Report on the Phase 1 Bitterroot River Tributary Inventory Project for The Fisheries Restoration and Irrigation Mitigation Act (FRIMA) Program

Fiscal Year 2002

Prepared for:
Montana Department of Fish, Wildlife and Parks

By:
James E. Rokosch

February, 2004

Bitter Root Irrigation Structure on Three Mile Creek

INTRODUCTION

The Bitterroot River watershed has the longest history of irrigation practices in Montana, beginning in 1842 with the diversion of water from Burnt Fork Creek by the Jesuit Fathers of St. Mary's Mission to raise potatoes, wheat and oats. With the enactment of the Bannack Statutes in 1865 and subsequent Montana Supreme Court decision in 1921 declaring the Doctrine of Prior Appropriation to be the valid Montana water right law, irrigation practices have presented severe ongoing challenges to the fisheries of the Bitterroot River and its tributaries. Migratory populations of native bull (Salvelinus confluentus) and westslope cutthroat (Oncorhyncus clarki lewisi) trout have been especially impacted. The Montana Department of Fish, Wildlife and Parks (MDFWP) prohibits possession of bull trout from waters throughout the watershed, and has adopted catch-and-release regulations for cutthroat trout in nearly all of the Bitterroot mainstem and in some tributaries. The fact that MDFWP specifically includes ditches, canals and sloughs in their fishing regulations indicates that such irrigation conduits are inducing significant losses of fish from stream fisheries. In addition to direct losses of fish to ditches, irrigation impacts also include blockage of fish passage by structures and chronic dewatering of many tributaries and portions of the mainstem.

In the past two decades MDFWP has had a growing focus on the importance of tributaries to mainstem fisheries, especially with respect to fluvial native trout. Fish population surveys, genetic analyses and recent radio telemetry efforts generally indicate that: upper reaches of the tributaries support widespread populations of often genetically pure native trout; the migratory component of most tributary populations has been diminished, possibly to the point of extinction in some cases; irrigation ditches and structures are often present where such diminishment is evidenced. As noted by apparent fish population response to fishing regulation restrictions and focused efforts on Skalkaho Creek, there is reason for optimism that restoration of fluvial populations of native trout can occur in many, if not most, of the Bitterroot tributaries.

Although irrigation structures and ditches are present on many tributaries, little documentation of fish entrainment exists for most ditches on private lands. Electrofishing efforts on four ditches in the Skalkaho drainage documented entrainment (Personal Communication, Chris Clancy, MDFWP Fisheries Biologist, February, 2002). In the case of the Hi-Line Canal, two separate surveys of a 980 foot reach yielded 24 bull trout and 139 cutthroat trout. Survey efforts by the Bitterroot National Forest (BNF) have also documented entrainment by a number of irrigation ditch systems with points of diversions on national forest lands (Personal Communication, Robert Brassfield, USFS Fisheries Biologist, March and August, 2003). These results indicate both the potential viability of survey efforts and the need for documentation to extend to other tributaries with associated ditch systems, particularly on private lands.

PROJECT GOALS

The intent of this inventory project was to initiate a Phase 1 effort to develop a fish passage/screening plan for the tributary network of the Bitterroot River watershed. With existing time and budgetary constraints, the efforts proposed for FY 2002 were to be conducted on the major ditch systems of a selected set of eleven tributaries. A mouth-to-headwaters passage/screening plan was to be developed for one of the selected tributaries utilizing newly acquired data from this project, existing fisheries data from MDFWP and the Bitterroot National Forest (BNF), and a geographic inventory of all irrigation structures and ditches. Recommendations for prioritized site-specific passage and entrainment solution options (eg. screens, ladders, flumes, siphons, etc.) were to be included, providing a basis for future construction project proposals to FRIMA or other funding sources. For the remaining tributaries, partial mouth-to-headwaters plans were to be initiated focusing on the major ditch systems.

A Phase 2 inventory effort intended to build upon the Phase 1 project, will yield comprehensive mouth-to-headwaters plans for a majority of the tributaries selected for the Phase1 effort, as well as initiating surveys and passage/screening plan development for four more selected tributaries.

DESCRIPTION OF SELECTED PROJECT AREAS

The tributary streams selected for the FY 2002 inventory project were:

(Westside) – Lolo, Kootenai, Sweathouse, Mill, Blodgett, Lost Horse, Tin Cup
(Eastside) – Eight Mile, Three Mile, Sleeping Child, Tolan.

Streams were selected for this initial effort primarily on the basis of MDFWP personnel knowledge of potential irrigation impacts and a restoration focus prioritization matrix developed by the Bitter Root Water Forum (BRWF). This matrix included ten criteria: fish potential, degree of dewatering, geomorphic integrity, inclusion on the Montana Department of Environmental Quality's 303d list of impaired streams, agency interest, known public interest, watershed size, feasibility of solving problems, stream miles burned in 2000, and contribution to a municipal water system.

Lolo Creek was selected primarily due to its size, location towards the mouth of the Bitterroot River and MDFWP knowledge of potential irrigation impacts.

Kootenai Creek contains bull and cutthroat trout. The cutthroat are genetically pure. Kootenai is rated as a high priority watershed in the BRWF matrix.

Sweathouse Creek contains bull and cutthroat trout. Genetic testing indicates cutthroat trout are hybridized with Yellowstone cutthroat. Sweathouse is rated as a high priority watershed.

Mill Creek contains both native trout species. Cutthroat hybridization with rainbow trout is indicated by genetic testing. Radio telemetry indicates migratory behavior in the cutthroat population. Mill Creek is rated a high priority watershed.

Blodgett Creek contains cutthroat trout; bull trout are rare. Cutthroat hybridization with rainbow trout is indicated. Migratory behavior in cutthroat is present. Blodgett is rated as a low priority watershed.

Lost Horse Creek contains bull and cutthroat trout. Cutthroat hybridization with rainbow trout is indicated. Migratory behavior in cutthroat is indicated. Lost Horse is rated a high priority watershed.

Tin Cup Creek holds both bull and cutthroat trout. Cutthroat hybridization with both rainbow and Yellowstone cutthroat trout is indicated. Migratory behavior in cutthroat is present. Tin Cup is rated a high priority watershed.

Eight Mile Creek contains genetically pure cutthroat trout. Bull trout presence is not documented. Eight Mile is rated a high priority watershed.

Three Mile Creek and its tributary Ambrose Creek contain genetically pure cutthroat trout. There is one record of a bull trout from 1980. Three Mile is rated a medium priority watershed.

Sleeping Child Creek contains bull trout and genetically pure cutthroat trout. Sleeping Child is rated a high priority watershed.

Tolan Creek contains both native trout species. Genetic status for cutthroat is unknown. Tolan is rated a low priority watershed.

METHODS AND MATERIALS

Data acquisition for this inventory was focused on the major ditches diverting and intersecting each tributary. Although selection of ditches to be surveyed was initially based on proximity to the stream mouth and considerations of ditch volume, configuration and perceived degree of entrainment and/or blockage, the obtaining of permission for access and sampling logistics became the priority considerations. Methods of obtaining access included use of a water rights database developed by Brian Shay (BNF), the Montana cadastral website, innumerable phone calls to personal referrals, and personal visits to residences.

Sampling methods employed were electrofishing with either backpack (Coffelt Mark 10) or bank apparatus (Coffelt VVP-15 unit and 4500 watt generator) by 2 or 3 person crews of MDFWP personnel and private consultant. A block net was used if the headgate or natural barrier did not appear sufficient to prevent most fish from escaping upstream of the survey reach. Some conductance and water temperature data (handheld Corning Checkmate 90) was monitored. Generally, survey reaches were between 500 to 1000 feet

in length. Fish captured in the ditches were identified, measured, enumerated and returned to the stream where practical. Survey data is presented in presence/absence and catch-per-effort formats. Global positioning system (GPS) data (handheld Garmin eTrex Vista) and digital photos were obtained for most survey reaches and irrigation structures. Some physical data such as ditch dimensions and flow volume (Price AA or pygmy flow meter with digitizer) was collected from the ditches. A list of contacted ditch personnel and landowners was compiled.

RESULTS AND DISCUSSION WITH RECOMMENDATIONS

The logistics of gaining access on private property to conduct surveys in private ditches were far greater and far more time consuming than anticipated for this initial Phase 1 effort. The number of streams proposed for this initial phase of developing a screening and passage plan for the tributary network of the Bitterroot watershed was beyond the budget capabilities of the project. Access was denied on Eight Mile Creek, and was either not determined or not fully obtained for the creeks not discussed below. Extending the effort as intended in the Phase 2 and 3 proposals would be necessary to develop a screening/passage plan for the majority of the 15 streams identified in the intended three-phase effort.

Data and information presented below is organized by stream and each irrigation ditch system associated with that stream. Site descriptions, physical data, and fisheries data are presented for each reach. Management considerations and recommendations are presented for each irrigation system. Existing background stream fisheries information is primarily from MDFWP (2001) and BNF (2002) data files, Clancy (2001) and personal communication with MDFWP and BNF personnel and local residents. Data presented in the following text are compiled in Table 1.

Tincup Creek

Stream Fisheries Information

Westslope cutthroat trout are abundant from 5.4 to 16 miles from the mouth, while bull trout are rare to uncommon and have not been documented above 11.6 miles. Little data exists between the mouth and 5.4 miles, but neither species has been recorded in this reach. However, rainbow (Oncorhynchus mykiss), brown (Salmo trutta) and primarily brook (Salvelinus fontinalis) trout are relatively common in the lower 9 miles, but have not been recorded above 9.1 miles. Rainbow spawning has been documented in the lower mile of the creek.

The genetic data for westslope cutthroat indicate hybridization. A sample of 50 fish collected in 1982 were hybridized with rainbow, and a sample of 10 fish collected in 1992 were also hybridized with rainbow as well as Yellowstone cutthroat. Tincup Lake was sampled in 1998 (7 fish) and tested pure, although one locus was characteristic of both westslope and rainbow.

Radio telemetry data indicates a fluvial component of the westslope population still exists. Three adult fish captured in the Bitterroot mainstem have been documented migrating up the creek, 2 in 1999 and 1 in 2001. The 2 fish in 1999 traveled 4.85 and 5.85 miles, respectively, before their signals could not be further located. It is possible, but not documented, they migrated further upstream.

McIntosh-Morello Lowline Ditch: Reach 1

The point of diversion (POD) and headgate of this significant canal is on the north side of Tincup Creek within the Bitterroot National Forest approximately 1/8th mile west of the Forest Service boundary and roughly 4 miles upstream of the mouth at latitude/longitude N 46 00.548, W 114 13.272. This ditch is the farthest upstream of the ditches diverting water from Tincup Creek.

The dam is of post and removable plank construction lined with plastic (Figure 1A) and is not believed to be a fish barrier. The headgate housing is concrete with an adjustable steel gate (Figure 1B) that opens directly to a culvert under the access road and discharges to the open cobble and gravel bottomed ditch (Figures 1C, 1D).

The ditch was 12.0 feet wide at a measured cross section, with an average depth of 0.75 feet. Flow in the ditch was fairly rapid across much of its width at 2.0-2.9 feet per second (ft/sec). Discharge of the ditch was 16.7 cubic feet per second (cfs). A staff gage on a flume located in the ditch 129 feet downstream of the culvert was read at 0.90 feet. Discharge of the creek approximately 200 feet downstream of the ditch was also measured at 16.7 cfs. This measurement was taken at a point where the flow was constricted to a wetted width of 27 feet. There may be more error in the creek measurement as only 5 increments of discharge were summed versus 20 for the ditch measurement. A staff gage in the creek at the diversion headgate was read at 1.30 feet. Conductivity was measured at 16.88 *us* and the water temperature was 12.5 degrees Celsius.

A 1000 foot section was measured downstream from the culvert and electrofished using the bank shocking unit with a 3 person crew on August 28, 2002. A total of 13 fish were captured: 5 westslope cutthroat trout between 2 and 3.7 inches, 4 brook trout between 2 and 3.9 inches, 1 brown trout that measured 6.2 inches and 3 sculpins between 2.6 and 3.5 inches. Approximately 6 additional unidentified 3 to 4 inch fish were also observed but not captured. The section was fairly high gradient and shallow with little holding water or instream and bank cover, and would be considered poor fish habitat. Forest Service personnel snorkeled a portion of the ditch near the headgate in 2002 and observed 7 westslope cutthroat, 7 brook and 1 brown trout of undisclosed lengths.

McIntosh-Morello Lowline Ditch: Reach 2

This reach of the ditch is located approximately 2 miles downstream (downditch) of the headgate at the intersection of Singing Pines Road and the main Tincup Creek Road. The upstream end of the section is just downstream of the culvert on Tincup Creek Road

at latitude/longitude N 46 00.478, W 114 12.440, and the downstream end of the section is at latitude/longitude N 46 00.583, W 114 12.541.

The ditch was approximately 6 to 8 feet wide and 1.5 to 2.5 deep throughout the 1000 foot length of the section. Stream flow and discharge data were not obtained. Conductivity was measured at 14.53 *us* and the temperature was 14.8 degrees Celsius. The section was fairly low gradient with slow velocity, good depth, good instream and bank cover, and would be considered good fish habitat. Figures 2A and 2B show the downstream end of the section viewing upstream and downstream, respectively.

The section was electrofished with the bank shocking unit by a 3 person crew on August 29, 2002. A total of 10 fish were captured: 6 westslope cutthroat trout between 3.5 and 4.7 inches, and 4 brook trout between 4.0 and 5.9 inches. Another 8 to10 unidentified fish between 3 and 7 inches were also observed but not captured. In discussion with ditch company personnel, it was learned the ditch had been dewatered 1 to 2 weeks prior to sampling and had just recently returned to a fuller level with the release of water from Tincup Lake. This could have affected the number of fish in this section of the ditch at the time of sampling. Several area residents reported fish up to 12 inches were commonly observed in this section of the ditch and some residents regularly fished the ditch. Ditch personnel also reported observing significant numbers of fish in the ditch in the spring during cleaning operations.

Management Considerations and Recommendations

The diversion dam does not appear to significantly impact fish passage, therefore no recommendations are made for any modifications at this time.

The ditch generally runs water for irrigation from May through September. Water from Tincup Lake is released for the ditch following high water. The ditch appeared to be running at normal capacity when surveyed. Ditch management has expressed an interest in exploring screening of the ditch.

Recommendations include:

- No modification of the diversion dam appears necessary with respect to fish passage at this time.
- Although survey efforts did not capture high numbers of trout (very likely impacted by a recent dewatering of the ditch for management/maintenance), reports from local residents and ditch management indicate significant numbers of trout are entrained in the ditch. Therefore, given the size of the ditch, along with its length of diversion, and expressed interest, strong consideration should be given to the cost effectiveness and benefits of screening this ditch.
- Based on discussion with management, and considering the length of this ditch, there may be potential for increasing transport efficiency of the ditch, which could reduce the need for diverting some water.

Mill Ditch: Reach 1

The POD and headgate of this ditch is located about 2 miles upstream of the mouth on the north side of the north channel of the creek a short distance downstream of the channel split at latitude/longitude N 45 59.910, W 114 11.780. It can be reached by taking Moose Meadows Road south off of Tincup Creek Road and turning east onto Base Camp Road.

The dam is of post and plank construction and may be a partial fish barrier seasonally (Figure 3A). The difference in water surface above and below the structure was 2.1 feet. The headgate housing is concrete with an adjustable steel gate that opens directly into a culvert under the access road (Figures 3B, 3C). The ditch starts at the culvert (Figure 3D).

A staff gage on the Parshall flume in the ditch downstream of the headgate was read at 0.76, which equated to 10.4 cfs on the rating chart posted on the headgate. The estimated average width and depth of the 1000 foot section that was electrofished was 10-12 and 0.5-1 feet, respectively. Discharge of the creek (2.3 cfs) was measured about 100 feet downstream of the diversion at a point where flow was constricted to a wetted width of 10.75 feet. The creek was considered to be significantly dewatered at this level. Conductivity was measured at 16.85 *us* and water temperature was 16.5 degrees Celsius.

A 1000 foot section was measured downstream of the culvert and electrofished by a 3 person crew on August 28, 2002. A total of 34 trout were captured: 17 westslope cutthroat between 1.7 and 4.9 inches and 17 brown trout between 1.9 and 4.4 inches. The section was moderate in gradient and shallow with little instream and bank cover, and would be considered poor fish habitat.

Mill Ditch: Reach 2

This reach is located roughly 1 mile downstream of the headgate on the Jean Taylor property, east of the Stan Mitchell property. The latitude/longitude coordinates at the middle and downstream end of the 1000 foot section were N 46 00.495, W 114 10.749 and N46 00.555, W114 10.825, respectively.

The ditch was approximately 4 to 6 feet wide and 1 to 2.5 feet deep in this section and somewhat variable. Flow and discharge data were not obtained. Conductivity was measured at 17.16 *us* and water temperature was 16.4 degrees Celsius. Figures 4A and 4B show the downstream end of the section with respective upstream and downstream views. The section was fairly low gradient with mostly slow velocity, generally good depth and fair cover, and would be considered fair to good fish habitat. A large amount of filamentous algae was observed in the reach.

The 1000 foot section was electrofished with the bank shocking unit by a 3 person crew on August 29, 2002. Two fish were captured: 1 westslope cutthroat trout at 2.2 inches and 1 brown trout at 6.3 inches. One other unidentified fish of 6 to 8 inch length was

observed, as well as 2 western toads and 3 spotted frogs. Area residents reported only occasionally observing fish in the ditch in this section.

Management Considerations and Recommendations

Although MDFWP has a water lease in Tincup Creek, the creek was significantly dewatered at the ditch's POD. With the amount of water diverted by this ditch relative to the stream flow, and the type of habitat present in Reach 2, it was surprising so few trout were captured in Reach 2. Given the habitat present in Reach 1, the number of trout captured seems significant.

Recommendations are:

- The diversion dam structure should be more closely evaluated as to possible modifications that would reduce any barrier effect it presently has on the fishery.
- Consideration of a screen on this ditch should be explored.
- Increases in transport efficiency could have potential to reduce the amount of water diverted.

Click-Matteson Ditch

This ditch runs parallel to the Mill Ditch for most of its length and has its POD about ¼ mile upstream of the Mill Ditch on the north side of the creek. Because of its proximity to Reach 2 on the Mill Ditch, a 300 foot section was electrofished with a backpack unit by a 2 person crew on August 29, 2002. The latitude/longitude coordinates of the downstream end of the section are N 46 00.591, W114 11.066. Figures 5A and 5B show the respective upstream and downstream views at the downstream end of the section.

The ditch was approximately 2-3 feet wide and 0.5-1.5 feet deep with low velocity and significant bank cover. Fish habitat would be considered fair. No physical or water column data was obtained.

No fish were captured or observed.

Management Considerations and Recommendations

Although there may be merit in surveying this ditch closer to its POD, and in inspecting its diversion structure, due to its relative size and survey results, no recommendations are offered for modifications of this system with respect to reducing impacts on the fishery.

Recommendations for a Fish Passage/Screening Plan

The recommendations above are viewed as key elements for developing a comprehensive plan. Other ditch systems that may require examination include the Chaffin-Whinnery, the Ford-Hollister Highline, the Ross Ditches, and the Shockley-Loftos-Cooper Ditch. Inspection of all road culverts should also be done to ensure none are significant passage

barriers. Some consideration should also be given to inspecting the ditches associated with Spoon Creek, a major tributary of Tin Cup Creek.

Lost Horse Creek

Stream Fisheries Information

Little population data exists for the lower 5 miles of the creek, which is primarily private land. Rainbow trout have been documented to spawn in the lowest mile. Area residents have reported catching rainbow, westslope cutthroat, brown and brook trout in this section of the creek. Most of the existing population data is from 5.6 miles (FS Road #5621-Lake Como Road) to ~18.5 miles (just below lower Twin Lake). Westslope cutthroat trout are common to abundant in most of the upper 13 miles, while bull trout are uncommon to rare. A pair of bull trout was observed spawning in 1995 at 14.9 miles from the mouth. Brook trout presence diminishes in an upstream gradient, becoming rare at 14.9 miles. Rainbow and brown trout have been documented up to 7.3 miles from the mouth. Population data also exists for the lower 2 miles of the South Fork of Lost Horse Creek. Westslope cutthroat are common to abundant, bull trout are uncommon to rare, brook trout are common to abundant near the mouth, rainbow have been documented up to 2 miles from the mouth, and brown trout were absent.

Genetic data consists of a sample of 12 westslope trout collected in 1994 which indicated ~12% hybridization with rainbow trout.

Radio telemetry data documented one westslope cutthroat trout captured in the mainstem Bitterroot migrating into Lost Horse Creek in 2001, indicating a small fluvial component of the population may still persist.

Bitter Root Irrigation District (BRID) Supply Ditch

The POD and headgate of this significant canal is located on the south side of the creek about 5.5 miles upstream of the mouth on Bitterroot National Forest land and is about 300 feet downstream of FS Road #5621, the Lake Como Road. It is the most upstream POD on the creek with latitude/longitude coordinates N 46 06.024, W 114 15.543.

The diversion dam is log and boulder construction and may be a partial seasonal barrier (Figure 6A). The headgate housing and spillway is concrete with 2 adjustable steel gates that discharge directly to the ditch (Figure 6B). A cross-section of the ditch near the midpoint of the 1000 foot section was 12.5 wide (wetted width) with an average depth of 0.45 feet. Flow velocity ranged from 0.1-0.3 ft/sec at the edges to 1.6 ft/sec in the middle of the ditch. Discharge of the ditch was measured at 4.9 cfs. Discharge of the creek was measured at 20.2 cfs several hundred feet upstream of the diversion. This section of the ditch was considered to be good to fair fish habitat at this level of flow. Figures 6C and 6D show respective downstream and upstream views of the ditch at the 500 foot midpoint of the section, which has latitude/longitude coordinates N 46 05.965, W 114 15.470. Conductivity was measured at 14.97 *us*, and water temperature was13.9 degrees Celsius.

A 1000 foot section of the ditch directly downstream of the headgate was electrofished on September 5, 2002 by a 3 person crew using a bank shocking unit. A total of 32 fish were captured: 2 westslope cutthroat at 3.3 and 3.8 inches, 16 brook trout between 2 and 7.3 inches, 1 brown trout at 4.4 inches, 10 sculpins (Cottus cognatus) between 2 and 3.1 inches and 3 long-nosed dace (Rhinichthys cataractae) between 2.9 and 3.5 inches. Approximately another 80 unidentified fish avoided capture. Electrofishing was not efficient with the conditions present, especially the low conductivity. A 2 person crew of Forest Service personnel snorkeled a section of the ditch approximately ½ to ¾ mile downstream of the headgate on 2 dates in 2003. A 130 foot section was snorkeled on June 12, 2003 and only 2 unidentified 3-4 inch fish were observed. On July 14, 2003, a 500 foot section was snorkeled with much different results: 13 westslope cutthroat up to 8 inches and 138 brook trout (79 $\leq$ 4 inches, 58 at 4-8 inches, 1 at 8-10 inches) were observed.

Management Considerations and Recommendations

The character of this ditch, and its impacts on the creek's fishery, changes dramatically over the course of the irrigation season. BRID has a high water right for the creek and a significant amount of water is diverted between mid-May and mid-July. Discharge was measured at 210.88 cfs on July 14, 2003. Following this period, the ditch is used to convey diverted water to users with POD's off the ditch, and considerably less water is diverted. Discharge was measured at 16.81 cfs on July 23, 2003. As noted above, when the survey was conducted in September, 2002, discharge was measured at 4.9 cfs. Although this discharge is a fraction of the amount diverted during high water, its impact may still be significant, as it amounts to a diversion of nearly 25% of the stream flow. The number of trout observed in the ditch is significant. However, it is not known how levels of entrainment vary with discharge, or when the highest levels of entrainment occur. BRID is in the process of installing automated flow measuring and headgate adjusting mechanisms at the POD, which should benefit the fishery by increasing the efficiency of diversion.

BRID is also developing plans, in consultation with the Bureau of Reclamation (BOR), to modify the existing diversion dam with construction of rock v-weirs. This would be expected to eliminate any passage impacts of the existing structure.

Recommendations are:

- The implementation of the modifications to the diversion dam should be encouraged and assisted if necessary.
- The automation of flow monitoring will yield valuable data for consideration of a fish screen. Headgate automation will be valuable for not only increasing diversion efficiency, thereby conserving water, it would also serve as a safety feature to protect a fish screen if one were installed.
- Screening of this ditch warrants serious consideration. Although brook trout appear to be most numerous, substantial numbers of westslope cutthroat trout are being entrained. The wide range of discharge presents challenges for optimum design, and

prevention of entrainment for the entire irrigation season may not be achievable. Further efforts to understand when the largest proportion of entrainment occurs would be useful. Ditch management has expressed interest in considering screening options.

Clausen-Kramis Ditch

The POD of this canal is located one mile downstream of the BRID Supply Ditch POD on the north side of the creek. It is the second most upstream diversion on the creek. The reach at the headgate was felt to be such poor habitat (shallow, high gradient and velocity, little cover) that sampling would likely yield few fish. Therefore, a more suitable section was chosen about one mile downstream of the headgate at latitude/longitude N 46 06.919, W 114 14.095. The downstream end of the section is 0.5 miles up the road from FS Road #496 where the ditch parallels the road on the south side. This section of the ditch appeared to be better habitat (deeper, lower gradient and velocity, better cover). The ditch was 4-6 feet wide (wetted width) and 1-1.5 feet deep for most of the section. The diversion structure consists of a loose rock and plastic weir that extends upstream but only a short distance from the north bank. It does not impair fish passage.

A 1000 foot section was electrofished on September 6 by a 3 person crew using a backpack shocking unit. No fish were captured, however, 5 fish at 3-10 inches were observed, the largest of which was a brown trout.

Management Considerations and Recommendations

Although few fish were observed in the survey, a local resident at the POD has regularly observed trout in the ditch. There are stock water rights on this ditch, so water is diverted until winter. Even though the ditch is relatively small, the length of time of diversion may have implications for westslope cutthroat trout migrating from the stream in the fall.

Recommendations include:

- Some further fishery and flow data would be helpful to determine if screening this ditch would yield substantial benefits. If screening were warranted, the size of the ditch and its configuration suggest costs would be moderate.

Recommendations for a Fish Screening/Passage Plan

The BRID Supply Ditch discussed above should be considered a key component of a comprehensive plan. Other ditch systems that may have significant impacts include the Club House Ditch and the Low Ditch on the north side of the creek, and the McCarty Ditch, the Norman-Andrews Ditch, the Benson-Davies Ditch, and the Ward Ditch on the south side of the creek. Inspection of road culverts for passage implications is also necessary.

Tolan Creek

Stream Fisheries Information

Population data is available from the mouth to 7.3 miles upstream and from a tributary at 8.2 miles from the mouth. Westslope cutthroat are common to abundant throughout the creek. Bull trout are rare in the lower 5 miles, but are common further upstream. Brook trout are common to abundant in the lower 2.1 miles, but absent further upstream. Brown trout are uncommon at the mouth and absent further upstream. Rainbow trout have not been documented in the creek.

No genetic data is available for the creek.

Telemetry data has not provided evidence of a fluvial component of the westslope cutthroat population.

Lower Wetzsteon Ditch

The POD for this ditch is on the East Fork of the Bitterroot River. It intersects Tolan creek on the Wetzsteon property about ¼ mile upstream from the mouth where additional water is diverted from the creek. Discharge of the creek upstream of the ditch was measured at 6.1 cfs. Discharge of the ditch was 1.5 cfs. The ditch was 7.8 feet wide (wetted width) at the cross-section with an average depth of 0.59 feet and a maximum velocity of 0.76 ft/sec.

A 500 foot section of the ditch was electrofished by a 2 person crew on September 9, 2002 with a backpack unit. A total of 15 westslope cutthroat were collected ranging in size from 1.8 to 6.4 inches in length. Two spotted frogs were also observed.

Upper Wetzsteon Ditch

The POD of this ditch is on Tolan Creek about 250 feet upstream of the lower ditch. Discharge of the ditch was 3.3 cfs. At the cross-section, the ditch had a wetted width of 5.5 feet, an average depth of 0.73 feet and a maximum velocity of 1.6 ft/sec. The ditch averaged about 3 feet in width with a fairly high gradient throughout the section.

A 500 foot section was electrofished on September 9, 2002 by a 2 person crew with a backpack unit. A total of 23 fish was collected: 20 westslope cutthroat ranging in size from 1.8 to 7.8 inches and 3 brook trout between 2.6 and 7.3 inches.

Management Considerations and Recommendations

Tolan Creek supports healthy populations of both westslope cutthroat trout and bull trout. Although genetic data is lacking, the absence of rainbow trout suggests the cutthroat population may be pure. These two ditches are believed to be the only irrigation ditches

impacting the creek. Although they are small, they can divert the majority of the creek's flow, and do entrain substantial numbers of native trout. They likely also impact passage. They are operated under one ranch ownership.

Recommendations are as follows:

- Screens should be considered for both ditches. With the relatively small size of the ditches, and the number of native fish observed and present in the creek, the benefits appear likely to be cost-effective.
- Some modification of the diversion structures would likely improve passage. A siphon or aqueduct could be considered for the lower ditch, but a means of diversion would still be needed.

Recommendations for a Fish Screening/Passage Plan

This creek is probably one of the least complicated in the Bitterroot watershed with respect to irrigation impacts. Beyond obtaining landowner involvement and design consultation for the two ditches discussed above, confirming the absence of other irrigation structures and inspecting road culverts for passage implications comprise the remaining effort necessary for a comprehensive plan.

Sleeping Child Creek

Stream Fisheries Information

Population data is available from 1.0 to 16.9 miles upstream of the mouth. Westslope cutthroat trout are common to abundant throughout the length of the creek. Bull trout are generally absent from the mouth upstream to 4.5 miles, uncommon from 4.5 to10.2 miles, and common above 14.5 miles. Brook trout are relatively uncommon up to 8 miles, rare at 10.2 miles, and absent at 14.5 miles. Rainbow trout have only been documented at 1.9 miles and brown trout are generally rare up to 4.5 miles with one fish documented at 10.2 miles.

Genetic sampling shows the westslope cutthroat population to be pure, based on a sample of 42 fish collected in 1985 and 1989.

Telemetry data has not provided evidence of a fluvial component of the westslope cutthroat population.

Duth Ditch: Reach 1

The POD and headgate of this ditch is located on the Evans property, about ¾ mile upstream of the mouth on the north side of the creek at latitude/longitude N 46 09.370, W 114 08.616. The diversion dam is constructed of large boulders with wooden plank wings (Figures 7A and 7B), and is considered a barrier at most flow levels with a drop of approximately 10 feet. Water is directed to the headgate at lower flows with smaller boulders and plastic. The headgate housing is concrete, and wood planks are used to

adjust the amount of water diverted (Figure 7C). The headgate discharges directly to the ditch (Figure 7D).

Discharge of the ditch (1.4 cfs) was measured within the concrete structure, which was 4.9 feet wide with an average water depth of 1.05 feet. This depth was lower than normal flow by about 2 inches according to a local resident. Maximum velocity was 0.53 ft/sec. The ditch was 3-4 feet wide and 0.5-1 feet deep for most of the section that was sampled. Conductivity was measured at 120.6 *us* and water temperature was 17.9 degrees Celsius.

A 750 foot section immediately downstream of the headgate was electrofished on August 26, 2003 by a 2 person crew with a backpack unit. A total of 37 fish were collected: 10 brown trout from 2.8 to 4.1 inches, 4 brook trout between 2.9 and 3.4 inches, 9 mountain whitefish (Prosopium williamsoni) from 2.4 to 4.1 inches, and 14 long-nosed suckers (Catostomus catostomus) between 1.6 and 2.2 inches.

Duth Ditch: Reach 2

This reach is located less than ½ mile below Reach 1, the downstream end of which is where the ditch comes against and parallels the Sleeping Child Road just above the Woodhouse lateral ditch. The latitude/longitude coordinates where the ditch goes through a culvert on Sleeping Child Drive are N46 09.687, W 114 08.954. This point is 300 feet upstream of the section's lower end. Figures 8A and 8B show respective upstream and downstream views from this point. The section ends 480 feet further upstream at the next culvert under Sleeping Child Drive. As can be seen from the photos, water level in the ditch had recently been considerably higher. Discharge was estimated at ~0.5 cfs. This probably had some effect on the number of fish sampled. Due to equipment malfunction, conductivity and temperature were not sampled.

A 780 foot section (plus ~30 feet of the lateral at the lower end) was electrofished on August 27, 2003 by a 2 person crew with a backpack unit. Fourteen fish were collected: 1 westslope cutthroat trout at 2.8 inches, 9 mountain whitefish between 2.7 and 4.1 inches, and 4 long-nosed suckers from 2.1 to 3.8 inches.

<u>Management Considerations and Recommendations</u>

Sleeping Child Creek has considerable potential to play an important role in the restoration of native trout populations of the Bitterroot River, given the numbers of native fish documented for the stream.

The diversion dam for this ditch system is the most significant irrigation feature impacting the creek fishery. Due to its proximity to the mouth, it may be precluding nearly the entire creek from supporting fluvial populations of native trout. Recent modification of the diversion dam in the Bitterroot River for the Republican Ditch has greatly increased access to Sleeping Child Creek for native fish in the river.

It was somewhat surprising that cutthroat trout were nearly absent in the survey effort and nonnative trout were more numerous, given existing population data. This ditch discharges into the Hedge Ditch, and it is possible that fish sampled in the survey could have originated from the Hedge Ditch, as well as from the creek.

Recommendations are as follows:

- Either modification of the existing diversion dam to incorporate tiered step pools, or construction of a fish ladder would greatly benefit upstream passage for native trout and reestablish access to many miles of the creek.
- Additional assessment of native trout numbers in the ditch appears warranted before strong consideration of screening the ditch. However, given its size, the cost of screening would likely be moderate.

Evans Ditch: Reach 1

The POD and headgate of this ditch is about 0.9 mile upstream of the Duth Ditch headgate at latitude/longitude N46 09.114, W115 07.731. It is located on the north side of the creek immediately downstream of the bridge on Little Sleeping Child Road on the John Berra property. The diversion dam is constructed of boulders and plastic (Figure 9A), and is not considered a fish barrier. The headgate is an adjustable steel gate fitted to a steel culvert (Figure 9B), and discharges directly to the ditch at the end of the culvert (Figure 9C). Much of the surveyed reach had stream-like characteristics (Figure 9D).

Discharge of the ditch was measured approximately 50 feet from the headgate, and had a value of 2.01 cfs. Where discharge was measured, the ditch had a wetted width of 6.2 feet, an average depth of 0.44 feet, and a maximum velocity of 1.38 ft/sec. Width of the reach generally varied from 4-6 feet and depth from 0.5-1 feet. Conductivity was measured at 113.9 *us*, and temperature at 19.3 degrees Celsius.

The reach (500 feet) was surveyed August 26, 2003 by a 2 person crew with a backpack electrofishing unit. Fish captured included 20 westslope cutthroat trout between 1.7 and 2.6 inches in length (2 of which were suspected to be possibly hybridized with rainbow trout), 1 brook trout 6.2 inches long, 1 brown trout that measured 3.3 inches, 2 sculpins 1.5 and 3.0 inches long, and 25 long-nosed suckers ranging between 1.3 and 3.9 inches in length.

Evans Ditch: Reach 2

The Evans Ditch discharges into the Duth Ditch approximately 375 feet from the Duth Ditch headgate. The ditch runs trough a culvert approximately 300 feet upstream from the point of discharge (Figure 10A). A 300 foot section of this ditch, which was 1 to 2 feet wide and 0.5-0.75 feet deep, was surveyed upstream of this culvert (Figure 10B) on August 26, 2003 by a 2 person crew with a backpack unit. No fish were captured or observed.

Management Considerations and Recommendations

Westslope cutthroat trout numbers were much higher than those surveyed in the Duth Ditch less than a mile downstream, and nonnative trout were nearly absent. Since this ditch discharges into the Duth Ditch, which discharges into the Hedge Ditch, it again is possible, but less likely, that some fish surveyed could have originated from the Hedge Ditch, as well as from the creek.

The primary impact of this ditch system on the fishery is entrainment of fish, not blockage of fish passage.

Recommendations include:

- Screening of the ditch should be considered. The amount of entrainment, the relatively small ditch size, and its location and configuration, suggest substantial cost-effective benefits.
- Improving the transport efficiency of the ditch may also reduce the amount of water needed for diversion.

Recommendations for a Fish Screening/Passage Plan

Most of the remaining irrigation from the creek has apparently converted from ditch systems to pump and pipe systems. This needs confirmation, and inspection of road culverts to ascertain any fish passage problems needs to be done. Otherwise, the two ditch systems discussed above are the primary irrigation systems impacting the creek fishery.

Three Mile Creek

Stream Fisheries Information

Population data is available from 0.5 miles upstream of the mouth in the Lee Metcalf National Wildlife Refuge to 15.5 miles upstream, which is approximately 0.25 miles above Arasta Creek. Westslope cutthroat trout are not documented until 5.5 miles upstream of the mouth, where they are rare to uncommon up to 8.7 miles. They are listed as abundant from 12.4 to 15.5 miles. There is one record from 1980 of a bull trout at 6.4 miles. Brook trout are common to abundant between 2.6 and 8.7 miles, rare to 13.4 miles, and absent further upstream. Brown trout have only been documented at 0.5 miles in 1992 when 5 were noted. There is one record of a rainbow trout documented at 0.5 miles from the same survey in 1992. Local residents have reported catching brown and rainbow trout above the Supply Ditch upstream nearly to Hoover Lane (2.6 to ~5miles from the mouth).

Genetic testing of ten westslope cutthroat trout collected in 1994 indicate the population is genetically pure.

No telemetry data exists for Three Mile Creek.

Bitter Root Irrigation District (BRID) Ditch

The BRID diversion structure and headgate is approximately 9 miles upstream of the mouth on the Brown Valley Ranch. Latitude/longitude coordinates for the structure are N46 35.598, W113 56.695. The concrete and steel structure is designed such that ditch water and creek water are kept separate and not ponded. Ditch water can pass under the creek or waste flows can be discharged into the creek (Figure 11A), and creek water can also be diverted into the ditch (Figure 11B) via separate headgates. The vertical drop of the creek at the structure is nearly four feet and is considered to be a barrier at most flows.

The upstream end of the 500 foot reach that was surveyed is located at latitude/longitude N46 35.508, W113 56.868, immediately south of the green metal gate on the BRID access road that turns off of the main lane to the Brown's ranch house. This is approximately 500 feet downstream of the structure. This section was chosen due to its depth and bank cover. Latitude/longitude coordinates for the downstream end of the reach are N46 35.447, W113 56.944. Figure 11C shows the upstream end of the reach viewing downstream, and Figure 11D shows the downstream end viewing upstream. The reach averaged approximately 15 feet in width, and depth ranged between 1 to 2.5 feet. Discharge was not measured due to equipment malfunction. Conductivity was measured at 31.8 *us*, and temperature at 19.3 degrees Celsius.

The 500 foot reach was electrofished with a backpack unit by a 2 person crew on September 15, 2002. Thirty-six long-nosed suckers were captured, ranging between 2.3 and 4.4 inches in length. No trout were captured or observed.

<u>Management Considerations and Recommendations</u>

Some positive aspects of the BRID structure design are that creek and ditch flows are not merged, there is virtually no ponding upstream (stream velocity is reduced with accompanying sediment deposition), and discharge to and from the creek can be controlled with adjustable headgates. Negative aspects include the following: the structure is a probable barrier to upstream fish passage at most flows; diversion of creek water to the ditch is not screened, thereby allowing entrainment of fish: discharge of ditch waste flows into the creek are not screened, thereby allowing nonresident fish to be introduced into the creek.

Westslope cutthroat trout are more abundant above the structure than below. Although habitat conditions (habitat diversity, substrate, vegetation, woody debris, temperature) may be more favorable above the structure, the reduction of fish passage may also be a

strong factor. Young resident fish migrating downstream may not be able to return past the structure to more favorable habitat as spawning adults.

Diversion of creek water occurs primarily after BRID shuts down flows from Lake Como (Rock Creek), usually some time in September. Diversion of creek flows in the fall is for stock water. The BRID canal is used to convey this water to users down the ditch. This is a very inefficient conveyance because the width of the ditch is designed to carry much larger flows. At times, nearly the entire creek flow may be diverted to convey enough water for usage. Fish migrating downstream would be entrained. Although no trout were captured in the survey, local residents do report cutthroat trout being observed in the ditch. Creek water may be diverted well into December in some years.

Waste flows from the ditch may be introducing nonresident nonnative fish into the creek, which could negatively impact management and restoration of native westslope cutthroat trout. Local residents have observed nonnative trout remaining in the ditch above the creek after flows have been shut off. The impacts of appropriated water being discharged into the creek channel are being assessed by an ongoing Montana Department of Environmental Quality (DEQ) 319 Grant project, and may have implications for fisheries management as well as water quality. This assessment is expected to be available after June, 2004.

Recommendations are as follows:

- Modification of the existing structure to provide for upstream passage should be considered. Construction of tiered step pools and a staging pool incorporated into the concrete apron may be possible. Creek flows could be diverted to the other side of the structure during construction, which could take place prior to or after the normal irrigation season.
- Although screening the diverted creek water to prevent entrainment may be possible, it may be more practical and cost-effective to explore either leasing the stock water rights, increasing the efficiency of conveying the water to reduce the amount diverted, providing assistance to develop alternative water sources, or a combination of the above.
- The BRID ditch extends more than 50 miles from Lake Como to the structure on Three Mile Creek, and may have several places where fish enter the ditch. As noted above, trout have been observed remaining stranded in the ditch following the shutoff of flows. Although it would be desirable to prevent entrainment throughout the length of the ditch, such recommendations are beyond the scope of this effort. It may be possible to screen the waste flows discharged into the creek to block the introduction of nonnative fish, but the value of such an effort to ensure genetic integrity of the creek's native fish may be judged to not warrant the cost at this time.

Supply Ditch

The Supply Ditch diversion dam/headgate structure is located 2.6 miles upstream of the mouth. The structure is constructed of concrete, steel, and wood with the headgate located on the north side of the creek (Figure 12A). Although it is difficult to see from

the photo (Figure 12B), the vertical drop of the creek at the structure is nearly 15 feet, therefore, the structure is considered a barrier at all flows. Creek and ditch flows intermingle with considerable ponding upstream of the structure (Figure 12C). There is a second concrete and steel headgate on the ditch 150 feet downstream of the headgate at the creek. This 150 foot section was quite deep (over 4 feet) with steep banks and a very soft substrate, and could not be efficiently, nor safely, surveyed with a backpack unit. One brook trout approximately 12 inches long, and two other 4-5 inch fish believed to be trout, were observed in this section, and it was suspected many more were present.

The reach that was surveyed extended 850 feet downstream of the second headgate described above, and averaged about 4 feet in width, with depths between 1 and 2 feet. Ditch banks were densely covered with vegetation that extended into the ditch (Figure 12D), making the electrofishing effort difficult to conduct. Figure 12D shows the downstream end of the reach (latitude/longitude at N46 33.842, W114 02.908) viewing upstream. Ditch discharge was not measured due to equipment malfunction. Conductivity was measured at 258 *us*, and temperature at 11.3 degrees Celsius. Conductivity and temperature were also measured in the ditch upstream of the structure at Ambrose Creek Road, with conductivity measuring 235 *us*, and temperature 15.1 degrees Celsius. Conductivity and temperature were measured as well in Three Mile Creek immediately below the structure, with conductivity measuring 241 *us*, and temperature 12.8 degrees Celsius.

A 2 person crew with a backpack unit electrofished the 850 foot reach September 22, 2003. A total of 22 fish were captured: 5 mountain whitefish between 5.4 and 5.9 inches long, and 17 long-nosed suckers ranging in length from 1.3 to 6.9 inches.

Management Considerations and Recommendations

The Supply Ditch structure and creek intersection negatively impact the creek's fishery potential in several ways: it is a definite barrier to upstream fish passage; it allows entrainment of fish with flows diverted from the creek; it allows the introduction of nonresident nonnative fish into the creek; it has altered the creek habitat downstream as well as upstream of the structure.

As a fish passage barrier, the structure essentially precludes the creek's ability to support a fluvial population of westslope cutthroat trout. Native trout numbers in the Bitterroot River in the area around the creek are quite low, and if restored, the creek's native fishery could help to increase river populations. Habitat conditions in the creek downstream of the structure are presently not conducive to supporting native fish, so access to more desirable habitat upstream is an important consideration, along with attention to improving habitat.

The potential for loss of fish with diverted flows from the creek certainly exists, but with the merging of creek and ditch flows, it is difficult to ascertain if entrained fish are from the creek, or already in the ditch before it reaches the creek. Although trout were not captured in the survey effort, local residents have been salvaging trout left stranded in the

ditch after flows have been shut off and returning them to the creek for several years. Significant flows have been diverted during summer low flow periods.

The merging of the creek and ditch facilitates introduction of fish to the creek from outside the watershed. If management for native trout is a priority, such introduction is a compromising factor. The extent to which this may be occurring is unknown. Sources of fish entry into the ditch were not determined for this effort.

The impacts of the structure on the physical habitat of the creek were beyond the scope of this project, however, channel downcutting is evident below the structure, and changes in flow regime and substrate are evident both upstream and downstream.

Recommendations include the following:

- There may be potential for a bypass or fish ladder on the north side of the creek. Such a bypass would have to intersect the outflow ditch in some fashion. Modification of the existing structure by construction of tiered step pools could also be considered.
- Construction of a siphon would eliminate the merging of ditch and creek flows, but a means to allow for diversion of creek water to the ditch would need to be provided. This diversion would need to be screened to prevent entrainment. A return to the creek could be constructed on the creeks' north side, and could possibly be incorporated into a bypass.
- The possibility of water leasing may be worth exploring, as it could eliminate the need for a diversion mechanism, as well as the need for a screen and return channel. In conjunction with siphon or aqueduct construction, it could also allow for replacing the existing structure such that the creek could pass under the ditch. This would also eliminate the need for a bypass or fish ladder.

THREE MILE CREEK FISH PASSAGE/SCREENING PLAN

The two most important components of a screening/passage plan for Three Mile Creek are described above: the BRID Ditch, and the Supply Ditch. Further development and implementation of the recommendations for these two systems are the highest priorities for mitigating irrigation impacts on the fishery.

Most other irrigation from the creek has converted from ditch systems to pump and pipe systems. However, there are two active private diversion structures and ditches that are impacting the fishery: the Gates (Powell) Ditch and the Brown (Porch) Ditch.

The Gates Ditch is located between the Supply and BRID ditches approximately 6.5 miles above the mouth at latitude/longitude N46 34.429, W113 59.223. The diversion dam/headgate structure is constructed of concrete, steel, and wood (Figure13A) with a vertical drop of three feet (Figure 13B). It is considered a fish barrier at most flow levels. The headgate structure is 3.8 feet wide. Discharge was measured on July 31, 2003 at 1.67 cfs. Depth in the structure was 0.5 feet and the maximum velocity was 1.58 ft/sec.

Recommendations are the following:

- Modify the existing structure by incorporating tiered step pools to facilitate upstream passage.
- Survey the ditch to assess the extent of entrainment.
- Depending on survey results, consider screening the ditch. Its size, location, and configuration suggest moderate costs.

The Brown Ditch is located above the BRID Ditch structure approximately 10.3 miles from the mouth at latitude/longitude N46 36.164, W113 56.231. The diversion/headgate structure is constructed of concrete, steel, and wood (Figure14A). Rock has been placed downstream of the structure reducing the vertical drop and forming steps (Figure 14B). The structure may still restrict upstream passage at low flow levels. The ditch is about 2 feet wide. Discharge was not directly measured, but was visually estimated around 1cfs. As this ditch is closer to the creek's headwaters where cutthroat populations are higher, the potential for entrainment of native trout seems likely.

Recommendations include:
- Modify the downstream end of the structure to improve passage at low flows.
- Survey the ditch to assess the extent of entrainment.
- Based on survey results, consider screening the ditch. Its size and configuration suggest moderate costs.

There are 16 road culverts on the creek from the one directly at the mouth in the Lee Metcalf National Wildlife Refuge to the uppermost one approximately 13.4 miles from the mouth. These culverts were visually inspected, and none appeared to present problems for fish passage. Locations and some latitude/longitude coordinates for the culverts are presented in Table 2.

In summary, there are four irrigation systems on Three Mile Creek that are impacting fish passage and potential entrainment of fish. The recommendations above are made with a focus on the restoration of connectivity between the creek's native trout fishery and that of the Bitterroot River. Collectively implemented, it is felt the recommendations would optimize the potential for restoration of a fluvial westslope cutthroat trout population. Implementation of any recommendations for each of the systems could yield benefits for the fishery. Further assessment prior to any implementation would aid in evaluating implementation cost-effectiveness and is advised.

ACKNOWLEDGEMENTS

Appreciation is expressed to the following for their support, participation, and/or assistance with this project: Mark Lere, Chris Clancy, and Leslie Nyce of Montana Fish, Wildlife and Parks, Rob Brassfield, Jeff Watkins, Julie Kightlinger, and Brian Shay of the Bitterroot National Forest, Roxa French of the Bitter Root Water Forum, Gary Schatzer of the Bitter Root Irrigation District, Jon Joost of the Supply Ditch Association, Gary Evans and Ted Marsolek of the Tincup Water Company, Bob Banner, Rick McElwee, Jack and Jay Evans, Stewart Duth, Julio Fase, John Berra, Ray and Debbie

Stevens, and Bill Good. Apologies are expressed to those whom were helpful, but not mentioned here.

SOURCES

Brassfield, R. 2003. Personal communication. Stevensville Ranger District Fisheries Biologist. USDA Forest Service, Bitterroot National Forest, Stevensville.

Brassfield, R. 2002. Unpublished data. USDA Forest Service, Bitterroot National Forest.

Clancy, C. G. 2002. Personal communication. Area Fisheries Biologist. Montana Department of Fish, Wildlife and Parks, Hamilton.

Clancy, C. G. and L. Javorsky. 2001. Statewide Fisheries Investigations. Bitterroot Forest Inventory. Project F-78-R5, R6. Montana Fish, Wildlife and Parks, Helena.

Good, W. 2003. Skalkaho Creek Migratory Fish Restoration Plan: Some Management And Research Options For Native Trout In Skalkaho Creek. Prepared for USDA Forest Service, Bitterroot National Forest.

[MDWWP] Montana Department of Fish, Wildlife and Parks. 2001. Fish Presence-Absence Sites: Bitterroot River Drainage, MT.

[SEO] State Engineer's Office. 1965. Water Resources Survey, Ravalli County, Montana. Part I. History of Land and Water Use on Irrigated Acres. 81 p.

[SEO] State Engineer's Office. 1965. Water Resources Survey, Ravalli County, Montana. Part II. Maps Showing Irrigated Areas. 31 p.

Figure 1A.

Figure 1B.

Figure 1C.

Figure 1D.

Figure 2A.

Figure 2B.

Figure 3A.

Figure 3B.

Figure 3C.

Figure 3D.

Figure 4A.

Figure 4B.

Figure 5A.

Figure 5B.

Figure 6A.

Figure 6B.

Figure 6C.

Figure 6D.

Figure 7A.

Figure 7B.

Figure 7C.

Figure 7D.

Figure 8A.

Figure 8B.

Figure 9A.

Figure 9B.

Figure 9C.

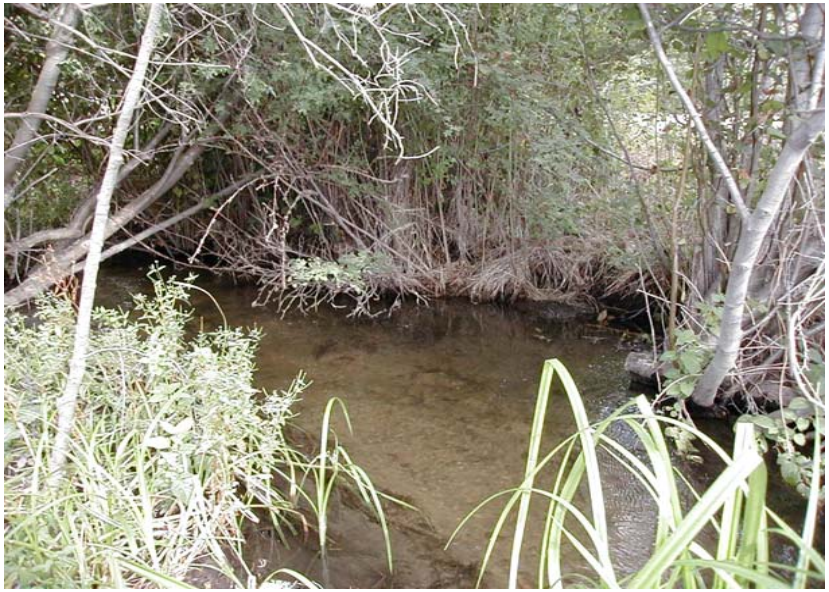

Figure 9D.

Figure 10A.

Figure 10B.

Figure 11A.

Figure 11B.

Figure 11C.

Figure 11 D.

Figure 12A.

Figure 12B.

Figure 12C.

Figure 12D.

Figure 13A.

Figure13B.

Figure 14A.

Figure 14B.