I. Project Title: Smallmouth bass control in the middle Green River

Note: Synthesis report for 2004, 2005, and 2006 is due in March 2007.

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III. Project Summary:

The Upper Colorado River Endangered Fish Recovery Program has determined that control of nonnative fish in the upper Colorado River basin is essential to the recovery of the four endangered fish species: Colorado pikeminnow, razorback sucker, humpback chub, and bonytail. This determination has been documented specifically for humpback chub in Desolation/Gray canyons in Section 4.3.2 of the Humpback Chub (*Gila cypha*) Recovery Goals (USFWS 2002). The humpback chub recovery goals identify channel catfish as the principle predator of humpback chub in Desolation/Gray canyons. However, in conjunction with recent low flow years, smallmouth bass numbers have been on the rise in both Desolation and Gray canyons (J. Jackson, UDWR, personal communication) and elsewhere in the middle Green River (K. Christopherson, and M. Fuller personal communication). This information resulted in a recommendation from the December 2003 Nonnative Fish Control Workshop (Grand Junction, CO) to attempt control of this species in Desolation/Gray canyons.

The purpose of this project is to minimize the expansion of smallmouth bass in the Green River. The objectives to meet this goal are 1) Calculate an annual population estimate of smallmouth bass in the middle Green River. 2) Remove smallmouth bass from the middle Green River from Echo Park (RM 344) to Swasey's Rapid (RM 132). This was the first year for this removal evaluation effort.

IV. Study Schedule: 2004 – TBD

V. Relationship to RIPRAP:

GENERAL RECOVERY PROGRAM SUPPORT ACTION PLAN

III. Reduce negative impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management).
III.A. Reduce negative interactions between nonnative and endangered fishes.
III.A.2. Identify and implement viable active control measures.

GREEN RIVER ACTION PLAN: MAINSTEM

III. Reduce impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management).
III.A. Reduce negative impacts to endangered fishes from sportfish management activities.
III.A.4. Develop and implement control programs for nonnative fishes in river reaches occupied by the endangered fishes to identify required levels of control. Each control activity will be evaluated for effectiveness, and then continued as needed.

VI. Accomplishment of FY 2004 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Electrofishing was the primary gear type used to collect smallmouth bass for a mark-recapture abundance estimate. Four complete shoreline electrofishing passes were completed in each reach of the Green River. On the first electrofishing pass smallmouth bass were marked with a Floy tag and on the remaining three passes smallmouth bass were examined for tags and removed from the river.

Task 1. Complete four smallmouth bass collecting passes from Echo Park to Split Mountain boat ramp (USFWS CRFP – Vernal)

The USFWS sampled the furthest upstream reach of the study area. The upstream 26-mile reach extended from Echo Park (RM 344) downstream to Split Mountain boat ramp (RM 318). This effort started with a marking pass on August 3 and was completed August 5. Two electrofishing rafts were used to sample both shorelines of the entire river reach. During the first pass, 327 smallmouth bass were measured, weighed, marked (with green floy tags), and released back to the river alive; another 114 that were a concern for tag retention were measured, weighed and removed. Three subsequent electrofishing passes were then completed. During the fourth pass, 61.8 hours were spent angling which produced 8 bass. During the removal passes, 55 recaptures and 2,385 unmarked bass were removed. The number of smallmouth removed this year was 2,440 (Table 1).

Table 1. Smallmouth bass collected from Echo Park to Split Mountain Boat Ramp; 2004.

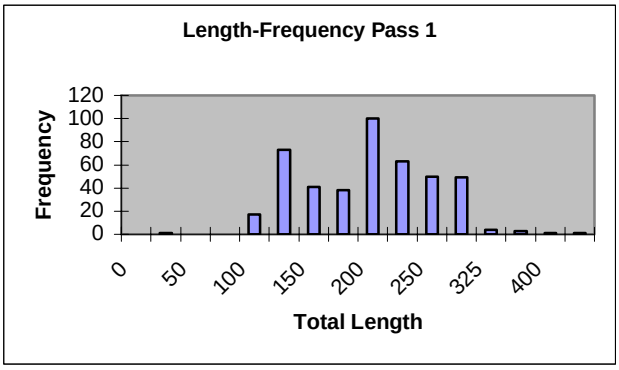
Echo Park – Split Mountain	Pass 1	Pass 2	Pass 3	Pass 4	Total
Date	8/3-5	8/16-18	9/7-9	9/13-16	
Marked & Released	327				327
Recaptures		19	15	21	55
# Removed, includes Recaptures	114	458	869	999	2440

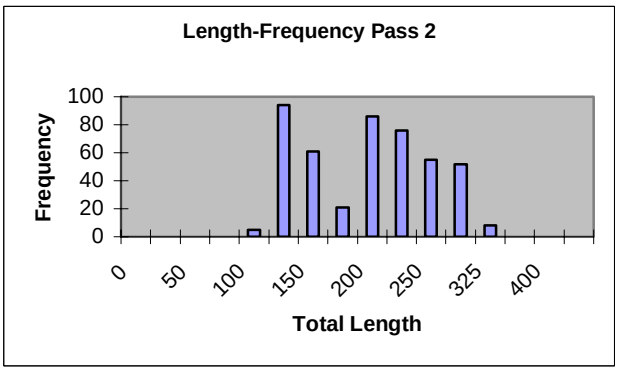
Abundance Estimate

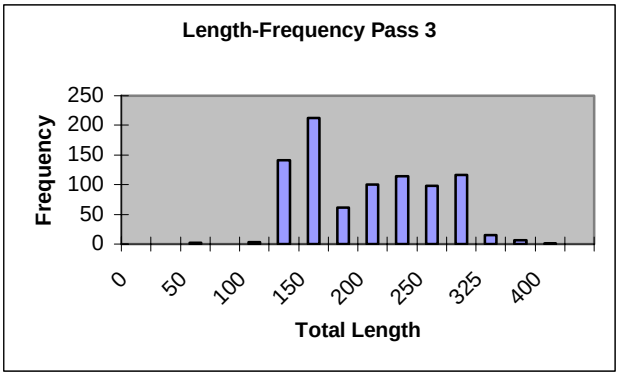
Mark-recapture allowed the determination of a smallmouth bass population estimate using the Lincoln-Peterson method. The program Capture was used to determine the estimate. A constant probability of capture was used M(o) for pass 1 and 2. The total number of captures, n, was 785. The number of bass captured, M(t+1), was 766. The population estimate for this section of the Green River is 5,778 bass with standard error 1042.73 and estimated probability of capture, p-hat, of 0.0679. Fish density estimates ranged from 158 to 318 bass/rmi. The total number of smallmouth bass removed (n=2,440) relates to 94 bass/rmi. From this estimate we are 95% confident that a 30-59% reduction in population was attained in the Echo Park to Split Mountain reach (Figure 3).

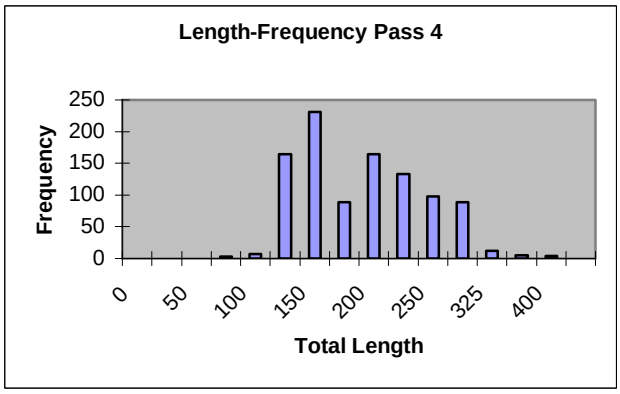
Size Structure

Mean length of smallmouth bass collected was 183 mm. Lengths were evaluated and no significant differences in mean total length between passes were found (F =2.51, P-value =.057, see Figure 1). However the Kolmogorov-Smirnov Comparison of length distribution between the first and last data sets (passes) shows significant difference. The maximum difference between the cumulative distributions, *D*, is 0.1373 with a corresponding *P* of 0.000. The percent of larger bass from the first pass was significantly higher as compared to the distribution of bass from the last pass. The smaller size distribution represented in the last pass could have resulted from 1) physical removal; 2) a decrease in larger bass vulnerability to electrofishing; 3) an increased vulnerability of smaller bass to electrofishing; or 4) from the cumulative outcome of more than one of the above scenarios.









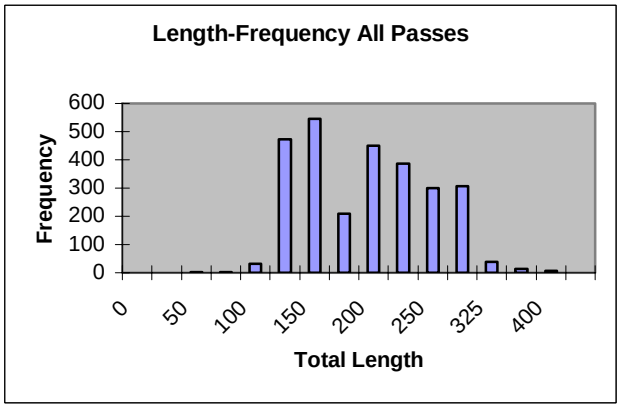


Figure 1. 2004 Length frequency of smallmouth bass caught electrofishing in the Green River between Echo Park and Split Mountain boat ramp (RM 344-318).

Smallmouth Bass Catch Rates

During the last two passes the river was very turbid. This condition caused change in sampling technique; electrofishing rate of travel was reduced and more arduous habitats (shallow water and boulder substrates) were sampled. Areas normally bypassed on account of equipment concern were electrofished. In part, this may be indicative of higher catch rates between the first and last two passes; see figure 2. The angling catch rate during the last pass resulted in .13 bass/hour.

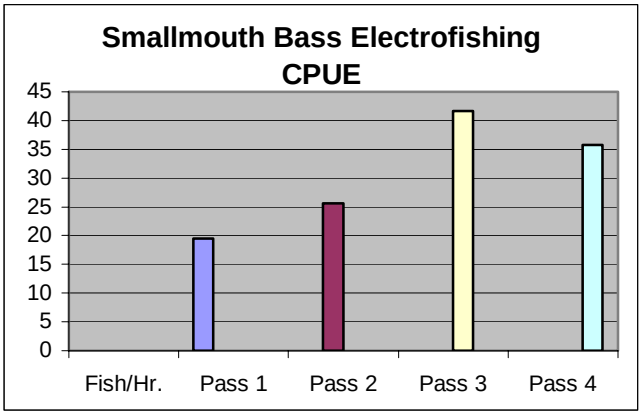


Figure 2. 2004 smallmouth bass catch per effort between passes; catch rate differences between passes are likely due to changes in sampling efficiency and technique.

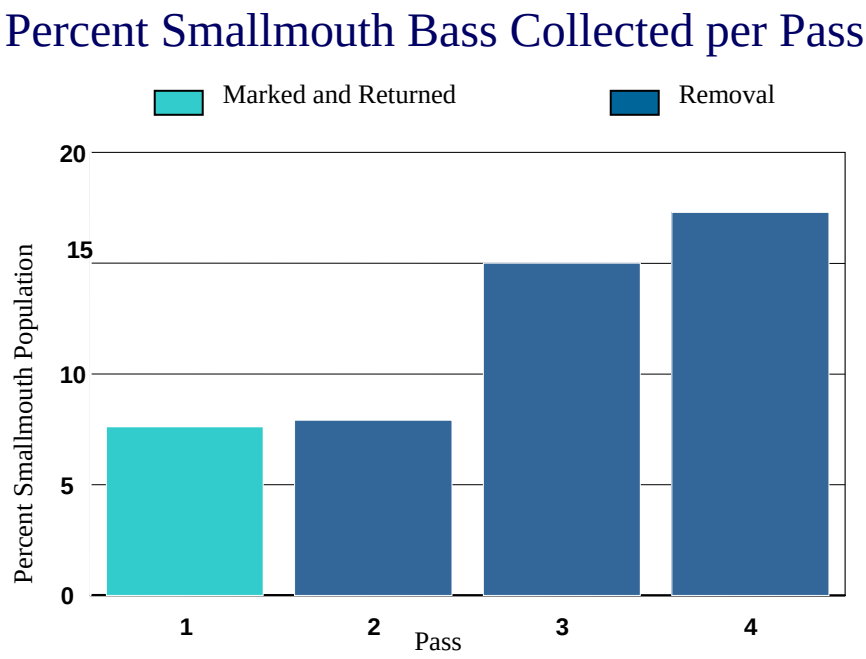


Figure 3. Percent smallmouth bass caught per electrofishing pass based on 2004 population estimate in the Green River between Echo Park and Split Mountain boat ramp(RM 344-318).

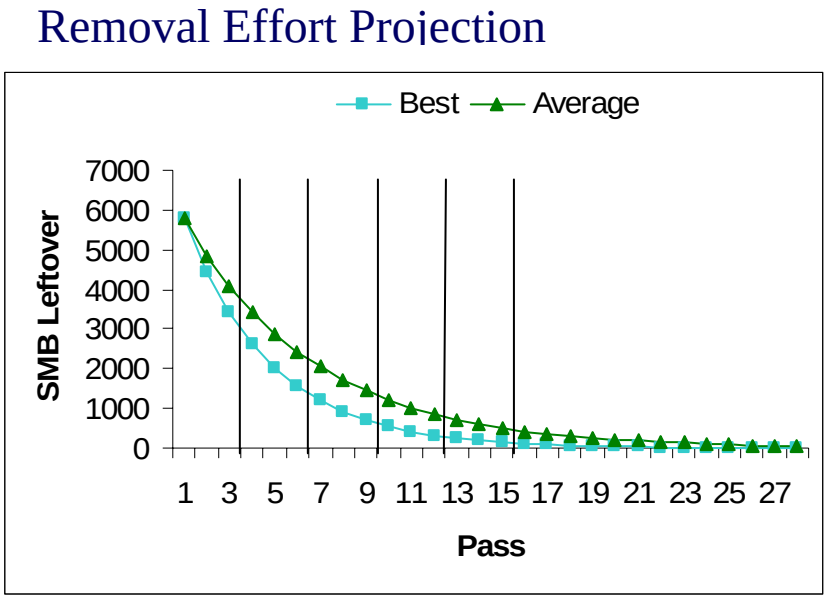


Figure 4. Theoretical smallmouth bass reduction per pass based on 2004 catch/pass and population estimate in the Green River between Echo Park and Split Mountain boat ramp (RM 344-318).

Movement

Movement of bass out of the study area was not detected in downstream sampling though only one sampling pass in the adjacent downstream reach occurred after the first marking pass in the Echo Park to Split Mountain reach. Though no recaptures occurred downstream, three recaptures (red flag tagged bass) from the Split Mountain to Sand Wash reach were collected upstream while sampling the Yampa River (different study).

Task 2. Complete four smallmouth bass collecting passes from Split Mountain boat ramp to Sand Wash boat ramp (UDWR – Vernal).

The first electrofishing pass for tagging smallmouth bass in the middle Green River began at the Split mountain boat ramp (RM 318) on 30 April 2004 and was completed on 3 June near the Sand Wash boat ramp (RM 215). This pass took 14 sampling days to complete. A total of 320 smallmouth bass were tagged using red flag tags and released into the river. Five northern pike, none of which were tagged, and seven walleye were also caught during this pass and removed from the river. The highest densities of smallmouth bass were encountered near the confluence of the Duchesne River (RM 248) and downriver to the Sand Wash boat ramp (RM215). Endangered fish species encountered included 41 Colorado pikeminnow and29 razorback sucker.

The first of three removal passes began at Split mountain boat ramp on 14 June and was completed on 15 July. This effort took 12 sampling days to complete and resulted in the capture and removal of 468 smallmouth bass and included five recaptures. The highest catch rates of smallmouth bass occurred on Dinosaur National Monument beginning at the Split Mountain boat ramp (RM 318) downriver to the Escalante spawning bar (RM 307). One walleye, two northern pike and six black crappie were also removed. Endangered fish encountered included eight Colorado pikeminnow and 11 razorback sucker.

The second removal pass for smallmouth bass in the middle Green River began on July 20 and was completed on August 9. This pass took 10 field days to complete and resulted in the removal of 690 smallmouth bass of which 23 were recaptures. Endangered species encountered included 15 Colorado pikeminnow. One walleye and four black crappie were also captured and removed.

The third and final removal pass began on August 11 and was completed on August 26. This pass took 9 field days to complete and resulted in the removal of 757 smallmouth bass of which 19 were recaptures. Two northern pike and three black crappie were also removed. Endangered species encountered included 15 Colorado pikeminnow and 19 razorback sucker. Highest capture rates of smallmouth bass continue to be at the uppermost stretch of this reach beginning at the Split Mountain boat ramp (RM 315) and continuing downriver to near the Escalante razorback spawning bar (RM 307). A total of 311 smallmouth bass were removed from this area during one day of electrofishing using two boats.

A total of 1,915 smallmouth bass including 47 of the 320 tagged fish were removed over the three electrofishing passes (Table 2). There weren't any tagged smallmouth bass from other researchers encountered in this reach of the middle Green River from Split Mountain boat ramp (RM 318) to Sand Wash (RM 215). Tagged fish from this reach were collected by other researchers in Yampa Canyon (Fuller), Lodore Canyon (Bestgen) and Desolation Canyon (Badame).

Table 2. Catch statistics for smallmouth bass removal evaluation in the middle Green River (Split Mountain – Sand Wash): 2004.

Pass	Effort (Hours)	Captures	CPUE	Number tagged	Recaptures
1	57.63	320	5.55	320	0
2	54.09	468	8.65	0	5
3	45.99	690	15.00	0	23
4	48.39	757	15.64	0	19
Total	205.10				47
Removed		1,915			

An initial population estimate was obtained by calculating two Lincoln-Peterson estimates. The first estimate was calculated using the first electrofishing pass as the marking pass and the second pass only as the recapture pass (Table 3). The second estimate used the first pass as the marking pass and the remaining three passes as the recapture pass (Table 4). A total of 320 smallmouth bass were tagged using red Floy flag tags on the first electrofishing pass. A total of 468 smallmouth bass were captured on the second pass and examined for marks. Only five recaptured smallmouth bass were collected in the second electrofishing pass. The abundance estimate of smallmouth bass using only the first and second passes was 24,960 with a 95% CI of 12,362 – 50,689 (Table 3). This represents an estimated density of 243 bass/mile and an exploitation rate of 7.6% of the initial population (C/N). An estimate of 12,813 (95% CI 9,772 – 17,237) smallmouth bass is obtained using all passes (Table 4). This represents 124 bass/mile and an exploitation rate of 15%.

Table 3. Two-pass abundance estimate for smallmouth bass in the middle Green River (Split Mountain – Sand Wash): 2004.

2004 Middle Green River (Split Mountain – Sand Wash)

Two-pass Lincoln-Peterson

Nhat = (C+1)(M+1)/(R+1)

= **24,960**

M =	320		
C =	468		
R =	5		

95 % Confidence Interval

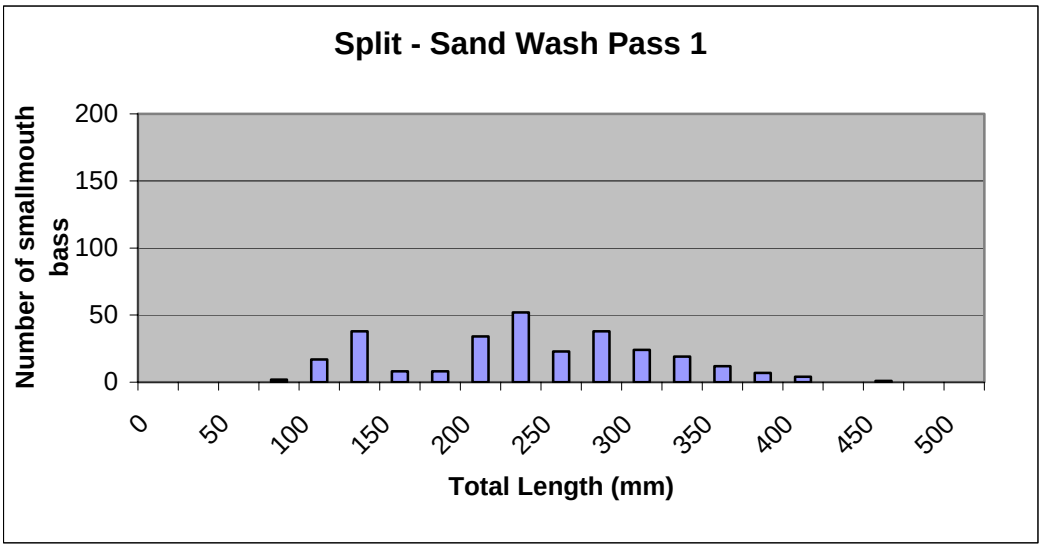
R = 5

Lower limit	**12,362**
Upper limit	**50,689**

Table 4. All-pass abundance estimate for smallmouth bass in the middle Green River (Split Mountain – Sand Wash): 2004.

2004 Middle Green River (Split Mountain – Sand Wash)			
All-pass Lincoln-Peterson		M =	320
Nhat = (C+1)(M+1)/(R+1)		C =	1915
		R =	47
=	**12,813**		
95 % Confidence Interval			
		R = 47	
Lower limit	**9,772**		
Upper limit	**17,237**		

Length frequency distribution shows the presence of multiple year classes including young–of-the-year throughout the study reach. A larger proportion of smaller smallmouth bass were collected during the third and fourth passes (Figures 5 and 6).



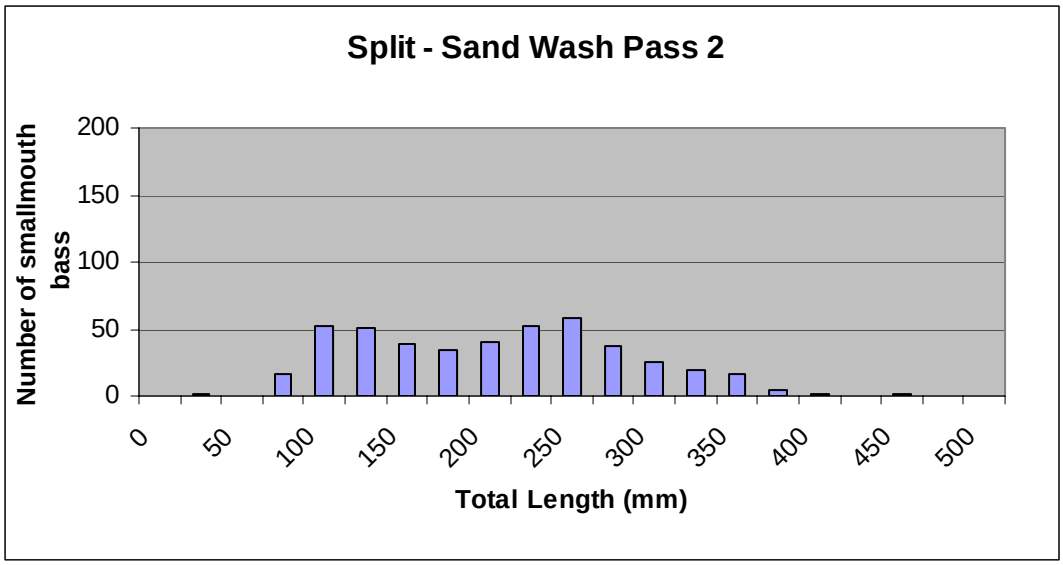
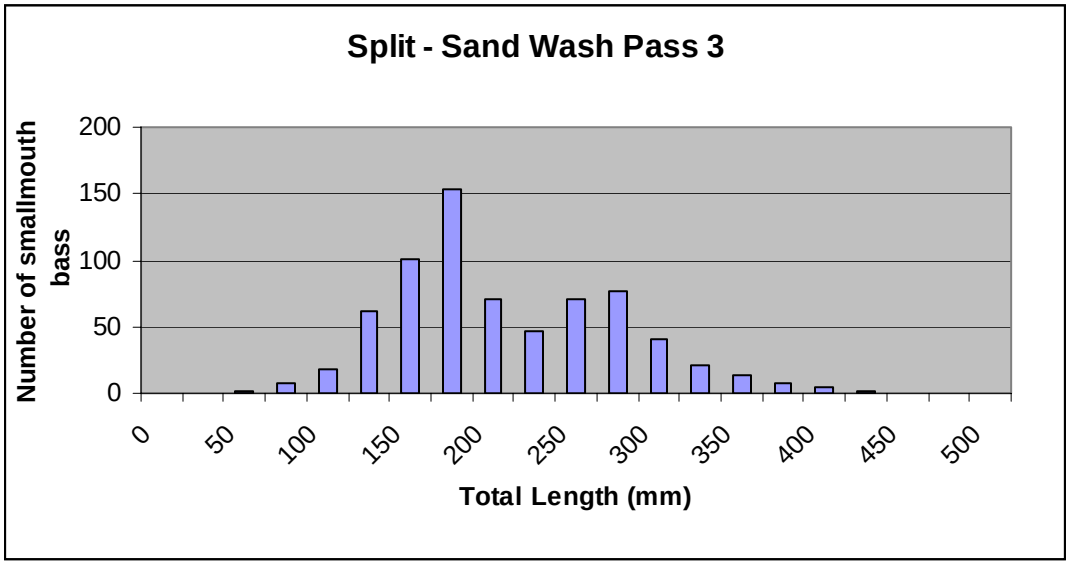


Figure 5. Length frequency distribution of smallmouth bass collected on the first (marking) pass and the second pass on the middle Green River from Split Mountain boat ramp (RM 318) to Sand Wash (RM 215): 2004



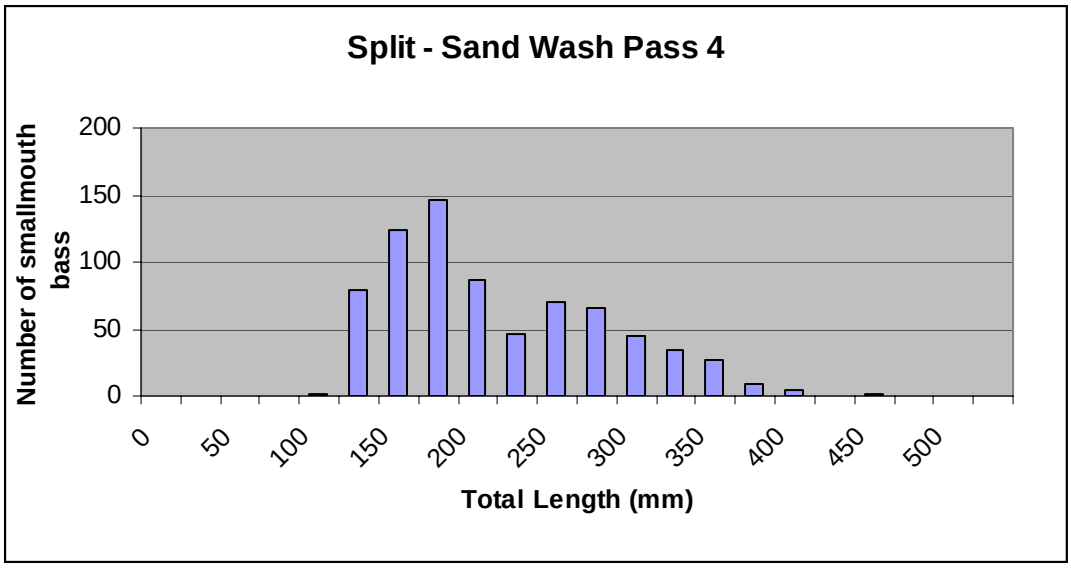


Figure 6. Length frequency distribution of smallmouth bass collected on the third and fourth pass on the middle Green River from Split Mountain boat ramp (RM 318) to Sand Wash (RM 215): 2004.

Task 3. Complete four smallmouth bass collecting passes from Sand Wash boat ramp to Swasey's Rapid (UDWR – Moab).

Four electrofishing passes were completed between Sand Wash (RM 216) and Swaseys Rapid (RM 132) between August 16 and October 1, 2004. Over 142 hours of electrofishing effort was expended and a total of 1,117 smallmouth bass were captured. During the third pass only one boat was used due to mechanical problems. The single electrofishing boat switched shorelines depending on the quality of the habitat. On all other passes two boats shocked continuously on both shorelines until Rock Creek Canyon (RM 176), at which time only areas with potential habitat were spot shocked. Smallmouth bass were found only in the upper 55 miles of Desolation Canyon (Figure 7).

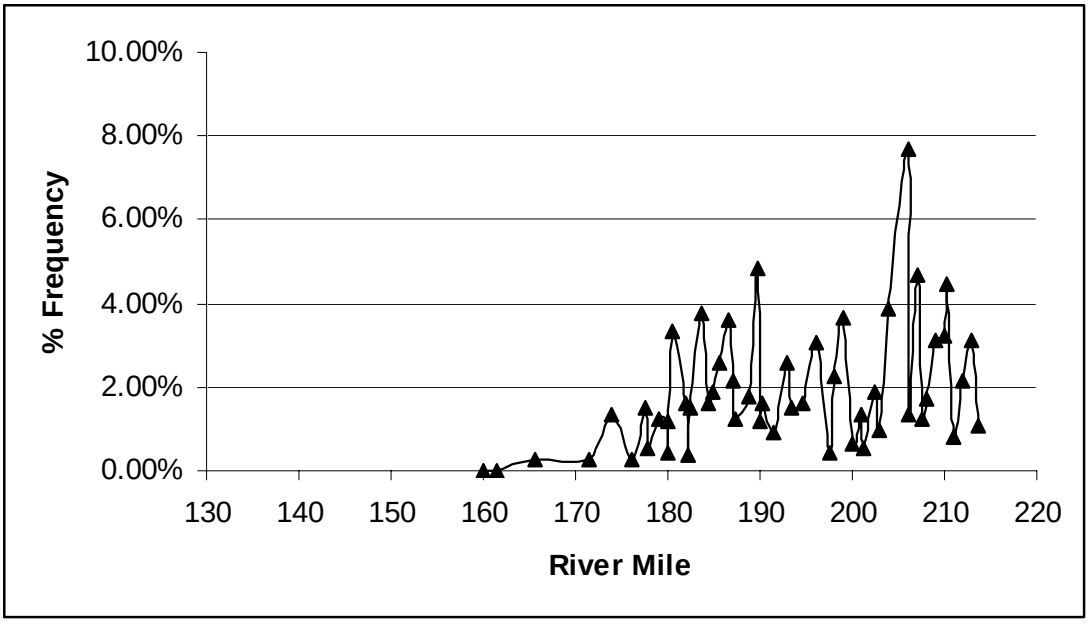


Figure 7. Percent frequency of smallmouth bass captures by river mile between Swasey's Rapid (RM 132) and Sand Wash (RM 216).

During the first pass, 178 smallmouth bass were tagged with yellow flag tags and released. Over the three subsequent passes, a total of 937 bass were removed. Of the bass removed, 32 were recaptured with yellow flag tags and 2 were recaptured with red flag tags (Table 5). The overall catch per unit effort (CPUE) was 7.82 fish per hour (Table 1).

Table 5. Catch Statistics for all smallmouth bass removal electrofishing passes in Desolation Canyon, 2004.

PASS	HOURS	CAPTURES	CPUE	TAGGED	RECAPTURES
1	40.56	180	4.44	178	0
2	36.40	270	7.42	0	14
3	21.12	250	11.84	0	4
4	44.61	417	9.35	0	14
TOTAL	**142.69**	**1,117**	**7.83**	**178**	**32**

Two Lincoln-Peterson population estimates were calculated to derive an initial population estimate.

$N = (C+1)(M+1)/(R+1)$

The first estimate used only recaptures of marked fish from the second pass. The two-pass estimate was 3,234 (95% C.I. 3,278 – 6,900) smallmouth bass in Desolation/Grey

Canyon (Table 6). The two-pass estimate represents a density of 58.8 bass per mile in the upper 55 miles of the canyon. Using the two-pass estimate our overall exploitation rate was 29% of the population (C/N). The second estimate pooled all recaptures from the three removal passes and then was calculated in the same manner as the two-pass estimate. The all-pass estimate was 5,212 (95% C.I. 7,023 – 3,401) smallmouth bass in Desolation/Grey Canyon (Table 6). The all-pass estimate represents a density of 94.7 bass per mile in the upper 55 miles of the canyon. Using the all-pass estimate our overall exploitation rate was 18% of the population.

Table 6. Lincoln Peterson estimate parameters for two methods of calculation.

Estimate Method	M	C	R	N
Two-Pass	178	270	14	3,234
All-Pass	178	937	32	5,212

The purpose for calculating the population estimate with all recapture passes pooled together is to smooth out the variance seen in recapture rates for all passes and reaches in the Green River removal reaches. It is likely that significant variations in recapture rates related to both over and under estimates of initial populations in each reach. The probability can be supported by looking at a comparison of density estimates, using both calculations, and CPUE rates for each reach (Table 7). The pattern of density estimates and overall CPUE rates between reaches should correlate. This correlation only occurs using the all-pass Lincoln-Peterson estimates in all reaches. It is our recommendation that this comparison of calculations be made again next year to see if the pattern continues.

Table 7. Comparison of two-pass and all-pass density estimates and CPUE for all removal reaches of the upper and middle Green River.

Estimate	Reach	Density	CPUE
2 Pass	Upper	222/mi	31/hr
	Middle	242/mi	11/hr
	Lower	59/mi	8/hr
All Pass	Upper	524/mi	31/hr
	Middle	124/mi	11/hr
	Lower	92/mi	8/hr

Length frequency distributions show the presence of multiple year classes including young of year smallmouth as far down canyon as river mile 184 (Figure 8). No significant shift in size structure was observed over the removal period.

Movement of smallmouth bass from the Split Mountain boat ramp to Sand Wash reach was documented by the capture of two red flag tagged smallmouth bass. The two recaptures represent 0.6% of the available tags released in the Split Mountain to Sand Wash reach. These fish were caught on August 18 and 19 at river miles 185 and 213 and measured 322 mm and 420 mm respectively.

In addition to smallmouth bass, 19 black crappie and 3 walleye were removed. No other fish were handled during the removal trips.

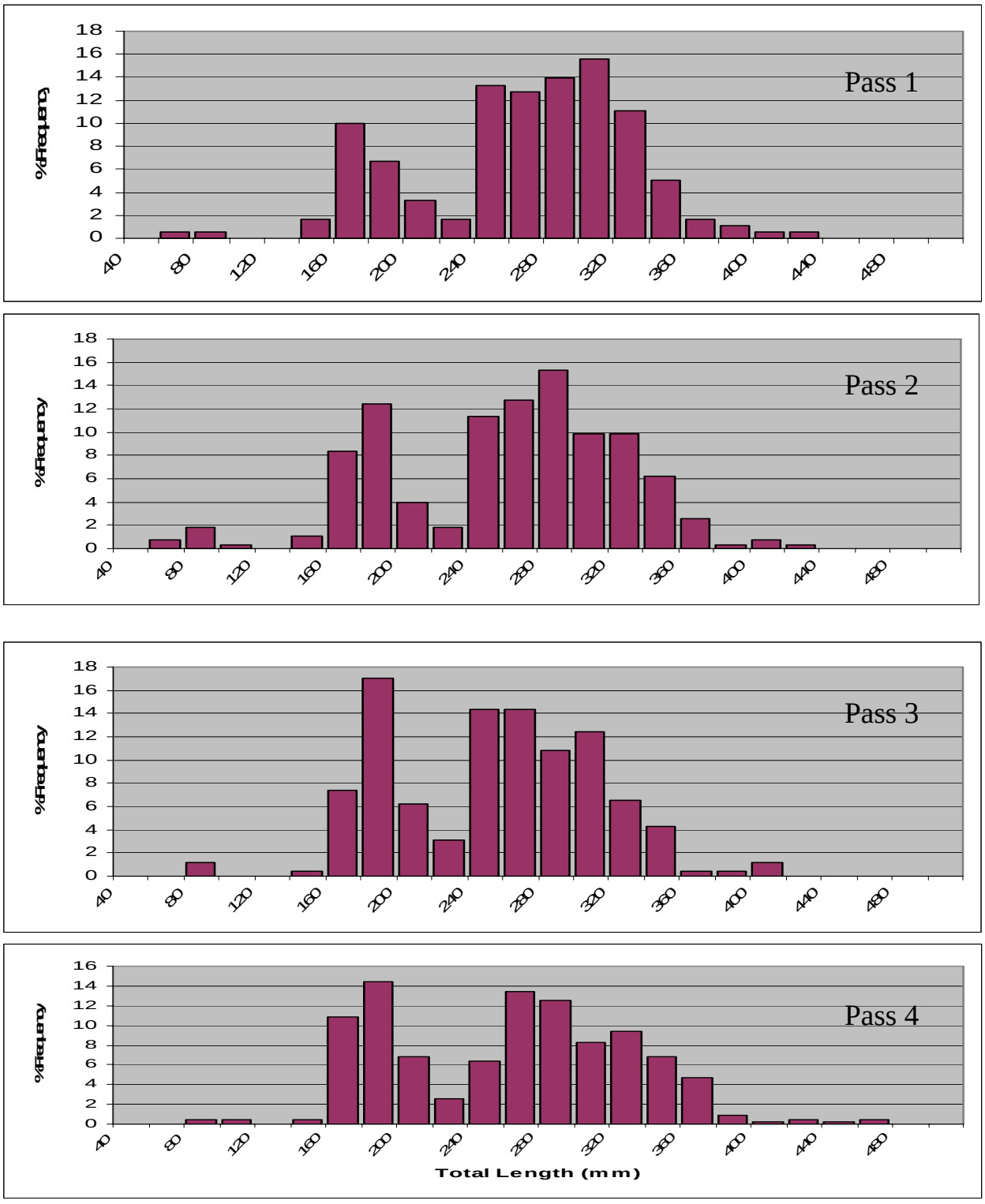


Figure 8. Smallmouth bass total length frequency charts for passes 1-4, Desolation Canyon of the Green River 2004.

Task 4. Data entry, analysis, and reporting

Data entry is complete. Analysis and reporting will be complete by December 15, 2004

VII. Recommendations:

Continue to evaluate removal of smallmouth bass in the Green River

VIII. Project Status: On track and ongoing

IX. FY 2004 Budget Status

A. Funds Provided: $185,000
B. Funds Expended: $185,000
C. Difference: $0
D. Percent of the FY 2004 work completed, and projected costs to complete: 100%
E. Recovery Program funds spent for publication charges: $0

X. Status of Data Submission: Tagging data for the 2004 field season will be submitted to the database manager by January 2005.

XI. Signed: Ron Brunson March 17, 2005
Principal Investigator Date