

An evaluation of fish entrainment into the Maybell Ditch
on the Yampa River, Colorado, 2007 and 2008.

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EXECUTIVE SUMMARY

The Maybell Ditch is a gravity-fed diversion ditch in the Yampa River within occupied habitat for adult Colorado pikeminnow *Ptychocheilus lucius*, a federally listed endangered fish species. The objective of this study was to determine if Colorado pikeminnow or other fish are entrained in the Maybell Ditch. The ditch is approximately 12 miles (19 km) long and the uppermost 1.4 miles (2.2 km) was sampled for fish. The ditch was sampled with a bank electrofisher mounted in a canoe during two days in October, 2007 and with hoop nets set along ditch margins from June 19 through July 11, 2008. Sampling totaled 3.6 hours of electrofishing effort and 1,341 hours of hoop net sets.

Results in 2007 showed that fish from the river were entrained into the Maybell Ditch at the end of the irrigation season in October, although no Colorado pikeminnow were captured. Eight fish species and 702 individuals or approximately 500 fish per mile were captured. Four nonnative species comprised 99% of the fish collected and included smallmouth bass *Micropterus dolomieu* (88%), white sucker *Catostomus commersonii* (8%), common carp *Cyprinus carpio* (2%), and creek chub *Semotilus atromaculatus* (1%). Only two native fish, both bluehead suckers *Catostomus discobolus*, were captured. The composition of fish species collected in the ditch was similar to the composition of fish species currently found in the river upstream of the ditch. Smallmouth bass were the most abundant species in both the ditch and the river.

Results in 2008 showed that adult roundtail chub *Gila robusta* were entrained in the Maybell Ditch during the migration period for Colorado pikeminnow. Both roundtail chub and Colorado pikeminnow are cyprinid species, share a common morphology, and occupy similar habitat; therefore, occurrence of large adult roundtail chub in the Maybell Ditch suggests that the more rare Colorado pikeminnow could also be entrained in the ditch. In addition, the lengths of the two roundtail (482 and 498 mm total length) captured in the ditch were similar to lengths of Colorado pikeminnow in the Yampa

River. No large fish of a size similar to the size of Colorado pikeminnow were caught during low-flow sampling but that is expected because there was no suitable habitat in the ditch to provide refuge for large fish.

No endangered fish were captured during sampling in 2007 and 2008, but those results are not conclusive regarding occupancy of Maybell Ditch by endangered fishes because the ability to detect the presence of Colorado pikeminnow and other taxa was low. Sampling was hindered because sampling occurred only during a short portion of the migratory season, the ditch was drained and refilled during sampling in 2008, and the area sampled during spring migration had high velocity with few velocity breaks that could serve as refuge for large fish such as Colorado pikeminnow suggesting that large-bodied fish entrained in the ditch would not remain for extended periods in the portion of the ditch that was sampled. To determine whether Colorado pikeminnow are entrained in the Maybell Ditch during their migration will require a more rigorous approach.

Uncertainties not addressed by sampling:

1. It is uncertain whether Colorado pikeminnow are entrained in the Maybell Ditch.
2. It is uncertain whether large adult fish that are entrained into the Maybell Ditch remain in the high-velocity upstream portions of the ditch that were sampled or whether they move downstream to areas of lower velocity in the lower portions of the ditch.
3. It is uncertain whether entrained fish move out of the main ditch channel into secondary ditches or fields.
4. It is uncertain whether entrained fish can return to the river at the downstream ditch return.

Conclusions:

1. Colorado pikeminnow were not found in the ditch during sampling.
2. Large, adult roundtail chub, a species very similar to Colorado pikeminnow were entrained during the pikeminnow migration period.
3. Sampling methods and constraints limited the ability to detect large-bodied species such as Colorado pikeminnow.
4. Small-bodied fish were found in the ditch in October and their species composition was similar to the composition of small-bodied fish in the river.

Recommendations:

1. Install a temporary weir that would continuously sample incoming ditch flow for entrained large-bodied fish during the Colorado pikeminnow migration period.
2. If a weir is not feasible, continue with hoop net sampling with increased effort (more nets) and for a longer period of time during migration.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
List of Tables	v
List of Figures	v
ACKNOWLEDGMENTS	vi
INTRODUCTION	1
STUDY AREA	2
METHODS	3
RESULTS	4
DISCUSSION	6
CONCLUSIONS	10
RECOMMENDATIONS	10
LITERATURE CITED	11

List of Tables

Table

1	Sampling period and effort in the Maybell Ditch, Colorado, 2007 and 2008 . . .	14
2	Fish captured in the Maybell Ditch, Colorado, Oct 3 and 4, 2007	15
2	Comparison of relative abundance (% composition) of fishes collected in the Yampa River and Maybell Ditch	16

List of Figures

Figure

1	Sampling period of Maybell Ditch in relation to hydrograph and start of Colorado pikeminnow spawning migration in the Yampa River, 2007 and 2008	17
2	Length frequency of fish captured in the Maybell Ditch, October 3 and 4, 2007	18

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INTRODUCTION

The Maybell Ditch is a gravity-fed diversion canal on the Yampa River within critical habitat for Colorado pikeminnow *Ptychocheilus lucius*, a fish species federally listed as endangered under the Endangered Species Act (16 U.S.C. 1531–1544). The Upper Colorado River Endangered Fish Recovery Program (Fish Recovery Program) was established in 1988 by a multi-agency cooperative agreement that assigned it responsibility for recovering four endangered fishes in the Colorado River Basin while providing for new water development to proceed (USFWS 1987). The Fish Recovery Program has a Recovery Action Plan that identifies specific measures needed to recover the endangered fishes. For the Yampa River, the Recovery Action Plan requires determination of if the Maybell Ditch diversion impedes movement or entrains Colorado pikeminnow. These investigations were also recommended by the Yampa Management Plan and the Yampa Programmatic Biological Opinion (Roehm 2004; USFWS 2005).

Previous studies determined that the Maybell Ditch diversion dam structure did not impede passage of Colorado pikeminnow during their seasonal spawning migrations (Modde et al. 1999). This included movement of pikeminnow over the diversion dam when migrating downstream to spawning areas and when returning back upstream to overwinter areas.

The purpose of this study was to determine if Colorado pikeminnow or other fish are entrained in the Maybell Ditch. The Maybell Ditch is owned and operated by the Maybell Ditch Association and is mostly on private property. In 2007 and 2008, representatives from the Recovery Program and the Ditch Association met and signed a Memorandum of Understanding (MOU) that described the background, responsibilities, benefits, actions, and products of sampling the ditch for fish. In accordance with the MOU, all sampling would occur in the portion of the ditch on Bureau of Land Management (BLM) land between the head gate and the start of private property at the lower end of Juniper Canyon and in a manner that would not harm water use by ditch shareholders. The objective of this study was to determine if Colorado pikeminnow or other fish species are entrained in the Maybell Ditch and survive until the end of irrigation season.

Tasks:

1. Coordinate with Maybell Ditch Association officers to determine the best methods for access to the Maybell Ditch within BLM land.
2. Conduct a site survey of the Maybell Ditch on BLM land to determine sampling locations and whether there are pools that could retain fish.
3. In 2007, sample pools or flowing water in the Maybell Ditch on BLM land for 1–2 days after ditch flows are normally reduced in late summer to determine if fish are present.
4. In 2008, sample the Maybell Ditch for fish during post runoff flows in early summer when Colorado pikeminnow typically migrate past the head-gate structure.

All tasks were completed in 2007 and 2008.

STUDY AREA

The Maybell Ditch was constructed in 1896 to supply water to agricultural ranch land near Maybell, Colorado. It is maintained and operated by the Maybell Ditch Association and is structure # 694 in Water Division 6, Lower Yampa River, District 44 of the Colorado Division of Water Resources (CDSS 2006). It has a decreed amount of 129 cubic feet per second (cfs), but total diversion volume depends on river discharge. The ditch inlet structure is in Juniper Canyon on BLM land on the north bank and is constructed of concrete set into an earthen and rock berm with two adjustable head-gate valves set over two 4-ft. (1.2 m) culverts that control inflow into an earthen channel. The diversion dam consists of boulders piled across the river channel which create a class II-III rapid at runoff flows and impounds water upstream into Juniper Canyon. From the head gate at river mile 90.3 (km 146.3) the ditch follows the river approximately 0.9 mile (1.4 km) and then crosses to the south-side of the river in a steel flume suspended over the river. The ditch parallels the river another 0.7 mile (1.2 km) before leaving Juniper Canyon. The ditch continues through several ranches generally following Colorado highways 40 and 318 and returns flow to the Yampa River near river mile 74.5 (km

120.7) just upstream of Boston Flats, a State Land Board property. In the area sampled, the ditch channel was trough-like with a flat bed and steep sloping banks with a 14.5 ft (4.4 m) width. Substrate was sand and silt, with occasional rubble rock. Overhanging willows occurred along most of the ditch.

Depending on weather, ditch withdrawals typically begin the last week of April and continue until the first of October when they are reduced and maintained at lower levels primarily for livestock watering. Diversions to the ditch typically cease prior to the first hard freeze in early November and the ditch remains dry through winter.

METHODS

In 2007 ditch sampling occurred during the post-migration period for Colorado pikeminnow at the end of the irrigation season after flow was reduced to a level that allowed safe and efficient sampling. Sampling gear was a Coffelt VVP-15 bank electrofisher with 5000-watt gas generator mounted in a canoe with two, 8-inch (20-cm), anodes and a wire-grid trailing cathode. Anodes were held by two people, one along each bank, in front of the canoe, and the ditch area was sampled with a sweeping motion while moving slowly upstream. Two people netted fish beside or behind each person with an anode; a third netter also pulled the canoe upstream and sampled approximately 1.4 miles (2.2 km) of ditch downstream of the head gate.

In 2008, ditch sampling occurred between the head gate and the flume in late spring and early summer during a portion of the downstream spawning migration period for Colorado pikeminnow. Hoop nets with a 30 in (76 cm) square mouth were placed behind velocity breaks along ditch margins. Velocity was measured at the mouth of each net and maximum depth and velocity was measured in the ditch adjacent to each net.

To determine whether a small craft could safely navigate and sample the ditch, the ditch

was electrofished in an upstream direction using a small flat-bottomed jon-boat fitted with a 9.9 HP outboard and the same electrofishing gear described previously except it had a single 9- inch (23 cm) anode sphere extended out the front of the boat. A single netter sat in the front of the boat. Although shocking in an upstream direction is not efficient for catching fish, it was done because navigating the boat while shocking in a downstream direction was difficult and unsafe in the narrow channel.

Fish were held in water-filled buckets until full and then identified and measured (total length). Weights for individual fish were later estimated based on length-weight relationships derived from the same species collected in the Yampa River. Native fish captured in the ditch were relocated to the Yampa River. Northern pike *Esox lucius* to Loudy Simpson pond and smallmouth bass *Micropterus dolomieu* ≥ 10 inches (250 mm) were to be transported to Elkhead Reservoir; but no fish were transported because no northern pike were captured and smallmouth bass were all < 250 mm.

Mean daily discharge in the Yampa River was measured at the U.S. Geological Survey “near Maybell, Colorado” gage #09251000, 4-miles (6.4 km) downstream of the ditch head gate (USGS 2007).

RESULTS

Post-migration sampling occurred October 3 and 4, 2007 and totaled 3.6 hrs of bank electrofishing effort (Table 1). Yampa River flows ranged 627–798 cubic feet/sec (cfs) or 18–23 cubic meters/sec (cms) on those days (Figure 1). Ditch flows remained constant both days based on consistent readings of a height gage at the flume. Average water depth of the ditch was 1.6 ft (50 cm), maximum depth was 2.3 ft (70 cm), and velocity measured in the center of the ditch channel was 1 ft/sec (30.5 cm/sec). Secchi depth (water visibility) was 0.6 ft (17 cm). There were no pools of adequate depth to provide refuge for larger fish such as Colorado pikeminnow but there were a few rocks, bends, and bank constrictions that created velocity breaks suitable for smaller fish.

Ten fish species and a total of 702 individuals or approximately 500 fish per mile of ditch sampled were collected. No endangered fish were captured. Four nonnative fish species comprised 99% of all fish collected and included smallmouth bass *Micropterus dolomieu* (88%), white sucker *Catostomus commersonii*, (8%), common carp *Cyprinus carpio*, (2%), and creek chub *Semotilus atromaculatus*, (1%). Only two native fish, both bluehead suckers *Catostomus discobolus*, were captured (Table 2). Length of fish ranged from a 1-inch (28-mm) sand shiner *Notropis stramineus* to a 14 inch (350-mm) channel catfish *Ictalurus punctatus*. Smallmouth bass ranged from 2–10 inches (55–249 mm), but most bass were young-of-year or yearlings less than 5-inches (125 mm) long (Figure 1). Biomass of all fish was 32.4 lbs (14.7 kg) including 22.7 lbs (10.3 kg) of bass.

Summer sampling during the migration period of Colorado pikeminnow was by hoop netting and occurred on three occasions from June 19 through July 11 (Table 1). Yampa River flow ranged 2,220–8,830 cfs (63–250 cms) on sample days and peaked at 16,800 cfs (476 cms) on May 23 (Figure 1). Sampling was interrupted from about July 4–7, while the ditch flow was shut off and the ditch was drained to repair head gate damage caused by high spring flows. Most nets were set along ditch margins usually within velocity breaks located downstream of willow clumps or sharp bends. During summer sampling average depth in the ditch was 2.6 ft (0.8 m) and ranged 2.3–3.6 ft (0.7–1.1 m); average velocity was 3.3 ft/sec (1 m/sec). Velocity at net mouths averaged 1.3 ft/sec (0.4 m/sec) and ranged 0.6–2.6 ft/sec (0.2–0.8 m/sec). Between five and nine hoop nets were set on each sample occasion totaling of 1,341 hours of netting. Nets fished an average of 67 hours each and were checked every 2–23 hours for fish (Table 1). Boat electrofishing included 0.8 hours of effort on June 28.

In 2008, migration-period sampling started in mid June based water temperatures consistently greater than 54° F (12° C) and declining flow which are environmental conditions that often signal migratory movements by Colorado pikeminnow in the upper Yampa River (Figure 1). This date was consistent with the start of migration estimated

from back-calculation of days from July 23 when the first Colorado pikeminnow larvae was captured for the season (K. Bestgen, personal communication). Those fish were likely spawned about 14 days prior (7 days of incubation from spawning to hatch plus 7 days from hatch to emergence) on about July 9 (K. Bestgen personal communication). I estimated that Colorado pikeminnow began migratory movements around June 18, 3 weeks prior to spawning. In retrospect, using the same calculations, spawning migration in 2007 began on May 22 (Figure 1). This was based on a Colorado pikeminnow larvae that was captured on June 26 (Bestgen and Haines 2007).

Two fish were captured in hoop nets in 2008, both native roundtail chub *Gila robusta*. One was captured on June 19 and the other on June 26. The first was 19 in (482 mm) long with spawning coloration and tubercles and was tagged with 134.2 kHz PIT tag # 3D9-257-C6B-30CE. The other fish was 20 in (498 mm) long, weighed 2.9 lbs (1,325 grams), and was tagged with PIT tag # 3D9-257-C6B-3520. Both fish were released in the river. No fish were captured with boat electrofishing in summer, but the electrofishing unit was apparently not working correctly based on an inability of the unit to even stun two small fish that were observed but not caught.

DISCUSSION

Fish from the river were entrained in the Maybell Ditch, including two adult roundtail chub. Because of their similarities with Colorado pikeminnow, the occurrence of large adult roundtail chub in the Maybell Ditch suggests that Colorado pikeminnow could also be entrained in the ditch. Both species are members of the minnow family Cyprinidae and they are morphologically and behaviorally similar. They share a streamlined, fusiform body shape, piscivorous behavior, occupy similar habitat, and likely have similar swimming performance. The lengths of the two roundtail chub captured in the ditch were similar to lengths of Colorado pikeminnow in the Yampa River (Bestgen et al. 2007a). No large fish were caught of a size similar to the size of Colorado pikeminnow during low-flow sampling but that is expected because there were no pools of suitable

depth to hold larger fish like Colorado pikeminnow.

No endangered fish were captured during sampling in 2007 and 2008, but those results are not conclusive regarding occupancy of Maybell Ditch by endangered fishes because the ability to detect the presence of Colorado pikeminnow and other taxa was low. Sampling was hindered because sampling occurred only during a short portion of the migratory season, the ditch was drained and refilled during sampling in 2008, and the area sampled during spring migration had high velocity with few velocity breaks that could serve as refuge for large fish such as Colorado pikeminnow suggesting that large-bodied fish entrained in the ditch would not remain for extended periods in the portion of the ditch that was sampled. To determine whether Colorado pikeminnow are entrained in the Maybell Ditch during their migration will require a more rigorous approach.

The only endangered fish with potential for entrainment are adult Colorado pikeminnow that live upstream of the ditch inlet; none of the other three endangered fishes including razorback sucker *Xyrauchen texanus*, humpback chub *Gila cypha*, and bonytail *Gila elegans* live in this area of the Yampa River. Adult Colorado pikeminnow have the greatest potential for entrainment when they move past the inlet structure during their annual downstream migration to spawning areas in the lower 20 miles (32 km) of the Yampa River. Resident pikeminnow in Juniper Canyon are also a concern because of potential entrainment during localized non-migratory movements in the large pool above the inlet.

Radio-telemetry studies have shown that Colorado pikeminnow apparently avoided entrainment in the Maybell Ditch during downstream migrations but those telemetered fish represented only a small percentage of the population. From 1981 to 1983, 12 of 14 Colorado pikeminnow implanted with transmitters upstream of the Maybell Ditch migrated downstream and successfully navigated the ditch inlet without being entrained. Of the two remaining fish, one was a non-migrant and the other fish disappeared during the downstream migration period (Archer and Tyus 1984; Miller et al. 1982; Wick et al.

1983). There was no direct evidence that this fish was entrained in the ditch but it is one of several possible explanations for its disappearance. Other plausible explanations for disappearance of that fish include failure of the transmitter, the fish moving to an area not monitored for radio signals, the monitoring crew missing radio signals, or the fish captured and removed by a fisherman or predator.

Past telemetry data that show Colorado pikeminnow have the ability to avoid entrainment during the migratory period does not demonstrate conclusively that all migrating pikeminnow avoid entrainment. Determining whether Colorado pikeminnow are entrained at the Maybell Ditch will require a more rigorous approach such as continuous sampling of the ditch when pikeminnow are most likely to move past the ditch during their annual spawning migration. Spawning migrations for pikeminnow in the Yampa River typically begin in June or early July as summer flows decline and water temperatures increase (Tyus 1990). These movements start about a month after spring peak runoff and occur earlier in low-water years and later in high water years based on mean annual flow and water temperatures (Bestgen et al. 1998; Tyus 1990). After spawning, Colorado pikeminnow typically return to their former residence to overwinter until the next annual migration (Tyus 1990). Pikeminnow that live upstream of the ditch inlet must pass the inlet structure annually as many as 10–15 times during their lifetime and therefore have many opportunities for entrainment into the ditch. Thus entrainment of even a even if a small portion of all migrates each year could have population-level effects.

Fish that were captured in the ditch most likely originated in the river because it is unlikely that fish overwintered and survived after ditch flow was shut off the previous year. Every winter the ditch inlet is closed and the ditch dries up or freezes, preventing overwintering of fish in the ditch. The fate of fish entrained in the ditch was not determined including if fish moved downstream to lower portions of the ditch, were entrained into lateral ditches, or moved downstream through the ditch back to the river.

Although the river immediately upstream of the ditch head gate was not sampled in this study, the small-bodied fish community in Juniper Canyon was probably similar to that observed by Bestgen et al. (2007b) farther upstream; therefore, the fish community in the ditch in October 2007 was similar to that in the river, further supporting entrainment of fish by the ditch. Shoreline sampling in the Yampa River, 10-20 miles upstream of the head gate in September and October, 2006, collected 17 fish species and one hybrid and the small-bodied fish community was dominated by smallmouth bass and other nonnative fishes (Bestgen et al. 2007b). Only 10 species and one hybrid were collected in the Maybell Ditch including eight species that occurred in the river and two species, bluehead sucker and channel catfish, not collected in the river (Table 3). Nonnative species dominated both areas, led by smallmouth bass, but sand shiner (*Notropis stramineus*) and black bullhead (*Ameiurus melas*) which were abundant in the river, were rare in the ditch. Based on boat electrofishing in Juniper Canyon, large-bodied fishes immediately upstream of the head gate include Colorado pikeminnow, roundtail chub, flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker, white sucker, smallmouth bass, northern pike, and channel catfish (L. Martin, personal communication).

It would be reasonable to assume that more small native fish would be entrained during late summer if their numbers were higher in the river upstream of the ditch inlet. But, smallmouth bass were the most abundant species in both the ditch and the river and the lack of native fish in the ditch reflects that few native fish currently occupy that portion of the river. It was notable that fish captured in the ditch were mostly smaller than 5 inches (125 mm) and did not include larger fish that I would expect to find immediately upstream in the river. However, the scarcity of fish larger than 5 inches (125 mm) in the area of the ditch sampled in October 2007 may be due to larger fish avoiding the inlet, having greater swimming speed to avoid entrainment, or moving downstream in the ditch out of the portion of ditch that was sampled.

Uncertainties not addressed by sampling:

1. It is uncertain whether Colorado pikeminnow are entrained in the Maybell Ditch.
2. It is uncertain whether large adult fish that are entrained into the Maybell Ditch remain in the high-velocity upstream portions of the ditch that were sampled or whether they move downstream to areas of lower velocity in the lower portions of the ditch.
3. It is uncertain whether entrained fish move out of the main ditch channel into secondary ditches or fields.
4. It is uncertain whether entrained fish can return to the river at the downstream ditch return.

CONCLUSIONS

1. Colorado pikeminnow were not found in the ditch during sampling.
2. Large, adult roundtail chub, a species very similar to Colorado pikeminnow were entrained during the pikeminnow migration period.
3. Sampling methods and constraints limited the ability to detect large-bodied species such as Colorado pikeminnow.
4. Small-bodied fish were found in the ditch in October and their species composition was similar to the composition of small-bodied fish in the river.

RECOMMENDATIONS

1. Install a temporary weir that would continuously sample incoming ditch flow for entrained large-bodied fish during the Colorado pikeminnow migration period.
2. If a weir is not feasible, continue with hoop net sampling with increased effort (more nets) and for a longer period of time during migration.

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Table 1— Sampling period and effort in the Maybell Ditch, Colorado, 2007 and 2008.

Collection dates	Yampa River flow (cfs)	time of sampling	sampling gear	# samples	hours of effort	# fish
<u>2007</u>						
Oct 3–4	627–798		EL-canoe	<u>2</u>	3.6	702
<u>2008</u>						
June 19	8830		hoop net	5	136	1
June 25–30	5360–6960		hoop net	9	981	1
<u>July 9–11</u>	2110–2620		hoop net	<u>6</u>	<u>314</u>	<u>0</u>
Total				20	1,341	2
June 28			EL-boat	1	0.8	0

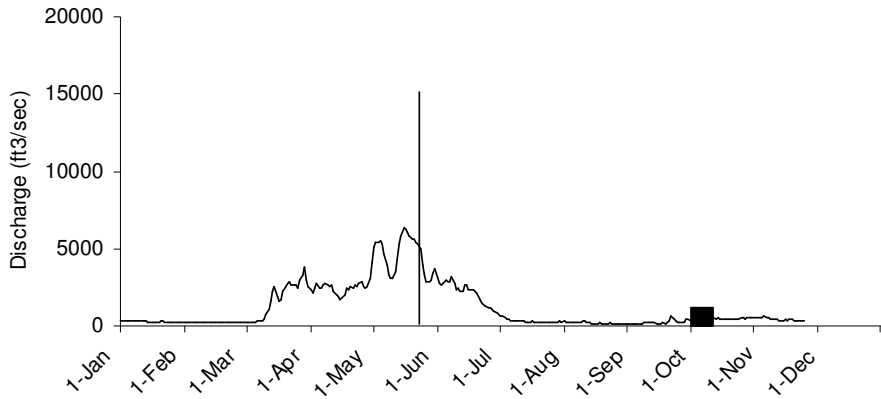
Table 2. Fish captured in the Maybell Ditch, Colorado, October 3 and 4, 2007.

	# fish	Relative	Biomass		Total Length (mm)
		abundance	kg	lbs	Average (range)
		%			
<u>Nonnative Species</u>					
smallmouth bass	618	88	10.3	22.7	94 (55–249)
white sucker ¹	54	8	2.4	5.2	147 (102–220)
common carp	16	2	1.3	2.9	152 (90–212)
creek chub	7	1	0.2	0.3	127 (96–146)
black bullhead	1	0.1	<0.1	<0.1	54
black crappie	1	0.1	<0.1	0.1	143
channel catfish	1	0.1	<0.1	0.9	350
iowa darter	1	0.1	<0.1	<0.1	55
sand shiner	1	0.1	<0.1	<0.1	28
<u>Native species</u>					
bluehead sucker	2	0.3	0.1	0.2	153 (146–160)
Total	702		14.7	32.4	

¹ Includes one flannelmouth x white sucker hybrid

Table 3. Comparison of relative abundance (% composition) of fishes collected in the Yampa River and Maybell Ditch. River collections from Table 6 in Bestgen et al. (2007b).

species	Yampa River	Maybell Ditch
smallmouth bass	51	88
sand shiner	16	0.1
black bullhead	14	0.1
white sucker	12	8
fathead minnow	3	0
iowa darter	1	0.1
creek chub	1	1
brook stickleback	0.7	0
common carp	0.4	2
flannelmouth sucker	0.1	0
roundtail chub	0.1	0
speckled dace	0.1	0
bluegill	0.1	0
green sunfish	0.1	0
northern pike	0.1	0
white x flannelmouth sucker hybrid	<0.1	<0.1
black crappie	<0.1	0.1
pumpkinseed	<0.1	0
bluehead sucker	0	0.3
channel catfish	0	0.1
Total fish sampled	10,059	702



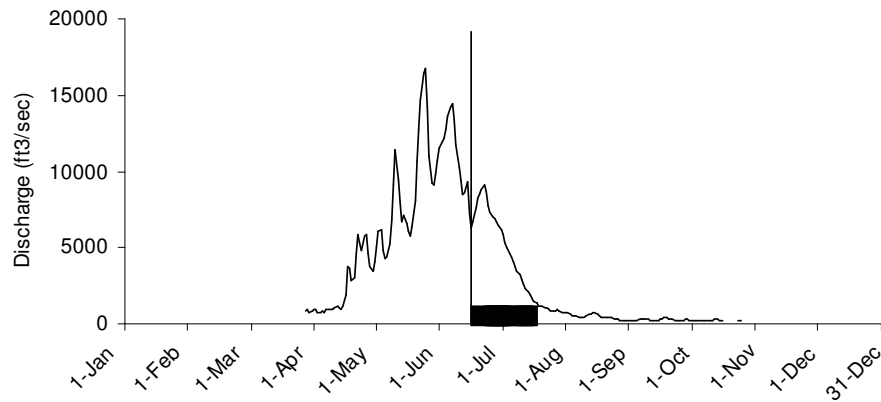
2007

estimated migration start:

May 22

sample period:

October 3–4



2008

estimated migration start:

June 18

sample period:

June 19–July 11

Figure 1. Sampling period of Maybell Ditch in relation to hydrograph and estimated start of Colorado pikeminnow spawning migration in the Yampa River, 2007 and 2008. Vertical line denotes estimated start of migration movement based on back-calculation of dates from occurrence of first Colorado pikeminnow larvae collected downstream of the spawning bar. Dark bars represent sampling period.

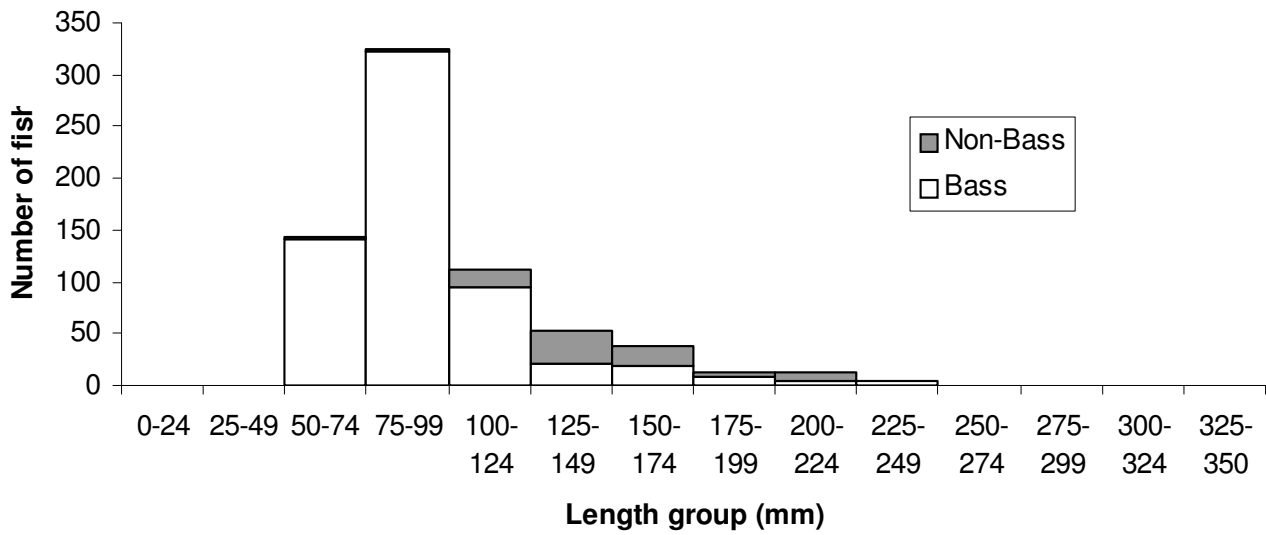


Figure 2. Length frequency of fish captured in the Maybell Ditch, October 3 and 4, 2007.