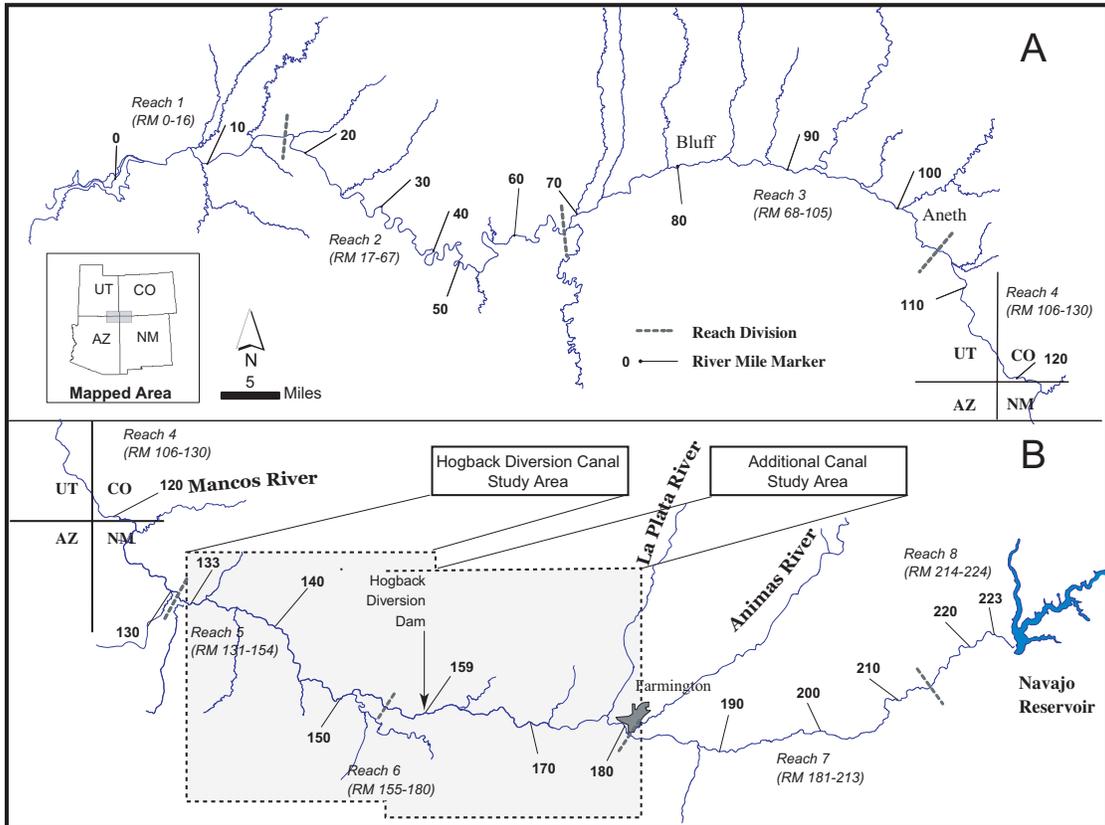


**AN ASSESSMENT OF FISH ENTRAINMENT IN THE HOGBACK DIVERSION CANAL,
SAN JUAN RIVER, NEW MEXICO, 2004 AND 2005**

**A SAN JUAN RIVER BASIN RECOVERY IMPLEMENTATION PROGRAM
FUNDED PROJECT**



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31 March 2006

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SAN JUAN RIVER, NEW MEXICO, 2004***

prepared for:

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U.S. Bureau of Reclamation
Upper Colorado Regional Office
125 South State Street, Room 6107
Salt Lake City, UT 84138-1102

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Executive Summary

Hogback Diversion Canal

1. Four sampling efforts
 - a). 01-02 October 2004 (flow ceased for annual event "Shiprock Days")
 - b). 28-29 October 2004 (flow reduced to ca. 100 cfs)
and 14-15 December 2004 (flow terminated)
 - c). 30 September-02 October 2005 (flow ceased for annual event "Shiprock Days")
 - d). 21-22 November 2005 (flow terminated)

 2. Total of 11,399 fish collected
 - a). 11,087 small-bodied individuals (i.e., red shiner, speckled dace)
 - b). 312 large-bodied individuals (290 were either flannelmouth or bluehead sucker)

 3. Non-endangered fishes:
 - a). 14 species
red shiner numerically dominate samples comprising 70% of catch
ichthyofaunal composition and abundances mirror side channels

 4. Endangered fishes
 - a). Colorado pikeminnow - 201 individuals collected (2004, n=140; 2005, n=61)
 - 1). Post Age-0 Colorado pikeminnow: N=17
Length: 151 mm to 315 mm TL (132 mm to 264 mm SL)
Mass: 25 to 270 gms
Three were pit-tagged (441E521F4B, 441E41576B, 441F105A69)
 - 2). Age-0 Colorado pikeminnow: N=184
Length: 42 mm to 79 mm TL (33 mm to 65 mm SL)
Thirteen were marked with green VIE tags
 - b). Razorback sucker - none collected

 5. Endangered fish are being entrained in Hogback Diversion Canal
 - a). stock after cessation of annual diversion activities
 - b). screen to reduce entrainment
 - c). annual salvage of live fish immediately following cessation of flow until
efficiency of any screening mechanism has been assessed
-

Executive Summary (continued)

Farmers Mutual, Jewett Valley, and Fruitland Irrigation canals

1. Two sampling efforts for each canal (all sampling conducted in 2005)
 - a). 10-12 August 2005 (during irrigation season)
 - b). 1-3 November 2005 (flow terminated)

 2. Total of 684 fish collected
 - a). 675 small-bodied fish (i.e., red shiner, speckled dace)
 - b). 9 large-bodied individuals collected (all flannelmouth sucker from Jewett Canal)

 3. Non-endangered fishes:
 - a). 12 species
Age 0 and age 1 flannelmouth sucker and bluehead sucker numerically dominate the ichthyofaunal composition comprising 69% of the catch.
Fish relative abundances most closely mirror main channel versus side channels.

 4. Endangered fishes
 - a). Colorado pikeminnow - 19 individuals collected - all in Fruitland Canal
 - 1). No post Age-0 Colorado pikeminnow
 - 2). Age-0 Colorado pikeminnow (n=19)
All collected on 2 November 2005 (post irrigation season)
Length: 54 mm to 71 mm TL (42 mm to 55 mm SL)
None were marked with green VIE tags
 - b). Razorback sucker - none collected

 5. Endangered fish are not generally being entrained in the small canals
 - a). fish collected in Fruitland Irrigation Canal were taken about xx days post-stocking
 - b). stock after cessation of annual diversion activities
 - c). or stock downstream of diversion heads
-

Background

The San Juan River is a major tributary of the Colorado River and drains 99,200 km² in Colorado, New Mexico, Utah, and Arizona. From its origins in the San Juan Mountains of southwestern Colorado at elevations exceeding 4,250 m, the river flows west for about 570 km before confluenting with the Colorado River. Major perennial tributaries to the San Juan River are (from upstream to downstream) Navajo, Piedra, Los Pinos, Animas, La Plata, and Mancos rivers, and McElmo Creek. In addition there are numerous ephemeral arroyos and washes that contribute little flow annually but input large sediment loads (Figures 1 and 2).

There is considerable human activity within the floodplain of the San Juan River between Shiprock and Navajo Dam. Irrigated agriculture is practiced throughout this portion of the San Juan River Valley and adjacent uplands. Water for these crops is usually supplied by and transported via one of several irrigation networks scattered throughout the basin. Much of the river valley not devoted to agriculture (crop production and grazing) consists of small communities (e.g., Blanco and Kirtland) and several larger towns.

The Hogback Diversion Canal system transports water to land on the north side of the San Juan River with the main canal being about 26 mi long and the network of laterals comprising 135 mi. The primary canal originates about 8 mi east of Shiprock, New Mexico, and terminates about 17 mi northwest of Shiprock (Figure 3).

The headgate of the Hogback Irrigation System is a flat-sloped riprap dam located at River Mile 158.7 on the north bank of San Juan River, immediately adjacent to U. S. Highway 64, San Juan County, New Mexico. It was rebuilt in 2001-2002 to provide for the more efficient and reliable diversion of water while allowing for fish passage over a wide range of discharge in the river. About 50% of the canal is concrete lined (upstream most 13 mi) while the remaining portion is earth-lined.

Immediately downstream of the diversion structure is the Hogback Diversion Canal settling channel or settling canal. This reach of the system can accommodate between 250-300 cfs, is about 15 m wide at the water's surface, about 1-3 m deep, and has a water velocity of about 0.5-0.75 m/sec. A few mi downstream, the Hogback Diversion Canal narrows markedly. Its width at the water's surface is about 5 m, depth about 1 m and water velocity about 0.5-1.0 m/sec. Flow in this portion of the Hogback Diversion Canal is generally 140-160 cfs. The Hogback Diversion Canal is usually operated from May through October with demand highest during the early portion of the irrigation season.

Numerous structures cross the Hogback Diversion Canal including U.S. Highways, unmaintained roads, arroyos, and culverts and related canal structures. There are at least 25 such structures between the diversion dam headgates and Canal Creek. The distances between these structures vary from <0.1 mi to just over 3 mi.

As Colorado pikeminnow were present during each of the 2004 sampling efforts in the Hogback Diversion Canal, the San Juan River Biology Committee decided to expand the study to include the three additional, although markedly smaller (in length and volume) irrigation canals of the San Juan River between Farmington and Shiprock, New Mexico. The 2004 sampling of the Hogback Diversion Canal was to be replicated in 2005 while two sampling trips in each of the three smaller canals would be conducted during 2005.

The diversion of river water for irrigation or power-generating purposes is well known to have deleterious effects on fish populations (Jensen et al., 1982; Edinger and Kolluru, 2000; Carter and Reader, 2000). Fish either become entrained into water diversion intakes or become impinged on intake screens. Fishes with drifting early life history phases (i.e., young-of-year) are very likely to become entrained into water diversions as they are passively transported downstream with the current (Carter and Reader, 2000). Highly mobile fish species (juvenile and adults) are also quite likely to become entrained into water diversions, often as a result of their seasonal movements throughout the river channel (Hallock and Van Woert, 1959; McKinley et al., 1998).

The primary risk to juvenile and adult fish that become entrained in irrigation canals is the loss of water during or after the irrigation season. Complete mortality of fish entrained in

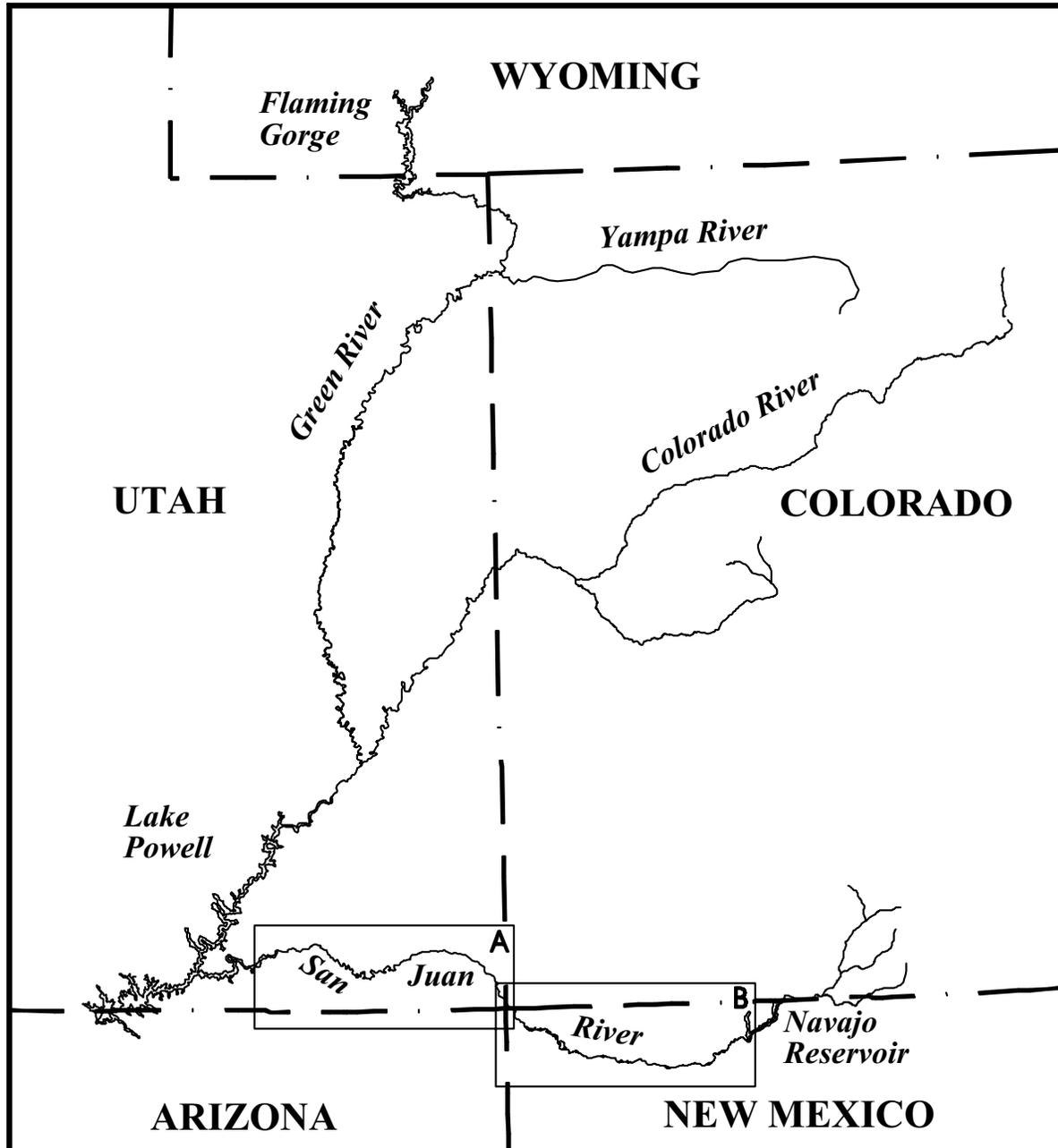


Figure 1. Location of the San Juan River within the Upper Colorado River Basin. The study area is outlined and labelled "A" and "B" with reference to subsequent maps in this report.

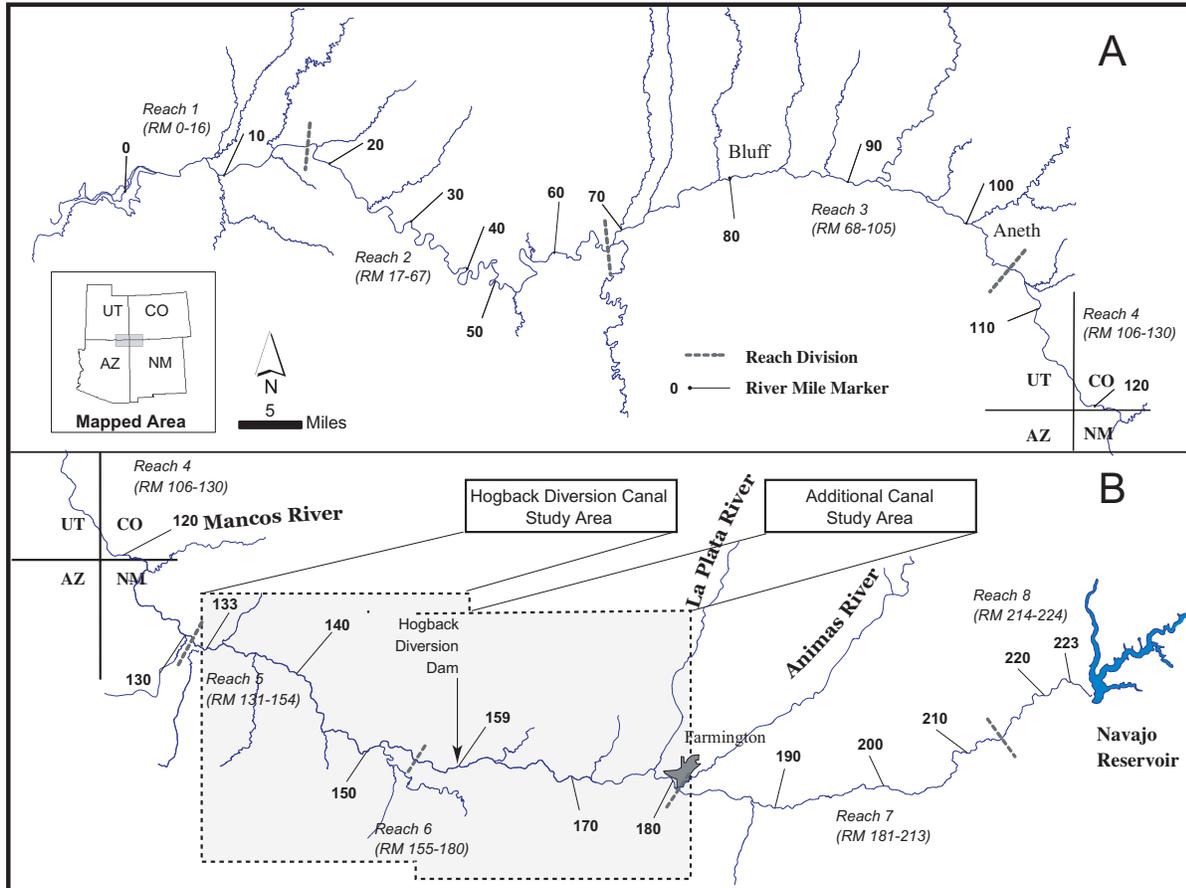


Figure 2. Map of the San Juan River Basin and location of the Hogback Diversion Canal System study area within the Basin as well as the three smaller canal systems added to the study in 2005 (=additional canal study area; see Figure 7).

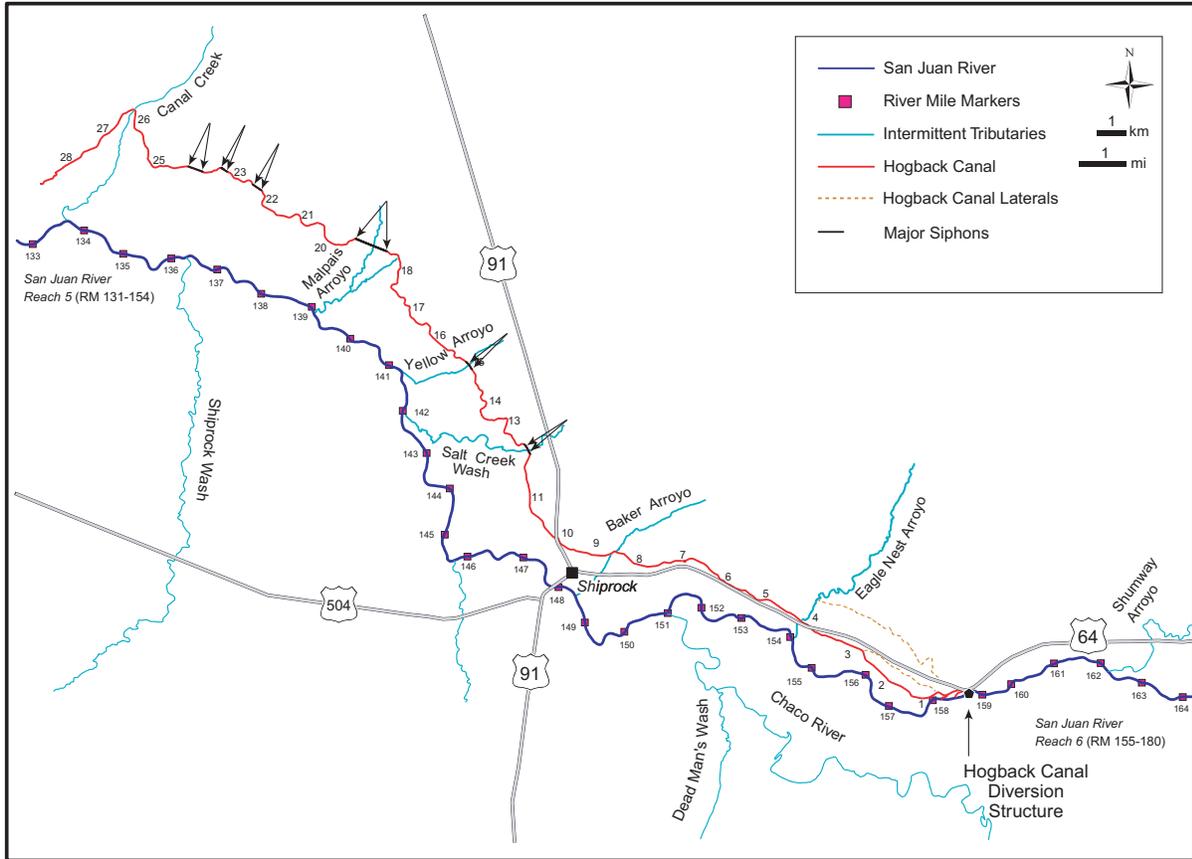


Figure 3. Map of Hogback Diversion Canal System and the surrounding study area.

irrigation structures would not be unexpected as canals ultimately dry following cessation of water diversion. The rate of drying is dependant on a variety of factors including canal morphology, distance from the source, and climatic conditions. The loss of entrained fishes has been recognized as a major cause in the decline of migratory fish populations particularly in the Pacific Northwest of the U. S. (National Marine Fisheries Service, 1994).

The scope and magnitude of this problem has also been recognized in California where policies have been implemented to help minimize the mortality of fishes caused by water diversions. The California Department of Game and Fish has adopted a statewide fish screening policy for the purpose of excluding salmon, steelhead, and federally (ESA) listed species from irrigation diversions. The installation of fish screens is now mandated for any new or modified diversions and for all diversions within the critical habitat boundaries of federally listed species.

Similar concerns for Colorado River endangered fishes (Colorado pikeminnow, razorback sucker, bonytail, and humpback) have also been recognized by resource managers in Colorado (U. S. Bureau of Reclamation, 2003). Construction of a fish screen was selected as a recommended alternative as part of the Final Environment Assessment for the Grand Valley Project Diversion Dam and Government Highline Canal. The purpose of that screen was to exclude Colorado River endangered fishes from becoming entrained in diversion canals during the irrigation season (April through October).

Populations of two Colorado River endangered fishes (Colorado pikeminnow and razorback sucker) exist in the San Juan River, New Mexico. Attempts are being made to increase the distribution of these species in the San Juan River to reaches upstream of the Hogback Diversion Canal and both taxa are known to undertake extended spawning migrations (Colorado pikeminnow: Tyus and McAda, 1984; Irving and Modde, 2000; razorback sucker: Tyus and Karp, 1990; Karp and Mueller, 2002). The extensive movement inherent in these fish increases their risk of becoming entrained in irrigation canals, such the one at the Hogback Diversion.

A wealth of data are available on the adult and juvenile ichthyofaunal community of the San Juan River in the vicinity of the Hogback Diversion structure (Geomorphic Reach 6 of the San Juan River). Autumn large-bodied monitoring efforts over the past three years clearly indicate that native sucker are the numerically dominant species (of large bodied fish) in that portion of the San Juan River. This study will investigate temporal entrainment of native fishes in the Hogback Diversion Canal and three smaller canals, compare the ichthyofaunal population size and structure of entrained fishes with that of the mainstem San Juan River, and provide recommendations regarding the need for selective fish screens at the Hogback Diversion Canal headgates.

Study Area

Hogback Diversion Canal - General Section Descriptions (Figure 4; Appendix A) Section One

Immediately downstream of the Hogback Diversion structure lies the Hogback Diversion Canal settling channel or settling canal. This settling basin ends ca. 0.3 mi downstream of the head gates at the first wasteway structure. This section is concrete-lined and has a water velocity of 0.25-0.75 m/sec which (low velocity) allows a portion of the suspended sediment to precipitate before moving further down the canal. This reach of the system can accommodate between 250-300 cfs, is about 16 m wide at the water's surface and 1- 2 m deep. In the middle of this section there is a 6-foot diameter culvert that crosses the canal above the water and rests on three concrete pillars. The pillar supporting the culvert collect debris (on the upstream side) and create that small eddies on the downstream side. At the downstream-most end of this section, a portion of the water is returned to the river (through a "wasteway channel") and the remainder continues on to the next section. The volume of water directed into the wasteway and amount allowed to continue through the canal are controlled by separate gates.

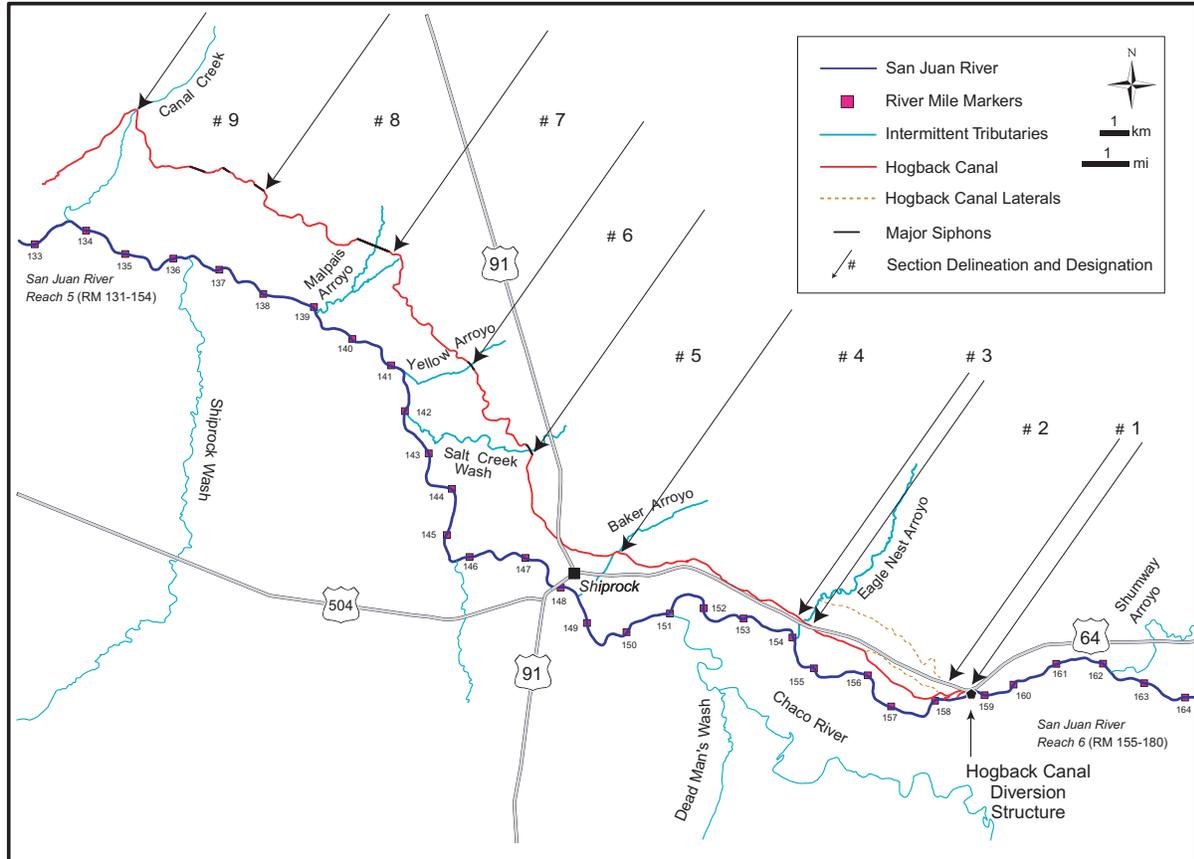


Figure 4. Map of Hogback Diversion Canal System with individual canal Sections indicated (see Appendix A).

Section Two (Figures 5 and 6)

Section two begins immediately downstream of the first wasteway and ends at the inflow of the aqueduct that leads under U.S. Highway 64 (UTM Coordinates: 718979E, 4069295N to 714712E, 4071415N). Because of the large number of fish present in this section, it was divided into six subsections (Figures 5 and 6). The first, section 2.1, begins immediately downstream of the first wasteway structure and continues to the first vehicle crossing (UTM Coordinates: 718979E, 4069295N to 719248E, 4069202N). The Hogback Diversion Canal Gauging station is located about 50 m downstream of the head of subsection 2.1 (U.S.G.S. 364442108324500 Hogback Diversion Canal Flume Satellite Transmitter).

At the lower end of subsection 2.1 is the Hogback Diversion Canal pumping station which distributes irrigation water to two laterals located above (in elevation) the canal. A check gate in the canal just downstream of the pump station allows some control of the volume of water passing this point. The first pump-fed lateral is located about 50 m uphill from the Hogback Diversion Canal and 100 m downstream of the pump station. This lateral generally parallels the Hogback Diversion Canal and conflues with the canal in subsection 2.3. The second pump-fed lateral is on the north side of U.S. Highway 64 and travels about 3.5 mi before emptying into Eagles Nest Arroyo.

The habitat in this subsection is characterized by sand-cobble substrate with some overhanging vegetation and woody debris providing cover. Directly downstream of the headgate for this subsection is a small reach (50 m) with large boulder and broken concrete debris. Shoreline vegetation is predominantly grasses with some salt cedar (*Tamarisk chinensis*) and Russian olive (*Elaeagnus angustifolia*) sparsely dispersed. Canal width is approximately 5 m with a depth of approximately 1.5 m

Subsection 2.2 begins at the first vehicle crossing and continues downstream to the second vehicle crossing (UTM Coordinates: 717268E, 4069729N to 718979E, 4069295N). The canal in this subsection remains earthen lined with a sand substrate and a few areas possessing cobble. As immediately upstream, some overhanging vegetation and woody debris piles provide instream cover. Shoreline vegetation consists of grasses, salt cedar, Russian olive and willow (*Salix* spp.). In the middle of the subsection there is an old concrete check structure (no longer in use) that causes the formation of a large, deep pool habitat. Canal width in this subsection is approximately 4 m with a depth of approximately 1.5 m

Subsection 2.3 begins at the second vehicle crossing and ends at the first footbridge (UTM Coordinates: 717268E, 4069729N to 716092E, 4070850N), contains basically the same habitats as in subsection 2.2 except that it does not contain any check structures (old or current).

Subsection 2.4 begins at the first footbridge and ends at the fourth vehicle crossing (UTM Coordinates: 716092E, 4070850N to 716033E, 4071051N). Aquatic habitats in this subsection are generally the same as subsections 2.2 and 2.3. The third vehicle crossing, which is in subsection 2.4, but was not used as a boundary point because this study reach would have been markedly shorter than that of the other subsection.

Subsection 2.5 begins at the fourth vehicle crossing and ends at the second footbridge (UTM Coordinates: 716033E, 4071051N to 715575E, 4071252N). Habitat and characteristics of this section are generally the same as 2.2, 2.3, 2.4. Return flow from the lower elevation pump-fed lateral empties in to the Hogback Diversion Canal about 10 m upstream of the downstream end of this subsection (fourth vehicle crossing). Water from the return is very clear especially compared to water in the Hogback Diversion Canal.

Subsection 2.6 begins at the second footbridge and ends at the aqueduct that travels under U.S. Highway 64 (UTM Coordinates: 715575E, 4071252N to 714712E, 4071415N). A concrete slab extends about 4 m from the 2 m diameter aqueduct. This is the last subsection of section two and, with the exception of habitats in the vicinity of the aqueduct, aquatic habitats in this subsection are generally the same as those from 2.2 through 2.5.

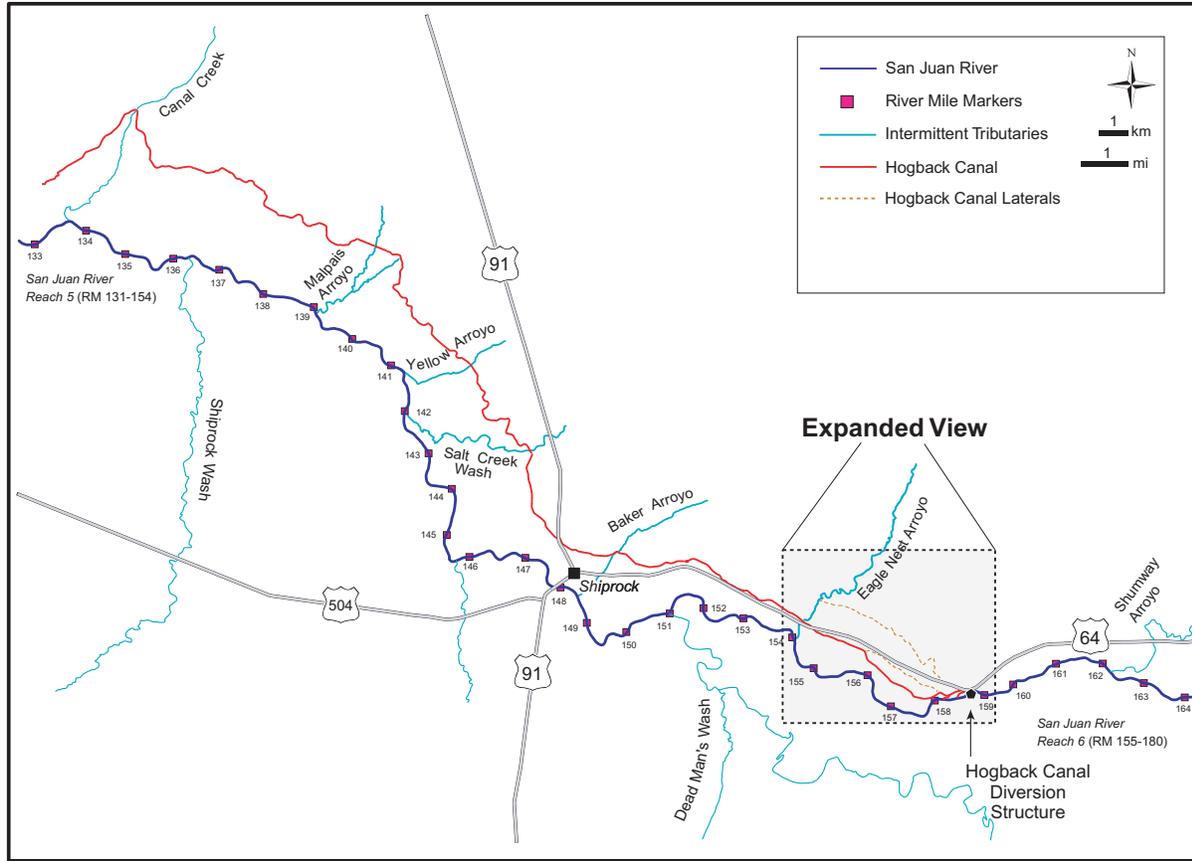


Figure 5. Map of Hogback Diversion Canal System and the area shown in Figure 6.

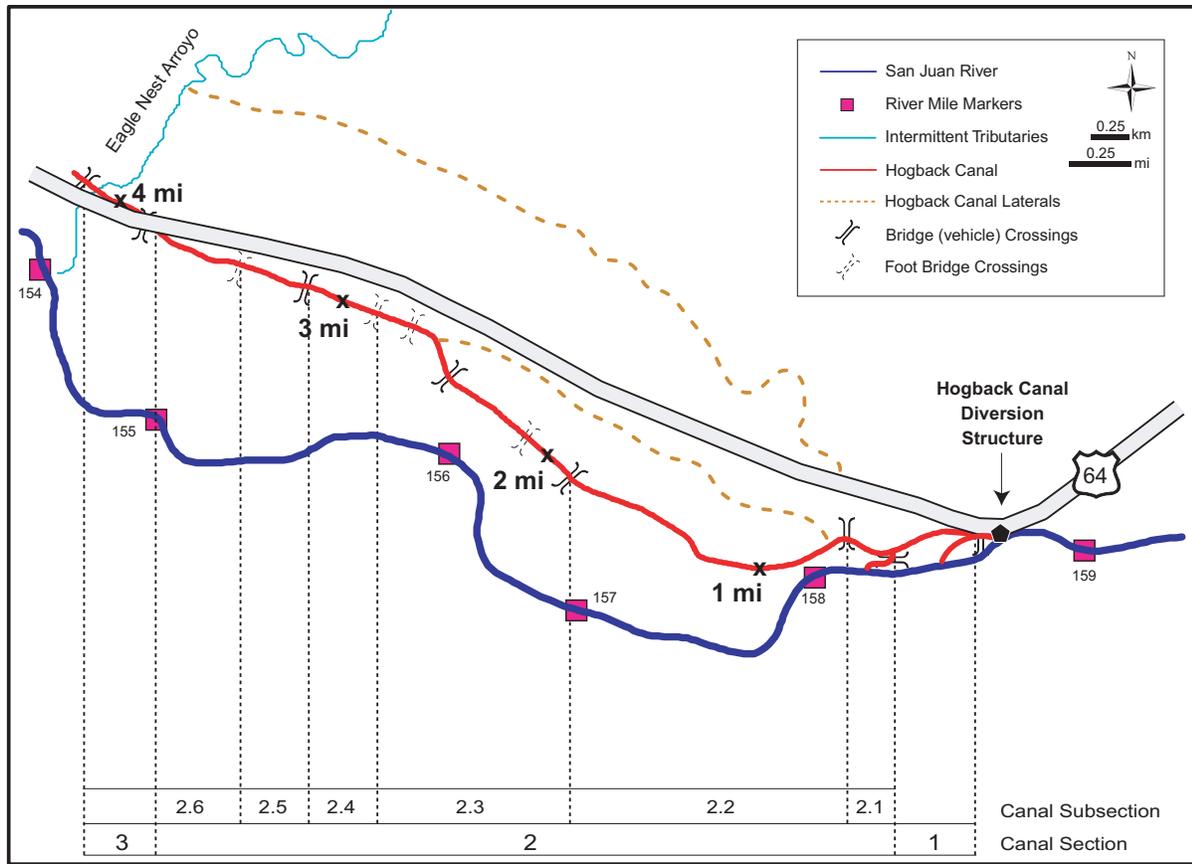


Figure 6. Map of Sections 1, 2, and 3 of the Hogback Diversion Canal System.

Section Three

Section three begins at the outflow of the U.S. Highway 64 aqueduct and ends at the inflow of the siphon at Eagle Nest Arroyo (UTM Coordinates: 714286E, 4071897N). This short section (ca. 0.3 mi) of the canal is concrete-lined and has a single diversion point (immediately upstream of the Eagle Nest Arroyo siphon). The circular gate is near the bottom of the canal and, when open, diverts water to an adjacent concrete-lined spillway that flows directly into Eagle Nest Arroyo. Adjacent to the inflow of the siphon is a low-head structure that impounds water at the siphon. If the siphon gate was closed, water spilling over the low-head structure would flow into the aforementioned concrete spillway and to Eagle Nest Arroyo. The width of the canal in this section is about 5 m and depth is approximately 1.5 m.

Section Four

Section four begins at the outflow of the Eagle Nest Arroyo siphon and ends at the inflow of the aqueduct at Baker Arroyo (UTM Coordinates: 708116E, 4074222N). The first half of this section (starting at Eagle Nest arroyo) is earthen lined with a sand substrate. Riparian vegetation in this portion of the canal is primarily salt cedar and Russian olive both of which occasionally overhang the canal. Instream cover is provided by debris collecting at various places along the canal. The second half of this section of the Hogback Diversion Canal is concrete-lined. Near the terminal end of Section 4 is a wasteway structure that, when open, directs water north to Baker Arroyo. Below the gate of the wasteway is a concrete spillway that channels water into a concrete-lined pool that is about 10 m long, 5 m wide, and 0.5 m deep. This pool retains water for extended periods after flow in the canal has ceased and is a temporary refuge for fish that are entrained when there is flow in the wasteway.

Section Five

The outflow of the Baker Arroyo aqueduct is the upstream boundary of this section while the inflow of the siphon at Salt Creek Wash (UTM Coordinates: 705120E, 4077435N) is the downstream boundary. This section of the Hogback Diversion Canal is concrete-lined and water travels under NM State Highway 491 through a 2 m diameter culvert. There is very little instream cover in this section of the canal. A wasteway structure is present immediately upstream of head of the siphon at Salt Creek Wash.

Section Six

Section six begins at the outflow of the siphon at Salt Creek Wash(UTM Coordinates: 705155E, 4077503N) and ends at the inflow of the siphon at Yellow Arroyo (also called Jim's Canyon). The canal in this section is earthen-lined with *Chamisa*, salt cedar, and Russian olive on the banks and numerous grasses and cattail mats in the canal. There is a wasteway structure (UTM Coordinates: 703324E, 4080097N) just upstream of the inflow of the siphon at Yellow Arroyo.

Section Seven

The outflow of the siphon at Yellow Arroyo marks the beginning of Section 7 while the Malpais wasteway structure designates the terminal end of this segment. In Section 7, the canal is concrete-lined and contains numerous large pieces of broken concrete (formerly canal lining) which provide some instream cover. *Chamisa* and salt cedar generally line the canal banks in this section of the canal. In some areas of Section 7, enough sand and silt has accumulated to allow grasses and emergent aquatic vegetations to exist. When the Malpais wasteway (UTM Coordinates: 700608E, 4083273N) is being used, water cascades over the canal service road.

Section Eight

Section eight begins immediately downstream of the Malpais wasteway and continues to the inflow of the fifth Hogback Diversion Canal siphon (unnamed). This reach of the canal

is concrete-lined, 3-5 m wide, 1 m deep, and has many areas of accumulated silt and considerable emergent aquatic vegetation. This vegetation is primarily cattails and grasses, both of which provide instream cover. As noted in upstream segments, salt cedar and chamisa are the dominant canal riparian vegetation.

Section Nine

The final section of the study area begins at the outflow of the fifth siphon and ends at the inflow of the sixth siphon (also unnamed) located on the east bank of Canal Creek. Water that reaches this point (rare occurrence) can be diverted into the Canal Creek, into the siphon, or a combination of both. In Section 9, the canal is about 3 m wide, 1 m deep, earthen-lined, and extremely overgrown with salt cedar and russian olive. Near the outflow of the fifth siphon water depth is between 1.5-2.5 m and the substrate is comprised of large pieces of concrete debris, cobble, and sand. Substrate is primarily sand and silt in the remainder of the Hogback Diversion Canal. Check and lateral gates that divert water south are present about 0.2 mi downstream of the outflow of the fifth siphon.

Rapidly declining water levels in this section of the canal (following cessation of water diversion) form isolated pools about 24 h after diversion at the headgate terminates. Isolated pools that usually form on either side of the check and lateral gates remain longer than other pools in the reach and provide a temporary refuge for fishes.

“Smaller Canals” General Section Descriptions (Figure 7)

The Farmers Mutual Canal both begins and ends upstream of the Hogback Diversion intake while the Jewett Valley Canal begins and ends downstream of the Hogback intake. Fruitland Irrigation Canal, which is the longest (ca. 23 miles) of the three smaller canals, begins at the Animas River and ends almost 10 miles west of the Hogback intake. The Jewett Valley Canal is about 8.5 miles long while the Farmers Mutual Canal is about 14.5 miles in length. The canals operated from June through October 2005. Flow in the Fruitland Irrigation Canal was generally between 70-100 cfs while it was ca. 50 cfs in the other two canals.

Materials and Methods

During the September (early October) sampling trips to the Hogback Diversion Canal both a backpack shocker and small mesh seines (6 ft x 10 ft x 3/16 in mesh) were used to collect fish. Seines were primarily used in shallow (< 1 m) and low-velocity habitats. Seining was the primary method of sampling isolated pools present in the canal. Conversely, a backpack shocker (Smith-Root LR-24) was used when water depth or large boulder substrate precluded effective seining. A portion of subsection 2.2 (downstream of the Hogback Diversion Canal Gauging Station) was the only segment that had to be sampled using the backpack shocker.

During the late October (early November, December) collecting trips, the aforementioned sampling methods were again employed. Concrete-lined sections and areas that had shallow isolated pools were seined. The backpack shocker (Smith-Root LR-24) was used in areas where deep water (ca. 1 m) was the primary habitat present. The backpack shocker was also used in both shallow and deep isolated pools in cases when seining was inhibited by surface ice. During those occasions, surface ice was broken into small pieces and subsequently several passes were made through the habitat with the backpack shocker.

Large-bodied fish (i.e., generally > 140 mm TL) collected were kept in a 200 gallon aerated live-well, which was divided by a porous screen into two 100 gallon sections. Endangered fish were kept segregated (in one compartment of the live) from other large bodied fishes. Water (ca. 120 gallons) in the live-well was acquired from the mainstem of the San Juan River (at the Hogback Diversion Structure) at the beginning of each days activities. Enough sodium chloride was added to the live-well water so that a 5% concentration was achieved. In addition, a commercial fish “stress coat” was dissolved in the water at ratio of 1

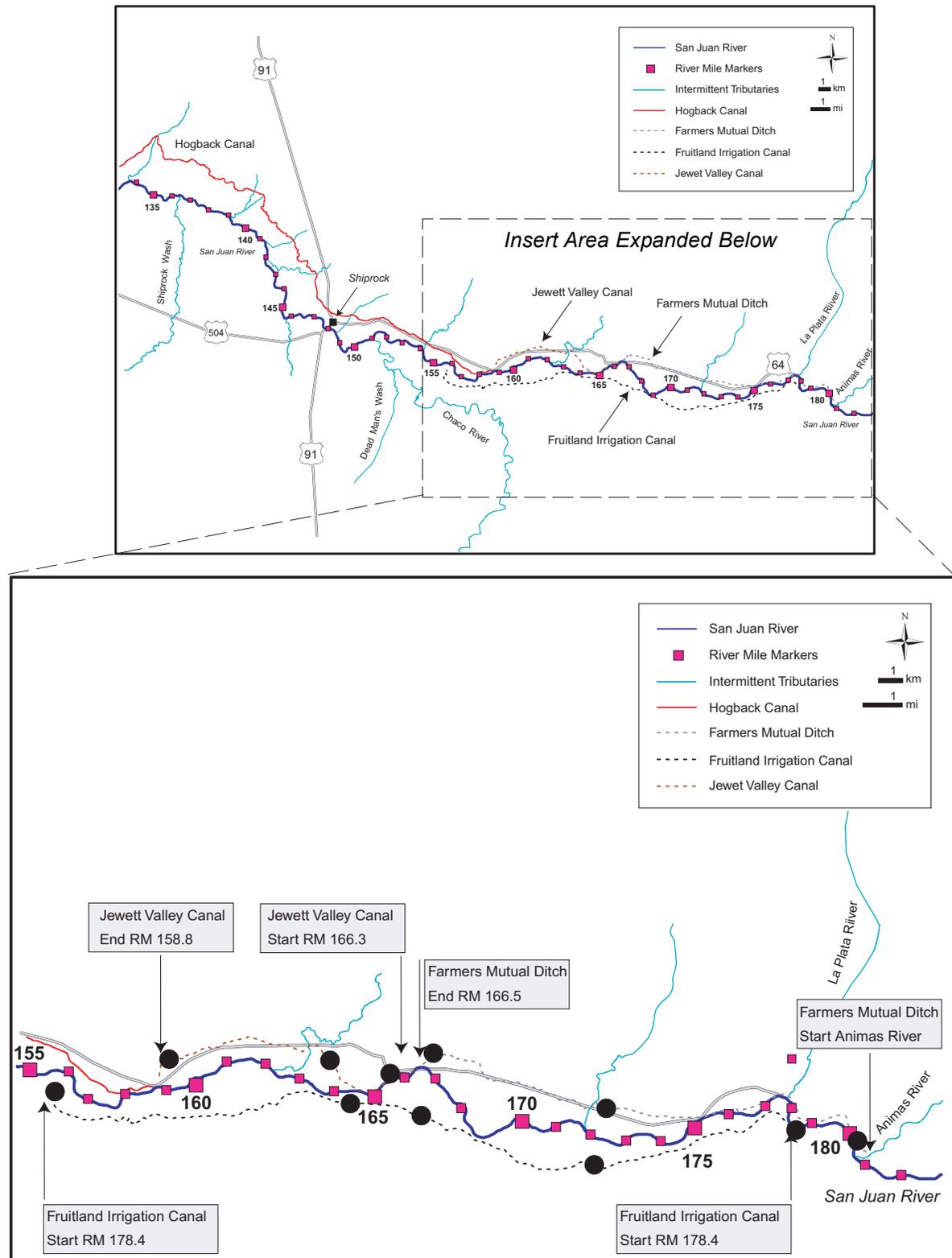


Figure 7. Map of the Farmers Mutual, Jewett Valley, and Fruitland Irrigation canals and their location in comparison to the Hogback Diversion Canal. Solid black circles in lower map indicate sampling locations.

ml of stress coat to 1 gallon of water (manufacturer's recommendations). The vehicle transporting the live-well and large-bodied was driven to the banks of the San Juan River for processing of the large-bodied fish occurred along the banks of the San Juan River.

Processing of large-bodied fish (including endangered fishes) involved identification, enumeration, determining total (TL) and standard (SL) lengths (mm), and body mass (gm). In addition, endangered fishes (Colorado pikeminnow), which were kept and processed separately from other fishes, were scanned for the presence of a Passive Integrated Transponder tag (PIT tag) and examined for Visible Implant Elastomer (VIE) marks prior to being released. Age two and older endangered fish were anaesthetized in solution containing MS-222, carefully examined for pit tags, photographed, monitored during recovery, and released in the San Juan River. All native large-bodied fish (i.e., ca. 140 mm TL) were returned to the San Juan River downstream of the Hogback Diversion Headgate structure.

Sampling of fishes in the three small canals during 2005 was conducted during 10-12 August, while the amount of water being diverted was near canal capacity, and again 1-2 November when diversions of water had ceased. During the November sampling effort, fish were collected exclusively with small mesh seines (6 ft x 10 ft x 3/16 in mesh) while both a backpack shocker and seines were used in August. An attempt was made to sample near the head, middle, and mouth of each canal system. Three sites were sampled in both the Farmers Mutual and Jewett Valley canals while five sites were sampled in the Fruitland Irrigation Canal.

All non-endangered small-bodied fishes collected during this study were preserved in a 10% formalin solution and return to the laboratory where they were identified, counted, and measured (largest and smallest individual per species per sample).

Mean daily discharge in the Hogback Diversion Canal (U.S.G.S. 364442108324500 Hogback Diversion Canal Flume Satellite Transmitter) was obtained for the entire 2004-2005 Hogback Diversion Canal operating period (Figure 8). Mean daily discharge for the Fruitland Irrigation Canal was also recorded during 2005 (Figure 9) however those data were not available for either the Jewett Valley nor Farmers Mutual canals. Universal Transverse Mercator (UTM) coordinates were acquired with a handheld global positioning system (GPS) unit for points which designate the upper and lower extent of each individual study segment. Canal water temperatures were recorded hourly throughout the 2004 study period by recording devices set at in the Hogback Diversion Canal System. The device failed in 2005 so water temperatures were not available.

Objectives

The San Juan River Basin Recovery Implementation Program's Long Range Plan identified a need to assess levels of fish entrainment at diversion dams (Project Task 2.3.10 Evaluate entrainment of all life stages at diversion dams). The study reported herein was conducted in response to a June 2004 Request for Proposals (RFP) designed to address that concern. While the goal and objectives (Table 1) dealt with quantification of entrainment in the Hogback Diversion Canal, a primary purpose of the work was to assess (make a recommendation) the need for some type of additional screening (to reduce/eliminate entrainment) of the Hogback Diversion Canal.

The study was expanded in 2005 to include an assessment of the entrainment of fishes in three "smaller" canals in the San Juan River Basin. The expanded sampling called for a survey of fishes in the Fruitland Irrigation, Jewett Valley, and Farmers Mutual canals.

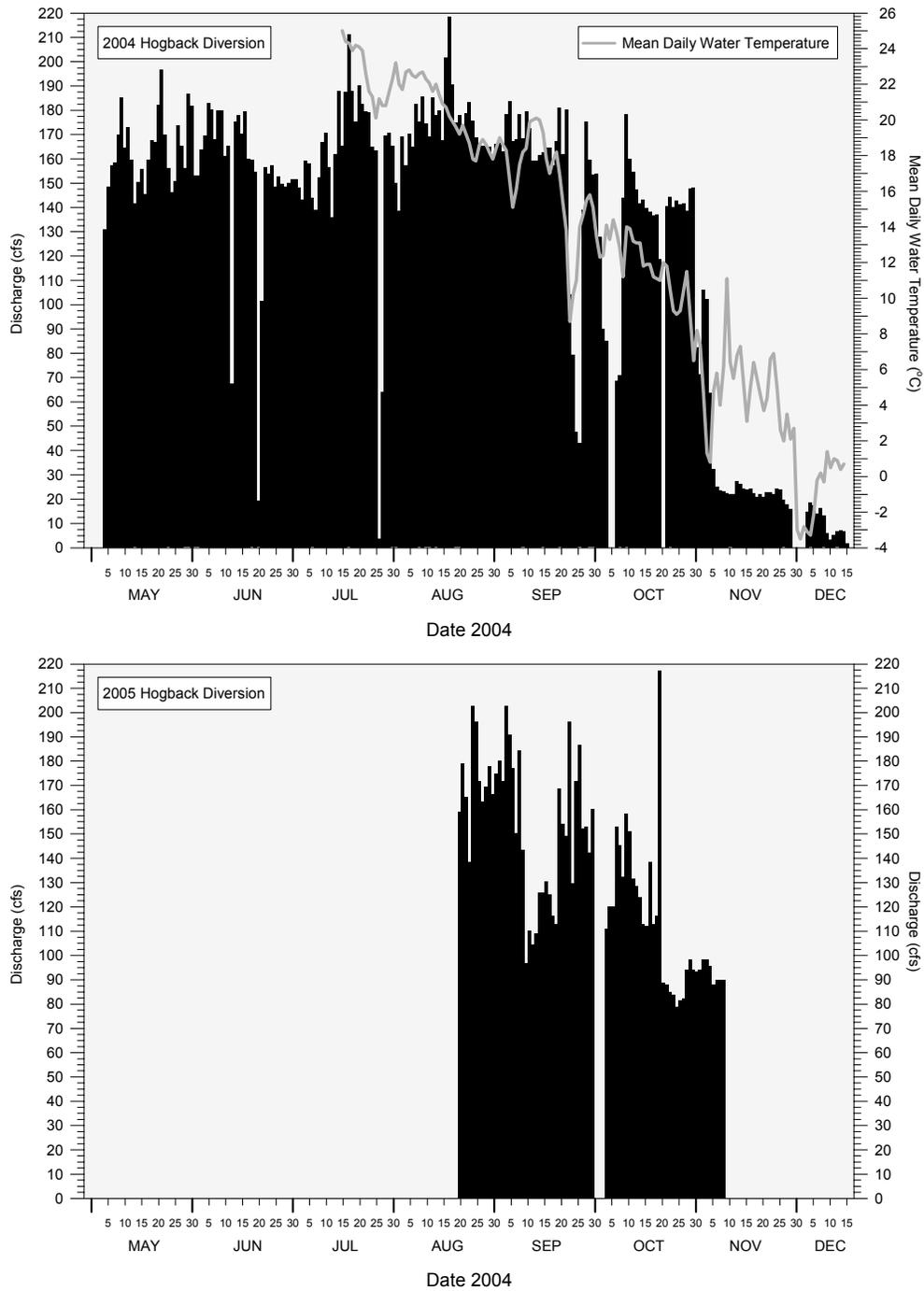


Figure 8. Mean daily discharge and mean daily water temperature (Section 2 thermograph) during 2004 and 2005 in the Hogback Diversion Canal System, San Juan River, NM.

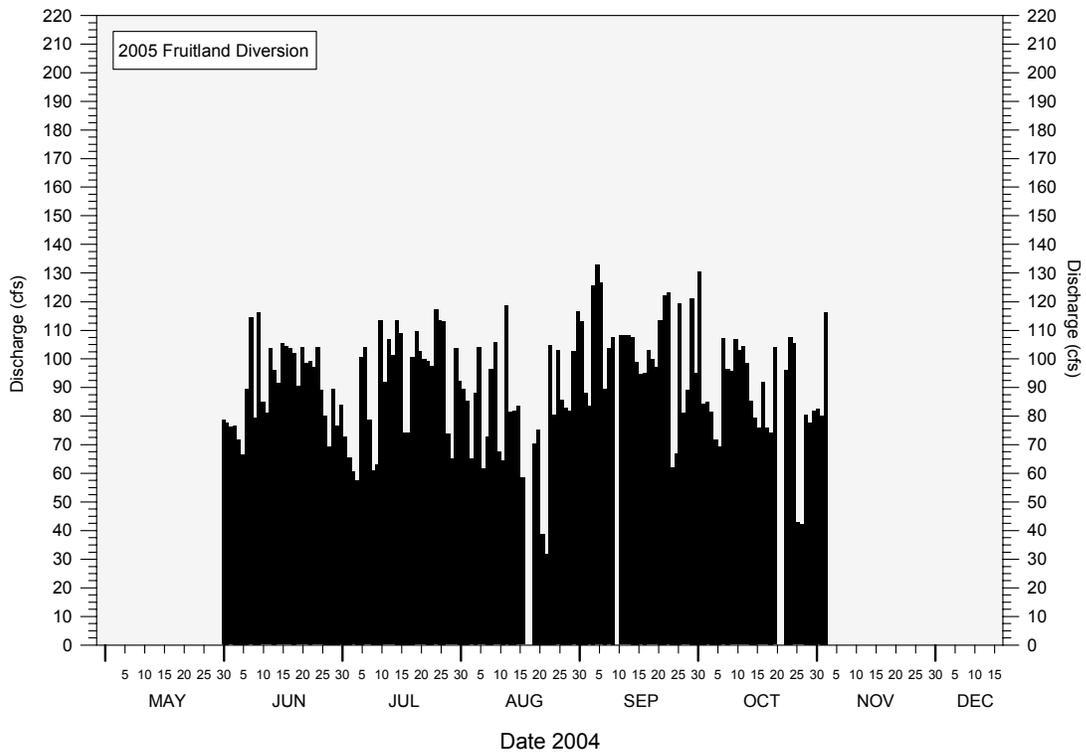


Figure 9. Mean daily discharge during 2005 in the Fruitland Irrigation Canal System, San Juan River, NM.

Table 1. Goal and objectives of Federal Grants 04-FG-40-2213 entitled: "Assessment of Fish Entrainment in the Hogback Diversion Canal."

STUDY GOAL AND OBJECTIVES	DETAILS
STUDY GOAL	
A	DOCUMENT THE MAGNITUDE AND CHARACTERISTICS OF NATIVE FISHES INTO THE HOGBACK DIVERSION CANAL FROM THE SAN JUAN RIVER TO GUIDE DESIGN AND OPERATIONAL CRITERIA FOR POTENTIAL SCREENING FOR PROTECTION OF THE ENDANGERED AND NATIVE FISH.
B	DOCUMENT THE ICHTHYOFALUNAL COMPOSITION OF THE FRUITLAND IRRIGATION CANAL, THE JEWITT IRRIGATION CANAL, AND THE FARMERS MUTUAL IRRIGATION CANAL DURING THE 2005 IRRIGATION SEASON.
STUDY OBJECTIVES	
1	QUANTIFY ENTRAINMENT OF FISHES INTO THE HOGBACK DIVERSION BY SPECIES AND SIZE IN 2004 AND 2005 DURING THE NORMAL OPERATION PERIOD OF THE DIVERSION STRUCTURE.
2	QUANTIFY ENTRAINMENT OF FISHES INTO THE FRUITLAND IRRIGATION CANAL, THE JEWITT IRRIGATION CANAL, AND THE FARMERS MUTUAL IRRIGATION CANAL IN 2005 DURING THE NORMAL OPERATION PERIOD OF THE IRRIGATION CANALS.
3	EVALUATE ENTRAINMENT RATES OF FISHES FROM THE SAN JUAN RIVER TO DETERMINE THE LOSS OF FISH FROM RIVERINE POPULATIONS.
4	PROVIDE RECOMMENDATIONS ON THE NEED FOR FISH SCREENING.

Results

A total of 11,399 fish representing five families and 14 species were collected during the 2004-2005 Hogback Diversion Canal sampling period (Table 2). Red shiner was the most abundant species comprising 70.6% of the catch with speckled dace being the second most abundant taxon accounting for 17.1% of the catch (Table 3). The next two most abundant fishes, flannelmouth sucker and bluehead sucker, were 4.8% and 3.3% of the catch, respectively. The remaining 10 species collectively were 4.2% of the catch. A total of 199 Colorado pikeminnow were collected in the canal but razorback sucker were not taken during 2004-2005.

Large fish (e.g., fish > 140 mm TL) were represented by four species and 312 specimens (Table 4). Only two large channel catfish were collected but both individuals were relatively large (470 mm - 483 mm TL, 1000 gm) and were taken in the upper reaches of Section 2. Flannelmouth sucker was the numerically dominate large-bodied fish collected in the Hogback Diversion Canal during 2004 -2005 comprising 75.0% (n=234) of that catch (Table 4). There were 139 flannelmouth sucker taken that were \geq 200 mm TL, with the largest individual being 535 mm TL, 475 mm SL, and 1.4 kg. Bluehead sucker was the second most abundant of the large fishes collected comprising 19.0% (N=56) of the sample. Eleven of the large-bodied bluehead sucker were \geq 200 mm TL with the largest being 340 mm TL (285 mm SL) and 340 gms. Colorado pikeminnow was represented by 17 individuals >140 mm TL and are discussed in detail in the "Colorado pikeminnow" subsection of results.

Small bodied fish (e.g., both small bodied taxa and age-0 or juvenile individuals of large fish) comprised the majority (97.3%) of the Hogback Diversion Canal catch in 2004-2005 (Table 5). The four species representing the large-bodied fish samples were also present, as age-0 or juvenile fish, in the small-bodied samples. Red shiner numerically dominated the catch of small-bodied fish accounting for 72.2% of the total catch. The second most abundant taxon in this group was speckled dace which were 17.5% of the catch. Age-0 bluehead sucker and flannelmouth sucker were the third and fourth, respectively, most abundant fishes.

There were five species of large-bodied fish that were not represented by adult individuals but instead were represented in the collections only by age-0 specimens (common carp, white sucker, green sunfish, bluegill, and largemouth bass. Four species (Colorado pikeminnow, flannelmouth sucker, bluehead sucker, and channel catfish) were represented by both ontogenetic stages (adult and age-0). The 199 age-0 Colorado pikeminnow collected in the Hogback Diversion Canal during 2004 all appeared to be the result of augmentation activities. Details on the collection of age-0 Colorado pikeminnow are presented later in results.

The longitudinal distribution of fish in the Hogback Diversion Canal was heavily skewed towards the head of the system. Section 2 contained the most standing water and therefore the most available habitat and resulted in 33 fish collections (all yielding fish). Conversely, only one to four collections were made in each of sections 3, 4, 5, 6, and 7 while a single collection was made in section 8. Of the seven sections that yielded fish (sections 2, 3, 4, 5, 6, 7, 8), over 94% of the catch was in section 2 and 2.3% in Section 4 (Table 6). The remaining four sections produced between 31 and 124 specimens (0.4% to 1.1% of the catch).

The Farmer's Mutual Canal yielded the fewest specimens both per trip and for the study (Table 7). A total of 39 individuals representing eight species were collected in this canal during the two sampling trips. Colorado pikeminnow was not collected in the Farmer's Mutual Canal during this study. The most abundant taxa were largemouth bass (n=15) followed by flannelmouth sucker (n=9) and speckled dace (n=7). The largemouth bass taken ranged in length from 39-104 mm SL with the larger specimens collected during the November sampling effort (versus August). Surprisingly, red shiner (n=1; 57 mm SL) was only collected at Farmer's Mutual Canal; it was not taken in either the Jewitt Canal nor Fruitland Diversion Canal. Young-of-the-year flannelmouth sucker were collected in Farmer's Mutual Canal in

Table 2. Scientific and common names and species codes of fish collected in the Hogback Diversion Canal, Fruitland Irrigation Canal, Jewett Valley Canal, and Farmers Mutual Canal, San Juan River drainage, New Mexico, during 2004-2005.

Scientific Name	Common Name	Species Code
Order Cypriniformes		
Family Cyprinidae		
	carps and minnows	
<i>Cyprinella lutrensis</i>	red shiner	(CYPLUT)
<i>Cyprinus carpio</i>	common carp	(CYPCAR)
<i>Pimephales promelas</i>	fathead minnow	(PIMPRO)
<i>Ptychocheilus lucius</i>	Colorado pikeminnow	(PTYLUC)
<i>Rhinichthys osculus</i>	specked dace	(RHIOSC)
Family Catostomidae		
	suckers	
<i>Catostomus commersoni</i>	white sucker	(CATCOM)
<i>Catostomus (Pantosteus) discobolus</i>	bluehead sucker	(CATDIS)
<i>Catostomus latipinnis</i>	flannelmouth sucker	(CATLAT)
Order Siluriformes		
Family Ictaluridae		
	bullhead catfishes	
<i>Ameiurus melas</i>	black bullhead	(AMEMEL)
<i>Ictalurus punctatus</i>	channel catfish	(ICTPUN)
Order Salmoniformes		
Family Salmonidae		
	trouts and salmons	
<i>Salmo trutta</i>	brown trout	(SALTRU)
Order Atheriniformes		
Family Poeciliidae		
	livebearers	
<i>Gambusia affinis</i>	western mosquitofish	(GAMAFF)
Order Perciformes		
Family Centrarchidae		
	sunfishes	
<i>Lepomis cyanellus</i>	green sunfish	(LEPCYA)
<i>Lepomis macrochirus</i>	bluegill	(LEPMAC)
<i>Micropterus salmoides</i>	largemouth bass	(MICSAL)

Table 3. Summary of all 2004-2005 fish collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	8,009	70.6	29	87.9
common carp	I	4	**	3	9.1
fathead minnow	I	255	2.3	23	69.7
Colorado pikeminnow	N	199	1.8	15	45.5
speckled dace	N	1,944	17.1	29	87.9
SUCKERS					
white sucker	I	8	**	5	15.2
flannelmouth sucker	N	541	4.8	30	90.9
bluehead sucker	N	378	3.3	24	73.7
BULLHEAD CATFISHES					
black bullhead	I	3	**	3	9.1
channel catfish	I	5	**	4	12.1
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	36	**	10	30.3
SUNFISHES					
green sunfish	I	7	**	3	9.1
bluegill	I	1	**	1	3.0
largemouth bass	I	9	**	6	18.2
TOTAL		11,399			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=33 samples.

** <0.1%

Table 4. Summary of 2004-2005 large fish (ca. > 140 mm TL) collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	17	5.5	7	21.2
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	234	75.0	15	45.5
bluehead sucker	N	56	18.0	12	36.4
BULLHEAD CATFISHES					
black bullhead	I	1	0.3	1	3.0
channel catfish	I	4	1.2	3	9.1
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		312			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=33 samples.

Table 5. Summary of 2004-2005 small-bodied fish collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	8,009	72.2	29	87.9
common carp	I	4	**	3	9.1
fathead minnow	I	255	2.3	23	69.7
Colorado pikeminnow	N	182	1.6	10	30.3
speckled dace	N	1,944	17.5	29	87.9
SUCKERS					
white sucker	I	8	0.1	5	15.2
flannelmouth sucker	N	307	2.8	28	84.8
bluehead sucker	N	322	2.9	23	69.7
BULLHEAD CATFISHES					
black bullhead	I	2	**	2	6.1
channel catfish	I	1	**	1	3.0
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	36	0.3	10	30.3
SUNFISHES					
green sunfish	I	7	0.1	3	9.1
bluegill	I	1	**	1	3.0
largemouth bass	I	9	0.1	6	18.2
TOTAL		11,087			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=33 samples.

** <0.1%

Table 6. Summary of all 2004-2005 fish collections, by sampling section, from the Hogback Diversion Canal, San Juan River drainage, New Mexico. See Figure 3 for Section designations.

SPECIES	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6	SECTION 7	SECTION 8
CARPS AND MINNOWS							
red shiner	7,832	35	31	6	29	63	13
common carp	3	-	-	-	1	-	-
fathead minnow	222	-	1	4	7	16	5
Colorado pikeminnow	73	-	83	13	26	4	-
speckled dace	1,840	10	56	21	10	4	3
SUCKERS							
white sucker	5	-	-	1	-	2	-
flannelmouth sucker	456	-	47	12	12	8	3
bluehead sucker	269	-	42	23	6	25	7
BULLHEAD CATFISHES							
black bullhead	2	-	-	-	-	-	-
channel catfish	6	-	-	-	-	-	-
TROUTS AND SALMONS							
brown trout	-	-	-	-	-	-	-
LIVEBEARERS							
western mosquitofish	33	-	-	-	2	1	-
SUNFISHES							
green sunfish	6	-	-	-	-	-	-
bluegill	1	-	-	-	-	-	-
largemouth bass	6	-	1	-	1	1	-
TOTAL (n=11,399)	10,754	45	265	86	94	124	31
% TOTAL BY SECTION	94.3	0.4	2.3	0.8	0.8	1.1	0.3

Table 7. Summary of fish from the Hogback, Farmers Mutual, Jewett Valley, and Fruitland canals, San Juan River drainage, New Mexico, during 2004 and 2005.

SPECIES	RESIDENCE STATUS ¹	HOGBACK CANAL 2004-05	FARMERS MUTUAL CANAL 2005	JEWETT CANAL 2005	FRUITLAND CANAL 2005
CARPS AND MINNOWS					
red shiner	I	8,009	1	-	-
common carp	I	43	-	2	-
fathead minnow	I	255	2	2	5
Colorado pikeminnow	N	199	-	-	19
speckled dace	N	1,944	7	19	118
SUCKERS					
white sucker	I	8	-	-	1
flannelmouth sucker	N	541	9	54	186
bluehead sucker	N	387	-	83	141
BULLHEAD CATFISHES					
black bullhead	I	3	3	3	1
channel catfish	I	5	1	-	-
TROUTS AND SALMONS					
brown trout	I	-	1	1	-
LIVEBEARERS					
western mosquitofish	I	36	1	-	1
SUNFISHES					
green sunfish	I	7	-	1	1
bluegill	I	1	-	-	-
largemouth bass	I	9	15	1	6
TOTAL		11,399	39	166	479

¹ N = native; I = introduced

August (28-38 mm SL) and November (73-80 mm SL) as were bluehead sucker (52-65 mm SL in November). The largest fish taken in this canal was a 245 mm SL brown trout. No other fish > 150 mm SL were collected in the Farmer's Mutual Canal.

The Jewett Canal produced nine species and the second highest number of fishes (from small canals) during the 2005 survey. The 166 specimens collected were numerically dominated by flannelmouth sucker (n=54) and bluehead sucker (n=83). Young-of-the-year flannelmouth sucker and bluehead sucker were collected in Jewett Canal in both August and November 2005. Large (>150 mm SL) flannelmouth sucker were primarily taken in the canal during November when nine individuals (151-218 mm SL) were collected. Additional YOY fish species collected in this canal were common carp (n=2; 29-30 mm SL), black bullhead (n=4; 25-47 mm SL), green sunfish (n=4; 25-83 mm SL), and largemouth bass (n=2; 77-78 mm SL). Colorado pikeminnow was not collected in the Jewett Canal during the 2005 study.

The Fruitland Diversion Canal yielded the largest number of fishes of the three small canals sampled during 2005. As with the Jewett Canal sample, suckers numerically dominated the catch in the Fruitland Diversion Canal comprising 68% (n=328) of the total catch. This canal was the only one to produce each of the following three species: Colorado pikeminnow (n=19), white sucker (n=1), and western mosquitofish (n=1). It also yielded almost five times the number of specked dace (N=118) taken collectively at the other two canals. Nine of the 10 species collected in this canal were represented by wild YOY individuals. The exception was Colorado pikeminnow which was represented by 19 captive-reared and stocked specimens 40-55 mm SL. All 19 Colorado pikeminnow were taken during the 2 November 2005 sampling effort; at least one was taken at each of the three Fruitland sampling sites. One of the aforementioned individuals carried a green VIE tag. The largest fish collected in this canal were flannelmouth sucker (139 mm SL) and bluehead sucker (135 mm SL).

Colorado pikeminnow

The 140 Colorado pikeminnow taken in the Hogback Diversion Canal during 2004 were collected in sections 2 (N=27), 3 (N=83), 6 (N=26) and 7 (N=4; Table 8). Pikeminnow collected ranged in length from 42 mm to 315 mm TL (33 mm to 264 mm SL; Figure 10). Eleven of the Colorado pikeminnow taken were post age-0 individuals >150 mm TL (162 mm to 315 mm TL; 130 mm to 264 mm SL) with the largest specimen being 315 mm TL (Appendix B). Three of the post age-0 pikeminnow were PIT tagged (441E521F4B, 441E41576B, 441F105A69). While all pit tagged pikeminnow were collected in Section 2, the 11 VIE tagged age-0 pikeminnow were taken in sections 2, 4, and 6. Age-0 Colorado pikeminnow (N=129) ranged in length from 42 mm to 79 mm TL (33 mm to 65 mm SL). A single 29 October 2004 collection in Section 4 at canal mile 8.6 yielded 83 age-0 Colorado pikeminnow, five of which were marked with a green VIE tag; the largest single collection of this species during this study (Table 8).

There were about 280,000 YOY Colorado pikeminnow stocked in 2004, most of which were potentially available to entrainment in the Hogback Diversion Canal (Table 9). The source of the eleven 2004 green VIE tagged fish was a stocking of 20,000 individuals on 21 October 2004 between the APS Weir (RM159.2) and Hogback Diversion (RM 163.7) by BIO-WEST (Table x). Eight of the 11 tagged fish were collected one week after release while the other three were taken seven weeks after release. It is not known if these latter three fish had been in the canal during the seven week period or if they had recently been entrained.

In 2005, there were 61 Colorado pikeminnow taken in the Hogback Diversion Canal. While none of these specimens contained a PIT tag, two were marked with green VIE tags. Both of the aforementioned specimens were collected on 21 November 2005 in Section 2 (Subsection 4). All except two (97%) of the 2005 Hogback Colorado pikeminnow were taken on 21 November with specimens exhibiting a clumped versus random distribution. Individual samples of 12, 13, and 30 Colorado pikeminnow were taken.

Table 8. Summary of all 2004-2005 Colorado pikeminnow collections (n=201) from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6	SECTION 7
01-02 Oct 2004 (n)	8	-	-	-	-	-
Length Range TL	162-315 mm	-	-	-	-	-
Length Range SL	130-264 mm	-	-	-	-	-
PIT Tag #	441E521F4B	-	-	-	-	-
Green VIE Tag	-	-	-	-	-	-
28-29 Oct 2004 (n)	-	-	83	-	26	4
Length Range TL	-	54-227 mm	-	42-64 mm	47-61 mm	-
Length Range SL	-	32-187 mm	-	33-51 mm	37-49 mm	-
PIT Tag #	-	-	-	-	-	-
Green VIE Tag	-	-	5	-	3	0
14 Dec 2004 (n)	19	-	-	-	-	-
Length Range TL	46-301 mm	-	-	-	-	-
Length Range SL	35-257 mm	-	-	-	-	-
PIT Tag #	441E41576B 441F105A69	-	-	-	-	-
Green VIE Tag	3	-	-	-	-	-
01 Oct 2005 (n)	2	-	-	-	-	-
Length Range TL	159-184 mm	-	-	-	-	-
Length Range SL	126-146 mm	-	-	-	-	-
PIT Tag #	-	-	-	-	-	-
Green VIE Tag	-	-	-	-	-	-
21 Nov 2005 (n)	47	-	-	-	-	-
Length Range TL	59-171 mm	-	-	-	-	-
Length Range SL	42-142 mm	-	-	-	-	-
PIT Tag #	-	-	-	-	-	-
Green VIE Tag	2	-	-	-	-	-
21 Nov 2005 (n)	-	12	-	-	-	-
Length Range TL	-	59-75 mm	-	-	-	-
Length Range SL	-	41-60 mm	-	-	-	-
PIT Tag #	-	-	-	-	-	-
Green VIE Tag	-	-	-	-	-	-
TOTAL	76	12	83	0	26	4

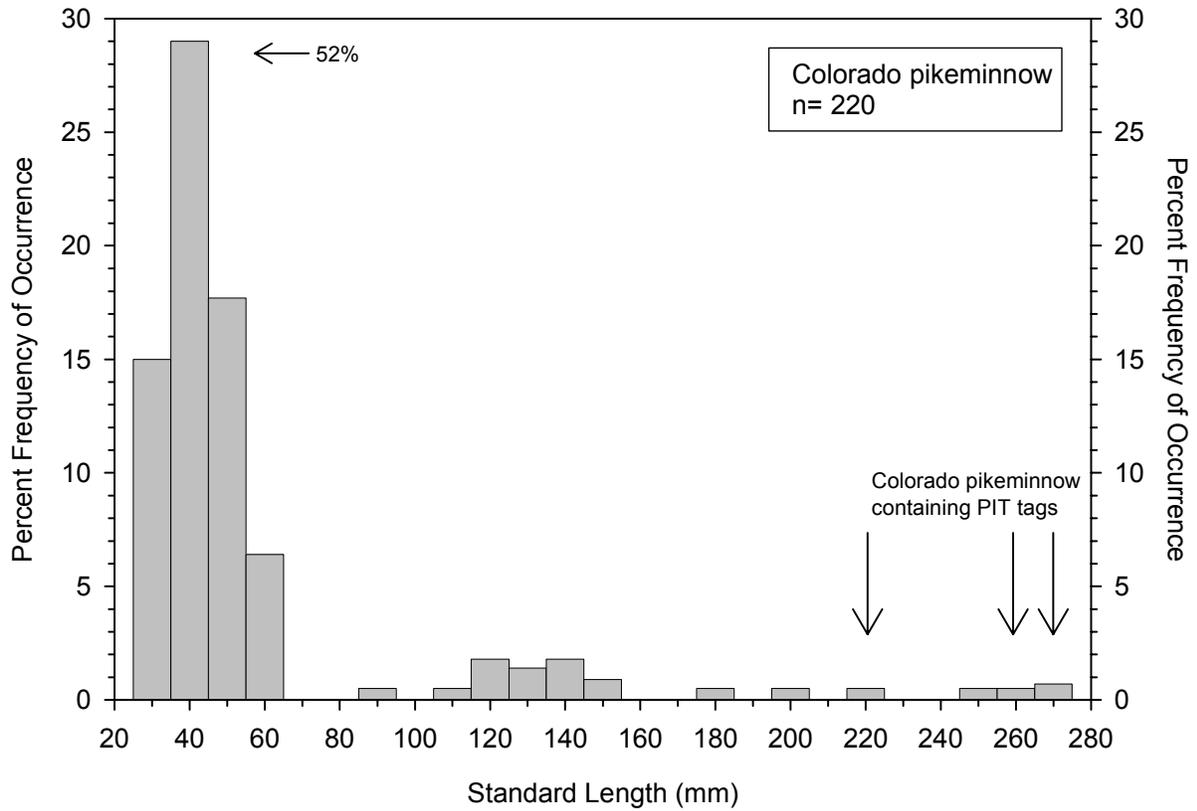


Figure 10. Length frequency distribution of Colorado pikeminnow collected in the Hogback Diversion Canal System during 2004-2005 and Fruitland Irrigation Canal during 2005.

Table 9. Responsible entity, date, location, and number of YOY Colorado pikeminnow stocked in the San Juan River in 2004 and 2005 (Copied from Golden et al. 2006).

AGENCY	LOCATION	RIVER MILES	N
21 October 2004			
U.S. Fish and Wildlife Service	Animas Confluence to Hatch Trading Post	180.2-169.5	60,000
BIO-WEST	Fruitland Diversion to Lower Valley Lion's Club	175.6-174.0	10,000
BIO-WEST	APS Weir to Hogback Diversion	159.2-163.7	20,000 *
U.S. Fish and Wildlife Service	Hogback Diversion to Shiprock	159.2-147.9	50,000
28 October 2004			
U.S. Fish and Wildlife Service	Animas Confluence to Hatch Trading Post	180.2-169.5	100,000
U.S. Fish and Wildlife Service	Hogback Diversion to Shiprock	159.2-147.9	40,000
20 October 2005			
U.S. Fish and Wildlife Service	Animas Confluence to Hatch Trading Post	180.2-169.5	80,500
BIO-WEST	Side Channel below Fruitland Diversion	175.8	6,000 *
BIO-WEST	Side Channel above PNM Weir	167.5-167.4	14,000 *
U.S. Fish and Wildlife Service	Hogback Diversion to Shiprock	159.2-147.9	34,550
3 November 2005			
U.S. Fish and Wildlife Service	Animas Confluence to Hatch Trading Post	180.2-169.5	52,600
U.S. Fish and Wildlife Service	Hogback Diversion to Shiprock	159.2-147.9	115,120

* = Colorado pikeminnow marked with green VIE tag

A total of about 302,200 YOY Colorado pike minnow were stocked in the San Juan River during 2005. The source of the green VIE tagged specimens was a 20 October 2005 release of pikeminnow between River Miles 167.4-175.8. The absence of flow in the Hogback Canal during the 21-22 November 2005 sampling effort (end of irrigation season) combined with low air temperatures resulted in surface water freezing throughout the canal and ice over 50 mm thick in many pools. At least three of the Colorado pikeminnow collected in November 2005 were found dead and frozen in the ice (Section 3).

The source of the 19 Colorado pikeminnow taken in the Fruitland Irrigation Canal on 2 November 2005 was likely the 80,500 fish released by U.S. Fish and Wildlife Service on 20 October 2005 between the Animas-San Juan River confluence and Hatch Trading Post. Their other 2005 release (3 November) was accomplished after completion of our sampling efforts. The vast majority of the Fruitland Irrigation Canal catch was the site near in the middle reach of the canal. Unlike the Colorado pikeminnow in the Hogback Irrigation Canal which (in 2005) ranged in length from 42-146 mm SL, the specimens in the Fruitland Irrigation Canal were all about the same size (40-55 mm SL).

Discussion

The initial purpose of this study was to investigate the ichthyofaunal assemblages in the Hogback Diversion Canal for the purposes of determining if Colorado pikeminnow or razorback sucker were being entrained into the canal and, with those results, evaluate the need to screen the intake of the facility. Within one day of the initiation of sampling in the canal, eight large (162-315 mm SL) Colorado pikeminnow were taken within four miles of the headgates indicating that entrainment was in fact an issue and screening of the facility was necessary. By the end of the first year (of a two year effort), the stranding of numerous Colorado pikeminnow in the canal at the cessation of irrigation season provided the evidence necessary to initiate the process of screening for the facility. Collection efforts in the canal during the second year of the study were meant to refine the information acquired during the first sampling season and continue the search for entrained razorback sucker. The discovery of such relatively large numbers of Colorado pikeminnow in the canal prompted the San Juan River Recovery Implementation Program Biology Committee to add to the original study an investigate the ichthyofaunal composition of three smaller (i.e., volume of flow \leq to 100 cfs) irrigation diversion canals in the study area (Fruitland Irrigation, Jewett Valley, and Farmers Mutual canals).

There were very marked differences in both the ichthyofaunal composition and relative abundance by size class of fishes in the two separate types of canals. The fish community of the upstream most sections of the Hogback Diversion Canal was characterized by small-bodied (i.e., maximum size <100 mm TL), short-lived (2-5 years) fishes such as red shiner and speckled dace. While these two species were distributed downstream throughout the canal but were generally rare except in the upstream-most reaches. The numbers and size classes of the small-bodied fishes taken in the Hogback Diversion Canal suggested that multiple cohorts were being entrained and that they were likely reproducing in the system. Large-bodied (>150 mm TL), long-lived fishes like flannelmouth sucker and bluehead sucker were also present in several size classes but there was not the presence of YOY fishes as there were with red shiner, fathead minnow, and speckled dace. The design of the canal was such that fish collected in downstream reaches (from Section 2 onward) of the Hogback Diversion Canal had little chance of being able to return to the river. The further downstream one moved, the less likely the opportunity to return to the river.

The great variety of size classes (from 10 mm TL to >350 mm TL) of fish present in the canal indicate that fishes at the extremes of the size scale were both there by accident (small fish - involuntarily entrained) and choice (large fish - possessed swimming ability to avoid entrainment). It is not possible to ascertain whether moderate-sized fishes such as age 1-3 sucker (>100 mm TL) were involuntarily transported into the canal or had chosen to follow the flow. Regardless, the ultimate fate of fishes, no matter their size, in the Hogback

Diversion Canal was the same. The numerous pools present throughout the expansive diversion system after the cessation of flow were subjected to evaporation, freezing and rapid deterioration of water quality all which resulted in death to fish prior to the reinitiation of flow the following irrigation season. Most of the stocked Colorado pikeminnow collected were taken in the aforementioned pools soon after flow ceased. It is unlikely that we were able to collect all of the Colorado pikeminnow present, even under the advantageous sampling conditions of low flow and isolated pools.

The fish community of the three smaller canals were numerically dominated by post age-0 native fishes. Speckled dace, flannelmouth sucker, and bluehead sucker were over 90% of the catch in the two largest (Fruitland Irrigation and Jewett Valley) of the three canals. It is noteworthy that red shiner was absent from the those two canals and represented by only one specimen in the Farmers Mutual Canal. Conversely, over 8,000 red shiner were taken in the Hogback Diversion Canal comprising over 70% of the catch in that system. The composition and abundance of these two groups of fishes best characterize the differences in ichthyofaunal composition between the two canal types. Fishes in the smaller canals were either small-bodied benthic taxa readily able to adapt to fast flowing waters (speckled dace) or small sized age-classes of large-bodied benthic species (flannelmouth sucker and bluehead sucker) also known to inhabit high velocity waters. Both groups of fishes could pass between the canal and mainstem river as long as there were not structural barriers to their dispersal. High flow (water velocity), lack of crevice habitats, and habitat homogeneity of the three small canals likely precluded its use by red shiner and fathead minnow.

The presence of 19 Colorado pikeminnow in the Fruitland Irrigation Canal in November 2005 suggest that these fish either chose to explore this non-mainstem habitats or were involuntarily swept into the canal. If this had been a random act, one would have expected to find only one or two (versus 19) individuals present in the canal. Ultimately, issues of entrainment of stocked fishes in the smaller canals can most easily be averted by timing stocking efforts to occur after the cessation of diversion activities.

Acknowledgments

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A New Mexico scientific collecting permit for fishes (# 1896: permit to S. P. Platania) was issued by the New Mexico Department of Game and Fish (NMGF). Access to the study site was provided by the Navajo Nation. Mr. Marlin Saggboy, Irrigation Supervisor, Shiprock Irrigation District, provided information about and access to the Hogback Diversion Canal system. Keller-Bliesner Engineering provided contact information and updates on the flow conditions in the San Juan River and Hogback Diversion Canal.

Literature Cited

- Carter, K.L. and J. P. Reader. 2000. Patterns of drift and power station entrainment of 0+ fish in the River Trent, England. *Fisheries Management and Ecology* 7:447-464.
- Edinger, J.E. and V.S. Kolluru. 2000. Power plant intake entrainment analysis. *Journal of Energy Engineering* 126:1-14.
- Golden, M.E., P.H. Holden, and B. Albrecht. 2006. Retention, growth, and habitat use of Colorado pikeminnow stocked as age 0 fish in the San Juan River from 2002-2005. Report to the San Juan River Basin Recovery Implementation Program Biology Committee, April 2006. 171 pp.
- Hallock, R.J. and W.F. Van Woert. 1959. A survey of anadromous fish losses in irrigation diversions from the Sacramento and San Joaquin Rivers. *California Fish and Game* 45:227-266.
- Hutcheson, K. 1970. A test for comparing diversities based on the Shannon formula. *Journal of Theoretical Biology* 29:151-154.
- Irving, D.B. and T. Modde. 2000. Home-range fidelity and use of historic habitat by adult Colorado pikeminnow (*Ptychocheilus lucius*) in the White River, Colorado and Utah. *Western North American Naturalist* 60:16-25.
- Jensen, A.L., S.A. Spigarelli, and M.M. Thommes. 1982. Use of conventional fishery model to assess entrainment and impingement of three Lake Michigan fish species. *Transactions of the American Fisheries Society* 111:21-34.
- Karp, C.A. and G. Mueller. 2002. Razorback sucker movements and habitat use in the San Juan River inflow, Lake Powell, Utah, 1995-1997. *Western North American Naturalist* 62:106-111.
- McKinley, S., G. Van der Kraak, G. Power. 1998. Seasonal migrations and reproductive patterns in the lake sturgeon, *Acipenser fulvescens*, in the vicinity of hydroelectric stations in northern Ontario. *Environmental Biology of Fishes* 51:245-256.
- National Marine Fisheries Service (NMFS). 1994. NMFS Southwest Region position paper on experimental technology for managing downstream salmonid passage. Experimental fish guidance devices: Position statement of National Marine Fisheries Service, Southwest Region. 7 pp.
- Tyus, H.M. and C. A. Karp. 1990. Spawning and movements of razorback sucker, *Xyrauchen texanus*, in the Green River basin of Colorado and Utah. *Southwestern Naturalist* 35:427-433.
- Tyus, H.M. and C. W. McAda. 1984. Migration, movements and habitat preferences of Colorado squawfish, *Ptychocheilus lucius*, in the Green, White, and Yampa rivers, Colorado and Utah. *Southwestern Naturalist* 29:289-299.
- U.S. Bureau of Reclamation. 2003. Endangered fish passage project at the Grand Valley Project Diversion Dam and fish screen in the Government Highline Canal. Final Environmental Assessment, Upper Colorado Region, Western Colorado Area Office, Grand Junction, Colorado. 59 pp.
-

Zar, J. H. 1984. *Biostatistical Analysis* (2nd edition). Prentice Hall, Englewood Cliffs, New Jersey. 718 pp.

Appendix A. Delineation of 2004-2005 Hogback Diversion Canal (San Juan River, New Mexico)
fish entrainment study sections (Sections correspond to Figure 4).

<u>Section #</u>	<u>Locality Descriptor</u>
SECTION 1	Settling Basin (0.4 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 0.0 to 0.4 miles downstream of the Hogback Diversion Structure
4069355	Northing 719887 Easting Upper boundary of the Section
4069203	Northing 719268 Easting Lower boundary of the Section
SECTION 2	Pump Station (3.4 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 0.4 to 3.4 miles downstream of the Hogback Diversion Structure
4069203	Northing 719268 Easting Upper boundary of the Section
4071444	Northing 714689 Easting Lower boundary of the Section
SECTION 3	Eagles Nest (0.3 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 3.9 to 4.2 miles downstream of the Hogback Diversion Structure
4071444	Northing 714689 Easting Upper boundary of the Section
4071742	Northing 714311 Easting Lower boundary of the Section
SECTION 4	Bakers Arroyo (4.4 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 4.2 to 8.6 miles downstream of the Hogback Diversion Structure
4071742	Northing 714311 Easting Upper boundary of the Section
4074015	Northing 708167 Easting Lower boundary of the Section
SECTION 5	Shiprock (3.3 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 8.7 to 12.0 miles downstream of the Hogback Diversion Structure
4074052	Northing 708102 Easting Upper boundary of the Section
4077314	Northing 705226 Easting Lower boundary of the Section
SECTION 6	Salt Creek Wash (2.6 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 12.3 to 14.9 miles downstream of the Hogback Diversion Structure
4077623	Northing 705069 Easting Upper boundary of the Section
4080032	Northing 703385 Easting Lower boundary of the Section
SECTION 7	Yellow Arroyo (3.3 canal miles long)
	New Mexico, San Juan County, Hogback Diversion Canal, from 15.1 to 18.4 miles downstream of the Hogback Diversion Structure
4080335	Northing 703173 Easting Upper boundary of the Section
4084171	Northing 700398 Easting Lower boundary of the Section

Appendix A. continued.

<u>Section #</u>	<u>Locality Descriptor</u>			
SECTION 8	Malpais Arroyo (2.7 canal miles long)			
	New Mexico, San Juan County, Hogback Diversion Canal, from 19.5 to 22.2 miles downstream of the Hogback Diversion Structure			
4084587	Northing	699388	Easting	Upper boundary of the Section
4086185	Northing	696220	Easting	Lower boundary of the Section
SECTION 9	Canal Creek (3.3 canal miles long)			
	New Mexico, San Juan County, Hogback Diversion Canal, from 22.6 to 25.9 miles downstream of the Hogback Diversion Structure			
4086406	Northing	695910	Easting	Upper boundary of the Section
4088913	Northing	691957	Easting	Lower boundary of the Section

Appendix B. Summary of Colorado pikeminnow collected in the Hogback Diversion Canal, San Juan River, during 2004-2005 and the Farmers Mutual, Jewitt Valley, and Fruitland canals during 2005.

Field Number	Number Collected	Total Length (mm)	Standard Length (mm)	Body Mass (gms)	Tag Information	Date Collected	Section Collected	Canal Mile
2004 TOTAL	140							
LER04-002	3	165	130	20	----	02 Oct 2004	2.6	3.6
		164	133	20	----	02 Oct 2004	2.6	3.6
		184	154	50	----	02 Oct 2004	2.6	3.6
LER04-003	4	315	264	270	441E521F4B	02 Oct 2004	2.5	---
		260	210	140	----	02 Oct 2004	2.5	---
		196	157	60	----	02 Oct 2004	2.5	---
		168	134	30	----	02 Oct 2004	2.5	---
LER04-006	1	162	130	30	----	02 Oct 2004	2.2	---
LER04-008	1	---	40	---	----	28 Oct 2004	7	17.8
LER04-009	3	47	37	0.5	----	28 Oct 2004	7	17.7
		58	45	1	----	28 Oct 2004	7	---
		61	49	1.1	----	28 Oct 2004	7	---
LER04-010	26	42	33	---	----	28 Oct 2004	6	---
		43	37	---	----	28 Oct 2004	6	---
		47	37	---	----	28 Oct 2004	6	---
		---	38	---	----	28 Oct 2004	6	---
		---	40	---	----	28 Oct 2004	6	---
		---	41	---	----	28 Oct 2004	6	---
		---	41	---	----	28 Oct 2004	6	---
		---	41	---	----	28 Oct 2004	6	---
		---	41	---	----	28 Oct 2004	6	---
		---	42	---	----	28 Oct 2004	6	---
		---	42	---	----	28 Oct 2004	6	---
		---	42	---	----	28 Oct 2004	6	---
		---	42	---	----	28 Oct 2004	6	---
		---	43	---	----	28 Oct 2004	6	---
		---	44	---	green VIE tag	28 Oct 2004	6	---
		---	44	---	----	28 Oct 2004	6	---
		---	44	---	----	28 Oct 2004	6	---
		---	44	---	----	28 Oct 2004	6	---
		---	45	---	green VIE tag	28 Oct 2004	6	---
		---	45	---	----	28 Oct 2004	6	---
		---	46	---	green VIE tag	28 Oct 2004	6	---
		---	46	---	----	28 Oct 2004	6	---
		---	46	---	----	28 Oct 2004	6	---
		---	46	---	----	28 Oct 2004	6	---
		---	48	---	----	28 Oct 2004	6	---
		---	49	---	----	28 Oct 2004	6	---
		---	50	---	----	28 Oct 2004	6	---
		---	51	---	----	28 Oct 2004	6	---
		---	51	---	----	28 Oct 2004	6	---

Appendix B. continued.

Field Number	Number Collected	Total Length (mm)	Standard Length (mm)	Body Mass (gms)	Tag Information	Date Collected	Section Collected	Canal Mile	
LER04-012	83	55	32	----	----	29 Oct 2004	4	8.6	
		54	32	----	----	29 Oct 2004	4	8.6	
		44	35	----	green VIE tag	29 Oct 2004	4	8.6	
		---	35	----	----	29 Oct 2004	4	8.6	
		---	36	----	----	29 Oct 2004	4	8.6	
		---	37	----	----	29 Oct 2004	4	8.6	
		49	38	----	----	29 Oct 2004	4	8.6	
		---	38	----	----	29 Oct 2004	4	8.6	
		---	38	----	----	29 Oct 2004	4	8.6	
		---	38	----	----	29 Oct 2004	4	8.6	
		---	38	----	----	29 Oct 2004	4	8.6	
		---	38	----	----	29 Oct 2004	4	8.6	
		---	38	----	----	29 Oct 2004	4	8.6	
		---	39	----	----	29 Oct 2004	4	8.6	
		---	39	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	40	----	----	29 Oct 2004	4	8.6	
		---	41	----	----	29 Oct 2004	4	8.6	
		---	41	----	----	29 Oct 2004	4	8.6	
		---	41	----	----	29 Oct 2004	4	8.6	
		---	41	----	----	29 Oct 2004	4	8.6	
		---	54	42	----	----	29 Oct 2004	4	8.6
		---	42	42	----	green VIE tag	29 Oct 2004	4	8.6
		---	42	42	----	green VIE tag	29 Oct 2004	4	8.6
		---	42	42	----	----	29 Oct 2004	4	8.6
		---	42	42	----	----	29 Oct 2004	4	8.6
		---	42	42	----	----	29 Oct 2004	4	8.6
		---	42	42	----	----	29 Oct 2004	4	8.6
		---	42	42	----	----	29 Oct 2004	4	8.6
		---	42	42	----	----	29 Oct 2004	4	8.6
---	42	42	----	----	29 Oct 2004	4	8.6		
---	42	42	----	----	29 Oct 2004	4	8.6		
---	42	42	----	----	29 Oct 2004	4	8.6		
---	42	42	----	----	29 Oct 2004	4	8.6		
---	42	42	----	----	29 Oct 2004	4	8.6		
---	42	42	----	----	29 Oct 2004	4	8.6		
---	55	43	----	----	29 Oct 2004	4	8.6		
---	---	43	----	----	29 Oct 2004	4	8.6		
---	---	43	----	----	29 Oct 2004	4	8.6		
---	---	43	----	----	29 Oct 2004	4	8.6		
---	---	43	----	----	29 Oct 2004	4	8.6		
---	---	43	----	----	29 Oct 2004	4	8.6		

Appendix B. continued.

Field Number	Number Collected	Total Length (mm)	Standard Length (mm)	Body Mass (gms)	Tag Information	Date Collected	Section Collected	Canal Mile	
LER04-012		---	43	----	----	29 Oct 2004	4	8.6	
		---	43	----	----	29 Oct 2004	4	8.6	
		---	43	----	----	29 Oct 2004	4	8.6	
		---	43	----	----	29 Oct 2004	4	8.6	
		57	44	----	----	green VIE tag	29 Oct 2004	4	8.6
		56	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	green VIE tag	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	44	----	----	----	29 Oct 2004	4	8.6
		---	45	----	----	----	29 Oct 2004	4	8.6
		---	45	----	----	----	29 Oct 2004	4	8.6
		---	45	----	----	----	29 Oct 2004	4	8.6
		---	45	----	----	----	29 Oct 2004	4	8.6
		---	46	----	----	----	29 Oct 2004	4	8.6
		---	46	----	----	----	29 Oct 2004	4	8.6
		---	46	----	----	----	29 Oct 2004	4	8.6
		---	46	----	----	----	29 Oct 2004	4	8.6
		---	46	----	----	----	29 Oct 2004	4	8.6
		---	47	----	----	----	29 Oct 2004	4	8.6
		---	47	----	----	----	29 Oct 2004	4	8.6
		---	47	----	----	----	29 Oct 2004	4	8.6
		---	48	----	----	----	29 Oct 2004	4	8.6
		---	48	----	----	----	29 Oct 2004	4	8.6
		---	49	----	----	----	29 Oct 2004	4	8.6
		---	50	----	----	----	29 Oct 2004	4	8.6
		---	51	----	----	----	29 Oct 2004	4	8.6
		---	51	----	----	----	29 Oct 2004	4	8.6
		---	51	----	----	----	29 Oct 2004	4	8.6
	---	54	----	----	----	29 Oct 2004	4	8.6	
	---	55	----	----	----	29 Oct 2004	4	8.6	
	---	62	----	----	----	29 Oct 2004	4	8.6	
	227	187	100	----	----	29 Oct 2004	4	7.7	
LER04-014	12	47	40	----	----	14 Dec 2004	2.5	---	
		52	42	----	----	14 Dec 2004	2.5	---	
		52	41	----	----	14 Dec 2004	2.5	---	
		53	41	----	----	14 Dec 2004	2.5	---	
		54	45	----	----	green VIE tag	14 Dec 2004	2.5	---
		54	42	----	----	----	14 Dec 2004	2.5	---
		54	40	----	----	----	14 Dec 2004	2.5	---
		56	44	----	----	----	14 Dec 2004	2.5	---
		58	44	----	----	----	14 Dec 2004	2.5	---

Appendix B. continued.

Field Number	Number Collected	Total Length (mm)	Standard Length (mm)	Body Mass (gms)	Tag Information	Date Collected	Section Collected	Canal Mile
LER04-014		60	45	----	green VIE tag	14 Dec 2004	2.5	---
		61	49	----	----	14 Dec 2004	2.5	---
		79	65	----	----	14 Dec 2004	2.5	---
LER04-015	2	269	224	150	441E41576B	14 Dec 2004	2.4	---
		301	257	220	441F105A69	14 Dec 2004	2.4	---
LER04-017	5	46	35	----	----	14 Dec 2004	2.1	---
		52	40	----	----	14 Dec 2004	2.1	---
		63	50	----	----	14 Dec 2004	2.1	---
		65	52	----	green VIE tag	14 Dec 2004	2.1	---
		66	50	----	----	14 Dec 2004	2.1	---
2005 TOTAL80 (61 in the Hogback Canal and 19 in the Fruitland Canal)								
LER05-015	2	184	146	30	----	01 Oct 2005	2.4	---
		159	126	20	----	01 Oct 2005	2.4	---
LER05-034	13	171	142	35	----	21 Nov 2005	2.4	---
		168	141	30	----	21 Nov 2005	2.4	---
		171	142	40	----	21 Nov 2005	2.4	---
		151	132	25	----	21 Nov 2005	2.4	---
		148	126	----	----	21 Nov 2005	2.4	---
		137	116	----	----	21 Nov 2005	2.4	---
		119	99	----	----	21 Nov 2005	2.4	---
		67	52	----	green VIE tag	21 Nov 2005	2.4	---
		70	55	----	----	21 Nov 2005	2.4	---
		59	45	----	----	21 Nov 2005	2.4	---
		63	49	----	----	21 Nov 2005	2.4	---
		69	46	----	----	21 Nov 2005	2.4	---
		70	54	----	----	21 Nov 2005	2.4	---
		30	42 to 68	----	-one green VIE tag	21 Nov 2005	2.4	---
LER05-032	1	61	46	----	----	21 Nov 2005	2.1	---
LER05-035 frozen in ice	3	68	54	----	----	21 Nov 2005	2.1	---
LER05-036	12	41 to 60	----	----	----	21 Nov 2005	3.x	---
Fruitland								
LER05-024	1	62	51	----	----	02 Nov 2005		---
LER05-026	17	57-71	40-55	----	----	02 Nov 2005		---
LER05-028 (DOA)	1	54	42	----	----	02 Nov 2005		---

Appendix C.

Summary of 2004-2005 Hogback Diversion Canal
fish collection results by sampling trip and ontogenetic stage

Table C-1. Summary of all 2004 fish collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	5,348	64.4	15	83.3
common carp	I	2	**	2	11.1
fathead minnow	I	150	1.8	14	77.7
Colorado pikeminnow	N	140	1.6	10	55.5
speckled dace	N	1,844	22.2	16	88.8
SUCKERS					
white sucker	I	8	**	5	27.7
flannelmouth sucker	N	448	5.3	17	94.4
bluehead sucker	N	318	3.8	16	88.8
BULLHEAD CATFISHES					
black bullhead	I	2	**	2	11.1
channel catfish	I	3	**	2	11.1
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	31	0.3	7	38.8
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	1	**	1	5.5
largemouth bass	I	9	0.1	6	33.3
TOTAL		8,304			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=18 samples.

** <0.1%

Table C-2. Summary of 2004 large-bodied fish (ca. > 140 mm TL) collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	11	4.1	5	27.7
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	202	77.0	8	44.4
bluehead sucker	N	47	17.9	9	50
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	0.7	1	5.5
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		262			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=18 samples.

Table C-3. Summary of 2004 small-bodied fish collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	5,348	66.5	15	83.3
common carp	I	2	**	2	11.1
fathead minnow	I	150	1.8	14	77.7
Colorado pikeminnow	N	129	1.6	6	33.3
speckled dace	N	1,844	22.9	16	88.8
SUCKERS					
white sucker	I	8	**	5	27.7
flannelmouth sucker	N	246	3.0	16	88.8
bluehead sucker	N	271	3.3	15	83.3
BULLHEAD CATFISHES					
black bullhead	I	2	**	2	11.1
channel catfish	I	1	**	1	5.5
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	31	0.3	7	38.8
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	1	**	1	5.5
largemouth bass	I	9	0.1	6	33.3
TOTAL		8,042			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=18 samples.

** <0.1%

Table C-4. Summary of the 1st 2004 Hogback Diversion Canal, San Juan River drainage, New Mexico, fish sampling effort (01-02 October 2004).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	4,150	69.1	6	100.0
common carp	I	1	**	1	16.6
fathead minnow	I	77	1.2	6	100.0
Colorado pikeminnow	N	8	0.1	3	50.0
speckled dace	N	1,299	21.5	6	100.0
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	252	4.2	6	100.0
bluehead sucker	N	174	2.9	6	100.0
BULLHEAD CATFISHES					
black bullhead	I	1	**	1	16.6
channel catfish	I	3	0.5	2	33.3
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	28	0.4	5	83.3
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	1	**	1	16.6
largemouth bass	I	6	0.1	3	50.0
TOTAL		6,000			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

** <0.1%

Table C-5. Summary of the large-bodied fish from the 1st 2004 Hogback Diversion Canal, San Juan River drainage, New Mexico (01-02 October 2004).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	8	4.9	3	50.0
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	118	72.3	5	83.3
bluehead sucker	N	35	21.4	5	83.3
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	1.2	1	16.6
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		163			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

Table C-6. Summary of the small-bodied fish from the 1st 2004 Hogback Diversion Canal, San Juan River drainage, New Mexico (01-02 October 2004).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	4,150	71.0	6	100.0
common carp	I	1	**	1	16.6
fathead minnow	I	77	1.3	6	100.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	1,299	22.2	6	100.0
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	134	2.2	6	100.0
bluehead sucker	N	139	2.3	6	100.0
BULLHEAD CATFISHES					
black bullhead	I	1	**	1	16.6
channel catfish	I	1	**	1	16.6
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	28	0.4	5	83.3
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	1	**	1	16.6
largemouth bass	I	6	0.1	3	50.0
TOTAL		5,837			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

** <0.1%

Table C-7. Summary of the 2nd Hogback Diversion Canal, San Juan River drainage, New Mexico, fish sampling effort (28-29 October 2004 and 14-15 December 2004).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	1,198	51.9	9	75.0
common carp	I	1	**	1	8.3
fathead minnow	I	73	3.1	8	66.6
Colorado pikeminnow	N	132	5.7	7	58.3
speckled dace	N	545	23.6	10	83.3
SUCKERS					
white sucker	I	8	0.3	5	41.6
flannelmouth sucker	N	196	8.5	11	91.6
bluehead sucker	N	144	6.2	10	83.3
BULLHEAD CATFISHES					
black bullhead	I	1	**	1	8.3
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	3	0.1	2	16.6
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	3	0.1	3	25.0
TOTAL		2,304			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=12 samples.

** <0.1%

Table C-8. Summary of the large-bodied fish from the 2nd 2004 Hogback Diversion Canal, San Juan River drainage, New Mexico (28-29 October 2004 and 14-15 December 2004).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	3	3.0	2	16.6
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	84	84.8	3	25.0
bluehead sucker	N	12	12.1	4	33.3
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		99			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=12 samples.

Table C-9. Summary of the small-bodied fish from the 2nd 2004 Hogback Diversion Canal, San Juan River drainage, New Mexico (28-29 October 2004 and 14-15 December 2004).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	1,198	54.3	9	75.0
common carp	I	1	**	1	8.3
fathead minnow	I	73	3.3	8	66.6
Colorado pikeminnow	N	129	5.8	6	50.0
speckled dace	N	545	24.7	10	83.3
SUCKERS					
white sucker	I	8	0.3	5	41.6
flannelmouth sucker	N	112	5.0	10	83.3
bluehead sucker	N	132	5.9	9	75.0
BULLHEAD CATFISHES					
black bullhead	I	1	**	1	8.3
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	3	0.1	2	16.6
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	3	0.1	3	25.0
TOTAL		2,205			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=12 samples.

** <0.1%

Table C-10. Summary of all 2005 fish collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	2,661	86.0	14	93.3
common carp	I	2	**	1	6.7
fathead minnow	I	105	3.4	9	60.0
Colorado pikeminnow	N	59	1.9	5	33.3
speckled dace	N	100	3.2	13	86.7
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	93	3.0	13	86.7
bluehead sucker	N	60	1.9	8	53.3
BULLHEAD CATFISHES					
black bullhead	I	1	**	1	6.7
channel catfish	I	2	0.1	2	13.3
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	5	0.2	3	20.0
SUNFISHES					
green sunfish	I	7	0.2	3	20.0
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		3,095			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=15 samples.

** <0.1%

Table C-11. Summary of 2005 large-bodied fish (ca. > 140 mm TL) collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	6	12.0	2	13.3
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	32	64.0	7	46.7
bluehead sucker	N	9	18.0	3	20.0
BULLHEAD CATFISHES					
black bullhead	I	1	2.0	1	6.7
channel catfish	I	2	4.0	2	13.3
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		50			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=15 samples.

Table C-12. Summary of 2005 small-bodied fish collections from the Hogback Diversion Canal, San Juan River drainage, New Mexico.

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	2,661	87.4	14	93.3
common carp	I	2	0.1	1	6.7
fathead minnow	I	105	3.4	9	60.0
Colorado pikeminnow	N	53	1.7	4	26.7
speckled dace	N	100	3.3	13	86.7
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	61	2.0	12	80.0
bluehead sucker	N	51	1.7	8	53.3
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	5	0.2	3	20.0
SUNFISHES					
green sunfish	I	7	0.2	3	20.0
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		3,045			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=15 samples.

Table C-13. Summary of the 1st 2005 Hogback Diversion Canal, San Juan River drainage, New Mexico, fish sampling effort (30 September - 02 October 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	212	64.8	9	100.0
common carp	I	2	0.6	1	11.1
fathead minnow	I	8	2.5	4	44.4
Colorado pikeminnow	N	2	0.6	1	11.1
speckled dace	N	40	12.2	8	88.9
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	42	12.8	8	88.9
bluehead sucker	N	16	4.9	6	66.7
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	0.6	2	22.2
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	1	0.3	1	11.1
SUNFISHES					
green sunfish	I	2	0.6	1	11.1
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		327			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=9 samples.

Table C-14. Summary of the large-bodied fish from the 1st 2005 Hogback Diversion Canal, San Juan River drainage, New Mexico (30 September - 02 October 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	2	20.0	1	11.1
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	5	50.0	3	33.3
bluehead sucker	N	1	10.0	1	11.1
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	2	20.0	2	22.2
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		10			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=9 samples.

Table C-15. Summary of the small-bodied fish from the 1st 2005 Hogback Diversion Canal, San Juan River drainage, New Mexico (30 September - 02 October 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	212	68.9	9	100.0
common carp	I	2	0.6	1	11.1
fathead minnow	I	8	2.5	4	44.4
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	40	12.6	8	88.9
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	37	11.7	8	88.9
bluehead sucker	N	15	4.7	6	66.7
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	1	0.3	1	11.1
SUNFISHES					
green sunfish	I	2	0.6	1	11.1
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		317			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=9 samples.

Table C-16. Summary of the 2nd 2005 Hogback Diversion Canal, San Juan River drainage, New Mexico, fish sampling effort (21-22 November 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	2,449	88.5	5	83.3
common carp	I	-	-	-	-
fathead minnow	I	97	3.5	5	83.3
Colorado pikeminnow	N	57	2.1	4	66.7
speckled dace	N	60	2.2	5	83.3
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	51	2.2	5	83.3
bluehead sucker	N	44	1.6	2	33.3
BULLHEAD CATFISHES					
black bullhead	I	1	**	1	16.7
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	4	0.1	2	33.3
SUNFISHES					
green sunfish	I	5	0.2	2	33.3
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		2,768			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

** <0.1%

Table C-17. Summary of the large-bodied fish from the 2nd 2005 Hogback Diversion Canal, San Juan River drainage, New Mexico (21-22 November 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	-	-	-	-
Colorado pikeminnow	N	4	10.0	1	16.7
speckled dace	N	-	-	-	-
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	27	67.5	4	66.7
bluehead sucker	N	8	20.0	2	33.3
BULLHEAD CATFISHES					
black bullhead	I	1	2.5	1	16.7
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		40			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

Table C-18. Summary of the small-bodied fish from the 2nd 2005 Hogback Diversion Canal, San Juan River drainage, New Mexico (21-22 November 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	2,449	89.8	5	83.3
common carp	I	-	-	-	-
fathead minnow	I	97	3.6	5	83.3
Colorado pikeminnow	N	53	1.9	4	66.7
speckled dace	N	60	2.2	5	83.3
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	24	0.9	4	66.7
bluehead sucker	N	36	1.3	2	33.3
BULLHEAD CATFISHES					
black bullhead	I	-	-	-	-
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	4	0.2	2	33.3
SUNFISHES					
green sunfish	I	5	0.2	2	33.3
bluegill	I	-	-	-	-
largemouth bass	I	-	-	-	-
TOTAL		2,728			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

Table C-19. Summary of fish from the Farmers Mutual Canal, San Juan River drainage, New Mexico, during 2005 (10 August 2005 and 01 November 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	1	2.6	1	16.7
common carp	I	-	-	-	-
fathead minnow	I	2	5.1	2	33.3
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	7	18.0	3	50.0
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	9	23.1	3	50.0
bluehead sucker	N	3	7.7	2	33.3
BULLHEAD CATFISHES					
black bullhead	I	1	2.6	1	16.7
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	1	2.6	1	16.7
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	-	-	-	-
bluegill	I	-	-	-	-
largemouth bass	I	15	-	-	-
TOTAL		39			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=6 samples.

Table C-20. Summary of fish from the Fruitland Diversion Canal, San Juan River drainage, New Mexico, during 2005 (11 August 2005 and 02 November 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	-	-	-	-
fathead minnow	I	5	1.0	2	20.0
Colorado pikeminnow	N	19	4.0	3	30.0
speckled dace	N	118	24.6	7	70.0
SUCKERS					
white sucker	I	1	0.2	1	10.0
flannelmouth sucker	N	186	38.8	7	70.0
bluehead sucker	N	141	29.4	7	70.0
BULLHEAD CATFISHES					
black bullhead	I	1	0.2	1	10.0
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	-	-	-	-
LIVEBEARERS					
western mosquitofish	I	1	0.2	1	10.0
SUNFISHES					
green sunfish	I	1	0.2	1	10.0
bluegill	I	-	-	-	-
largemouth bass	I	6	1.3	3	30.0
TOTAL		479			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=10 samples.

Table C-21. Summary of fish from the Jewett Canal, San Juan River drainage, New Mexico, during 2005 (12 August 2005 and 03 November 2005).

SPECIES	RESIDENCE STATUS ¹	TOTAL NUMBER OF SPECIMENS	PERCENT OF % OF TOTAL	FREQUENCY OF OCCURRENCE ²	% FREQUENCY OF OCCURRENCE ²
CARPS AND MINNOWS					
red shiner	I	-	-	-	-
common carp	I	2	1.1	1	20.0
fathead minnow	I	2	1.1	1	20.0
Colorado pikeminnow	N	-	-	-	-
speckled dace	N	19	10.6	4	80.0
SUCKERS					
white sucker	I	-	-	-	-
flannelmouth sucker	N	54	30.0	4	80.0
bluehead sucker	N	83	46.1	2	40.0
BULLHEAD CATFISHES					
black bullhead	I	3	1.7	2	40.0
channel catfish	I	-	-	-	-
TROUTS AND SALMONS					
brown trout	I	1	0.6	1	20.0
LIVEBEARERS					
western mosquitofish	I	-	-	-	-
SUNFISHES					
green sunfish	I	1	0.6	1	20.0
bluegill	I	-	-	-	-
largemouth bass	I	1	0.6	1	20.0
TOTAL		166			

¹ N = native; I = introduced

² Frequency and % frequency of occurrence are based on n=5 samples.

Table C-22. Summary of all 2004 fish collections, by sampling section, from the Hogback Diversion Canal, San Juan River drainage, New Mexico. See Figure 3 for Section designations.

SPECIES	SECTION 2	SECTION 4	SECTION 5	SECTION 6	SECTION 7	SECTION 8
CARPS AND MINNOWS						
red shiner	5,223	17	4	28	63	13
common carp	1	-	-	1	-	-
fathead minnow	122	1	-	6	16	5
Colorado pikeminnow	27	83	-	26	4	-
speckled dace	1,753	54	20	10	4	3
SUCKERS						
white sucker	5	-	1	-	2	-
flannelmouth sucker	367	47	12	11	8	3
bluehead sucker	215	42	23	6	25	7
BULLHEAD CATFISHES						
black bullhead	2	-	-	-	-	-
channel catfish	3	-	-	-	-	-
TROUTS AND SALMONS						
brown trout	-	-	-	-	-	-
LIVEBEARERS						
western mosquitofish	28	-	-	2	1	-
SUNFISHES						
green sunfish	-	-	-	-	-	-
bluegill	1	-	-	-	-	-
largemouth bass	6	1	-	1	1	-
TOTAL (n=8,304)	7,753	245	60	91	124	31
% TOTAL BY SECTION	93.4	3.0	0.7	1.1	1.5	0.4

Table C-23. Summary of all 2005 fish collections, by sampling section, from the Hogback Diversion Canal, San Juan River drainage, New Mexico. See Figure 3 for Section designations.

SPECIES	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6	SECTION 7
CARPS AND MINNOWS						
red shiner	2,609	35	14	2	1	-
common carp	2	-	-	-	-	-
fathead minnow	100	-	-	4	1	-
Colorado pikeminnow	46	-	-	13	-	-
speckled dace	87	10	2	1	-	-
SUCKERS						
white sucker	-	-	-	-	-	-
flannelmouth sucker	89	-	2	1	1	-
bluehead sucker	54	-	2	4	-	-
BULLHEAD CATFISHES						
black bullhead	-	-	-	-	-	-
channel catfish	3	-	-	-	-	-
TROUTS AND SALMONS						
brown trout	-	-	-	-	-	-
LIVEBEARERS						
western mosquitofish	5	-	-	-	-	-
SUNFISHES						
green sunfish	6	-	-	1	-	-
bluegill	-	-	-	-	-	-
largemouth bass	-	-	-	-	-	-
TOTAL (n=3,095)	3,001	45	20	26	3	-
% TOTAL BY SECTION	97.0	1.5	0.6	0.8	0.1	-