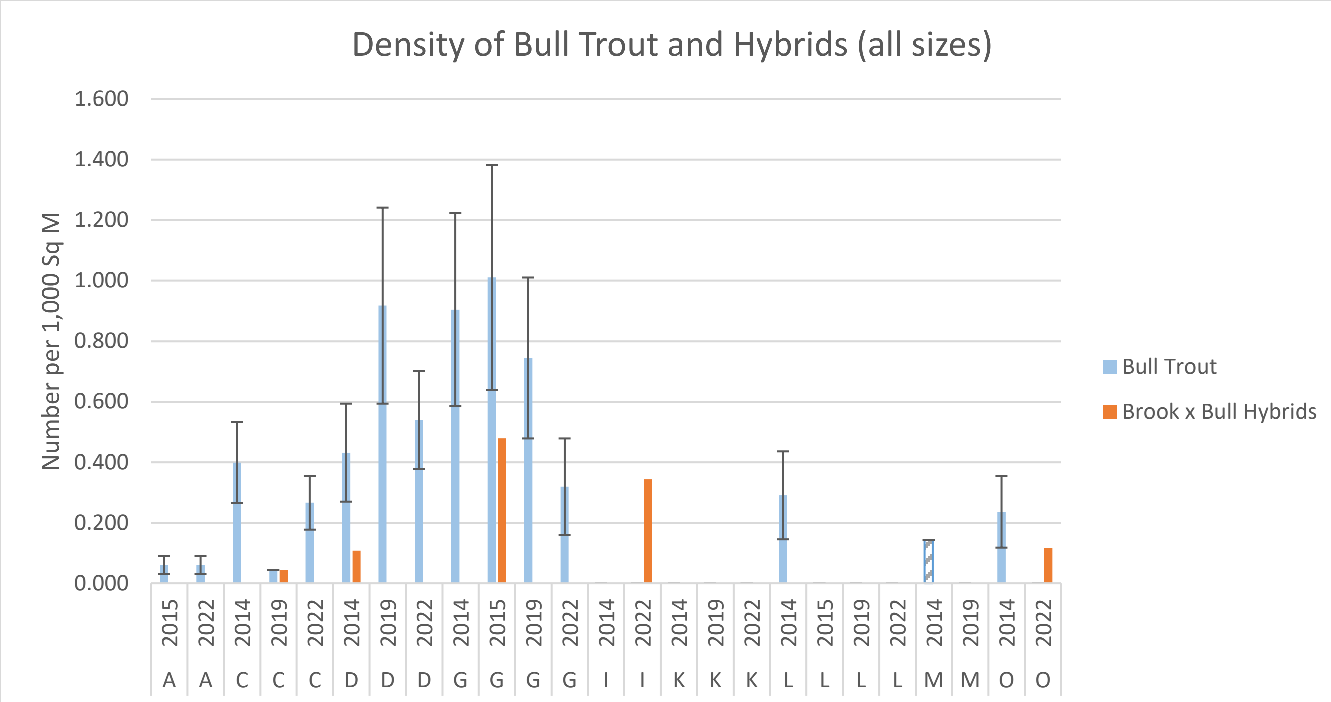

Figure 11. Density of Bull Trout and hybrids across all reaches and years. Reaches are organized with the most downstream on the left. Error bars represent the margin of error. No margin of error is available for hybrids or Reach M.

Redside Shiner

Redside Shiner have very uneven distribution in the Swan River, largely concentrated in Reach L (Valley Segment 5). Figure 12 below displays distribution of Redside Shiner. Abundance has varied significantly between years with no trend. No young-of-year have been observed during snorkel surveys.

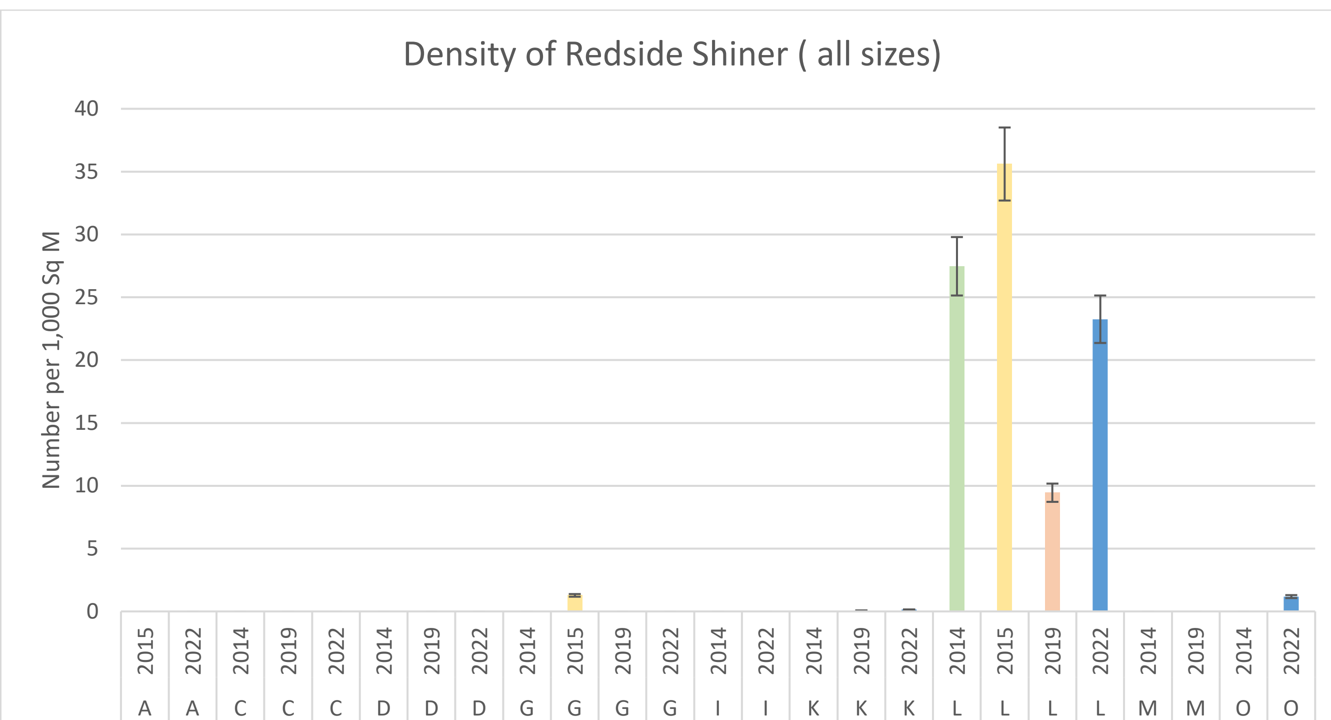

Figure 12. Density of Redside Shiner across all reaches and years. Reaches are organized with the most downstream on the left. Color coded bars represent sampling years. Error bars represent the margin of error.

Northern Pikeminnow

Similar to Redside Shiner, Northern Pikeminnow are largely concentrated in Reach L. No information is available to model population size or margin of error. Pikeminnows may be slightly increasing in numbers and distribution.

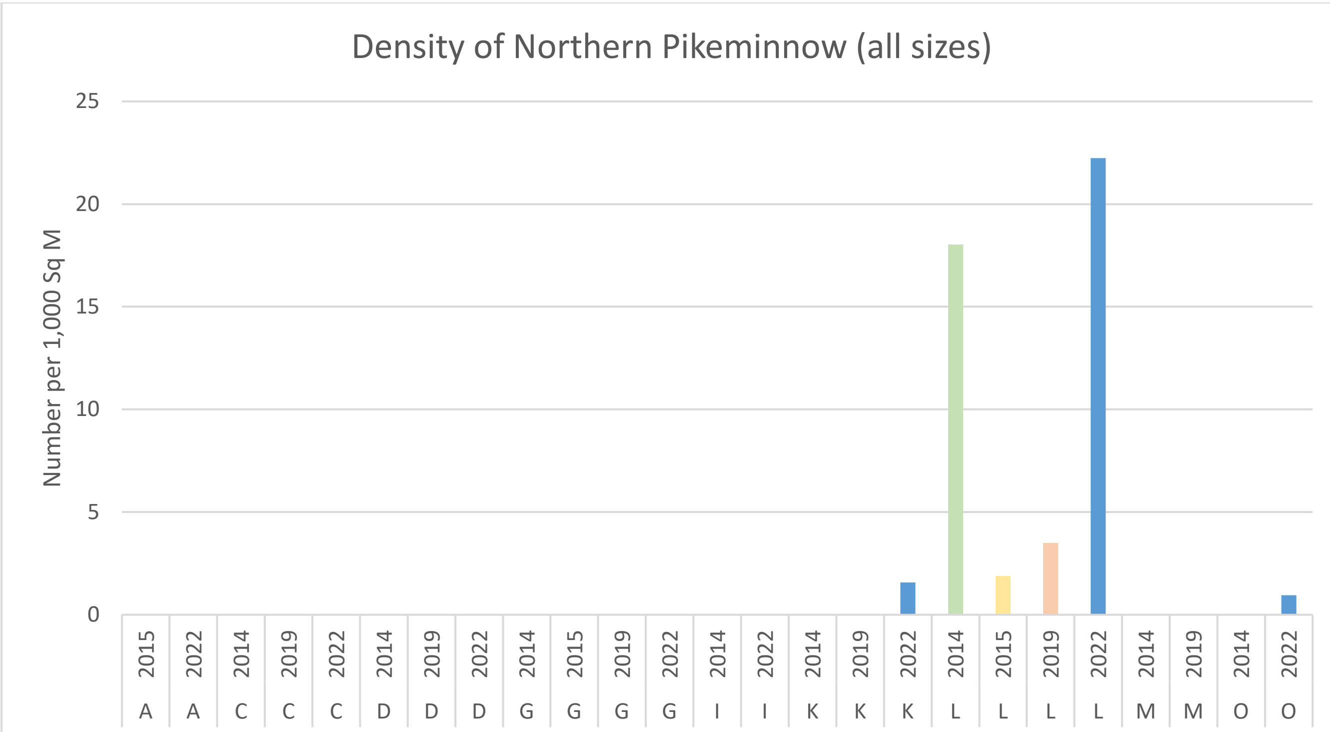

Figure 13.   Density of Northern Pikeminnow across all reaches and years. Reaches are organized with the most downstream on the left. Color coded bars represent sampling years. Error bars represent the margin of error.

Suckers

Suckers are relatively uncommon in the Swan River and seem to have uneven distribution. Suckers have never been observed in Reach D, I or M but no habitat co-variable explains why. Prior to 2022, divers did not attempt to identify the species. In 2022, all Suckers in Reach A were identified as Largescale Suckers. However, all suckers in Reach L in 2022 were identified as Finescale Suckers (also known as Longnose Suckers).   Until more data is gained, no attempt will be made to define species distribution. The following chart displays what has been observed to date. Suckers are uncommon and have a high margin of error, thus only drastic population changes will be detectable by snorkeling.

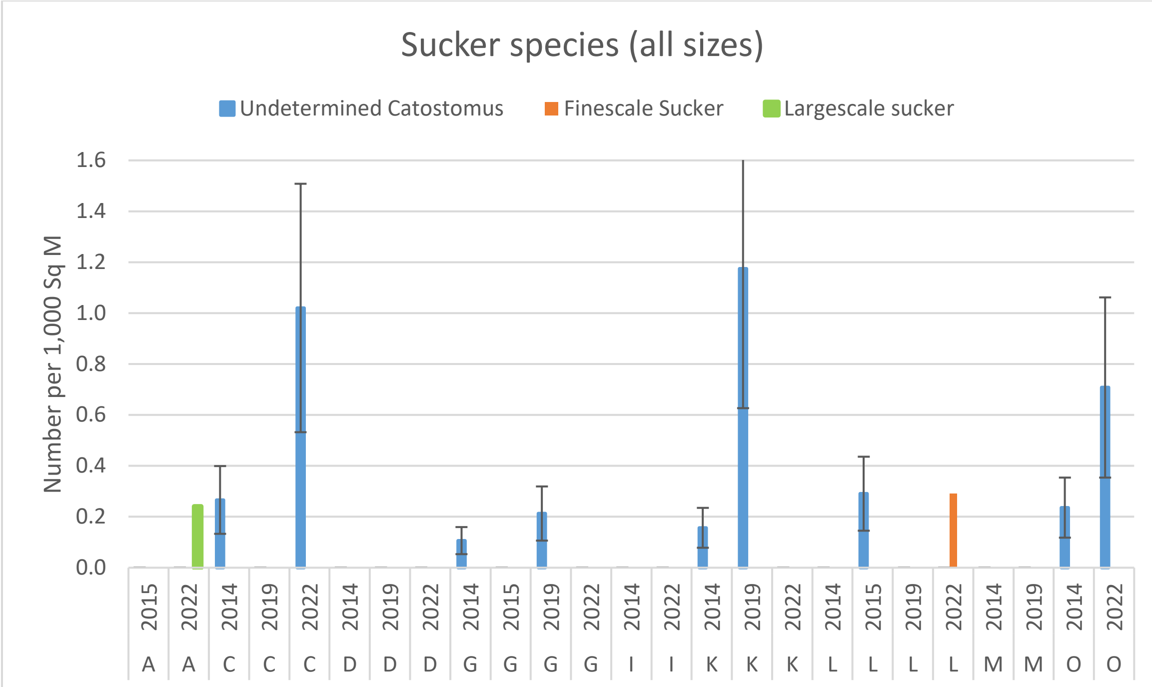

Figure 12. Density of Sucker species across all reaches and years. Reaches are organized with the most downstream on the left. Error bars represent the margin of error.

Other Species

To date, a total of 14 Brook Sticklebacks have been observed. Brook Sticklebacks have been found in Reaches G, K and L. Given the low numbers and inability to estimate P, it is unclear if this species is simply uncommon or avoids detection during snorkeling. Sticklebacks are typically found in wetlands in the Swan River valley and probably use the margins and backwaters of Swan River to colonize new areas. Sculpins are also uncommon with only 93 observed to date. Sculpins have been observed in all reaches except Reach A. Sculpins are cryptic species that easily hide in interstitial gaps of substrate. Snorkeling is probably not an effective method to monitor them.

It should be noted that other fish species are known to occur in the Swan River valley but have not yet been detected in the river during any snorkeling survey. Absence is also valuable data. Non-native Northern Pike are present in Swan Lake but appear unable to enter the river due to the cold water conditions. Non-native Lake Trout, Yellow Perch and Kokanee Salmon are numerous in adjoining lakes and have been periodically captured by anglers in the river. The absence of these species during snorkel samples suggest they have very low or episodic migrations from connected valley lakes. Non-native Central Mudminnow and (unconfirmed) Black Bullheads are also in a headwater tributary but not yet observed in the river. This gives hope that these species will not be able to invade more waterbodies. Pygmy Whitefish are a native species found in lakes but not expected in the river.

Conclusion and Recommendations

While not perfect, this monitoring program has improved understanding of fish distribution throughout the entire river, especially for non-game species. Results indicate that Mountain Whitefish, Rainbow Trout and Brook Trout are found throughout the river, although at lower density in the most downstream reaches. The lower valley segments appear to have less productivity, presumably due to very cold water temperatures. While angling and guided trips are more prevalent in the lower river, the reduced fish density does not appear to be related to harvest mortality since all size categories have reduced density, even those too small to catch. Mountain Whitefish may be declining, and Rainbow Trout may be increasing, but the amount of change is not yet large enough to have confidence. The discovery of Rainbow Trout young-of-year in all reaches with substantial side channels is valuable. Fisheries biologists have desired to find Rainbow Trout spawning locations and this study suggests spawning and rearing are widespread at side channels throughout the valley.

Cutthroat Trout appear to be functionally extirpated in the river. However a weakness in this monitoring program is the difficulty in identifying *Oncorhynchus* species. Snorkel alone will not be able to fully monitor changes in *Oncorhynchus*.

Brook Trout are more numerous in 2022 and it remains to see if this is a trend. Bull Trout are primarily found from Reach G downstream. Their absence in Reach I is unexpected. Redd counts indicate declining trend of Bull Trout abundance throughout the Swan River Valley, but in the river, there appears no particular trend on Bull Trout and hybrids abundance over time. Northern Pikeminnow and Redside Shiner are largely concentrated in Reach L. The uneven and uncommon distribution of Suckers needs further work. Divers need to improve their ability to identify Sucker species.

Sampling every 3 years appears to be a reasonable timeframe to monitor species distribution and abundance. Future sampling must include all 9 reaches and capture habitat data in Reach M.

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