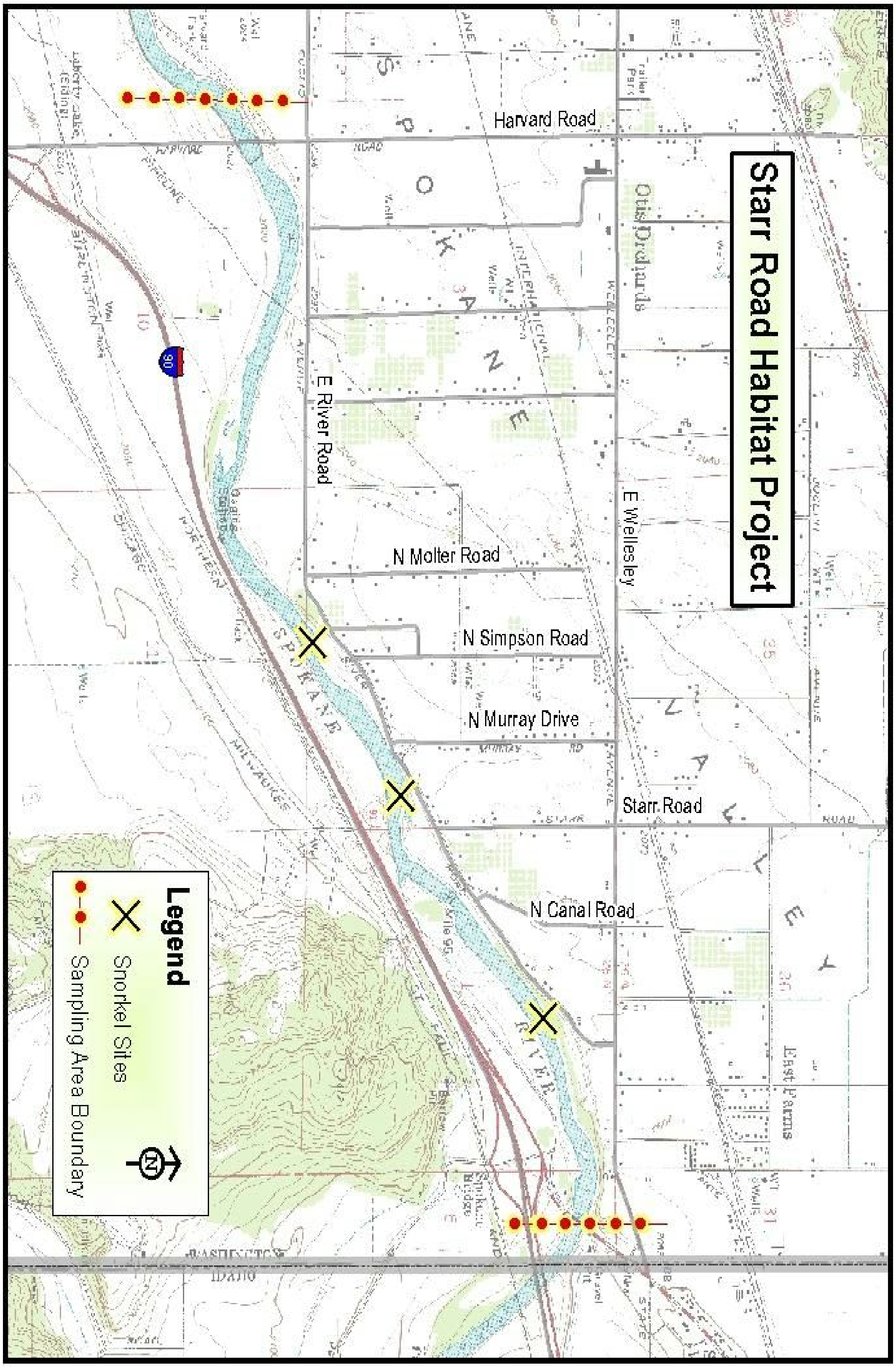
During the summer of 2015, between June and August, a baseline survey was conducted on the upper Spokane River between the Washington/Idaho Stateline to Harvard Road (Figure 1). The Washington Department of Fish and Wildlife (WDFW) has proposed a plan to install five large wooded debris (LWD) structures in the upper Spokane River near the Starr Road area, in the Spokane Valley. WDFW and Avista Corporation have shown the Starr Road area to be one of the major spawning areas for the Redband trout (*Oncorhynchus mykiss* var. *gairdneri)*. In the proposed plan, the LWD structures would be designed to provide habitat during high spring flows for juvenile Redband trout after emergence, as well as allow for escapement of possible predation by smallmouth bass (*Micropterus dolomieu*).

The objectives of the baseline survey, prior to possible instillation of structures, were to: (1) determine the abundance and density of Redband Trout, specifically juvenile fish, and Smallmouth Bass within the Starr Road, site 2, compared to the two reference sites, 1 and 3, (2) calculate a population and density estimate of Smallmouth Bass within the study area, between the Washington/Idaho Stateline and Harvard Road, (3) evaluate the amount of predation occurring on Redband Trout by Smallmouth Bass in the study area.

For objective 1, abundance and density was determined with a combination of snorkel surveys and minnow trapping. Snorkel surveys were conducted at the Starr Road area, as well as a reference reach above and below Starr Road. Both day and night snorkel surveys were conducted, within the same 24 hours, with 3 passes made at each site. Minnow trapping was to done to better estimate juvenile abundance in each reach. Twenty minnow traps, 10 wire mesh and 10 cloth mesh, were systematically set in each site and baited with either catfood or salmon roe. Traps were left overnight for approximately 10 to 12 hours, and then pulled in the way they were placed. Abundance was calculated as the average number of number of fish observed per habitat unit, pooled from both day and night surveys (fish/unit). (Pess et al. 2008). The density of site 1-3, for Redband Trout and Smallmouth Bass was estimated by dividing the estimated total abundance (*N*) by the length (m^2) of total habitat unit. During the entirety of the study, only 2 adult and 5 juvenile Redband trout were observed, all being at site 3 during the month of June. Site 2 had a higher abundance and density in the months of June and July, while Site 1 had the highest abundance and density in August (Table 1). There was a significant difference in the total abundance of Smallmouth Bass at site 2 when compared to site 1 and site 3 over the entirety of the sampling period,

Figure 1.

Study area on the Spokane River located between the Stateline of Washington and Idaho.



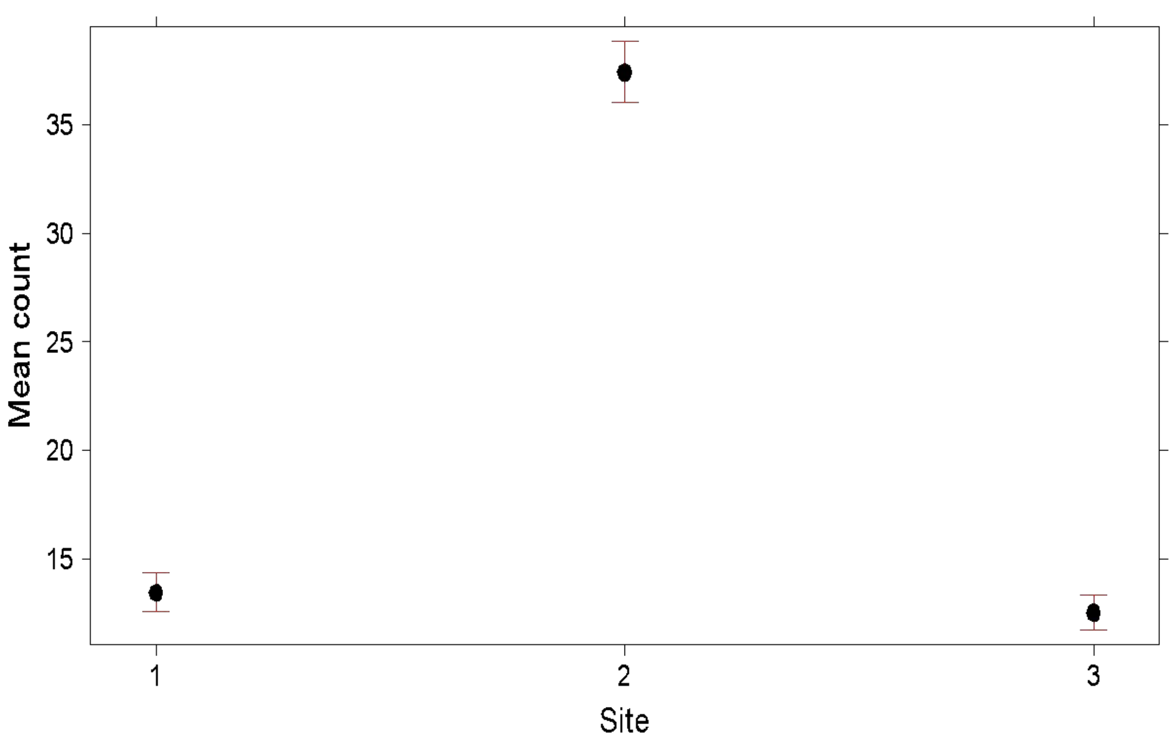
with both night and day surveys pooled (Figure 2). Site 2 had significantly more Smallmouth Bass observed during the night when compared to site 1 and site 3 (Figure 3). The abundance of 0-100mm Smallmouth Bass was greatest at site 2 when compared to site 1 and 3 (Figure 4). The 0-100mm Smallmouth Bass had a higher abundance during the night, compared to day, at site 2 (Figure 5), when compared to site 1 and 3. The 100-450mm Smallmouth Bass had a greater abundance site 2 during the day, compared to night, than site 1 and 3 (Figure 5). Smallmouth Bass were piscivorous at 155-370mm TL. There were significantly more Smallmouth Bass in the piscivorous size class range seen at site 2, when compared to site 1 and site 3 (Figure 6).

For objective 2, a mark-recapture survey was conducted from the Stateline, between Washington and Idaho, to Harvard Road. The mark-recapture survey was conducted twice a month, June through August, with one raft electrofishing and one angling event per month. An open population parameter model, POPAN, provided in the MARK program, was used to calculate abundance estimates for Smallmouth Bass ≥ 150mm and ≥ 200mm. Smallmouth Bass density was estimated by dividing the estimated abundance (*N*) by the length (km) of the river within the total study area. Scale samples were collected from each Smallmouth Bass to determine length at age class. Catch-per-unit-effort (CPUE) was calculated for Smallmouth Bass caught in the mark-recapture survey using both electrofishing and angling techniques. This was obtained by dividing the number of fish caught in each event by the total effort (hr) in each event. The abundance estimate for Smallmouth Bass in the upper Spokane River in 2015, for fishes ≥ 200mm was 1,307 (SE = 218; 95% C.I. = 945-1807) was higher than the previous estimate done by O'Connor and McLellan (2009) (908 Smallmouth Bass ≥ 200mm, SE = 284; 95% C.I. = 524-1691) (Table 2). The estimate calculated by O'Connor and McLellan (2009) for Smallmouth Bass included 3.6 more river miles than the estimate done in 2015, Harvard Road (rkm 148.9) to McMillian Road (rkm 145.3). The estimated density for Smallmouth Bass ≥ 150mm was 284 fish/km and 225 fish/km for fish ≥ 200mm (Table 2). Ages of Smallmouth Bass ranged from 1 to 9 years, which when compared to backcalculated lengths of Smallmouth Bass in Washington State the ages were consistent to previously published studies. Only scales from age 1+, and above, fishes were age (Table 3). There were 409 Smallmouth Bass captured between all angling and

Table 1. Smallmouth Bass total number (N), abundance (fish/unit), and density (fish/m2) for snorkel surveys conducted at sites 1-3.

Date	Site	Total (N)	Abundance (fish/unit)	Density (fish/m^2)
6/23/15	1	349	116	0.197
6/23/15	2	2106	702	0.595
6/23/15	3	525	75	0.188
7/14/15	1	90	30	0.053
7/14/15	2	270	112	0.076
7/14/15	3	191	64	0.07
8/19/15	1	427	142	0.243
8/19/15	2	311	104	0.089
8/19/15	3	186	62	0.068

Figure 2. Mean count of Smallmouth Bass at sites over the entire study, pooled for both day and night snorkel surveys. Error bars represent 95 percent confidence intervals around each mean count ($p < 0.001$, 95% C.I. = 36.002-38.828).



electroshocking events. The mean fish caught for angling per event was 65 (SD=34) with a CPUE of 13.7 (SD= 6.2). The mean fish caught for electroshocking was 25 (SD=3.5) and a CPUE of 13.8 (SD=0.23). The month that had the CPUE was in July (15.2) compared to other months sampled, using both techniques. When compared to the previous Smallmouth Bass study done in 2009, the CPUE was higher in 2015 (Table 4).

For objective three, Smallmouth Bass were collected by electrofishing and angling surveys during the mark-recapture estimate. For each Smallmouth Bass 150mm and above, diet samples were collected using pulsed gastric lavage. Diet samples were placed in Whirl-Pak bags with 70% ethanol and marked with: date of collection, weight, length, and transect number in which it was captured. Samples were stored in a lab freezer prior to examination. Smallmouth Bass were grouped into four size classes for diet analysis (150-199mm, 200-249mm, 250-299mm, 300-349mm, 350-399mm TL) for diet comparisons, as well as comparing each month sampled. Each prey item group of Smallmouth Bass diet (salmonids, Smallmouth Bass, Pumpkin Seed , Longnose Dace (*Rhinichthys cataractae*), unidentified non-salmonids, crayfish, macroinvertebrates, and other) was expressed as the total number of times seen in the diet, total weight, average weight, percent by weight, percent by number, frequency of occurrence, and index of relative importance.

A total of 251 stomach samples were collected from Smallmouth Bass ≥ 150mm between June and September (2015). Samples were split into individual months sampled to determine the diet change of Smallmouth Bass between months (Table 5). During June, macroinvertebrates (55.6%) and non-salmonids (20.4%) were the primary and secondary diet items (percent by weight) of Smallmouth Bass (n=66). In July (89), a diet shift occurred where crayfish were the primary diet item (46.1%) and unidentified non-salmonid fishes were the highest secondary diet item (31.2%). The highest primary diet item in August (n=91) was crayfish (34.9%), while Pumpkinseed was the highest secondary diet item (25.9%). A diet comparison for Smallmouth Bass, broken into 50mm size classes, was done to determine the differences in diet between individual size classes (Table 6). The primary diet item (percent by weight) for the 150-199mm (69.2%), 200-249mm (52.6%), and 250-299mm (42.6%) size classes was macroinvertebrates. A diet shift occurred in the 300-349mm size class, where crayfish was the primary diet item (38.8%).

Figure 3. Mean count of Smallmouth Bass for each site, pooled over the entire study, in day and night snorkel surveys. Error bars represent 95 percent confidence intervals around each mean count ($p < 0.001$, 95% C.I. = 63.652-58.401).

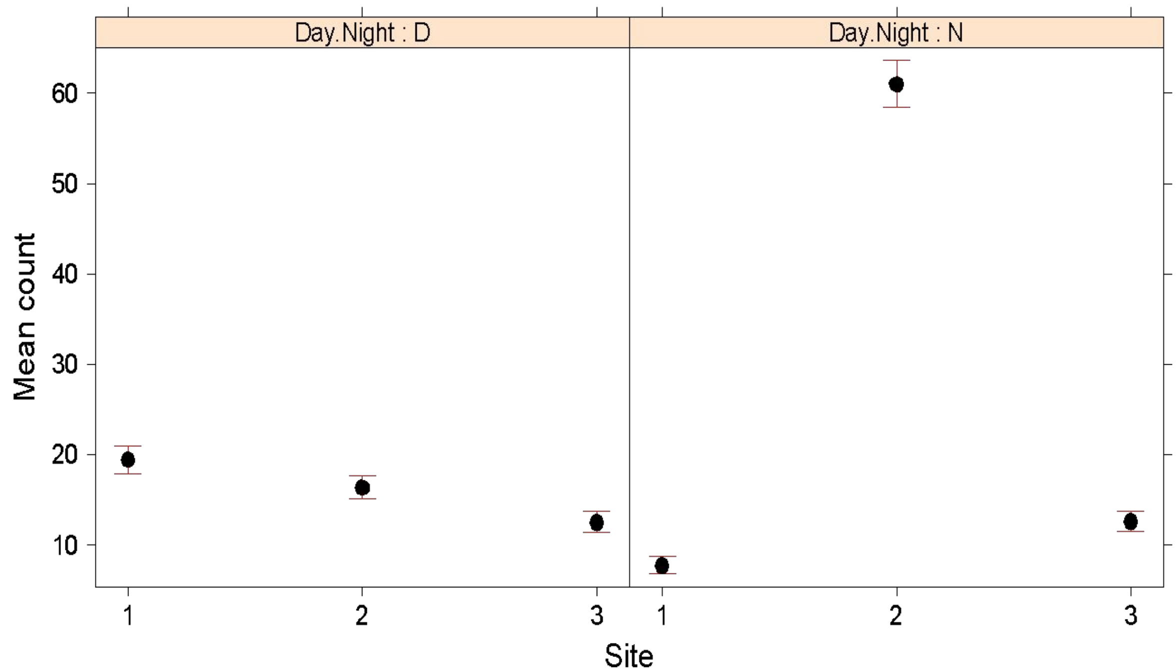
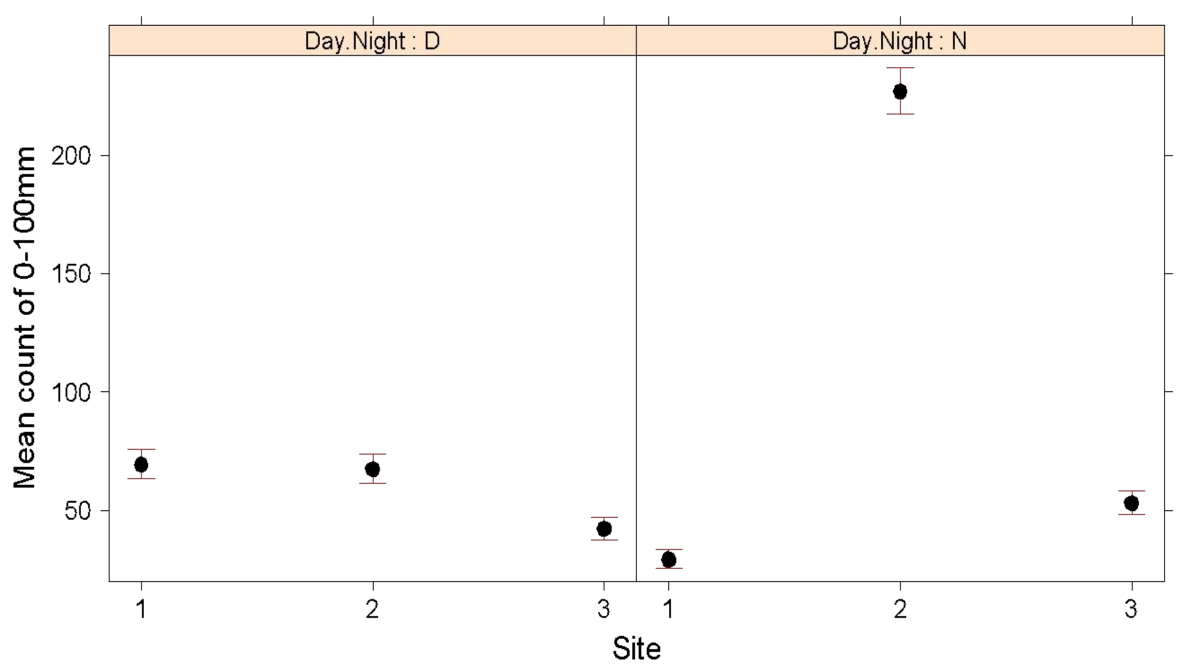


Figure 4. Mean count of 0-100mm TL Smallmouth Bass for each site, pooled over the entire study, in day and night snorkel surveys. Error bars represent 95 percent confidence intervals around each mean count ($p < 0.001$, 95% C.I. = 61.111-73.794).



Another diet shift occurred in the 350-399mm size class, where unidentified non-salmonid fishes were the primary diet item (61.8%). The size range in which piscivory occurred was between 155 and 372mm TL. July was the month with the greatest amount of piscivory, with a frequency of occurrence of 34.7% and an index of relative importance of 26.5%). The 350-399mm size class had the highest frequency of occurrence (66.6 %) and highest index of relative importance (32.9%) of piscivory (66.6 % and 32.9%), however there were only 6 individuals captured in this size range.

Conclusion

The lack of Redband Trout in the upper Spokane River during the study period is a major concern for the health of the Redband Trout fishery. It has been well established that there has been a recent decline in the population of Redband Trout in the upper Spokane River. There are a variety of factors that could play a part in decline of the Redband Trout population. Some hypotheses that have been proposed for the decline include: reduction in discharge during juvenile emergence, reduction in stream habitat, reduction in productivity, and an increase in non-native predators. The rapid growing population of Smallmouth Bass and the complete lack of Redband Trout at the Starr Road area, site 2, are both a sign that the Redband Trout population in the upper Spokane River is in dire need of rehabilitation. Incorporating LWD into the stream channel to provide juvenile fish habitat and refuge from predation has been shown to increase juvenile fish populations in a variety of studies (Cederholm 1997). Though the conditions of the study period during 2015 did not provide data for a typical water year, another study during normal water years should be completed. This would help to better determine: habitat and spawning usage of the Starr Road area, site 2, by Redband Trout and Smallmouth Bass, the number of subyearling fish at site 2, the amount of predation occurring on Redband Trout by Smallmouth Bass, the abundance of Smallmouth Bass in all size class at site 2, and a population estimate of Smallmouth Bass from the Washington/Idaho Stateline to MacMillan Road. Having data from both a low water year and normal water year would allow fisheries managers to make a more informed decision about whether installing LWD structures at the Starr Road area would be a valid effort to help boost the Redband population in the upper Spokane River.

Figure 5. Mean count of Smallmouth Bass, 0-100mm TL (p < 0.001, 217.149-236.832) and 100-450mm TL (p < 0.01, 95% C.I. = 61.611-73.794), pooled over the entire study, in day and night snorkel surveys. Error bars represent 95 percent confidence intervals around each mean count.

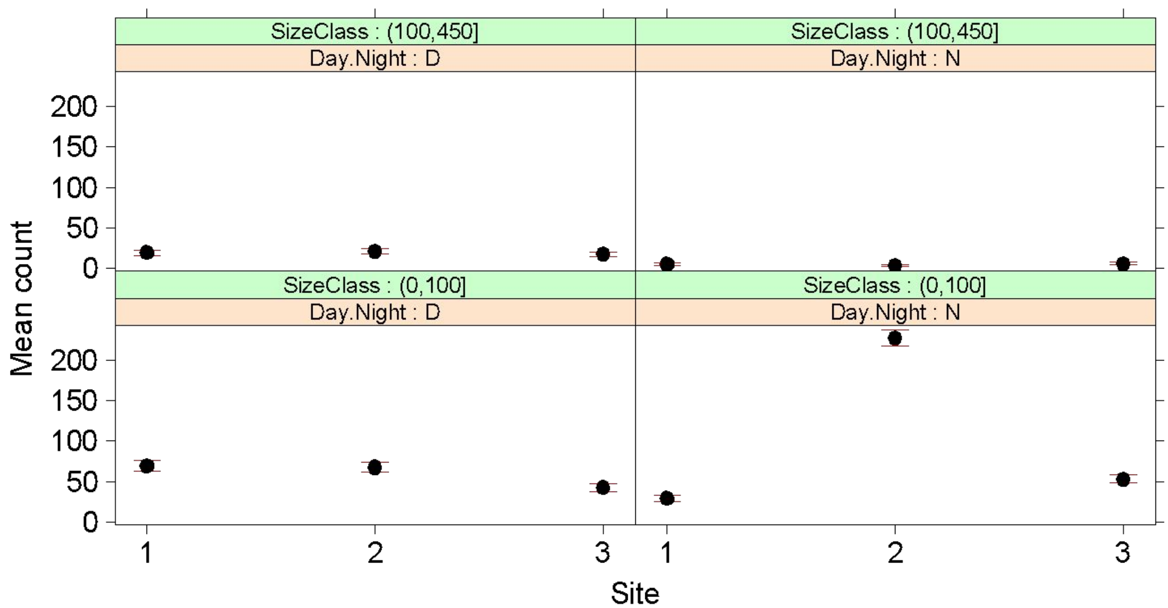


Figure 6. Mean count of piscivorous Smallmouth Bass, 155-370mm, pooled for day and night snorkel surveys, over the entire study. Error bars represent 95 percent confidence intervals around each mean count (p < 0.001, 95% C.I. = 7.603-10.654).

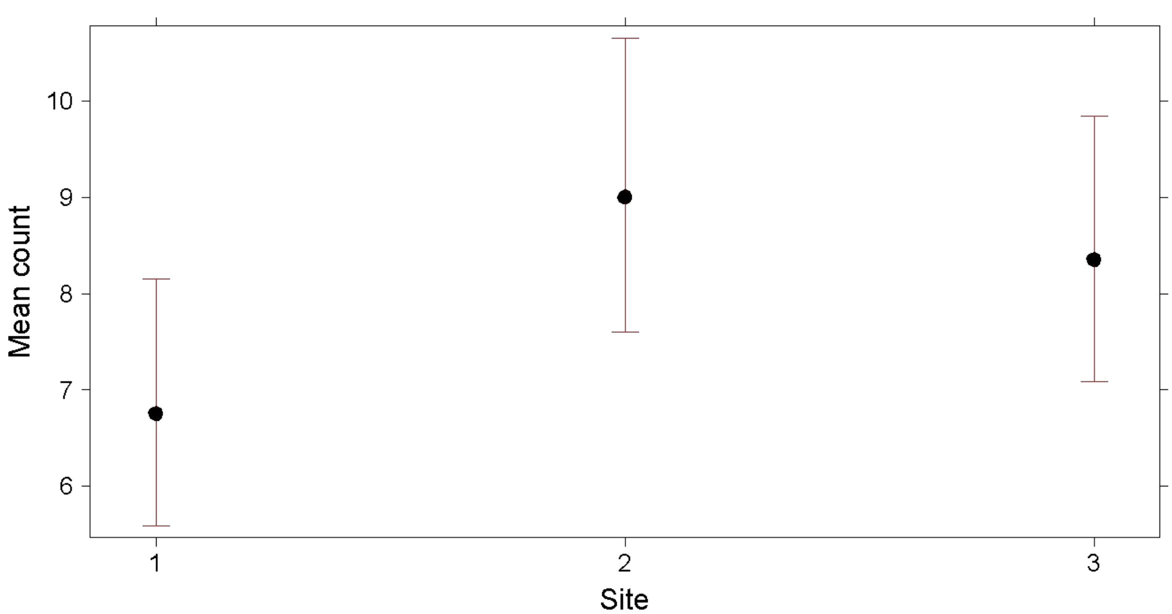


Table 2. Estimated abundance (95% CI) and density for Smallmouth Bass ≥ 200mm in 2009 and Smallmouth Bass ≥ 200mm, as well as ≥ 150mm in 2015.

Year	Size Class (TL)	Estimate (N; 95% C.I.)	SE	Density (fish/km)
2009	≥ 200mm	908 (524-1691)	284	100
2015	≥ 150 mm	1645 (1,171-2,310)	287	284
	≥ 200mm	1307 (945-1,807)	218	225

Table 3. Age class structure of Smallmouth Bass captured in 2015, with mean total length TL (± SD) and mean weight Wt (± SD).

Age	N	TL ± SD	Wt ± SD
0+	0	0	0
1+	3	90 ± 19	11 ± 7
2+	9	120 ± 17	37 ± 40
3+	29	172 ± 24	71 ± 26
4+	76	196 ± 27	109 ± 45
5+	91	230 ± 37	168 ± 66
6+	56	257 ± 35	221 ± 67
7+	33	291 ± 41	314 ± 112
8+	16	326 ± 24	428 ± 117
9+	1	345 ± 0	550 ± 0
Total	314	228 ± 58	179 ± 118

Table 4. Catch per unit effort (CPUE) of Smallmouth Bass in 2009 compared to 2015.

		Total Length		Weight	
Date	n	Mean	Range	Mean	Range
2009	190	269 (41)	206-422	255 (134)	108-855
2015	410	232 (55)	63-395	181 (111)	4-607

Table 5. Diet of Smallmouth Bass by months sampled, June through August 2015.

Date (n)	Primary Diet (% by wt.)	Highest FO (%)	Highest IRI (%)
6/2015 (66)	Macroinvert. (56.5%)	Macroinvert. (95.5%)	Macroinvert. (55.7%)
7/2015 (89)	Crayfish (46.1%)	Crayfish (59.5%)	Crayfish (40.6%)
8/2015 (91)	Crayfish (34.9%)	Macroinvert. (76.6%)	Macroinvert. (47.7%)

Table 6. Diet of Smallmouth Bass by 50mm TL size class, June through August 2105.

Date (n)	Primary Diet (% by wt.)	Highest FO (%)	Highest IRI (%)
150-199mm (61)	Macroinvert. (69.2%)	Macroinvert. (88.5%)	Macroinvert. (68.8%)
200-249mm (90)	Macroinvert. (52.6%)	Macroinvert. (70%)	Macroinvert. (52.5%)
250-299mm (67)	Macroinvert. (42.6%)	Macroinvert. (65.7%)	Macroinvert. (39.6%)
300-349mm (26)	Crayfish (38.8%)	Crayfish (69.2%)	Crayfish (30.7%)
350-399mm (6)	Un I.D. Non-Salmonid (61.8%)	Crayfish (100.0%)	Crayfish (33.9%)

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