RECLAMATION

Managing Water in the West

Animas River Fish Passage and Canal Entrainment Evaluation and Recommendations

Animas-La Plata Project, Colorado and New Mexico
Upper Colorado Region

U.S. Department of the Interior
Bureau of Reclamation
Western Colorado Area Office
Grand Junction and Durango, Colorado

April 2007

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Animas River Fish Passage and Canal Entrainment Evaluation and Recommendations

Animas-La Plata Project, Colorado and New Mexico
Upper Colorado Region

Prepared by

Michael S. Francis, Biologist

Western Colorado Area Office
Durango, Colorado

U.S. Department of the Interior
Bureau of Reclamation
Western Colorado Area Office
Grand Junction and Durango, Colorado

April 2007

Executive Summary

To meet an environmental commitment in the 2000 the Animas-La Plata Project Final Supplemental Environmental Impact Statement (FSEIS), the Bureau of Reclamation (Reclamation) evaluated the significance of the City of Farmington's Animas Pump Station #2 (APS) and Farmer's Ditch Diversion (FDD) as movement barriers for flannelmouth suckers (*Catostomus latipinnis* or FMS) and bluehead suckers (*C. discobolus discobolus* or BHS) as well as the issue of small/young-of-the-year (YOY) native sucker entrainment losses into canals.

A portion of both native sucker populations of sexually mature size were capable of ascending both diversions. Too few bluehead suckers were recaptured to allow for effective statistical analysis, but significantly more recaptured FMS ascended the APS than the FDD. The APS does not appear to be a significant barrier to fish over 400 mm in length while its gates are open, however the FDD is a more substantial barrier lacking in-channel gates. Both diversions are barriers to juvenile sucker movement, but to what degree could not be statistically determined as recaptures of smaller fish was under-represented. There was no significant difference in the net distance moved per year by flannelmouth suckers in the upper and middle reaches (above FDD and between FDD and APS respectively) but those in the lower reach move more in an upstream direction.

The Animas River was sampled for the presence of YOY native suckers from 2000-2002. The sample evaluation concluded that FMS and BHS reproduction in the upper Animas River was at high levels. The subsequent examination of existing data regarding current technologies for screening of small native sucker larvae indicate that effective methods for prevention of entrainment losses may have limited effectiveness and would be too costly in installation and maintenance. Numerous older juvenile suckers were found in sampling immediately below both diversions. In considering these factors together, Reclamation decided that loss of YOY suckers due to entrainment in canals, although occurring, was not a significant loss to the river's population nor effectively manageable at this time.

Reclamation recommends that the City of Farmington be contacted to attempt coordinating the operation of the APS gates to allow for greater native fish access to the upstream sections of the Animas River without negatively impacting the pump station operations. Reclamation further recommends the manual translocation of native suckers from downstream of both the APS and FDD to upstream of the FDD, emphasizing sexually mature and larger size class juvenile individuals, with care taken to ensure non-native species are excluded in the translocation efforts. Reclamation also offers additional points to be considered in determining if these recommendations should be implemented.

Acknowledgements

Many individuals assisted in collecting field data and processing information during the course of the five-year study. Steve Whiteman and Ben Zimmerman with the Southern Ute Indian Tribe were invaluable in terms of providing logistical support and annual report preparation since the initiation of the study. Dr. Rich Valdez was instrumental in providing guidance and in developing a study design.

Within the Bureau of Reclamation, Kirk Lashmett organized and led the study effort for several years. This report is an expansion of an earlier draft he developed with added analysis and discussion. Riecky Rieck routinely provided much appreciated assistance during the course of conducting field fishery surveys. Also assisting over the years were C. Marc Wethington of the New Mexico Department of Game and Fish and the staff of the Southern Ute Wildlife Resource Management Division: Rich Porambo, Aran Johnson, Danielle McGraw, Chris Olguin and Karen Peterson.

It is important to note that portions of the text herein are derived from the 2007 SWCA Environmental Consultants report to the Bureau of Reclamation entitled "Analysis of Existing Data on Potential Animas River Diversion Effects on the Movements of Adult Flannelmouth and Bluehead Suckers". Their detailed analysis of the data generated by the study should prove invaluable for the future conservation of native suckers in the Animas River.

Contents

Introduction

The Animas-La Plata Project (Project) Final Supplemental Environmental Impact Statement (FSEIS) was completed in July 2000 and the associated Record of Decision (ROD) was signed in September 2000. Reclamation is currently involved in implementing the environmental commitments for Refined Alternative 4 as defined in the FSEIS and restated in the ROD and the Project Environmental Commitment and Monitoring Plan.

This report is intended to meet the requirement to provide the "*…firm recommendation for mitigation due to the effects* [of non-Project structures potentially compounded or alleviated by Project operations] *on native fishes…*" (Reclamation 2000 and 2004). Reclamation could not effectively meet the original date suggested to provide this recommendation report "*…no later than 2005…*" but does meet the FSEIS intent of providing the recommendations "*…at least two years prior to project pumping from the Animas River.*"

Background

In consultation with the Fish and Wildlife Service, Reclamation acknowledged the difficulty in quantifying the long-term effects to native fish populations resulting from the Animas-La Plata Project's depletion and/or operation. This conclusion was based on the following facts:

1. The flow depletions resulting from the Animas-La Plata Project are relatively small in relation to other [non-Project] pre-existing depletions.
2. Very little is known of the relationship between fish habitat and flow levels in the Animas River.
3. The Animas-La Plata Project will actually enhance flows above historic rates in the river when releases are made from Ridges Basin Dam to provide Project water to downstream users.
4. Concerns exist regarding native sucker recruitment in the upper Animas River that might be related to fish migration barriers unrelated to the Project.

Reclamation concluded that the greatest potential threats to the long-term conservation of the Animas River native fishery were pre-existing non-Project structures diverting water from the river. Reclamation further determined that not enough specific information was available regarding these pre-existing diversions on the Animas River to determine if they were significant barriers to upstream movement of adult native suckers or if the structures result in significant loss of

small/young-of-the-year (YOY) fish from entrainment into canals as stated in Reclamation (2000 and 2004):

"The potential impact [of the Animas-La Plata Project] *to native fishes in the Animas River, especially the effects of chronic habitat reduction, may not be directly mitigatable*[1] *on the Animas River. Investigations should be initiated to determine whether or not fish barriers exist, whether small fish/young-of-the-year fish are significantly lost through entrainment in* [non-Project] *canals.... A firm recommendation for mitigation due to the effects* [of non-Project structures potentially compounded by Project operations] *on native fishes will be made by no later than 2005, at least two years prior to project pumping from the Animas River. Once this mitigation recommendation is approved and agreed to by the Service, CDOW* [Colorado Division of Wildlife]*, New Mexico Department of Game and Fish (NMDGF), and perhaps the Southern Ute Indian Tribe (SUIT), its implementation will immediately begin."*

Therefore, as an environmental commitment for unspecified potential impacts of Project operations on the native fishery of the Animas River, Reclamation committed to perform investigations to determine "*whether or not fish barriers* [on the Animas River] *exist, whether small fish/young-of-the-year fish are significantly lost through entrainment in canals…*". Subsequently, a study proposal was prepared and a Cooperative Agreement modification was implemented with the SUIT via their Division of Wildlife (SUDW) under Public Law 92-638 to perform the needed aquatic resource studies.

The two man-made structures identified in the study design as having the greatest potential to be barriers for native fish movement on the Animas River were the City of Farmington's Animas Pump Station #2 (APS, Figures 1 and 2, below) and the Farmer's Ditch Diversion (FDD, Figures 1 and 3, below).

The APS is located at river mile (RM) 11.9 (as measured from the confluence with the San Juan River) and has been operating since 1986 (personal communication, S. Williams 2007). The FDD is located at RM 21.9 and has been operating since 1892 (personal communication, R. Genauldi 2007), but not always in its current concrete configuration.

The FDD also has great potential to cause significant loss of YOY fish through entrainment in its delivery canal. Reclamation performed additional sampling and analysis relative to YOY native fish in an effort to determine potential long-term effects of the diversions on the native fishery of the Animas River.

[1] Spelling error. The intended word for this sentence was mitigable, the adjective form of mitigate, meaning able to be mitigated.

Figure 1: Map of Studied Diversions.

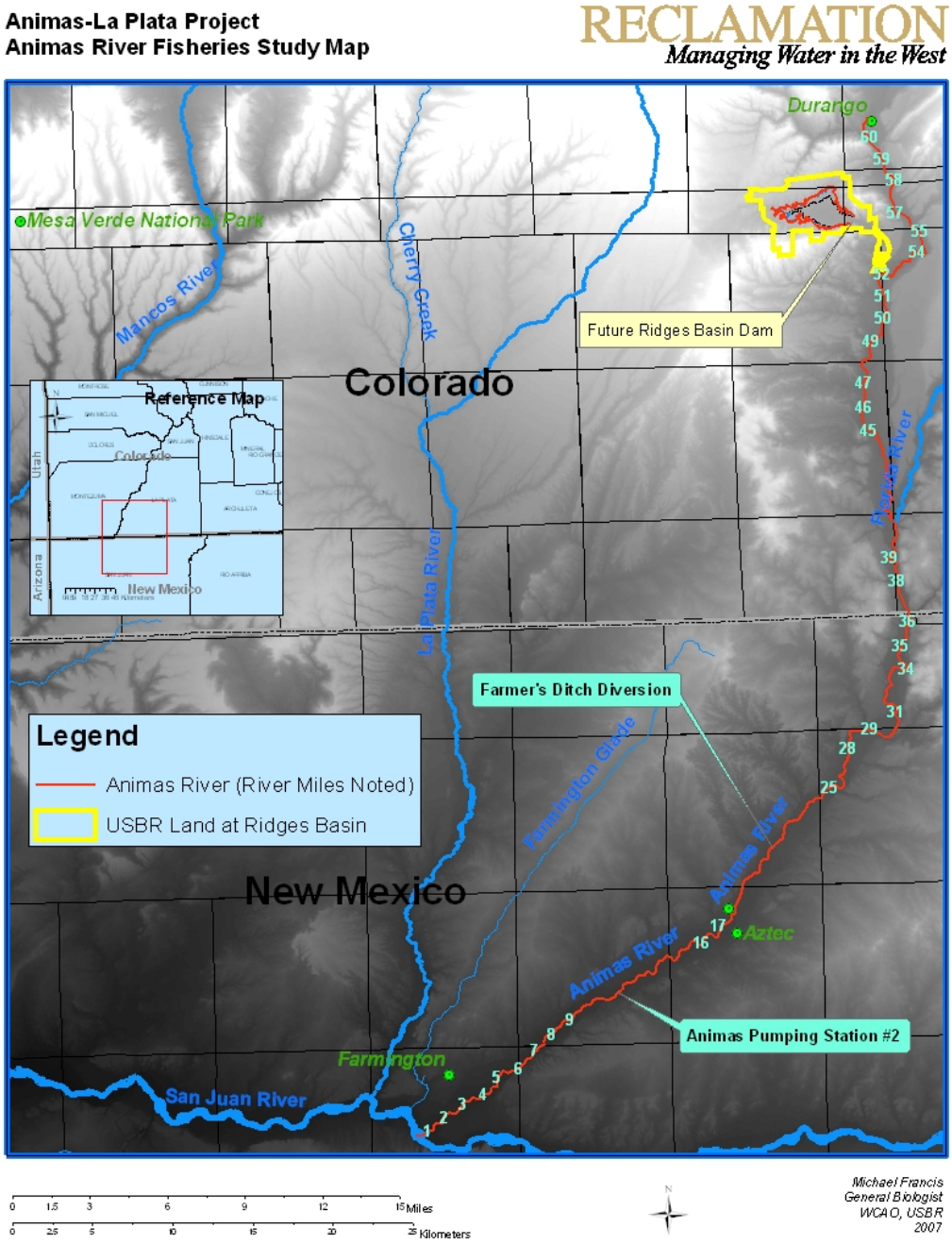


Figure 2: City of Farmington's Animas Pump Station #2 (APS) with open gates.

Figure 3: Farmer's Ditch Diversion (FDD) at relatively low flow conditions.

Figures 4 and 5 below show examples of important Animas River native fish, the flannelmouth (*Catostomus latipinnis* or FMS) and bluehead suckers (*C. discobolus discobolus* or BHS) specifically evaluated in this study.

Figure 4: Flannelmouth Sucker (FMS).

Figure 5: Bluehead Sucker (BHS).

The local importance of these native fish has changed since 112 km (69.6 miles) of the San Juan River were targeted for non-game fish eradication (Olson 1962 *in* Ptacek 2005). Recent evidence suggests that BHS populations are in decline throughout its historic range and are now found in less than half of its historic range. (Wheeler 1997, Bezzerides and Bestgen 2002 and Weitzel 2002 *in* Ptacek et al. 2005). FMS do remain widely distributed in the San Juan River drainage (Holden and Stalnaker 1975 *in* Rees et al. 2005). However, in many areas of the upper Colorado River basin, FMS populations are thought to be decreasing (Sigler and Sigler 1996 *in* Rees et al. 2005).

Rees et al. (2005) and Ptacek et al. (2005) identify fish passage barriers (specifically including diversion dams) as one of the primary threats to FMS and BHS. Blockage of spawning migrations has been identified as contributing to possible recruitment declines in FMS in the Colorado River (Chart and Bergersen 1992 and McKinney et al. 1999 *in* Paukert and Rogers 2004).

The BHS and FMS are considered a sensitive species by the US Forest Service (Ptacek et al. 2005 and Rees et al. 2005) but currently have no other federal protection status. The BHS and FMS are ‘Species of Concern’ and of ‘Special

Concern' in Utah and Wyoming respectively. The FMS are also of 'Special Concern' in Colorado (UDWR 2004). BHS are listed as being of possible concern in the Navajo Nation Endangered Species List (NNDFWL 2001).

The Range-Wide Conservation Agreement for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis* (RWCA), has the goal of "*…ensur[ing] the persistence of roundtail chub, bluehead sucker, and flannelmouth sucker populations throughout their ranges*". The RWCA has been signed by the state wildlife management agencies of Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming (UDWR 2004). This study and its associated recommendations may support the efforts of the RWCA's Coordination Team to achieve its conservation objectives on the Animas River.

Methods

Fish Barriers

Reclamation hypothesized that the APS and FDD diversion dams were partial or full barriers to juvenile and adult FMS and BHS attempting to migrate upstream. Figure 6 depicts SUDW and Reclamation staff surveying at the APS using a barge to carry the electrofishing apparatus.

Figure 6: Electrofishing at the Animas Pump Station #2.

In order to evaluate whether or not these diversions were significantly inhibiting upstream movement (migration) of native suckers, a multi-year study was initiated in 2001. The main tasks of the study were to capture and uniquely mark adult FMS and BHS below the two diversion dams (APS and FDD) suspected to be barriers to native fish migration via electrofishing and FLOY-tagging techniques (Figure 7, below) and to conduct subsequent surveys upstream of the dams to examine any movement of marked fish past the structures.

Further, electrofishing surveys were conducted immediately below each diversion dam to determine the presence or absence of juvenile native suckers, as well as to collect additional data on species composition, relative abundance and metrics.

Figure 7: FLOY-tagging a native sucker.

Sampling

Sampling was conducted with a Smith-Root 5.0 Gas Powered Pulsator electrofisher mounted on either a barge or raft. Sampling was conducted from near the Colorado/New Mexico state line downstream to the confluence of the Animas and San Juan Rivers. The electrofisher and the anodes generated a pulsed 220-volt DC electrical field of approximately 5 amps in order to temporarily stun the fish. All stunned fish were netted and then placed in a live well.

Recording

Upon completion of each sampling effort, fish collected were processed and total electrofishing time (effort) was recorded. Global Positioning System (GPS) readings were taken at each sampling site to record locations. All captured fish were identified to species, measured for total length, checked for visible abnormalities and sometimes weighed. All large native suckers (>150 mm Total Length) were checked for the presence of FLOY anchor tags. All native suckers greater than 150 mm with no FLOY-tag present were tagged with a uniquely coded FLOY-tag. All tag numbers for recaptured or newly marked fish were recorded.

Analysis

After the data collection and an initial analysis in conjunction with the SUWD, Reclamation contracted with SWCA Environmental Consultants (SWCA) in 2006 to perform a more refined analysis of the mark-recapture data to better define implications for adult native sucker movement past the diversions. SWCA identified reference reaches on the Animas River and examined data collected in three study reaches (below APS, between APS and FDD and above FDD) against the reference reaches. SWCA performed the statistical analysis of the recapture data and net movement per year.

SUWD also provided detailed analysis of fishery composition, length-frequency data and the relative occurrence of juvenile native fish above and below the diversion structures.

Fish Entrainment in Canals

To document small/YOY fish occurrence in the Animas River, sampling using a small-mesh beach seine was conducted at multiple locations in Colorado and New Mexico (Figure 8) in 2001.

Figure 8: Seine-netting YOY fish.

Sampling

Habitats selected for YOY sampling were generally low-flow side channel or backwater habitats along the Animas River. Sampling involved a single "sweep" of a beach seine through all or most of a given patch of habitat in order to maximize capture rates of YOY fish. The beach seine was 1/8-inch nylon mesh, 25 feet long, 7 feet high and included a bag, weight line and float line. Samples of YOY fish from each seine haul (Figure 9) were preserved in 10% formalin solution and excess fish were returned to the river. Sampling occurred in August of 2001.

Recording

For each collection sample, a sample number was assigned, locations were recorded with a GPS unit, and notes were taken on various site characteristics. Samples were returned to a laboratory and fish were identified to species, counted, and measured for total length.

Figure 9: A sample of YOY fish collected.

Analysis

Reclamation consulted with local fisheries biologists and known experts in the field to determine the general efficacy of directly studying the issue of small/YOY fish entrainment in canals from the Animas River and the possible implications of such entrainment on the long-term conservation of native suckers. SUWD worked with Reclamation to describe YOY fish samples taken from Colorado and from

New Mexico in terms of species composition and the relative abundance per species.

Reclamation also hired SWCA to perform a literature review and analysis of options available for YOY sucker canal entrainment management in the Animas River.

Results

General Results

Species Encountered

Table 1 lists the fish species collected from the Animas River from 2001 through 2005 during this study. Of note, most of the green sunfish (*Lepomis cyanellus*) and smallmouth (*Micropterus dolomieu*) and largemouth bass (*M. salmoides*) collected were found immediately below the two diversion dams being evaluated.

Table 1: Fish species captured during sampling of the Animas River.

Common Name	Species Name	Native?
Bluehead Sucker	***Catostomus discobolus discobolus***	**Yes**
Flannelmouth Sucker	***Catostomus latipinnis***	**Yes**
Bluhead / Flannelmouth hybrid	***Catostomus d. discobolus X latipinnis***	**Yes**
White Sucker	*Catostomus commersoni*	No
Flannelmouth / White Sucker hybrid	*Catostomus d. discobolus X commersoni*	No
Bluhead / White Sucker hybrid	*Catostomus latipinnis X commersoni*	No
Speckled Dace	***Rhynichtys osculus***	**Yes**
Mottled Sculpin	***Cottus bairdi***	**Yes**
Common Carp	*Cyprinus carpio*	No
Brown Trout	*Salmo trutta*	No
Rainbow Trout	*Onchorhynchus mykiss*	No
Cutthroat Trout	*Onchorhynchus clarki*	No
Smallmouth bass	*Micropterus dolomieu*	No
Largemouth Bass	*Micropterus salmoides*	No
Green sunfish	*Lepomis cyanellus*	No
Fathead Minnow	*Pimephales promelas*	No
Channel catfish	*Ictalurus punctatus*	No
Black Bullhead	*Ictalurus melas*	No

Fish Barriers

Recapture Rate

Recapture rates were relatively low for both native sucker species (12.3% for FMS and 2.1% for BHS) but comparable to other mark recapture studies of FMS (Chart and Bergersen 1992 and McKinney et al. 1999 *in* SWCA 2007).

In total, 3,369 FMS and 836 BHS were FLOY-tagged in the lower Animas River. Of the 4,205 total suckers tagged, 398 were subsequently recaptured during the five year study period (most in 2004 and 2005). Of the recaptured suckers, two were recaptured three times, thirty were recaptured two times and 366 were recaptured only once. In the lower section below the APS (RM 0.0-11.9), 322 BHS and 1,144 FMS were tagged and/or subsequently recaptured. In the middle section between the two diversions (RM 12.0-21.9), 322 BHS and 2,290 FMS were tagged and/or later recaptured. In the upper section upstream of FDD (RM21.9-36.0) 655 BHS and 1,550 FMS were tagged and/or later recaptured (Table 2).

Table 2: Total FLOY tagged native sucker marks and recaptures.

Year	FMS Tagged	BHS Tagged	FMS over APS	BHS over APS	FMS over FDD	BHS over FDD
2001	239	319	0	0	0	0
2002	122	59	0	1	0	0
2003	1,264	131	0	0	0	0
2004	2,105	705	31	0	5	1
2005	754	193	26	2	5	0
Total	**3,369**	**836**	**57**	**3**	**10**	**1**

The APS had the highest number of tagged suckers moving upstream of it. A total of sixty FLOY-tagged native suckers that were originally tagged downstream of the APS were subsequently recaptured above it, all but one in either 2004 or 2005. Fifty-seven FMS and three BHS managed to move upstream of this diversion. The FDD had only ten FMS and one BHS tagged below it subsequently recaptured above it.

Length/Frequency

Figures 10 and 11 (below) illustrate the length/frequency distributions for FMS and BHS sampled and recaptured. Observations in the field by various agency biologists led to general agreement that one or both of these diversions might be limiting recruitment of native suckers to the section of the Animas River above these two diversions (personal communication, M. Wethington, S. Whiteman and R. Valdez, 1999).

The populations of both of these species shows a much higher percentage of juvenile native suckers in the lower Animas River downstream of the APS and FDD indicating that smaller-bodied fishes might not be able to gain access to the upper reaches of the Animas River (Figures 12 and 13, below) (Zimmerman 2004).

Figure 10: Length frequencies of BHS tagged and recaptured by river section (SWCA 2007).

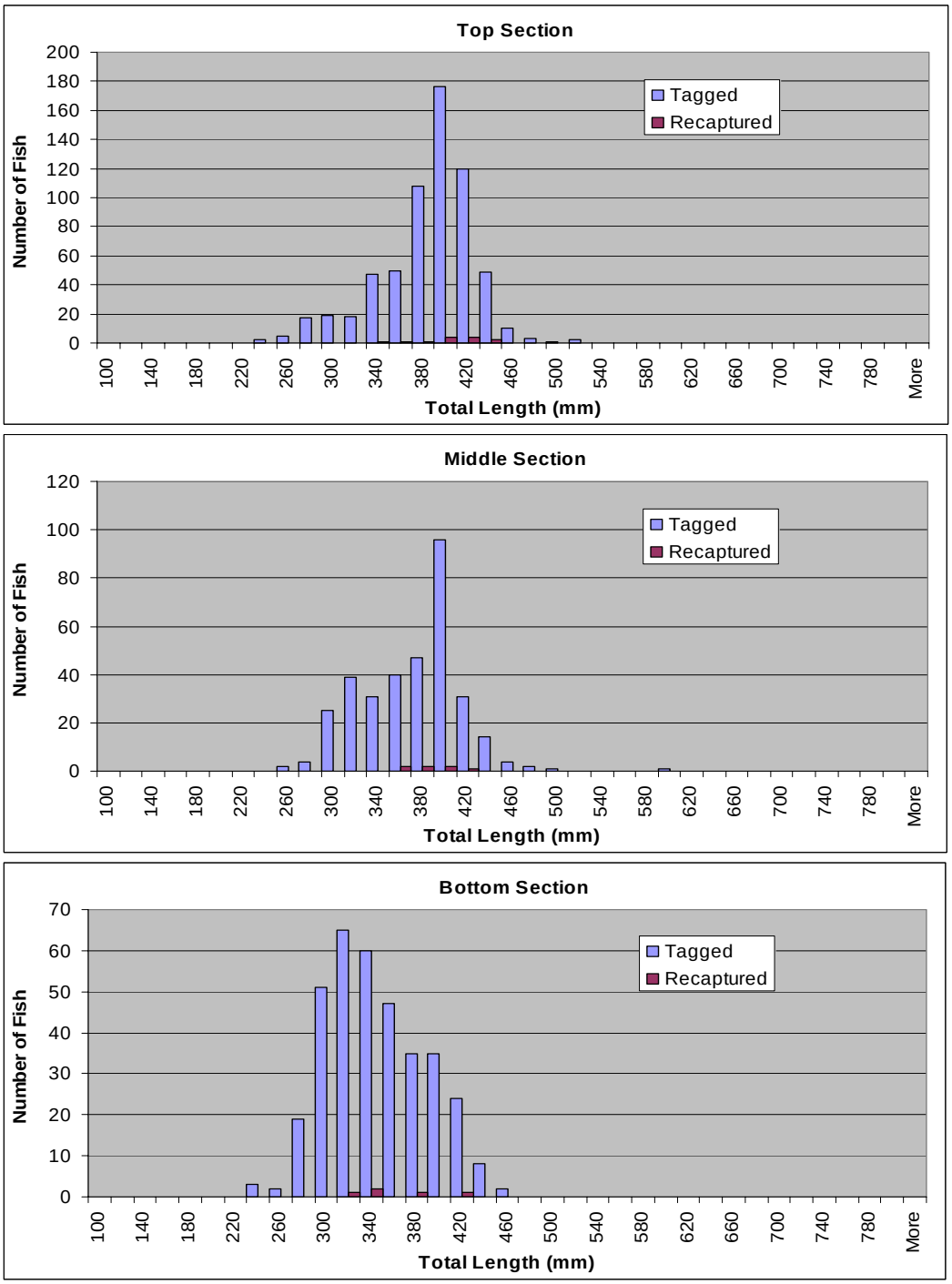


Figure 11: Length frequencies of FMS tagged and recaptured by river section (SWCA 2007).

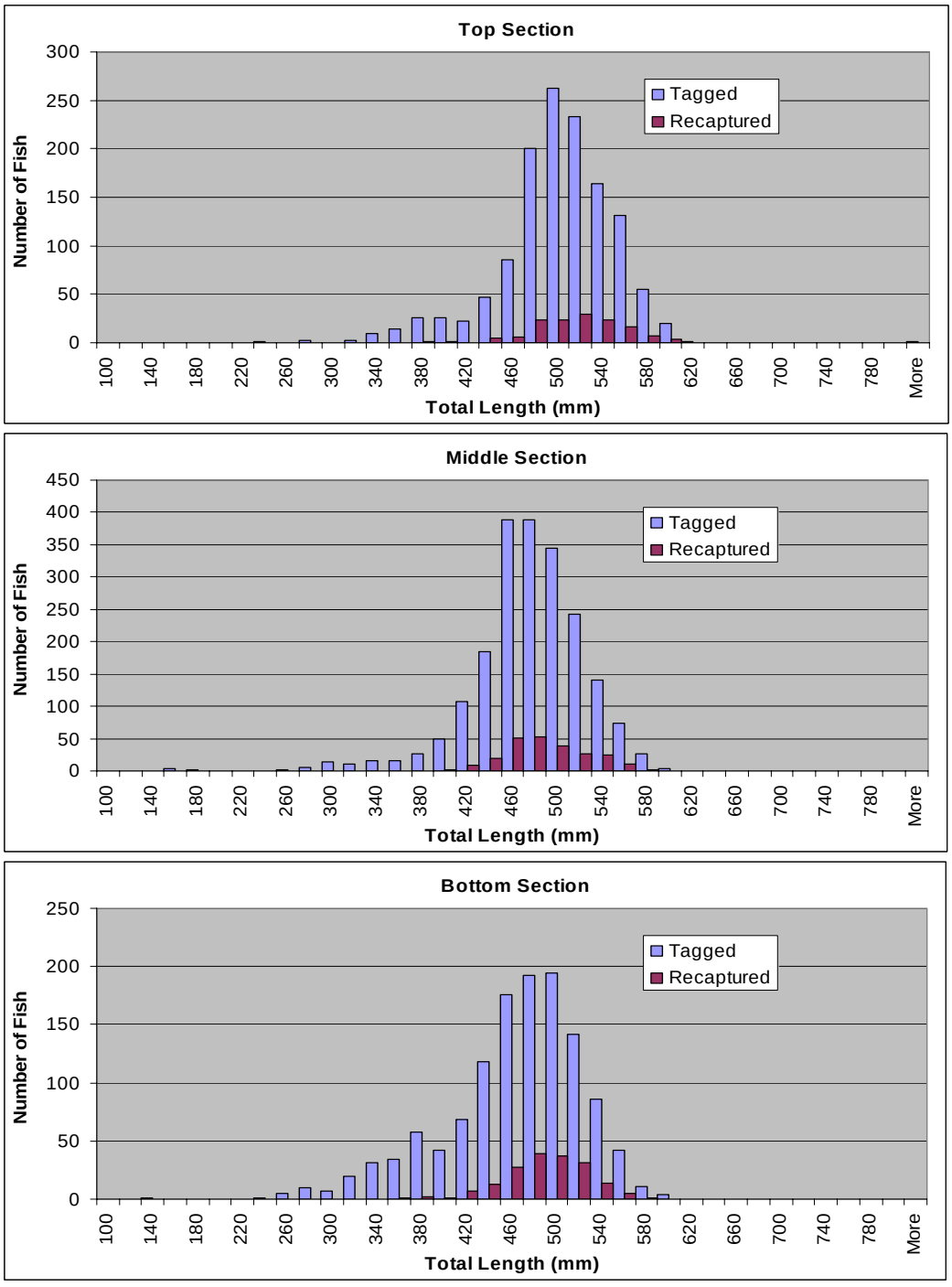


Figure 12: Length frequencies of FMS captured between River Miles 6.0 through 0.0, 2004 (n=427), below both diversions (Zimmerman 2004).

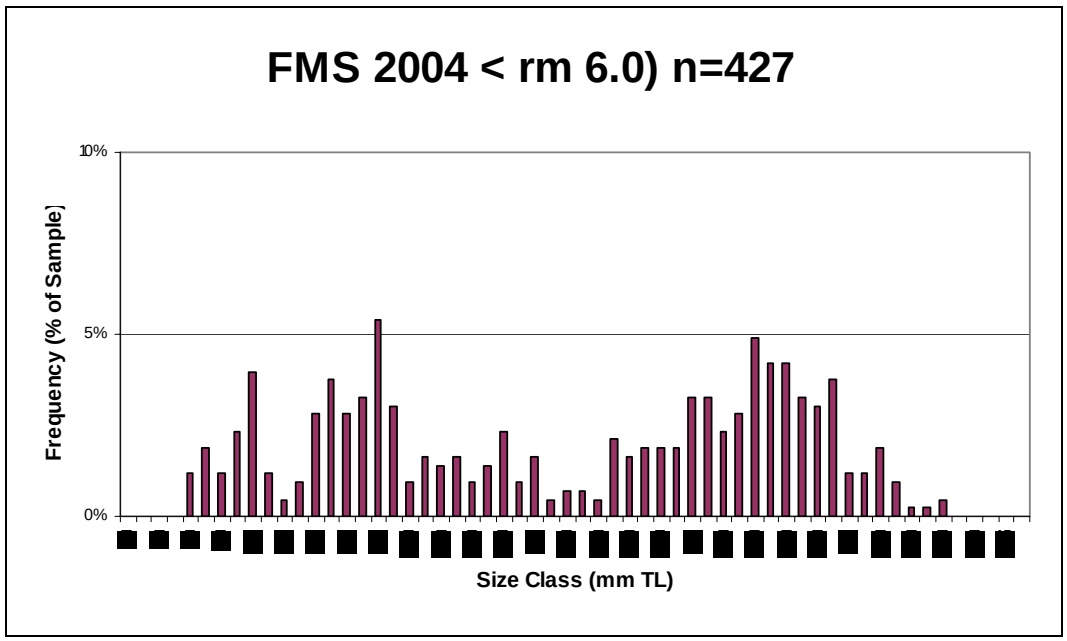
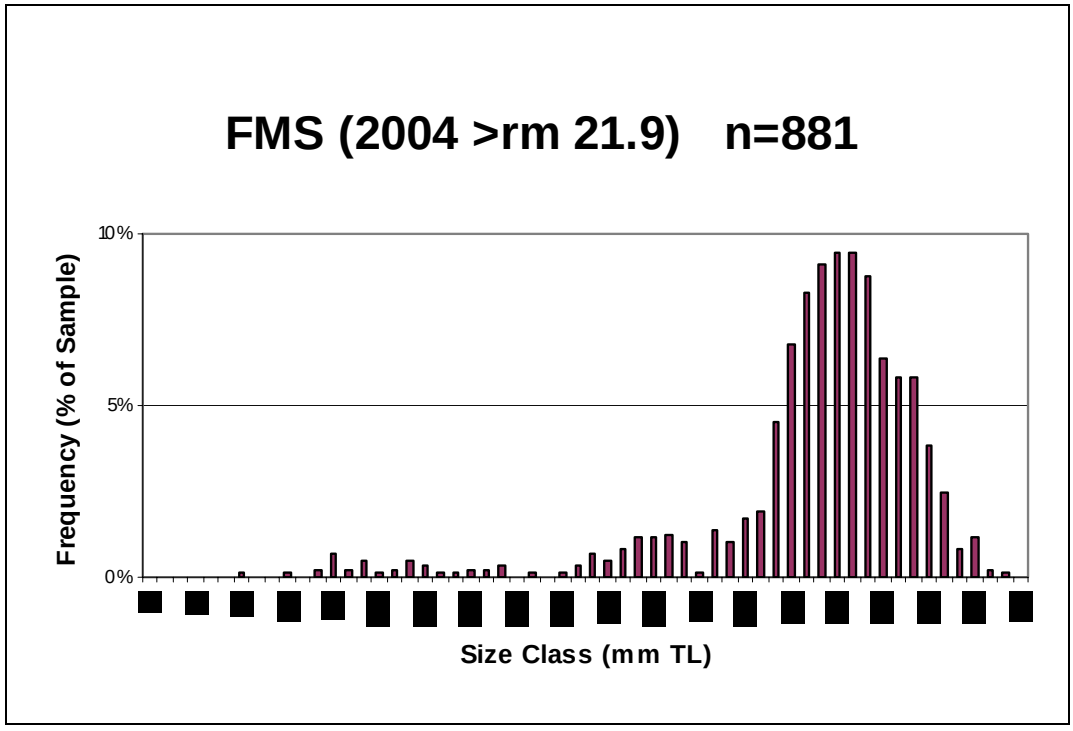


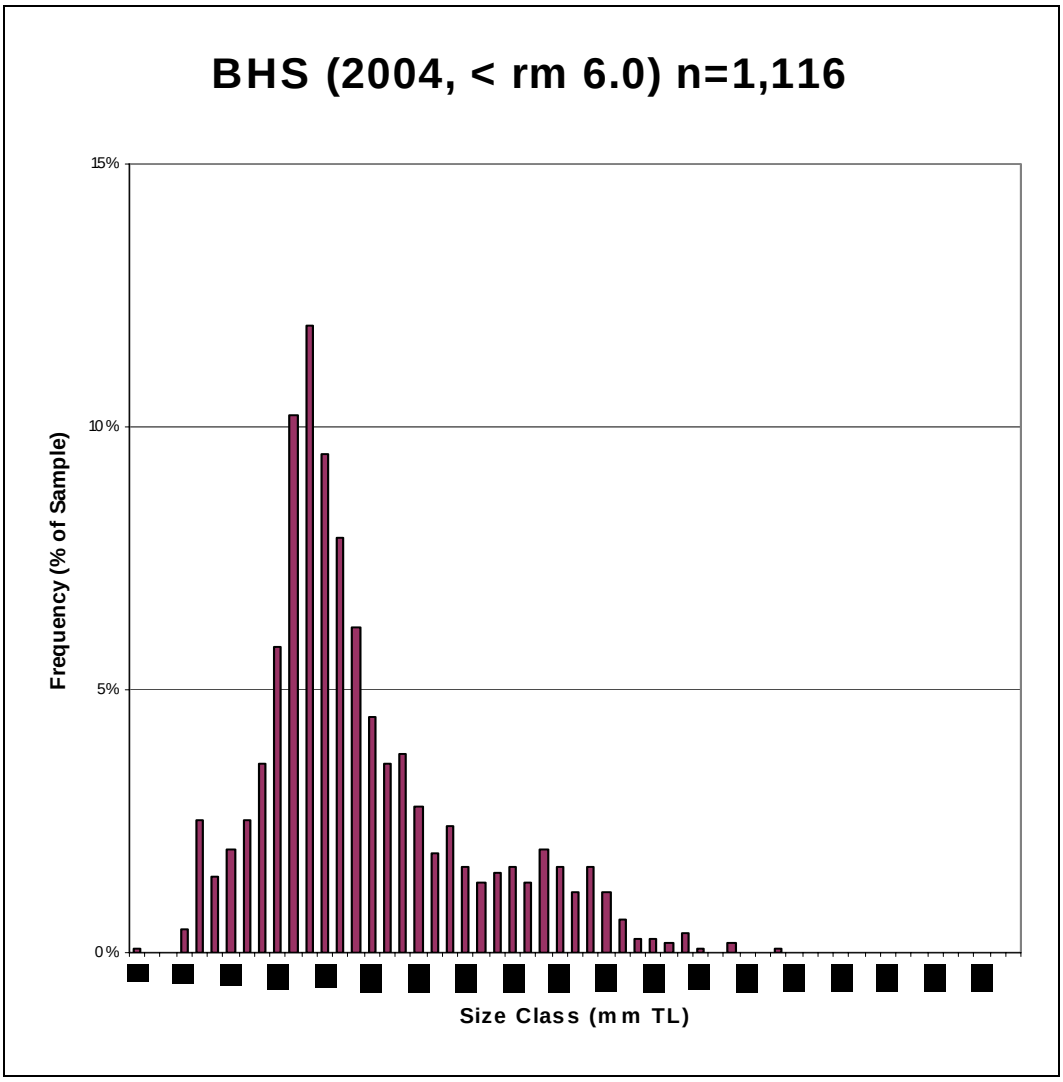
Figure 13: Length frequencies of FMS captured between River Miles 37.0 through 21.9, (n=881), above both diversions (Zimmerman 2004).



Comparing Figure 12 to Figure 13 clearly depicts the general lack of juveniles in the FMS population above the two diversions. It is reasonable to assume that the diversion structures are the reason for this disparity in juvenile fish distribution.

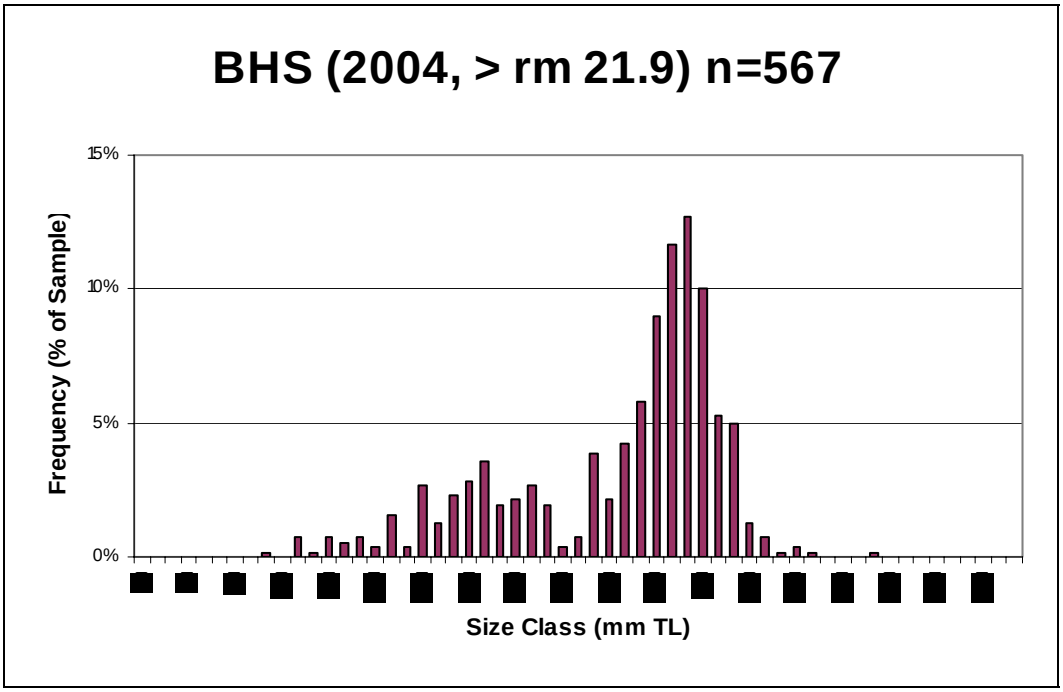
Figure 14 describes the length-frequency relationship for BHS collected from the lower six miles of the Animas River below the diversions. This reach of river had the highest percentage of juvenile BHS of any reach sampled in 2004.

Figure 14: Length frequencies of BHS captured between River Miles 6.0 through 0.0, (n=1,116), below both diversions. (Zimmerman 2004).



Comparing the data in Figure 14 to Figure 15 (below) suggests the same situation exists for BHS as for FMS relative to the effects of the diversions in preventing upstream migration of juvenile fish.

Figure 15: Length frequencies of BHS captured between River Miles 37.0 through 21.9, (n=881), above both diversions. (Zimmerman 2004).

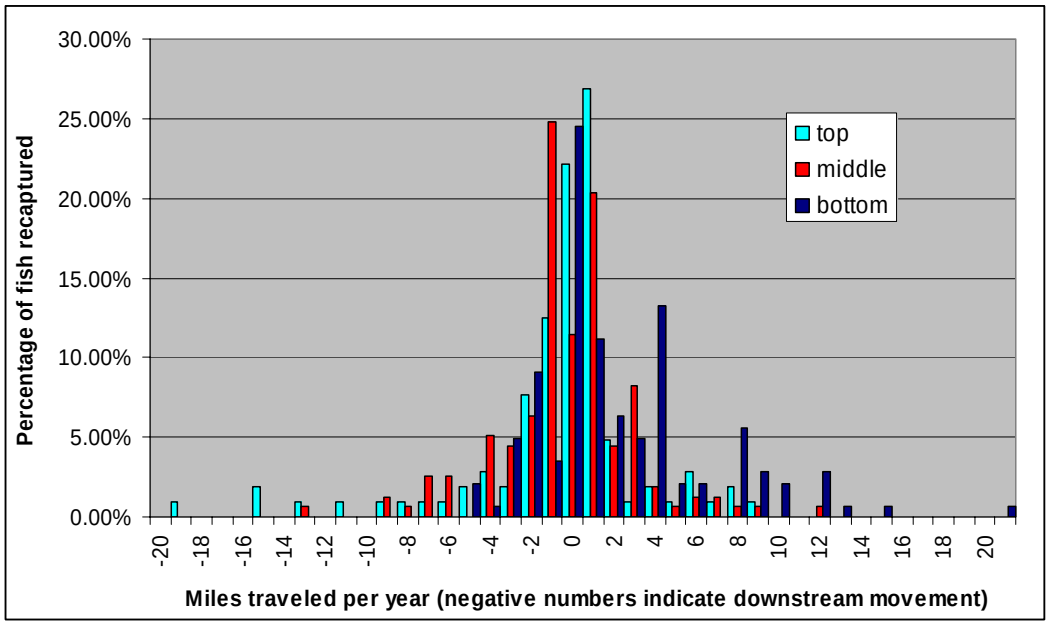


Net Annual Movement

The recapture sample size for BHS was too small for effective statistical analysis, but recaptured FMS generally moved little distance and on average in a slight downstream direction. No significant difference was found in the mean net distance moved per year by FMS in the middle and top sections (two-sample t-test, $t183 = 0.491$, $p = 0.624$) (Figure10 below, SWCA 2007).

FMS moved significantly farther upstream on average in the bottom section when compared to the top section (two-sample t-test, $t269 = 5.782$, $p<0.0001$), but sampling bias that precludes sampling fish moving upstream out of the sampled area may affect this finding (SWCA 2007). The SUDW reports that other river sampling above the target reaches did not exclude native sucker data collection and that all such fish collected were reported and included in the dataset provided to SWCA for analysis, therefore the potential bias for upstream movement is negated (personal communication, S. Whiteman 2007). However, such a sampling exclusion bias may still exist for the bottom section where fish could move downstream out of the sampling area (SWCA 2007).

Figure 10: Histogram of net river miles moved per year by FMS tagged in the top, middle, and bottom sections by percentage. Percentages based on initial capture location (SWCA 2007).



FMS tagged in the bottom section moved a mean net distance of 2.8 miles per year farther upstream than those tagged in the middle section (two-sample t-test, $t221 = 5.117$, $p<0.0001$). When only the upstream-moving fish were examined, FMS tagged in the bottom section (N = 79) moved a median net distance of 2.4 miles per year farther upstream than those tagged in the middle section (N = 63) (Mann-Whitney U test, U = 3516.00, $p<0.0001$) (SWCA 2007).

Upstream Movement

Farmer's Ditch Diversion

Recaptured sucker numbers ascending FDD from the middle section were compared to the number of suckers that moved upstream of Reference Reaches 1 and 2 in the top section (both 10 RM in length). A higher proportion of the recaptured fish moved upstream of Reference Reach 1 than Reference Reach 2 (Table 3, below). The cause for this may be linked to habitat quality.

Testing against Reference Reach 1 indicated that the FDD does pose a significant barrier to the upstream movement of FMS (chi-square test, df =1, $\chi 2 = 13.285$, $p<0.001$), blocking approximately 24% of the fish moving upstream from the middle to the top section. Testing against Reference Reach 2 indicated that the FDD does not pose a significant barrier to the upstream movement of FMS (chi-square test, df =1, $\chi 2 = 0.012$, $p>0.05$) (SWCA 2007).

Table 3: Data used in chi-square analysis of FMS in the middle section and Reference Reach 2 (RM 24.9-34.9) in the top section (SWCA 2007).

Sections Compared	Number that Stayed in Section	Number that Moved Upstream of Section	Totals
Middle section, RM 11.9-21.9 (observed)	71	6	77
Top section, RM 24.9-34.9 only (expected)	44	4	48
Totals	115	10	125

Additional reference reaches would have been necessary to strengthen (or refute) a statistical determination that the FDD poses a significant barrier to upstream migration of adult FMS. However, one reach comparison indicating a significant barrier to fish passage is enough for Reclamation to formulate a recommendation.

Animas Pump Station #2

FMS numbers ascending APS from the bottom section were compared to the number of suckers moving upstream of Reference Reach 3 and Reference Reach 4 in the top section. Approximately 45% more recaptured FMS ascended APS from the bottom section than had moved upstream of Reference Reach 3 (chi-square test, df =1, $\chi 2 = 33.309$, $p<0.001$) (Table 4) and approximately 48% more than Reference Reach 4 (chi-square test, df =1, $\chi 2 = 26.706$, $p<0.001$) (Table 5).

Table 4: Data used in chi-square analysis of flannelmouth sucker in the middle section and Reference Reach 3 (RM 21.9-33.8) in the top section (SWCA 2007).

Sections Compared	Number that Stayed in Section	Number that Moved Upstream of Section	Totals
Bottom section, RM 0-11.9 (observed)	55	65	120
Top section, RM 21.9-33.8 only (expected)	52	5	57
Totals	107	70	177

Table 5: Data used in chi-square analysis of FMS in the middle section and Reference Reach 4 (RM 24.9-36.8) in the top section (SWCA 2007).

Sections Compared	Number that Stayed in Section	Number that Moved Upstream of Section	Totals
Bottom section, RM 0-11.9 (observed)	55	65	120
Top section, RM 24.9-36.8 only (expected)	34	2	36
Totals	89	67	156

Both chi-square tests indicate that movement above APS was significantly greater than movement above the unconstrained reach in the top section, but movement may be under-represented due to variability in the reference reaches.

Farmer's Ditch Diversion Compared to Animas Pump Station #2

FMS numbers ascending the APS were compared to those ascending the FDD (chi-square test, df =1, $\chi 2 = 43.760$, $p<0.001$). Of the fish tagged in the bottom section and later recaptured, 54.2% had ascended the APS while 7.79% of FMS tagged in the middle section and later recaptured had ascended the FDD (Table 6).

Table 6: Data used in chi-square analysis of FMS in the middle section and bottom section (SWCA 2007).

Sections Compared	Number that Stayed in Section	Number that Moved Upstream of Section	Totals
Bottom section, RM 0-11.9 (observed)	55	65	120
Middle section, RM 11.9-21.9 (expected)	71	6	77
Totals	126	71	197

Of the few BHS recaptured upstream of their original tagging location, 4 out of 5 ascended the APS from the lower section and only 1 out of 4 ascended the FDD from the middle section. While insufficient samples of BHS were available for statistical analysis, the observations are in general agreement with the statistical findings for FMS.

Downstream Movement

Similar to the upstream movement analysis above, a greater proportion of FMS descended the APS than descended the FDD (chi-square test, df =1, $\chi 2 = 4.268$, $p<0.05$) (Table 7). This test indicates that the FDD may also inhibit downstream movement of native suckers. BHS were insufficiently represented to conduct an analysis.

Table 7: Data used in chi-square analysis of flannelmouth sucker in the middle section and Reference Reach 1 (RM 21.9-31.9) in the top section (SWCA 2007).

Sections Compared	Number that Stayed in Section	Number that Moved Downstream of Section	Totals
Middle section, RM 11.9-21.9 (observed)	125	75	200
Top section, RM 21.9-31.9 only (expected)	26	6	32
Totals	151	81	232

Fish Entrainment in Canals

Observations of sucker YOY in the Little Colorado River have shown that FMS and BHS YOY drifted an average of 5.3 miles while actively seeking nearshore areas (Robinson et al. 1998). The native sucker YOY congregate in shallow pools and backwater areas, as well as the shoreline areas of slow runs or pools (Haines and Tyus 1990 and Robinson et al. 1998 *in* SWCA 2007). The percentage of YOY suckers lost to entrainment would likely be greater when concentrated along the shoreline than if evenly distributed through the water column where YOY suckers lost would be proportional to the percentage of the flow diverted (SWCA 2007).

The Animas River was sampled for the presence of YOY native suckers from 2000-2002 (personal communication, B. Zimmerman 2007). Data indicates that successful FMS and BHS reproduction in the upper Animas River was at very high levels (Zimmerman 2002, Tables 8 and 9). Sampling below the FDD and APS diversions indicates that much of the YOY that drift downstream of the diversions survive to attempt a return to the upper reaches of the Animas River (Figures 12 and 14 above).

Table 8: Fish species composition and relative abundance results of overall Animas River YOY fish sampling (Zimmerman 2002).

Common Name	Scientific Name	Total Sample Size	Overall Relative Abundance
Flannelmouth Sucker	*Catostomus latipinnis*	8,681	89.7%
Bluehead Sucker	*Catostomus discobolus discobolus*	853	8.8%
Mottled Sculpin	*Cottus bairdi*	75	0.8%
Speckled Dace	*Rhinichthys osculus*	56	0.6%
Fathead Minnow	*Pimephales promelas*	4	0.0%
Common Carp	*Cyprinus carpio*	4	0.0%
White Sucker	*Catostomus commersoni*	1	0.0%

Table 9: Fish species relative abundance comparison between Colorado and New Mexico YOY sampling (Zimmerman 2002).

Common Name	Scientific Name	Colorado Relative Abundance	New Mexico Relative Abundance
		N=6,918	N=2,755
Flannelmouth Sucker	*Catostomus latipinnis*	87.9%	94.3%
Bluehead Sucker	*Catostomus discobolus discobolus*	10.6%	4.4%
Mottled Sculpin	*Cottus bairdi*	0.8%	0.7%
Speckled Dace	*Rhinichthys osculus*	0.6%	0.5%
Fathead Minnow	*Pimephales promelas*	0.0%	0.1%
Common Carp	*Cyprinus carpio*	0.1%	0.0%
White Sucker	*Catostomus commersoni*	0.0%	0.0%

The Colorado Division of Wildlife (CDOW) has researched various types of screens to keep native fish out of irrigation canals and non-native fish out of reclaimed ponds. CDOW's experience indicates that screens would not exclude fish larvae from canals. CDOW employed a 0.5 mm wedgewire screen and found it permeable to larval fish. The 0.5 mm screens effectively excluded larger fish and were self cleaning when installed at the proper angle, but were expensive (personal communication, A. Martinez, CDOW 2007 *in* SWCA 2007). Screens down to 0.1 mm are available on the market but would be more expensive and likely to become frequently obstructed (SWCA 2007).

Similar projects to protect fisheries resources by planning, design, construction, and maintenance of a fish screen on the Santiam Water Control District canal (N. Santiam River) in Stayton, Oregon have costs estimated at close to $400,000.00 for just the fish screen portions of the project (CBFWA 2007). A similar project in the Yakima Basin, the Fogarty Fish Screen, had an ultimate cost of $560,000.00 (Hudson 2000).

Discussion

Fish Barriers

In order to assess native fish migration barriers in the Animas River, SUDW and Reclamation implanted 4,205 adult native suckers with uniquely numbered and colored FLOY tags in the lower Animas River below Bondad, Colorado (RM 41.9) from 2001 through 2005. Recurring sampling of the Animas River in the lower portions revealed that neither the APS nor the FDD is a complete barrier to upstream migration of adult native fish but the FDD is likely a significant barrier and is certainly a more significant barrier to fish migration up the Animas River than the APS. A conservative assumption would be that the FDD is a significant barrier to upstream fish migration as evidenced in the comparison to Reference Reach 1. The effect of the two diversions combined may form an even more significant barrier to fish movement in the Animas River.

As the study could not feasibly identify when or at what flow native suckers moved past the diversions, absolute conclusions cannot be made about whether or not upstream movement is seasonal or flow related, but it is reasonable to assume that most, if not all, movement past the APS would be associated with the opening of a gate on the west side of the structure (Figure 3) due to the nature of its construction, where the lower portion is a vertical wall rather than a ramped structure (personal communication, S. Whiteman and S. Williams 2007). The FDD has no gates and, based on field observations, native suckers could only pass upstream of the FDD during periods of relatively high flow along the western edge of the structure where the top of the concrete structure is lower than the remainder (Figure 2).

Since this study shows that sexually mature native suckers are capable of moving upstream of the APS, manually moving suckers from the bottom section to the middle section alone would be impractical, but moving suckers from the bottom and/or middle section to the top section could possibly improve the long-term conservation of the species as the FDD is apparently a significant barrier to upstream fish movement (SWCA 2007).

Before employing manual translocation as a mitigative species conservation tool on the Animas River, agencies should determine whether or not the sucker population above the FDD is currently sustainable. This may depend upon where the native suckers spawn now and perhaps where they spawned prior to construction of the diversions. Spawning migration has not been conclusively documented for these species (Ptacek et al. 2005 and Rees et al. 2005 *in* SWCA 2007) and most studies have found the species to be relatively sedentary (Vanicek

1967, Holden and Crist 1981, Beyers et al. 2001, and Rees and Miller 2001 *in* Ptacek 2005) but migrations and distance movements have been observed (Weitzel 2002, Vanicek 1967 and Holden and Crist 1981 *in* Ptacek 2005). Reclamation cannot assume that individuals in the bottom and middle sections would preferentially spawn in the top section.

Further, it is unknown if the habitat in the top section is of adequate quality (or quantity) to support a larger native sucker population. If quality habitat is not readily available, translocated suckers may quickly return to previously established home ranges downstream, and young suckers may emigrate from the reach (SWCA 2007). It is likely that as older classes of native suckers die out, habitats will be available for new occupancy for younger breeding fish.

It is evident by the disparity of extant size classes between that found above versus below these Animas River diversions, that the possibility exists that younger size classes may not be replacing the sexually mature sizes of native suckers in the upper Animas River (Figures 12 and 14, above) (personal communication, R. Valdez *in* Whiteman 1999). This could eventually lead to a sharp decline in the numbers of native suckers in the upper reaches of the Animas River as the older fish decline in number due to age-related die-off. This size-class disparity strengthens the validity of physically translocating native fish to the upper reaches of the Animas River as a mitigative conservation measure.

Fish Entrainment in Canals

Due to the apparent impracticality and expense of fish screens to prevent native sucker YOY entrainment as well as the apparently strong reproduction occurring in the upper Animas River, Reclamation did not conduct a specific study to estimate entrainment losses, as a reasonable mitigative measure could not be recommended to exclude entrainment.

The proportion of native sucker larvae produced in the top section that are retained in suitable nursery habitats before reaching FDD is unknown. FMS YOY drift with the current for a period after hatching (Rees et al. 2005). Carter et al. (1986) and Robinson et al. (1998) indicate that YOY can and do actively choose to enter or escape the downstream drift from nursery habitats. Drift may serve as a mechanism to facilitate population dispersal and to locate suitable larval nursery habitat (Rees et al. 2005).

YOY suckers not retained in nursery habitats in the upper Animas River may drift downstream of the diversions or may be entrained in canals or at pump stations. Some may find suitable nursery habitat in lower sections or in canals and survive, but their repopulation of the upper section would be inhibited. If the YOY retention rates in the upper section are very low, the translocation of additional breeding-age fish to the top section may not significantly improve recruitment in the top section (SWCA 2007).

Chart and Bergersen (1992 *in* Rees et al. 2005) indicate that long-distance seasonal migration might be essential to the life history of FMS. Bezzerides and Bestgen (2002 *in* Rees et al. 2005) also indicate that periodic long-distance migration would be necessary to maintain relatively isolated populations that occur in smaller tributaries at higher elevations (perhaps such as the population in the upper Animas River). Rees et al. (2005) follow this discussion with the conclusion that upstream movement of juveniles and adults would be required to offset downstream drift of YOY fish.

The results of YOY sampling indicate that there is enough native YOY sucker recruitment in the reaches above the APS and FDD in Colorado to reasonably assume that reproduction rate is not currently a limiting factor for these species in the Animas River. If canal entrainment proves to be a minor issue in the overall conservation of the species due to high retention of larval suckers in the upper reaches of the Animas River, losses to entrainment or drift may not have significant bearing on the long-term viability of the Animas River populations of FMS and BHS. However, the length-frequency data presented above indicate that native YOY suckers may not be retained in sufficient numbers to maintain the populations over the long-term.

If a significant portion of YOY native suckers drift downstream of the diversions (as evidenced by the general lack of smaller size classes above the diversions and the high density of small size classes encountered below the diversion structures) juvenile translocation should be considered along with sexually mature adults as described above. These fish may be able to re-colonize the upper reaches of the Animas River once they reach larger sizes, but such inhibited upstream movement might not be sufficient for the maintenance of a viable long-term population without manual translocation.

Mitigative conservation efforts for native YOY suckers might benefit from improving retention of YOY suckers in existing or new nursery habitats upstream of the diversions once YOY retention rates are known and if such rates indicate a limiting factor for the species. River management to increase the availability of nursery habitats may improve the survival and recruitment of young native suckers (SWCA 2007). However, habitat management and manipulation is costly and difficult and often cannot guarantee results, only estimate or provide reasonable guesses as to the ultimate population effects.

Additional approaches for native sucker YOY management could include installation of partial canal screening or other instream structures capable of deflecting a portion of the drifting YOY that would normally become entrained in canals, acknowledging that not all could be screened, but perhaps enough to make a significant change in overall YOY sucker survivorship should YOY survivorship become identified as a limiting factor for native suckers in the Animas River system by future studies.

Lastly, population dynamics data should continue to be collected on the Animas River sucker populations as overall population, fecundity, survival, and growth are not well understood for these species in this system. A population viability analysis might substantially support more comprehensive native fish conservation planning in the Animas River.

Recommendations

Reclamation's fish passage evaluation demonstrates that neither Animas River diversion structure studied is a complete barrier to upstream movement of adult native suckers but FDD appears to be a significant barrier for the movement of native suckers.

Further, the YOY evaluation indicates that reproduction may not be limiting the native sucker populations in the upper Animas River, but the disparity of size classes recorded indicates that the diversions may prohibit the re-entry of younger classes of native suckers back into the reaches above the APS and FDD.

Based on an analysis of the results of the native sucker mark-recapture data, the YOY entrainment discussion provided above and the length-frequency data comparing above- to below-barrier sites, Reclamation recommends the following actions as mitigative conservation measures for native suckers in the Animas River for impacts resulting from the existence and operation of the FDD and APS which could potentially be compounded or alleviated by the operation of the ALP Project.

Fish Barriers

Animas Pump Station #2

The APS does not appear to be a year-round significant barrier to upstream movement of native suckers. However, the APS may only be passable when one of its gates is open. This happens in the winter or during high runoff flows (personal communication, P. Montoya, 2007). Reclamation therefore recommends that the City of Farmington (APS's owner and operator) be contacted to attempt coordination of gate operations to allow greater native fish access to upstream sections of the river without negatively impacting pump station operations, particularly targeting native fish migratory seasons where feasible.

Farmer's Ditch Diversion

As the FDD is an apparently significant barrier to native sucker movement, Reclamation recommends that native suckers be manually collected in both adult and juvenile size classes immediately downstream of the FDD (and perhaps the APS) and transported at least two miles upstream of the FDD. Such a collection should be conducted at least twice per calendar year when river conditions are suitable for safe collection of fish, such as in the fall and late winter.

If this recommendation is implemented, the most effective techniques known for collection are barge or bank electrofishing similar to what is depicted in Figure 6 above. Reclamation does not know if the number of suckers that could be collected would be sufficient to support a stable population of native suckers in the upper reaches of the Animas River. Reclamation cannot claim with absolute certainty that the current population would actually benefit from such translocation at this time, but indications are that the populations would, at some time, benefit from this action.

If implemented, extreme care should be taken to avoid the translocation of non-native predatory fish (bass or sunfish in particular) into the upper reaches of the Animas River as the FDD and APS structures also appear to be barriers to the upstream movement of non-native fish.

Fish Entrainment in Canals

As our evidence suggests that native sucker reproduction is not currently a limiting factor for the conservation of either the BHS or the FMS in the upper Animas River and that the prevention of YOY entrainment in canals would be at best moderately effective and very costly, Reclamation does not recommend the management of YOY sucker entrainment in canals as a mitigative conservation measure for the species.

As a significant portion of YOY apparently drift downstream through the diversions and later cannot return upstream through the diversions, juvenile native suckers should be included in translocations upstream of the diversions as described above.

Other Considerations

It is recognized that this report's investigations and resulting recommendations are based on the best data available as acquired in the four-year study period. Reclamation offers the following as other points to be considered in determining if the above recommendations should be implemented.

Population Viability Analysis

Additional collection of population, fecundity, survival, and growth data for these species in the Animas River system should be conducted so that a population viability analysis (PVA) could be completed to better identify threats and to evaluate the likelihood that the species would persist into the future. The results of a PVA would better determine if any actual benefit would be derived from native fish translocation in the Animas River.

Conservation Planning and Implementation

The Range-Wide Conservation Agreement for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis* (RWCA) is the current large-scale inter-agency conservation effort supporting FMS and BHS. The RWCA Coordination Team could develop partnerships for the implementation of the recommendations in this report and in the formulation of future long-term conservation planning or other recommendations based in part upon this evaluation.

Other Reclamation Commitments

While this report and its recommendations constitute completion of certain environmental commitments for unspecified potential impacts of the ALP Project to the Animas River fishery, Reclamation has further related commitments:

"Monitoring studies of project-affected waters on the Animas River will be implemented both prior to and continuing for at least four years after project operations begin (project pumping). These studies will be designed to better define the native fishery, to include better understanding apparent problems with native sucker recruitment, and to monitor trout populations. If it is concluded that the operation of the project is having significant adverse impacts to the downstream aquatic ecosystem, Reclamation will make every reasonable effort to modify project operations to either reduce or eliminate these impacts." (Reclamation 2000 and 2004).

Reclamation is currently monitoring ALP Project affected waters of the Animas River by fish mark-recapture / relative abundance surveys which will include at least four consecutive years of post-operational monitoring. This monitoring will serve to better define the native fishery and to monitor trout populations.

Reclamation is developing the study design to examine potential impacts of Project operations to the downstream ecosystem. The intended focus is to examine the Projects' potential to affect YOY retention in upper Animas River native fish nursery habitats which will also serve to provide a better understanding of the apparent problems with native sucker recruitment.

Reclamation will share the results of these studies with the RWCA members, the Fish and Wildlife Service and other affected or interested agencies in support of native sucker conservation efforts.

References and Literature Consulted

Bezzerides, N., and K. Bestgen. 2002. Status review of roundtail chub *Gila robusta,* flannelmouth sucker *Catostomus latipinnis,* and bluehead sucker *Catostomus discobolus* in the Colorado River Basin. Colorado State University, Fort Collins, CO.

Beyers, D.W., C. Sodergren, J.M. Bundy, and K.R. Bestgen. 2001. Habitat use and movement of bluehead sucker, flannelmouth sucker, and roundtail chub in the Colorado River. Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO.

Carter, J.G., V.A. Lamarra, and R.J. Ryel. 1986. Drift of larval fishes in the upper Colorado River. Journal of Freshwater Ecology 3:567-577.

Chart, T.E., and E.P. Bergersen. 1992. Impact of mainstream impoundment on the distribution and movements of the resident flannelmouth sucker (Catostomidae: *Catostomus latipinnis*) population in the White River, Colorado. Southwestern Naturalist 37(1):9-15.

Columbia Basin Fish and Wildlife Authority (CBFWA) Website. 2007. FY 2003 Lower Columbia Proposal 31030 [Online]. Available: http://www.cbfwa.org/FWProgram/ResultProposal.cfm?PPID=LC2003000031030

Haines, G.B., and H.M. Tyus. 1990. Fish associations and environmental variables in age-0 Colorado squawfish habitats, Green River, Utah. Journal of Freshwater Ecology 5:427-435.

Holden, P.B. and L.W. Crist. 1981. Documentation of changes in the macroinvertebrate and fish populations in the Green River due to inlet modification of Flaming Gorge Dam. Contract No. 0-07-40-S1357 for Water and Power Resources Service. Bio/West, Inc., Logan, UT.

Holden, P.B. and C.B. Stalnaker. 1975. Distribution and abundance of mainstream fishes of the middle and Upper Colorado River Basins, 1967-1973. Transactions of the American Fisheries Society 104:217-231.

Hudson, R. D. 2000. Upgrading and Installing Fish Screens: Developing Cost Estimates [Online]. Available: http://www.st.nmfs.gov/st5/Salmon_Workshop/18_Hudson.pdf

McKinney, T., W.R. Pearsons, and R.S. Rogers. 1999. Ecology of flannelmouth sucker in the Lee's Ferry tailwater, Colorado River, Arizona. Great Basin Naturalist 59:259-265.

Navajo Nation Department of Fish and Wildlife (NNDFWL). 2001. Endangered Species of the Navajo Nation. Navajo Nation Division of Natural Resources, Department of Fish and Wildlife Resources Committee Resolution No. RCMA-31-01[Online].
Available: http://www.natureserve.org/nhp/us/navajo/index.html#ftp

Olson H.F. 1962. Rehabilitation of the San Juan River. Federal Aid Project F-19-D4, Job No. C-16-4. New Mexico Game and Fish, Santa Fe, NM.

Ptacek, J.A., D.E. Rees, and W.J. Miller. 2005. Bluehead Sucker (*Catostomus discobolus*): a technical conservation assessment [Online]. USDA Forest Service, Rocky Mountain Region. Available:
http://www.fs.fed.us/r2/projects/scp/assessments/blueheadsucker.pdf

Paukert, C. and R. S. Rogers. 2004. Factors Affecting Condition of Flannelmouth Suckers in the Colorado River, Grand Canyon, Arizona. North American Journal of Fisheries Management 24:648–653.

Robinson, A. T., Clarkson, R. W., and R. E. Forrest. 1998. Dispersal of Larval Fishes in a Regulated River Tributary. Transactions of the American Fisheries Society 1998; 127: 772–786.

Rees, D.E. and W.J. Miller. 2001. Habitat selection and movement of native fish in the Colorado River, Colorado. Miller Ecological Consultants, Inc., Fort Collins, CO.

Rees, D.E., J.A. Ptacek, and W.J. Miller. 2005. Flannelmouth Sucker (*Catostomus latipinnis*): a technical conservation assessment [Online]. USDA Forest Service, Rocky Mountain Region. Available:
http://www.fs.fed.us/r2/projects/scp/assessments/flannelmouthsucker.pdf

Sigler, W.F. and J.W. Sigler. 1996. Fishes of Utah; a natural history. University of Utah Press, Salt Lake City, UT.

SWCA. 2007. Analysis of Existing Data on Potential Animas River Diversion Effects on the Movements of Adult Flannelmouth and Bluehead Suckers.

Utah Division of Wildlife Resources (UDWR). 2004. Range-Wide Conservation Agreement for Roundtail Chub *Gila robusta*, Bluehead Sucker *Catostomus discobolus*, and Flannelmouth Sucker *Catostomus latipinnis*. Draft 10.4.4.

USDI Bureau of Reclamation (Reclamation). 2000. Animas-La Plata Final Supplemental Environmental Impact Statement. Animas-La Plata Project, Colorado and New Mexico. Vols. I-III.

_____. 2004. Animas-La Plata Project Environmental Commitment and Monitoring Plan. Animas-La Plata Project, Colorado and New Mexico.

Vanicek, C.D. 1967. Ecological studies of native Green River fishes below Flaming Gorge Dam, 1964-1966. Ph.D. Thesis, Utah State University, Logan, UT.

Weitzel, D.L. 2002. Conservation and status assessments for the bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), roundtail chub (*Gila robusta*), and leatherside chub (*Gila copei*): rare fishes west of the Continental Divide, Wyoming. Wyoming Fish and Game Department, Cheyenne, WY.

Wheeler, C.A. 1997. Current distributions and distributional changes of fish in Wyoming west of the Continental Divide. M.S. Thesis, University of Wyoming, Laramie, WY.

Whiteman, S. L. 2000. 1999 Fish Studies on the Animas and La Plata Rivers. Cooperative Agreement No. 4-FC-40-15100.

_____. 2002. 2001 Fish Studies on the Animas and La Plata Rivers. Cooperative Agreement No. 4-FC-40-15100.

Zimmerman, B. H. 2003. 2002 Fish Studies on the Animas and La Plata Rivers. Cooperative Agreement No. 4-FC-40-15100.

_____. 2004. 2003 Fish Studies on the Animas and La Plata Rivers. Cooperative Agreement No. 4-FC-40-15100.

_____. 2005. 2004 Fish Studies on the Animas and La Plata Rivers. Cooperative Agreement No. 4-FC-40-15100.

_____. 2006. 2005 Fish Studies on the Animas River, southwestern Colorado and northwestern New Mexico. Cooperative Agreement No. 6-FC-40-18640.