I. Project Title: Smallmouth bass and channel catfish control in the lower Yampa River

II. Principal Investigator(s):
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III. Project Summary: This project is a continuation of work that began in 2001 to reduce the impacts of increasing smallmouth bass densities and channel catfish on native and endangered fish in the lower Yampa River. The methods and objectives for a specific year can be reviewed in the annual reports and a synthesis report for this project (Fuller, 2009). Study objectives included estimating the smallmouth bass population of the lower Yampa River in Yampa Canyon, reducing the abundance of smallmouth bass, analyzing catch rates to assess efficacy, determining native and nonnative fish composition, and locating possible "hotspots" of spawning activity. This year a marking pass for smallmouth bass population estimation was conducted, in addition to six removal passes for smallmouth bass and channel catfish >400mm total length (TL). The size composition and relative abundance of both nonnative and native species was also determined for five one-mile sub-reaches in order to monitor the fish community response to removal. In 2009 an extensive *Gila spp*. tagging component was introduced to the study in order to monitor populations of humpback and roundtail chubs.

IV. Study Schedule: To be continued as needed

V. Relationship to RIPRAP:
General Recovery Program Support Action Plan
III.A.2.c Evaluate the effectiveness and develop and implement an integrated, viable active control program.

Green River Action Plan: Yampa and Little Snake Rivers
III.A.1. Implement Yampa Basin aquatic wildlife management plan…

VI. Accomplishment of FY 2009 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

All seven passes were conducted this year, which included an early season pass in April. The smallmouth bass population estimate and fish community composition monitoring

were completed. All *Gila spp.* >150mm TL caught were PIT tagged and released.

Smallmouth Bass Population Estimate and Exploitation

In order to increase the number of tagged fish and maximize catch rates during mark-recapture passes, smallmouth bass were marked during pass 4. This also allowed the marking of bass in Yampa Canyon to coincide with tagging in Whirlpool Canyon/Split Mountain and the Uinta Basin. Therefore three removal passes were conducted before the population was estimated, and all estimates were generated following the removal of 627 sub-adult and 121 adult fish. During pass 4, 216 sub-adult (100-199mm) and 31 adult (≥200mm) smallmouth bass were marked with blue USFWS Floy tags. Of those fish, 22 sub-adults and three adults were recaptured in the fifth pass. The population of adult smallmouth bass was estimated at 432 (60-804 95% C.I.) and for sub-adult bass at 4,246 (2,557 – 5,934 95% C.I.; Table 1). For 2009, the number of bass per river mile was estimated at nine adult bass/mile and 92 sub-adults/mile, a decrease compared to 2008. In comparing population estimates from 2008 and 2009, the estimated number of adult bass remained similar, and the number of sub-adults appeared to decrease (Figure 1), although 95% confidence intervals did overlap. When comparing the population estimates for bass ≥100mm in 2005, 2008, and 2009, there has been a statistically significant (based on non-overlapping confidence intervals) decline in bass numbers since 2005 from over 22,000 to less than 5,000 (data not shown).

Based on the point estimates for sub-adults and adults, 30% of sub-adults and 37% of adults were removed in three passes (passes 5-7). If tag returns are used to calculate exploitation rates, 18% of sub-adult and 13% of adult fish were removed. In order to account for fish removed prior to the population estimate, removed fish from passes 1-3 were added to the point estimate generated after pass 4. This produced an estimate of 557 adults and 4,876 sub-adults. Using the number of bass removed over all seven passes, the exploitation for the entire season based on the previous estimates was 51.3% for adults and 39.9% for sub-adults. These numbers are consistent with exploitation rates for the entire season derived from capture probabilities (p) over the last three passes and applied over five removal passes. The average capture probability per pass for adults in the last three passes was 0.144 and for sub-adults was 0.114.

Smallmouth Bass Removal

The number of bass removed in each pass is shown in Table 2. Marked sub-adult fish were not observed growing into the adult size class, and the average growth between marking and recapture was 3.7mm for sub-adults. Therefore, the original length categories were used throughout the study. Only one possible young of year bass (TL = 44mm) was captured during pass 7, and all other fish <100mm appeared to be age-1 (TL=56-97mm in mid-July).

Pass 1 was a trial pass intended to assess the ability of crews to sample Yampa Canyon before high flows. Colder water temperatures (4-10°C) during this time may have kept catch rates very low. The following summary of catch rate data excludes pass one, since it was completed several weeks before the other passes and was not representative of the

removal study as a whole. For passes 2-7, the catch rate was 14.6 bass/hour (h), with 1.8 adult fish/h and 12.2 sub-adults/h. In order to compare the catch rate with previous years, the catch rate for smallmouth bass ≥100mm was calculated at 13.9 fish/hr, a decrease from 2008, but still greater than 2006-2007 (Figure 2). Catch rates for bass ≥100mm by pass showed a decrease in the last three passes (Figure 3). When catch rates were broken down into size classes, only catch rates for adults showed an overall decline by pass (Figure 4). Trends for catch per unit effort (CPUE) by pass were similar whether analyzing all bass ≥100mm, sub-adults, or all bass combined, reflecting the fact that 88% of bass captured were sub-adults or age-1. Length frequencies show the most abundant length category was fish 126-150mm (Figure 5), representing a large cohort (TL<125mm) from 2008 that had grown in size. This appears to be a cohort produced in 2007 which was comprised of fish <125mm in 2008, and which ranged in size this year between 126-175mm (Figure 6).

All seven passes planned for 2009 were completed, primarily because work began at higher flows compared to previous years. The catch rates during the earlier passes were comparable to those when flows decreased. Despite only three removal passes after the population estimate, 30% of the estimated bass ≥100mm were removed. Relatively high catch rates compared to past years are the result of a large number of fish 126-175mm.

Adult bass were distributed throughout the canyon in similar numbers (Figure 7), but sub-adult bass were more abundant in reaches 1-2. Compared to 2008, reach 1 had a similar number of sub-adult fish, but reach 2 increased drastically. Tag return data showed sub-adult bass predominantly either remaining within the reach of original capture, or moving downstream (see below). Also, the study reach above Yampa Canyon in Lily Park consists of a large percentage of smaller-sized fish at higher densities than those found in this study (Hawkins, 2008). Sub-adult fish may be moving into the canyon from high density areas upstream. Crews recorded congregation areas and the presence of bass expressing gametes that may indicate spawning activity throughout the season. Higher densities of bass, typically sub-adults, occurred in short stretches of river or backwaters at Bear Draw, Thanksgiving Gorge, Laddie Park, and Harding Hole. Crews also noticed higher bass densities along river left from Deerlodge Park to the canyon entrance. No spawning pairs or nests were observed, and fish observed expressing gametes were larger fish (>200mm TL).

Channel Catfish Removal

Thirty-two channel catfish >399mm TL were removed during the seven passes, with a catch rate of 0.18/h. In 2008, the CPUE for the same size of catfish was 0.54 fish/h. Catfish captures increased during pass 7, likely due to lower discharge, and more efficient electrofishing.

Ancillary Captures

Ancillary fish captures are listed in Table 3. Most noteworthy was the capture of a razorback sucker in Yampa Canyon at river mile 34. A search of the PIT tag database

indicated this fish was stocked into the Green River in 2004 at Ouray National Wildlife Refuge. Also of note was the occurrence of Colorado pikeminnow aggregations during the spawning period outside of the area recognized as the primary spawning reach. Crews did not electrofish the Cleopatra's Couch reach, where spawning is known to occur, but pikeminnow were observed congregating two miles above and one mile below this area. Fish in these congregations were not handled or processed.

Monitoring Reaches

Five monitoring reaches were sampled during pass 6. When the monitoring reaches were established in 2001 to correspond with data collected by Miller et al. (1982), a fifth reach between river miles 2 and 3 was established. This reach was sampled this year, although fewer fish were captured in this reach compared to upstream reaches. Three Colorado pikeminnow were caught in this reach, probably in route to or from the spawning area upstream. These captures increased the overall composition of Colorado pikeminnow in the monitoring reaches. For all the monitoring reaches combined, flannelmouth sucker and bluehead sucker were the most abundant species caught, followed by smallmouth bass, channel catfish, and roundtail chub (Figure 8). In comparison with 2008, flannelmouth sucker made up a greater proportion of the fish community than bluehead sucker (Figure 9). Channel catfish were a smaller portion of the catch in 2009 compared with both 2007 and 2008. Smallmouth bass comprised a much larger percentage of fish caught this year (12.6%), and roundtail chub appeared to remain similar to the last two years. Monitoring passes are usually scheduled when flows are approximately 2,000 cfs. River forecasts predicted this level of discharge during pass 6, but flows were slightly higher than those during the 2008 and 2007 monitoring passes. This could explain the decrease in catfish composition because channel catfish are often more difficult to sample with electrofishing when the water is deeper and boats are traveling more quickly through runs and riffles.

Movement of Marked Smallmouth Bass

Five of 31 adult (TL $\geq$200mm) bass were recaptured during the three removal passes. Of those bass recaptured, two (40%) were caught in the same reach where they were marked. Two bass (40%) moved into the next reach downstream, and one (20%) moved upstream into the Lily Park reach sampled by Colorado State University (CSU). No fish from the U.S. Fish and Wildlife Service (USFWS)/Utah Division of Wildlife Resources Whirlpool/Split Mountain study (SOW #123) were caught in Yampa Canyon this year. Two bass >200mm were caught from the CSU study reach upstream.

Thirty-nine of 216 marked sub-adult (TL 100-199mm) bass were recaptured during removal passes. Twenty-one (54%) of these sub-adult recaptures were found in the same reach where they were marked, seventeen (43%) were caught downstream, and one (3%) was caught upstream. Nine sub-adult bass were caught from the CSU study reach upstream. In looking at movement data between the CSU reach and this study, it is important to note that the CSU passes occurred earlier in the season than those of this project. Bass were marked in April in Lily Park, and therefore had more time to redistribute. There were only two passes conducted in Lily Park after fish were marked

in this study.

Nineteen bass marked in 2008 were recaptured this year, including five adults and 14 sub-adults. Adult and sub-adult fish had grown an average of 48mm and 30mm, respectively, in approximately a year. Half of the sub-adults were caught in the same reach where they were tagged, six (43%) were caught downstream, and one (7%) was caught upstream.

Preliminary Gila spp. *Results*

Four hundred one chubs (*Gila spp*.) were caught in all seven passes (TL=62-435mm). This included 15 fish identified as humpback chubs, many based on anal fin ray counts. All of the fish identified as humpback chubs had some characteristics indicative of roundtail chubs. The length frequency distribution of these fish can be seen in Figure 10. Fifty-eight percent of the chubs caught were adults (TL≥200mm), and 42% were sub-adults. Most of the sub-adults captures (100-150mm TL) appeared to be age-2 fish. Few fish less than 100mm TL were captured, which may be due to fish recruiting into electrofishing gear at sizes larger than 100mm TL. Three hundred twenty-two *Gila* were PIT tagged in six passes, and eight were recaptured during the study. No fish identified as humpbacks (n=15) were recaptured. Over the course of seven passes, chubs were encountered at an average rate of over one fish per mile. The distribution of chubs by reach is shown in Figure 11. Adults were distributed evenly throughout the canyon with the exception of reach 10. Sub-adults were mainly found in the lower reaches of the canyon. In general, roundtail chubs were common throughout the study.

Program MARK was used to generate population models and estimates based on the recaptures of these fish. Due to the smaller number of fish tagged in pass one, and the length of time between passes one and two, only the last six passes were used for the model. For all of the models considered, the probability of capture (p) varied among passes and was generally low (p=0.08-0.18). The probability of recapture (c) was also low (c=0.01). Several models tested converged on a population estimate equal to the number of individual fish captured. Population estimates, therefore, are based on low numbers of recaptures and low probability of capture, and should be considered preliminary and imprecise. The Huggins model (Huggins, 1989, 1991) was selected with p varying over time, c remaining constant, the last two passes having equal probability of capture, and parameters for humpback and roundtail chubs equal. The number of roundtail chubs was estimated at 362 individuals (TL>150mm; 95% C.I. 240-1,361; SE=204), and humpback chubs were estimated at 18 individuals (12-71, 95% C.I.; SE=11).

Four roundtail chub were also recaptured from previous years or outside this study reach. One chub tagged in this study was recaptured ~4 river miles downstream in Echo Park on the Green River. Three roundtail chub tagged in 2007 were also recaptured in Yampa Canyon. Two of these fish were originally tagged in Lily Park in 2007 and were recaptured in the upper reaches of Yampa Canyon this year. The third recaptured roundtail was originally tagged in 2007 in Whirlpool Canyon, recaptured again in 2008 in

Whirlpool, and recaptured this year in reach 9 of Yampa Canyon.

VII. Recommendations:

1) Continue with smallmouth bass removal, and maximize the number of removal passes during post-peak run-off by attempting to achieve seven passes. Sampling should begin when water temperatures are suitable (>15ºC) and flows allow for effective sampling. Catch rates can be high during higher flows, particularly for adults, as shown in pass 3. This year's early season sampling in April indicated that pre-runoff sampling is not effective for raft electrofishing, therefore sampling during this time should not be continued. Water temperatures seemed to be the most likely factor reducing catch rates during the first pass. Flows increase rapidly in spring, making raft sampling less effective in the higher discharge. Population estimates should also be continued for bass. Extra removal passes can be added at the beginning of the season to compensate for bass released alive during the marking pass later during sampling. Consider marking bass to coincide with tagging in the upstream reaches. The benefits of collecting movement data between study areas should be weighed against the probability of having fewer marked fish and possibly a less precise population estimate. Coordinating marking with the lower study reaches in the Green River did not indicate that large numbers of bass were moving between those two reaches.

2) Reach 1 continued to have the highest density of bass, a trend that has been consistent since 2004. The density of sub-adult bass also increased in reach 2, and movement data suggests the possibility of these fish moving from upstream. Additional removal passes may be feasible in this section during a range of flows and should be conducted to reduce bass densities in this area. Since CSU crews sample the adjacent area upstream before USFWS, it may be possible to overlap the two reaches to maximize removal in the open valley section above the canyon, effectively doubling the effort given to this stretch over a longer period of sampling. This may help to serve as a buffer between the highest density Lily Park area and the canyon-bound reaches. The installation of a weir structure in this area, another proposal being considered, may also help monitor and reduce fish movement, if it is constructed to restrict the movement of smaller sub-adult bass.

3) Continue to monitor chubs in this reach, but reduce the number of tagging occasions since specific objectives have not been identified for PIT tagging roundtail chubs. Roundtail chubs are quite common throughout the study reach, and the population is comprised of individuals in all size classes. Chubs should be monitored in this reach, but PIT tagging all chubs encountered required frequent stopping and slowed removal effort. Collecting these fish in some areas may involve moving the fish downstream onboard the raft since stopping to process them can be difficult at their site of capture. Also, handling and tagging chubs during higher water temperatures in mid-summer may increase stress. Smaller chubs appeared more susceptible to handling stress during this time. Chubs should be PIT tagged earlier in the study, and subsequent passes should include scanning for tags and collecting length data only. In particular,

smaller chubs should be monitored in order to detect effects of changing bass densities on the chub populations. If more specific data is required for chubs, a separate study should be conducted that specifically addresses those objectives and targets chubs with methods more successful at capturing them. All pertinent data collected under endangered fish protocols will still be gathered for any humpback chubs.

VIII. Project Status: On track and ongoing pending approval

IX. FY 2009 Budget Status
- A. Funds Provided: $126,627
- B. Funds Expended: $126,627
- C. Difference: -0-
- D. Percent of the FY 2009 work completed, and projected costs to complete:
- E. Recovery Program funds spent for publication charges: -0-

X. Status of Data Submission: Data are in Microsoft Excel format, and after minor revisions to standardize formatting, will be submitted to the database manager (submission expected by 31 Dec. 2009)

XI. Signed: *M. Tildon Jones* 11/9/2009 Submitted electronically
Principal Investigator Date

Fuller, M. 2007. Development of a smallmouth bass and channel catfish control program in the lower Yampa River. 2007 Annual Report. Recovery Implementation Program for the Recovery of Endangered Fishes in the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Denver, CO.

Fuller, M. 2009. Lower Yampa River channel catfish and smallmouth bass control program, Colorado, 2001-2006. Final Report, Recovery Implementation Program for the Recovery of Endangered Fishes in the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Denver, CO.

Hawkins, J. 2007. Yampa River northern pike and smallmouth bass removal and translocation. 2007 Annual Report. Recovery Implementation Program for the Recovery of Endangered Fishes in the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Denver, CO.

Hawkins, J. 2008. Evaluation of smallmouth bass and northern pike management in the middle Yampa River. 2008 Annual Report. Recovery Implementation Program for the Recovery of Endangered Fishes in the Upper Colorado River Basin. U.S. Fish and Wildlife Service, Denver, CO.

Huggins, R. M. 1989. On the statistical analysis of capture-recapture experiments. Biometrika 76:133-140.

Huggins, R. M. 1991. Some practical aspects of a conditional likelihood approach to capture experiments. Biometrics 47:725-732.
Miller, W.H., D.L. Archer, H.M. Tyus, and R.M. McNatt. 1982. Yampa River fishes study. Final report. U.S. Fish and Wildlife Service, Salt Lake City, UT.

Table 1. Lincoln-Petersen estimates of smallmouth bass in Yampa canyon, 2009, after three removal passes.

Size class	Abundance	95% CI	SE	CV (%)
Sub-adult (100-199mm TL)	4,246	2,557-5,934	844	20
Adult (>200mm TL)	432	60-804	186	43
>100mm (used in previous years)	6938	4238-9637	1350	19

Table 2. Smallmouth bass removed by pass, 2009.

Pass	Date	Bass <100mm	Bass 100-199mm	Bass >200mm
1	April 7-10	0	8	6
2	June 9-12	1	197	50
3	June 16-19	9	422	65
4	June 23-26	3	3	4
5	June 29-July 2	23	449	53
6	July 7-10	25	445	60
7	July 14-17	48	394	48
Total		109	1918	286

Table 3. Ancillary fish captures.

Species	Number removed
Northern pike	8
Walleye	2
Green sunfish	10
Bluegill	18
Black crappie	2
White sucker	35
Colorado pikeminnow	63
Roundtail chub	359
Humpback chub	15
Small *Gila spp.* (<150mm)	27
Razorback sucker	1

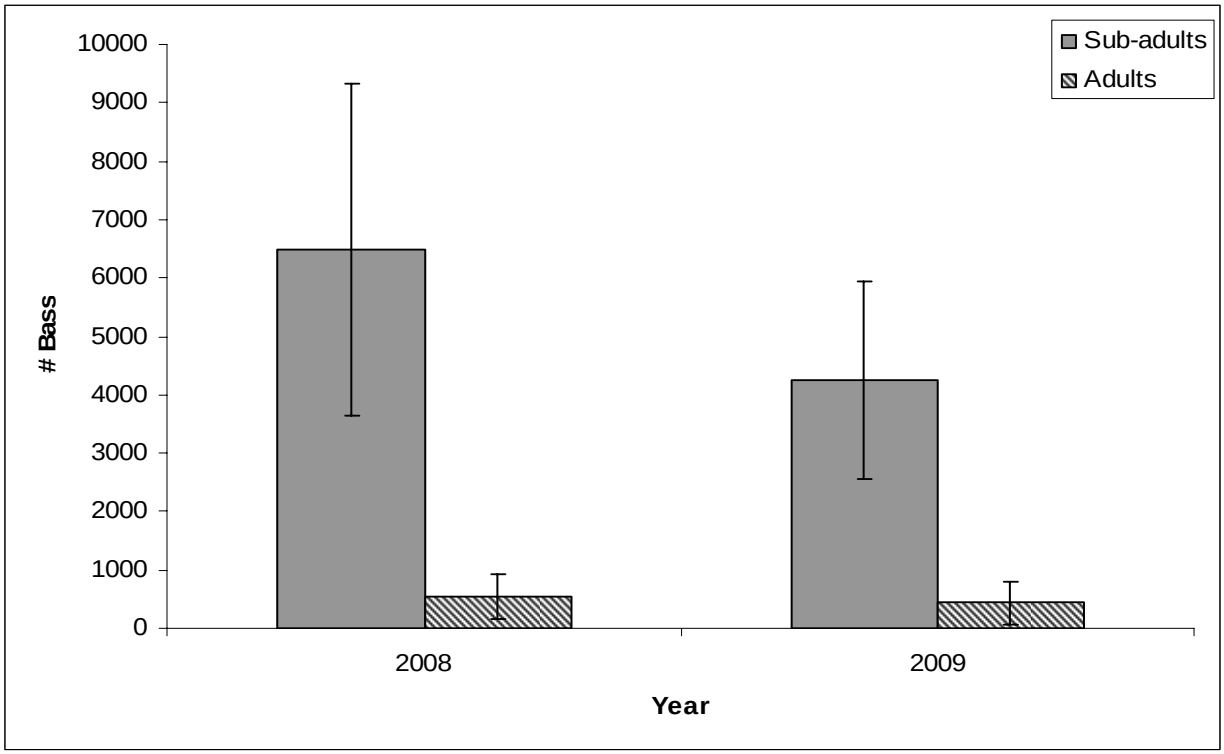

Figure 1. Population estimates with 95% confidence intervals for sub-adult and adult bass, 2008 and 2009.

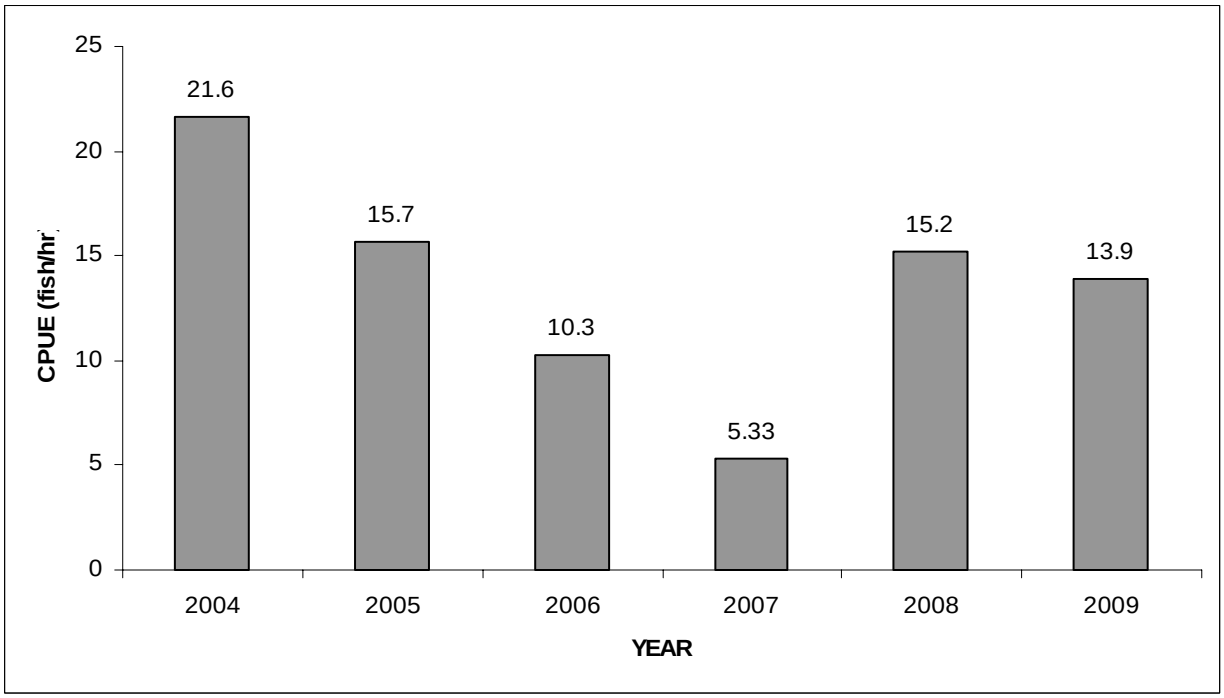

Figure 2. Catch per unit effort for smallmouth bass >100mm total length, all passes combined, 2004-2009.

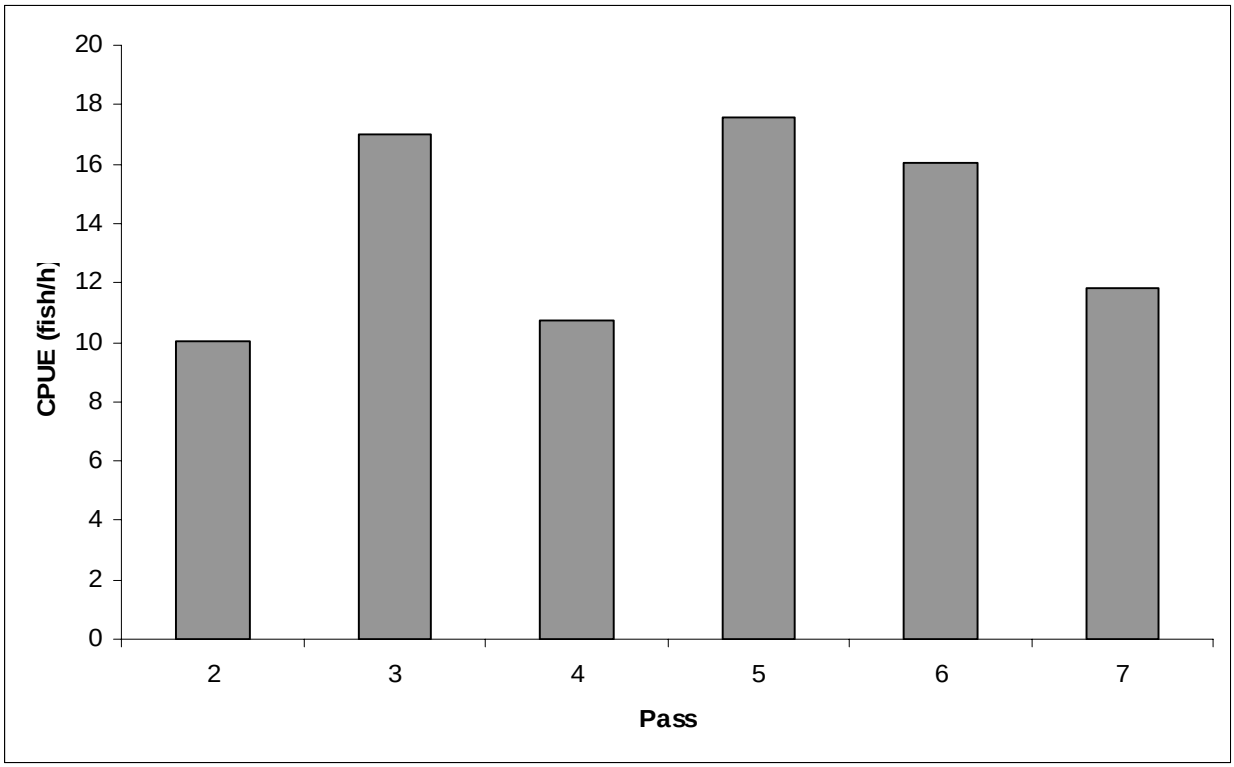

Figure 3. Catch per unit effort, all smallmouth bass >100mm by pass, 2009.

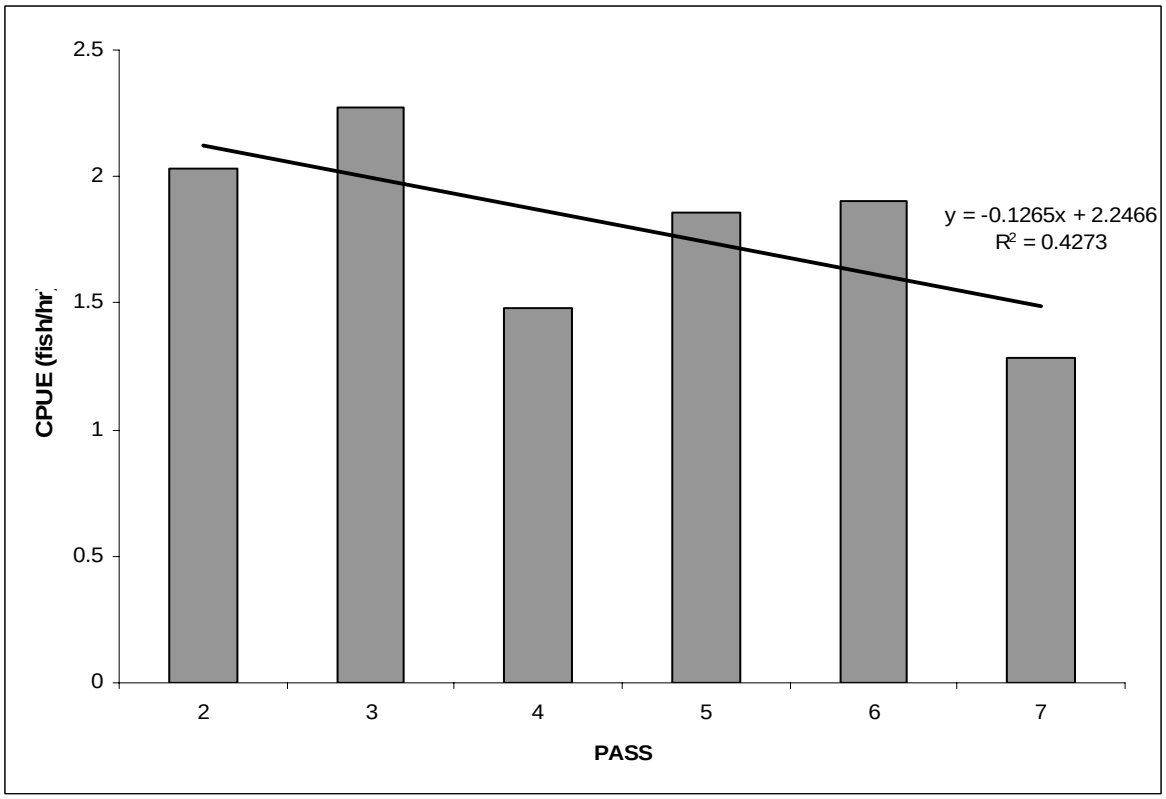

Figure 4. Catch per unit effort, adult smallmouth bass (TL>=200mm) by pass, 2009.

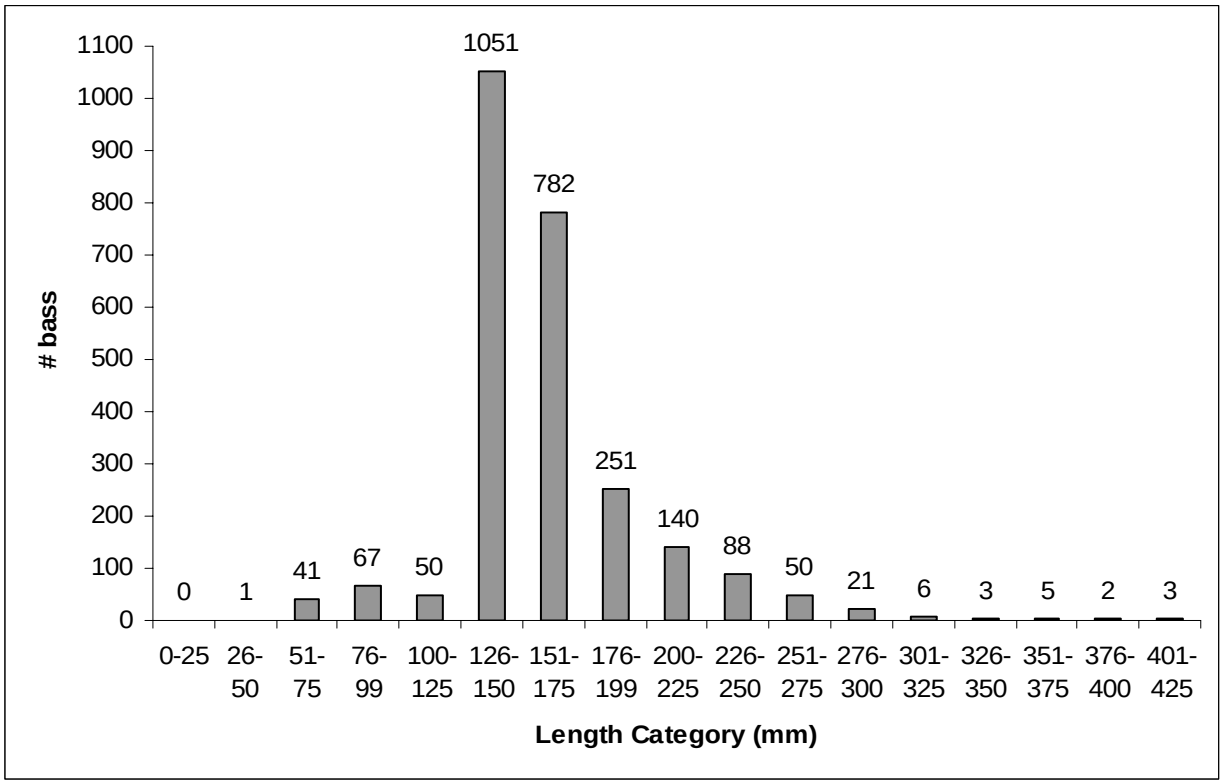

Figure 5. Length frequency of smallmouth bass caught in all passes, 2009.

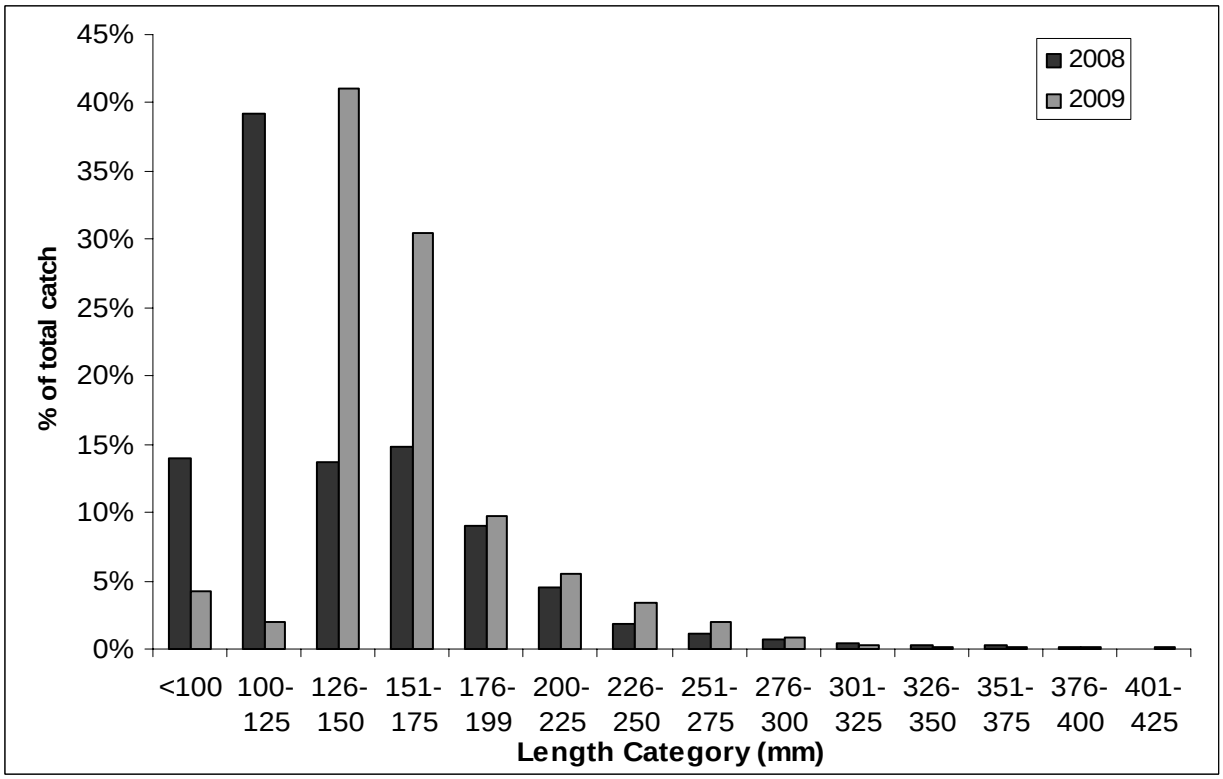

Figure 6. Length frequency of smallmouth bass, 2008-2009.

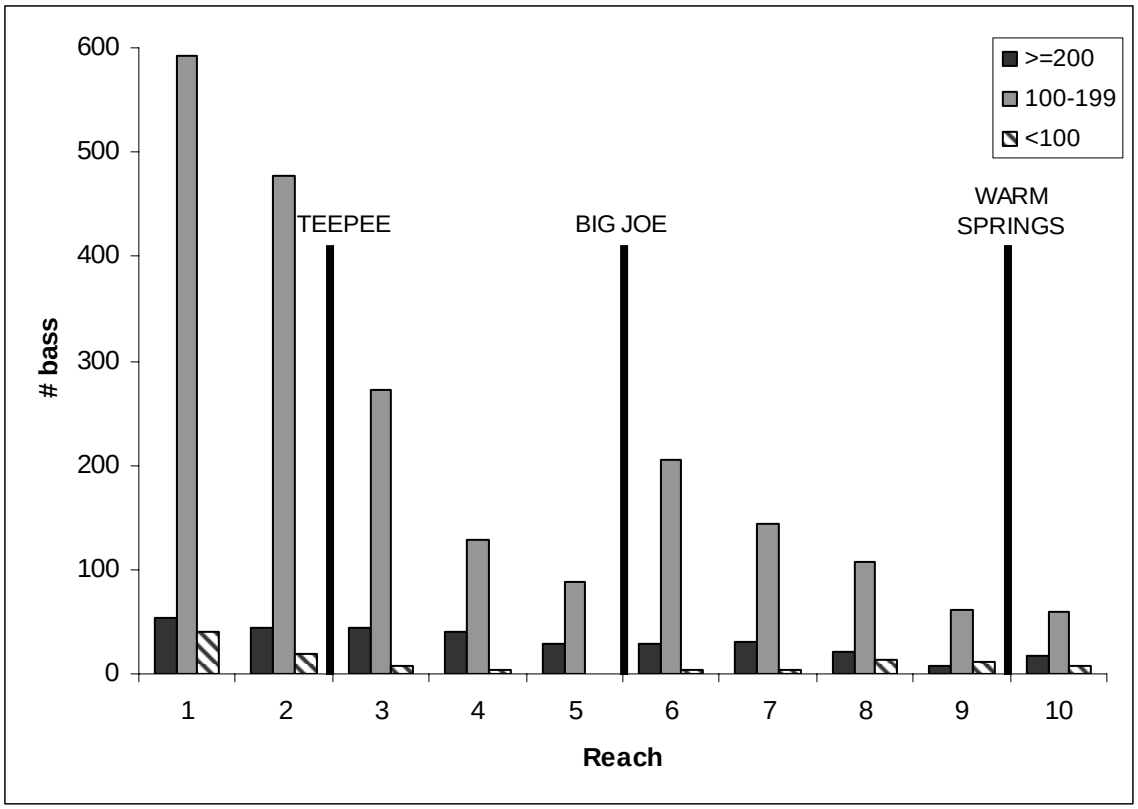

Figure 7. Total bass caught by age class, all passes, 2009. The approximate locations of prominent rapids are noted.

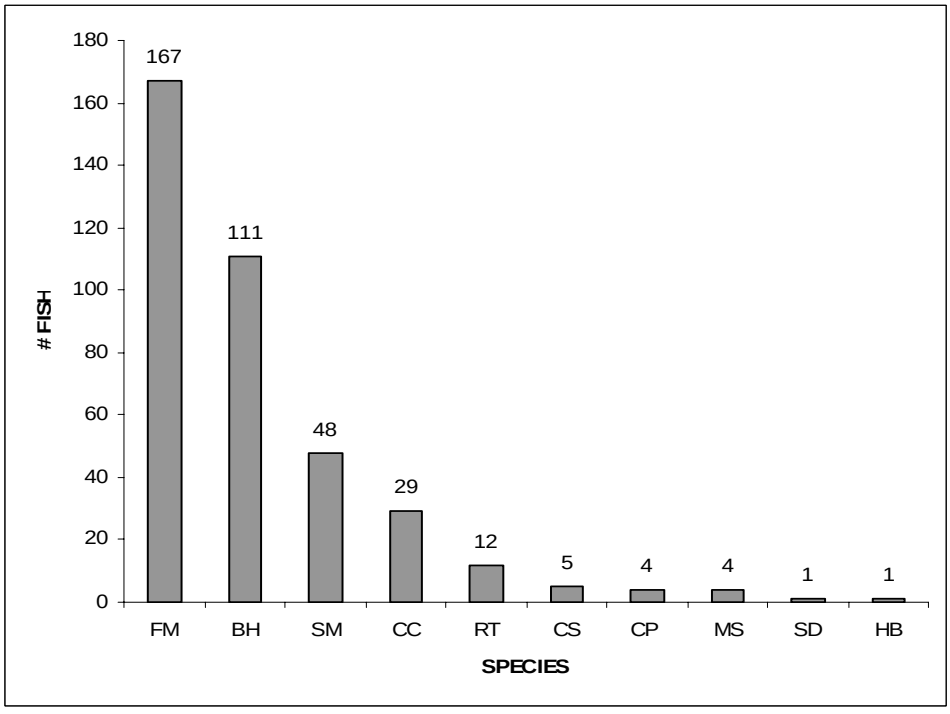

Figure 8. Total fish caught in five one-mile monitoring reaches, 2009.

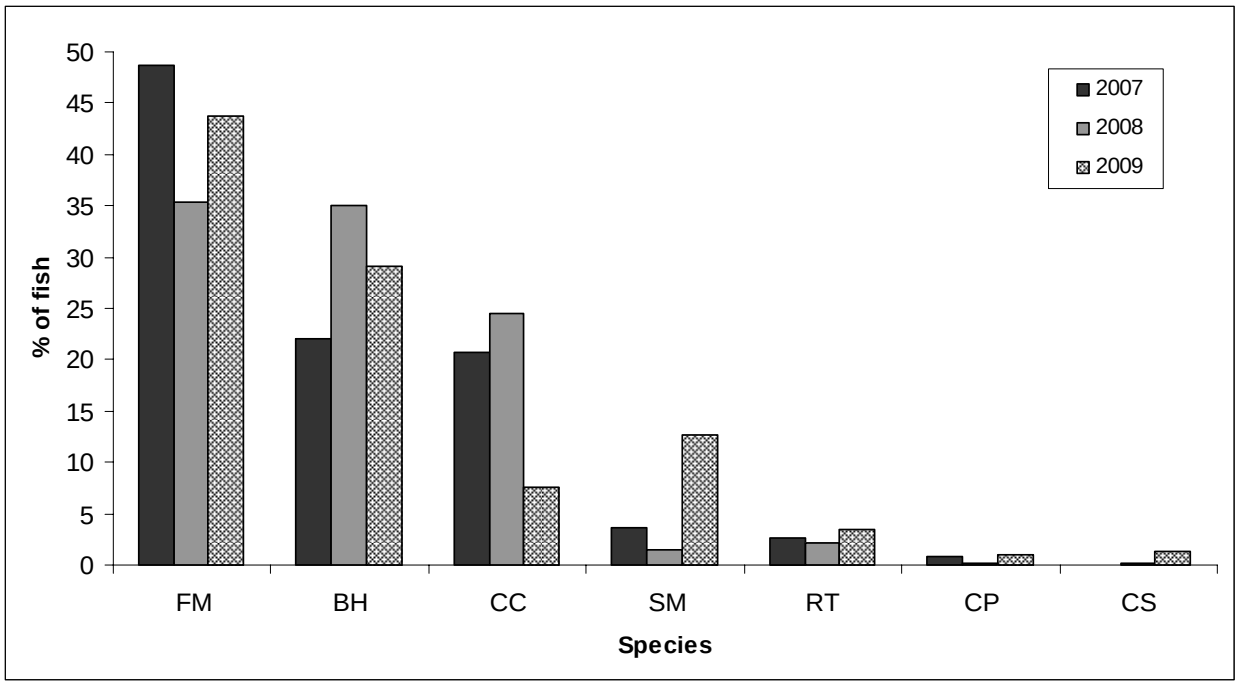

Figure 9. Species composition for all monitoring reaches combined, 2007-2009.

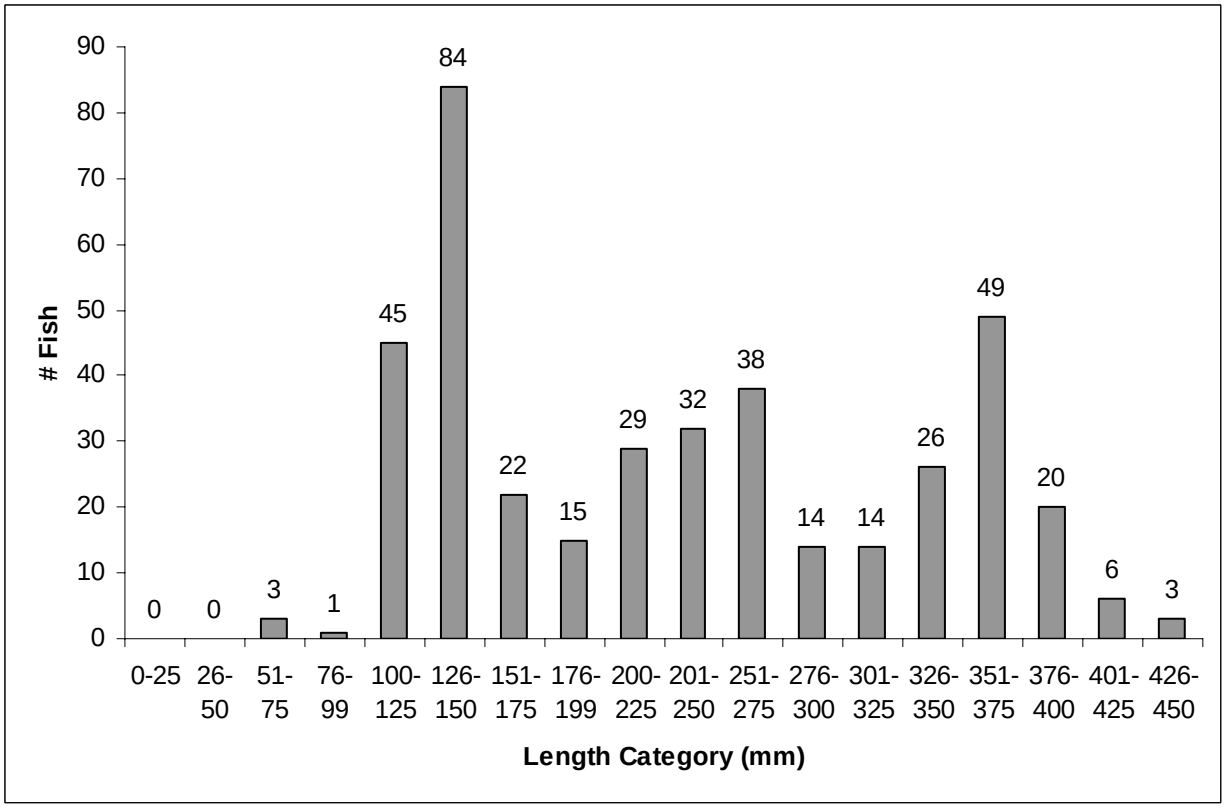

Figure 10. Total number of *Gila spp*. caught by length category, 2009.

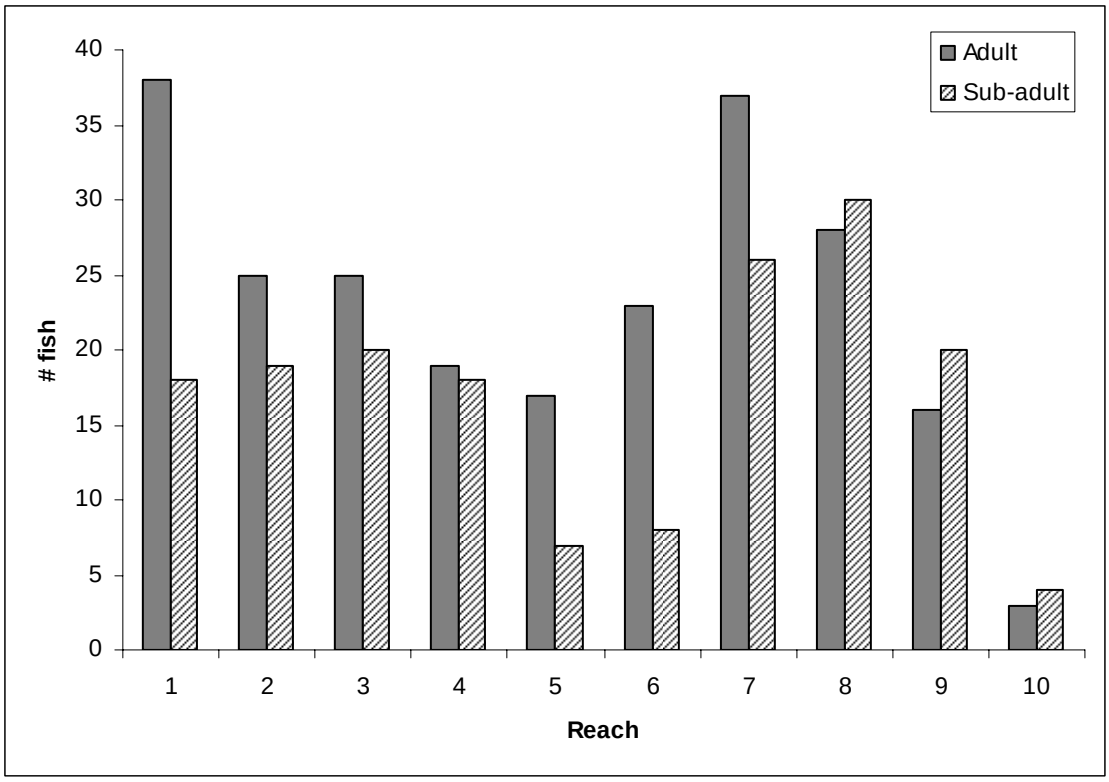

Figure 11. Distribution of *Gila spp*. by reach and age class, 2009.