COLORADO RIVER RECOVERY PROGRAM RECOVERY PROGRAM
FY 2011 ANNUAL PROJECT REPORT PROJECT NUMBER: FR- 115

I. Project Title: Cumulative Effects of Flaming Gorge Dam Releases, since 1996, on the Fish Community in Lodore and Whirlpool canyons, Green River.

II. Principal Investigator(s):

Lead Agency: Larval Fish Laboratory, Department of Fish, Wildlife, and Conservation Biology, Colorado State University; Bureau of Reclamation; U.S. Fish and Wildlife Service

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Date: 14 November 2011

III. Project Summary: The primary purpose of this study is to determine the cumulative effect that flow and temperature regimes have had on the fish community of the Green River in Lodore and Whirlpool canyons and recommend how to monitor effects into the future. A secondary purpose is to determine the distribution of the humpback chub population in Whirlpool Canyon to serve as the basis for future monitoring efforts. Future monitoring (i.e. population estimation), if deemed necessary, will be needed to evaluate the contribution of the Whirlpool Canyon population of humpback chub to the overall recovery of the species. A third purpose is to remove non-native fishes present in the study reach. A portion of that work is devoted to better understanding the reproductive ecology of smallmouth bass in the Green River study area. This will be accomplished by collection of young-of-year smallmouth bass, and analysis of otolith microstructure. This will allow determination of hatching dates of bass relative to streamflow and water temperature patterns, information that may be useful to understand

if flow releases from Flaming Gorge Dam may be useful to disadvantage smallmouth bass in the study area. Information gathered will be used to evaluate whether flow and temperature regimes from Flaming Gorge Dam are benefitting endangered fishes in the Green River without causing adverse changes in abundance of non-native fishes.

IV. Study Schedule: 2002-unknown.

V. Relationship to RIPRAP:

Green River Action Plan: Mainstem.

II.D. Evaluate and revise as needed, flow regimes to benefit endangered fish populations.

VI. Accomplishment of FY 2011 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

Task 1: Thermographs

Thermograph data will be provided by Ms. Carrie Cordova, U.S. Fish and Wildlife Service, Lakewood, and by Utah State University, at up to 10 other localities in the Green River. We assisted with data collection by removing thermographs from the river on a special trip in November. The Green River upstream of the Yampa River experienced a relatively cool thermal regime in 2008-2011, when water temperatures exceeded 20°C for just a few days each summer (Figure 1). This is comparison to the warmer 2007, when mean daily minima in summer often approached 20°C, and daytime highs reached 25°C on several occasions. Water temperatures in summer 2011 were even cooler than in 2008-2010 (Fig.1).

Task 2: Sample main channel fish community (large-bodied fishes).

We completed two electrofishing trips through the study area in 2011, as prescribed in the study proposal. We reported on data collected through 2006 in a summary report, data entry and verification is complete for 2007-2011.

A total of 11 native species, 19 nonnative species, and several hybrids have been collected in the study area by all sampling gears in the period 2002-2011 (Tables 1-2). The most species are captured by electrofishing, followed by seining, and trammel netting.

Abundance patterns of native fish in the entire study area that were captured in electrofishing samples beginning in 1994-1996 reflected a variably dynamic community for both non-native as well as native fishes (Table 2, Figure 3). For example, non-native

brown trout abundance, with the exception of 2008 was consistent and relatively high in Lodore Canyon but had relatively low abundance in Whirlpool Canyon (except 2008 at Jones Creek). Channel catfish reached a peak in abundance in both Lodore and Whirlpool canyons in the 2005-2008 period but have declined rather dramatically since that time including in 2011, the lowest year on record in Whirlpool Canyon; note the relatively low 1994-1996 abundance in Lodore Canyon as the lowest in the period of record, but only slightly higher than 2011. Common carp abundance appears to be declining in both reaches over time at a slow rate; catch rates are reduced by at least 50% in each reach since first samples were collected. Northern pike abundance was low overall but highest in Lodore Canyon and variable; most pike in Lodore Canyon are captured in the lowermost 8 km. Pike have low abundance in Whirlpool Canyon; Browns Park pike removal efforts in 2011is discussed more extensively below.

Smallmouth bass abundance in Lodore and Whirlpool canyons showed similar and declining trends since 2009; highest abundance in Whirlpool Canyon was in 2005-2007, and highest abundance in Lodore Canyon was in 2009. Abundance declines in Whirlpool since 2007 may reflect substantially increased removal effort beginning in that year, but declines in each reach may be due to strong environmental effects as well, especially in Lodore where removal effort is relatively low (two passes per year compared to up to 15) and also to lack of recent high recruitment. These comparative data will be useful to assess relative effects of removal and environmental influences on smallmouth bass populations. White sucker abundance was increasing in Lodore and Whirlpool canyons through 2009, with subsequent declines in 2010 and 2011. With the exception of 2008, white suckers in Whirlpool Canyon were relatively uncommon.

Bluehead sucker abundance is higher in Whirlpool than Lodore Canyon and abundance declined in each reach until 2009 or 2010; abundance increased slightly in 2011 but was lower in each reach than historical sample levels. Colorado pikeminnow abundance has been variable and relatively low over the study period, but increased in 2010 in each reach and then declined again in 2011. The finding of pikeminnow in upstream Vermillion Creek is discussed below. Flannelmouth sucker abundance, the most common large-bodied native fish in the study area, showed variable abundance patterns over time among reaches. In Whirlpool it was very abundant until 2008 and has since declined every year through 2011. Abundance of flannelmouth suckers in Lodore Canyon, especially since 2002, has been stable and in 2011 was higher than Whirlpool Canyon for the first time. Mountain whitefish has increase rather dramatically in the study area since about 2008 until 2010, but declined in each reach in 2011.

Abundance of all chub species declined rather dramatically, especially since 2002-2004, although Whirlpool abundance has increased slightly in 2010 and 2011. Those patterns were also reflected by trammel net sampling. In 2011, we captured 10 chubs by trammel netting in Whirlpool Canyon, and six were previously tagged (one in 2006 and thought to be a humpback chub). One chub captured and tagged in 2003 was also recaptured upstream in Yampa Canyon in summer 2011. These low patterns have resulted in spite of relatively good production of young in the last few years.

High flows in the Green River downstream of Flaming Gorge Dam but upstream of the Yampa River created an opportunity for Larval Fish Laboratory personnel to conduct additional sampling for non-native northern pike *Esox lucius* in spring 2011 in Browns Park. Typically only smaller pike are captured in seine samples taken in backwaters in July and September at Swinging Bridge near the Colorado-Utah state line. Their continued presence motivated additional floodplain sampling during high flows in May and June and many large pike, some exceeding three feet in length (n=22, 11-39 inches, 271-984 mm) were captured and removed; all were from a relatively restricted area about 1 mile long. During that sampling, two adult Colorado pikeminnow *Ptychocheilus lucius* were captured, one by angling and another in a trap net. This was unusual because pikeminnow are rare in the 56 mile reach between Flaming Gorge Dam and the upstream end of Lodore Canyon which includes the Swinging Bridge area.

Finding Colorado pikeminnow motivated additional Green River sampling in Browns Park National Wildlife Refuge on the 21-22 June via boat electrofishing. Two crews sampled from Swinging Bridge downstream 14 miles to Vermillion Creek, a tributary to the Green River a short distance upstream of the boundary of Dinosaur National Monument. One adult pikeminnow was captured near Crook Campground. High Green River flows also allowed access to the lower end of Vermillion Creek, where an additional 8 adult pikeminnow (23-27 inches, 595-692 mm total length,) were captured; at least three more were observed but not captured. In all, only five pikeminnow had been previously tagged and two of those were tags with number series that have not been used for many years, which may indicate that those fish reside in that section of the Green River for substantial periods of the year. Vermillion Creek, a relatively small, turbid, and low flow system, was relatively warm at 72°F (22°C) compared to the Green River (48°F, 9°C); several individual pikeminnow were tuberculate (nearing reproductive readiness) likely because of the warm water. Very high densities of suckers, both native flannelmouth sucker *Catostomus latipinnis*, non-native white sucker *Catostomus commersonii*, and their hybrids, were also captured. High reproductive condition for pikeminnow was not expected because of high, late, and cold flows and because pikeminnow in the downstream Yampa River did not spawn until late July in 2011. High flows benefitted sampling efforts because of increased access to important habitats. Findings also supported the importance of floodplain wetlands and flooded tributary mouths for enhancing condition of endangered fishes like Colorado pikeminnow. Results of Browns Park sampling in 2011 and in prior years will be presented at the Non-native fish workshop in December 2011.

Table 1.—Tentative list of fishes captured in the Green River, from Browns Park downstream to Rainbow Park with electrofishing, trammel nets, and seining, 2002-2011. N = native, I = introduced.

Species	Status	Electrofishing	Trammel netting	Seining
Mountain whitefish	N	X		X
Humpback chub	N	X	X	
Bonytail [1]	N	X	X	X
Roundtail chub	N	X	X	X
Colorado pikeminnow	N	X	X	X
Speckled dace	N	X		X
Bluehead sucker	N	X	X	X
Flannelmouth sucker	N	X	X	X
Razorback sucker	N	X		
Mountain sucker	N			X
Mottled sculpin	N	X		X
Cutthroat trout	I	X		
Brook trout	I	X		
Rainbow trout	I	X	X	
Brown trout	I	X	X	
Northern pike	I	X		X
Red shiner	I	X		X
Common carp	I	X	X	X
Creek chub	I			X
Fathead minnow	I			X
Sand shiner	I			X
Redside shiner	I	X		X
White sucker	I	X	X	X
WS x FM		X	X	
FM x BH		X		
WS x BH		X		
RZB x FM		X		X
Channel catfish	I	X	X	X
Black bullhead	I	X		X
Black crappie	I	X		X
Bluegill	I	X		X
Green sunfish	I	X		X
Smallmouth bass	I	X	X	X
Walleye	I	X		
Iowa darter	I			X

[1] Stocked fish.

Table 2.—Percent composition of fishes captured in Lodore and Whirlpool canyons, Green River, Colorado and Utah, in three periods, 2002-2004, 2005-2007, and 2008-2010, and 2011captured with raft electrofishing gear. Effort is in hours of electrofishing.

	% Abundance							
	2002-2004		2005-2007		2008-2010		2011	
Species	Lodore	Whirlpool	Lodore	Whirlpool	Lodore	Whirlpool	Lodore	Whirlpool
mountain whitefish	1.7	0.3	3.6	0.8	12.7	9.0	5.7	3.1
humpback chub	0	<0.1	0	0	0	0	0	0
bonytail	0	1.6	0	0.2	0	0	0	0
roundtail chub	0.2	1.0	0.1	0.2	0.1	0.2	0.2	0.7
Colorado pikeminnow	0.3	0.4	0.2	0.4	0.2	0.2	0.5	0.2
speckled dace	0.3	0.1	0.4	<0.1	0.6	0.6	0.2	0.9
bluehead sucker	12.6	25.2	11.7	22.8	5.7	23.9	9.0	33.5
flannelmouth sucker	23.3	26.8	24.7	28.9	20.4	28.7	31.0	30.9
mountain sucker	0	0	0	0	0	0	0	0
razorback sucker	0	0	0	<0.1	0	0	0.1	0
mottled sculpin	1.2	0.4	1.1	0.5	1.2	1.6	0.9	1.3
cutthroat trout	<0.1	0	<0.1	0	0	0	0	0
rainbow trout	1.8	2.5	1.1	1.7	0.5	2.2	1.2	4.2
cutthroat X rainbow trout	<0.1	<0.1	<0.1	0	0	0	0	0
brown trout	21.7	1.3	18.3	1.2	16.0	0.8	27.0	1.3
brook trout	0	0	<0.1	0.0	<0.1	0	0	0
red shiner	0.2	1.3	0.4	0.5	0.2	1.5	0	0.5
common carp	11.7	10.7	8.8	5.0	6.6	3.4	2.7	5.4
fathead minnow	0	0	0	0	0.1	0	0	0
sand shiner	0	<0.1	<0.1	<0.1	0.2	0.6	0	0
redside shiner	0.1	0	0.1	0	0.6	0.2	0	0.2
white sucker	8.5	1.6	10.2	2.2	18.9	2.8	11.7	3.1
bluehead X white sucker	0.3	0.4	0.5	0.2	0.1	0.1	0.4	0.2
flannelmouth X bluehead sucker	1.0	0.8	0.7	0.3	0.3	0.4	0.2	0.4
flannelmouth X white sucker	2.7	1.0	4.3	0.6	3.2	0.9	2.0	1.1
flannelmouth X bluehead X white sucker	<0.1	0.1	0.1	0	<0.1	0	0	0
razorback X flannelmouth sucker	0	0.1	<0.1	0.1	0	0	0	0
black bullhead	<0.1	<0.1	<0.1	0	<0.1	0	0	0
channel catfish	8.4	12.5	9.1	19.5	7.2	16.5	4.9	11.0
northern pike	0.2	0.1	0.4	0	0.2	0.1	0.3	0
green sunfish	0.2	0.2	0.2	0.2	<0.1	0.1	0	0
bluegill	<0.1	0	0.1	0.2	<0.1	0.1	0	0
green sunfish X bluegill	<0.1	0	0	0	0	0	0	0
smallmouth bass	3.5	11.4	3.7	14.0	4.7	5.9	2.1	2.0
black crappie	0.1	0.1	0	0.1	<0.1	0	0	0
walleye	0	0.1	<0.1	0.1	<0.1	0.2	0.2	0.2
Total fish	5937	4788	6745	4323	6224	2872	1296	553
Effort (hours)	91.3	60.8	80.7	51.1	75.1	48.9	25.9	13.8
# native species	7	9	7	9	7	7	8	7
% native species	39.6	55.8	41.9	53.9	41.0	64.3	47.5	70.5
# non-native species	14	13	16	12	17	13	8	9
% non-native species	56.3	41.8	52.5	44.8	55.4	34.3	50.0	27.9
# hybrid combinations	6	6	6	4	4	3	3	3
% hybrid combinations	4.1	2.4	5.6	1.3	3.6	1.4	2.5	1.6

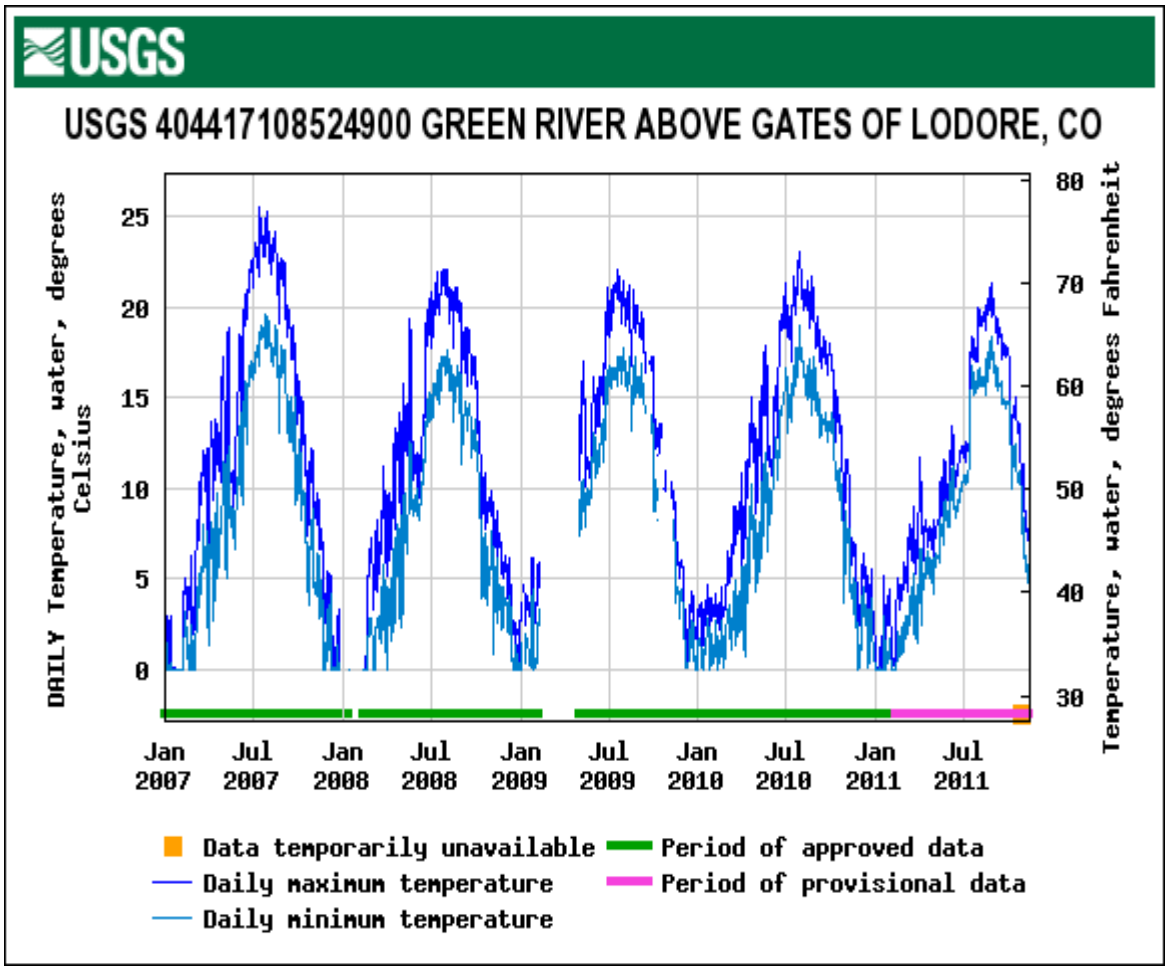
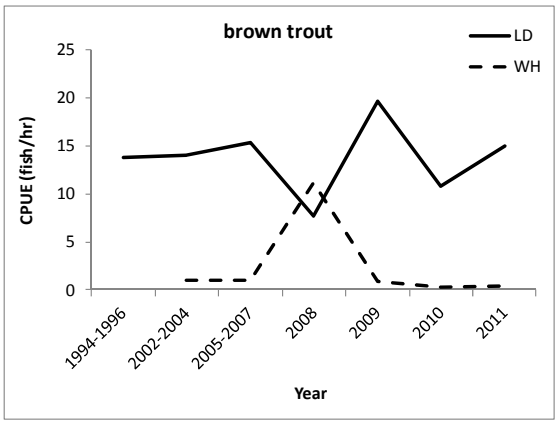
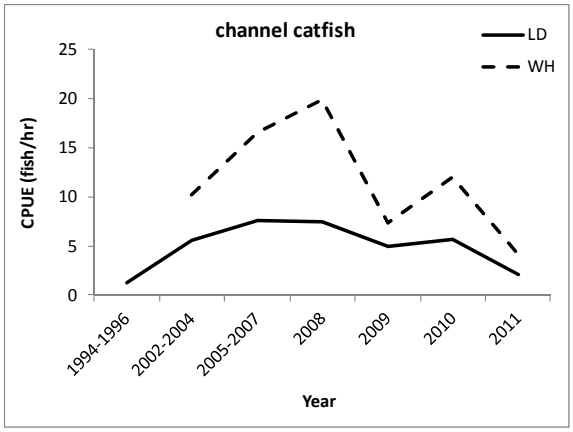
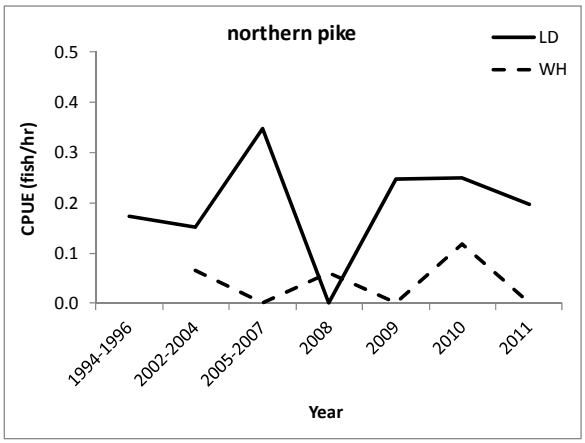
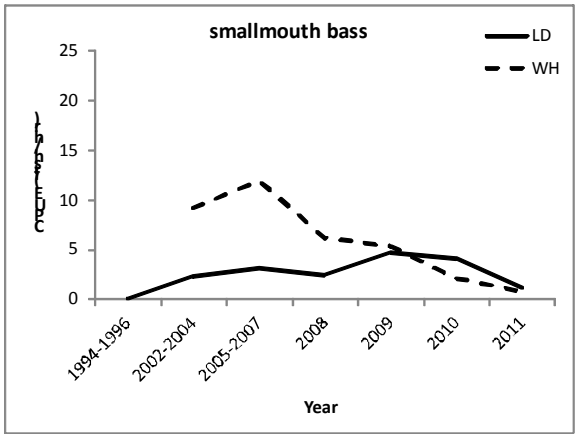


Figure 1. Green River water temperatures at the Gates of Lodore, near the Dinosaur National Monument campground, 2007-2011.


brown trout
LD
WH
CPUE (fish/hr)
25
20
15
10
5
0
1994-1996
2002-2004
2005-2007
2008
2009
2010
2011
Year


channel catfish
LD
WH
CPUE (fish/hr)
25
20
15
10
5
0
1994-1996
2002-2004
2005-2007
2008
2009
2010
2011
Year


northern pike
LD
WH
CPUE (fish/hr)
0.5
0.4
0.3
0.2
0.1
0.0
1994-1996
2002-2004
2005-2007
2008
2009
2010
2011
Year


smallmouth bass
LD
WH
25
20
15
10
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0
1994-1996
2002-2004
2005-2007
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2010
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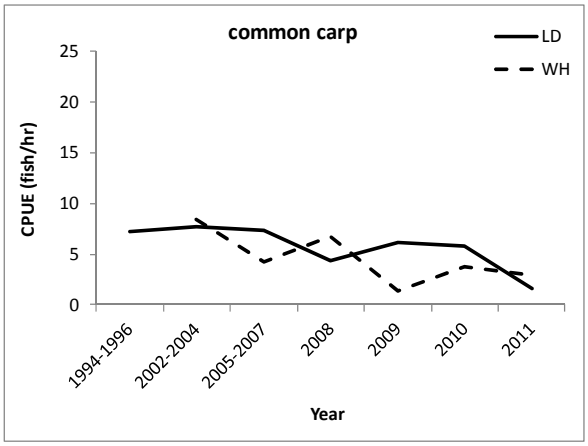
Year


common carp
LD
WH
CPUE (fish/hr)
25
20
15
10
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0
1994-1996
2002-2004
2005-2007
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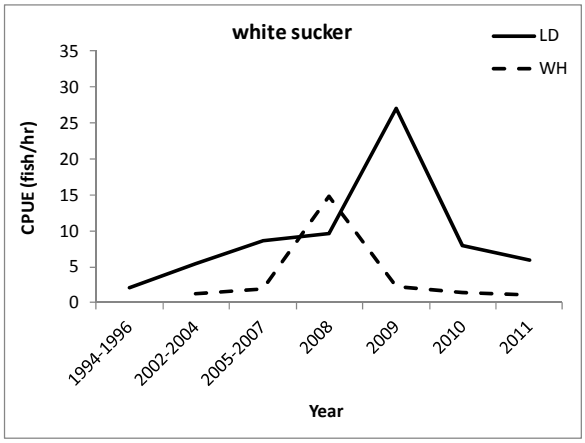
2009
2010
2011
Year


white sucker
LD
WH
CPUE (fish/hr)
35
30
25
20
15
10
5
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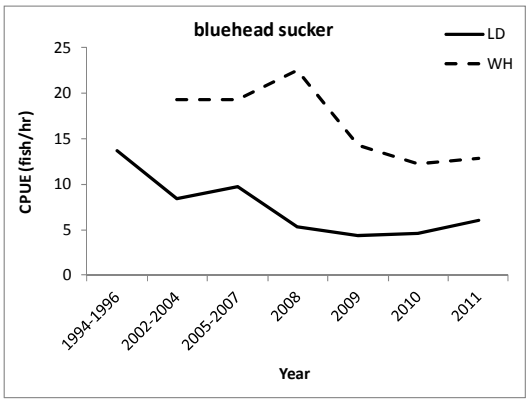
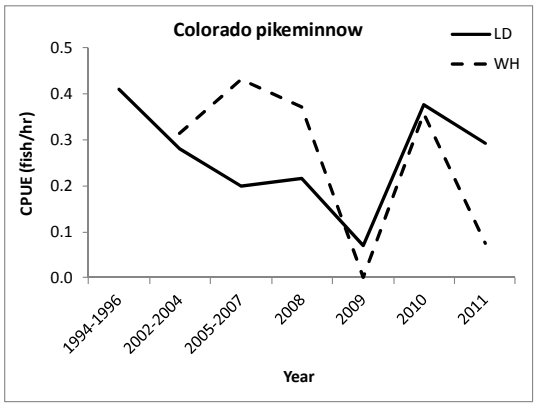
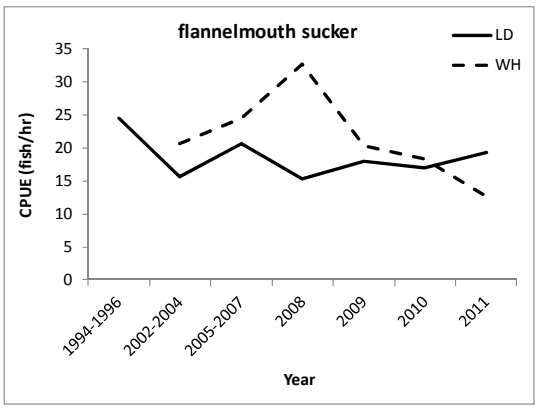
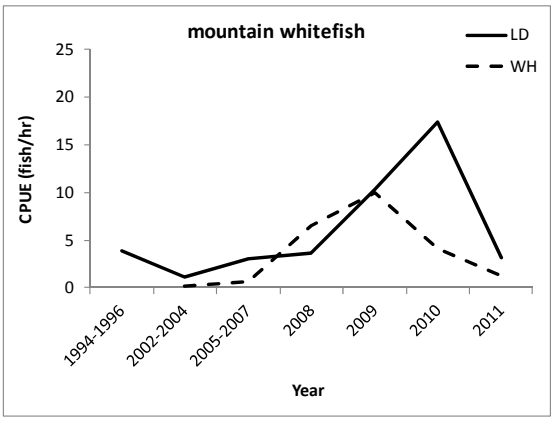
1994-1996
2002-2004
2005-2007
2008
2009
2010
2011
Year









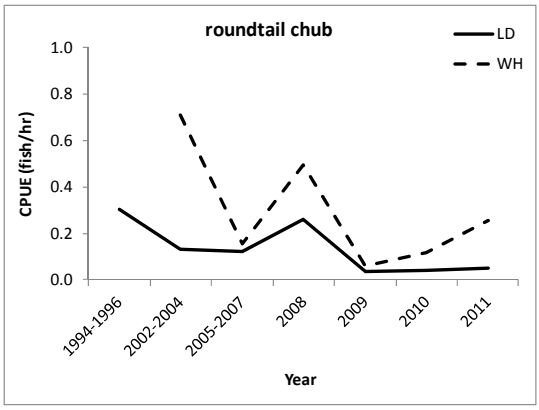


Figure 2.—Number of non-native brown trout, channel catfish, northern pike, smallmouth bass, common carp and white sucker, and native bluehead sucker, Colorado pikeminnow, flannelmouth sucker, mountain whitefish, and roundtail chub per hour of raft electrofishing effort in four reaches of Lodore Canyon and two reaches of Whirlpool Canyon, Green River, Colorado and Utah, in 1994-1996, and 2002-2011.

Trammel net sampling was generally conducted only once per year and only in Whirlpool Canyon, including in 2011. Overall, humpback chub and roundtail chub abundance was diminished substantially in recent years compared to the period 2002-2004 (Bestgen et al. 2006) and 2005 (Table 3). This pattern was similar to that reported for electrofishing sampling. Reduced chub abundance was coincident with invasion and establishment of large populations of smallmouth bass in Lodore and Whirlpool canyons. Recent absence of bonytail in sampling reflected that stocking occurred after our trammel net sampling trips. That no bonytail were recaptured from fish stocked the prior year furthered the notion that they have very low post-stocking survival (Bestgen et al. 2008). Increased chub abundance was detected in 2010 trammel net sampling. However, of the 16 chubs captured (all roundtail chubs) 7 (44%) were recaptures from previous years. As discussed above, a similarly high rate of chub recaptures (6 of 11 fish) occurred in 2011, indicating that the population remained small. One questionable identity humpback chub was captured in 2011, and represents a fish captured and similarly identified in 2006; it had grown about 2 mm per year in the recapture interval.

Table 3.—Number of bonytail, humpback chub, and roundtail chub captured in trammel net sampling in Whirlpool Canyon, Green River, Colorado and Utah, in 2005-2009. Fish of questionable identity are indicated with "?". Most fish were scanned for presence of a PIT tag; "unk" reflects either a recap not noted or fish not scanned for old tags.

	2005		2006			2007		2008			2009		2010		2011		
	recap		recap			recap		recap			recap		recap		recap		
Species	n	y	n	y	unk	n	y	n	y	unk	n	y	n	y	n	y	total
bonytail	2	35		3			3		3								46
humpback chub		1			1												2
humpback chub?											1					1	2
roundtail chub	23	5	9	1	3	5		10	2	1	4	2	9	8	5	5	92
roundtail chub?											1						1
total	25	41	9	4	4	5	3	10	5	1	6	2	9	8	5	6	143

Task 3: Sample small-bodied fish community.

About 100 seine samples were collected in the study area from middle Browns Park downstream to the lower end of Rainbow Park during summer and autumn 2011. We have begun identification of summer and autumn samples. We collected young-of-year northern pike in Browns Park again in spring and summer 2011, indicating successful reproduction by that species in that reach. Updated 2010 data are presented here.

Similar to electrofishing samples, percent composition of small-bodied fishes captured in seine samples was variable over four periods, 2002-2004, 2005-2006, 2007-2008, and 2009-2010 in the study area (Tables 4 and 5). The study area included Browns Park, Lodore Canyon, Whirlpool Canyon, and Island-Rainbow Park reaches, from upstream to downstream. Higher relative abundance of mountain whitefish in the 2002-2004 period reflected inclusion of spring samples, during which that species was more abundance. Post-2004 samples do not include spring sampling. Colorado pikeminnow were present but rare in seine samples in all periods, but relative abundance of most other native species, including roundtail chub, speckled dace, and flannelmouth sucker, were stable or increased over time. This was especially true for roundtail chub, which comprised 8.2% of fish in seine samples in 2009-2010. Bluehead sucker was most abundant in 2005-2006 and rarer recently. Abundance of native fishes increased from just over 7% in 2002-2004 to about 20% or more in the latter three periods.

Similarly, percent composition of non-native fishes declined after 2002-2004. The biggest decline was by red shiner and fathead minnow, while redside shiner and sand shiner remained relatively stable. White sucker abundance in seine samples increased over time, a pattern similar to that observed for white sucker captured with electrofishing through about 2010. Fewer samples in the three more recent periods reflected fewer years in the sampling period relative to 2002-2004, as well as the fewer number of backwaters to sample in those higher water years.

In 2007-2008, native fish abundance was usually highest in Lodore Canyon and Island-Rainbow Park reaches, followed by Browns Park, and Whirlpool Canyon, and a similar situation prevailed in 2009. However, in 2010 native fish abundance remained high in Lodore Canyon but was highest in Whirlpool Canyon and was also high in each of the other two reaches. Biggest increases were by speckled dace and bluehead sucker, but particularly roundtail chub, in Whilrpool Canyon, where it comprised 28% of seines samples. We captured large numbers of roundtail chub young (1000's) in Whirlpool Canyon backwaters in summer 2010 following a rainstorm and subsequent turbidity event. Mountain whitefish were more abundant downstream than upstream in 2010, a patterns opposite of what is normally observed, and roundtail chub abundance was of a similar pattern. Colorado pikeminnow were rare in seine samples in all reaches, and speckled dace abundance varied over reaches and years. Bluehead sucker abundance increased from up to downstream but was much more abundant in 2010 than 2009. Flannelmouth sucker showed a mostly opposite distributional pattern as they were more abundant upstream than downstream.

In 2007-2008, non-native fish abundance was usually lowest in Lodore Canyon and Island-Rainbow Park reaches, and higher in Browns Park and Whirlpool Canyon. In 2009, non-native

fish abundance in seine samples was highest downstream but that pattern switched in 2010, when they were most abundant in the two upstream reaches. Red and sand shiners were present in nearly every reach, including Browns Park, and increased dramatically in abundance from up to downstream, while fathead minnow and redside shiner were more abundant upstream than downstream. White sucker abundance was very high upstream, and particularly so in 2010.

Table 4.—Percent composition of fishes in seine samples collected in the study area, Browns Park, Lodore Canyon, Whirlpool Canyon, and Island-Rainbow Park, Green River, Colorado and Utah, in 2002-2004, 2005-2006, 2007-2008, and 2009-2010 sampling periods.

	% Relative Abundance			
Species	2002-2004	2005-2006	2007-2008	2009-2010
mountain whitefish	1.7	<0.1	0.1	<0.1
humpback chub	0	0	0	0
bonytail	<0.1	0	0	0
roundtail chub	0.2	0.9	3.1	8.2
Colorado pikeminnow	<0.1	<0.1	<0.1	<0.1
speckled dace	1.0	4.2	3.5	6.2
bluehead sucker	1.3	10.3	5.0	3.9
flannelmouth sucker	3.1	7.4	7.6	7.0
mountain sucker	0	0.3	0	0
razorback sucker?	0	0	<0.1	0
mottled sculpin	0.1	<0.1	0.1	0.1
rainbow trout	<0.1	<0.1	0	0
brown trout	<0.1	<0.1	<0.1	<0.1
brook trout	0	<0.1	0	0
red shiner	43.6	28.3	27.2	17.3
common carp	0.3	0.2	0.3	0.2
fathead minnow	10.4	4.4	4.5	7.6
sand shiner	26.2	27.6	23.7	20.1
redside shiner	6.7	4.5	6.3	4.0
creek chub	<0.1	<0.1	<0.1	<0.1
unidentified minnow	<0.1	0	<0.1	<0.1
white sucker	4.4	9.1	14.6	21.2
bluehead X white sucker	<0.1	<0.1	<0.1	<0.1
flannelmouth X bluehead sucker	<0.1	<0.1	<0.1	0.3
flannelmouth X white sucker	0.1	0.3	1.0	0.6
flannelmouth X bluehead X white sucker	0	<0.1	<0.1	<0.1
razorback sucker hybrid	<0.1	0	0	0
Utah sucker?	0	0	<0.1	0
unidentified sucker	0.1	<0.1	0.1	<0.1
black bullhead	<0.1	<0.1	<0.1	<0.1
channel catfish	<0.1	0	<0.1	<0.1
northern pike	<0.1	<0.1	<0.1	<0.1
plains killifish	<0.1	<0.1	<0.1	<0.1
Iowa darter	0	0	<0.1	0.1
brook stickleback	<0.1	<0.1	<0.1	<0.1
green sunfish	0.6	0.1	1.4	0.1
bluegill	<0.1	0.2	0.3	0.1
green sunfish X bluegill	0	0	<0.1	<0.1
smallmouth bass	0.2	1.9	1.3	2.9
black crappie	<0.1	<0.1	0	<0.1
Total fish	193264	59301	61276	62904
Effort (samples)	800	365	308	371
# native species	8	8	8	7
% native species	7.4	23.2	19.3	25.4
# non-native species	18	18	18	18
% non-native species	92.3	76.4	79.6	73.6
% unidentified species	0.1	<0.1	0.1	<0.1
# hybrid combinations	4	4	5	5
% hybrid combinations	0.2	0.4	1.0	0.9

Table 5.— Percent composition of fishes in seine samples collected in Browns Park, Lodore Canyon, Whirlpool Canyon, and Island-Rainbow Park, Green River, Colorado and Utah, in 2009-2010.

	2009				2010			
Species	BP	LD	WH	IRP	BP	LD	WH	IRP
mountain whitefish	0.1	<0.1	0	0.1	0	0.1	<0.1	0.2
humpback chub	0	0	0	0	0	0	0	0
bonytail	0	0	0	0	0	0	0	0
roundtail chub	0	1.8	4.7	2.7	0	0.3	27.8	4.9
Colorado pikeminnow	0	0	<0.1	0	0	0	0	0.2
speckled dace	2.8	14.9	0.9	1.6	3.2	11.6	1.9	3.9
bluehead sucker	4.0	5.1	0.4	0.5	4.0	3.1	4.4	15.4
flannelmouth sucker	11.6	6.9	1.6	1.8	14.2	8.6	7.8	6.6
mountain sucker	0	0	0	0	0	0	0	0
razorback sucker?	0	0	0	0	0	0	0	0
mottled sculpin	0	0	<0.1	0	0	0.1	<0.1	0.4
rainbow trout	0	0	0	0	0	0	0	0
brown trout	0.2	0	0	0	0.4	<0.1	0	0
brook trout	0	0	0	0	0	0	0	0
red shiner	<0.1	15.9	36.9	45.1	0.1	4.7	19.2	22.9
common carp	0.7	0.1	<0.1	0	0.8	0.5	0.1	0
fathead minnow	33.9	12.2	1.4	0.8	11.4	12.0	0.9	0.6
sand shiner	0	5.1	43.6	36.8	<0.1	6.5	28.7	32.2
redside shiner	1.9	12.9	1.5	0.3	1.8	4.3	1.8	3.1
creek chub	0	0.1	<0.1	0	0	<0.1	<0.1	0
unidentified minnow	0	<0.1	<0.1	0	0	<0.1	0	0
white sucker	42.1	21.4	8.4	7.6	61.8	38.0	5.2	8.1
bluehead X white sucker	0.2	0	<0.1	0	0	<0.1	0	0
flannelmouth X bluehead sucker	<0.1	0	0	0	<0.1	<0.1	1.1	0.1
flannelmouth X white sucker	1.4	0.7	0.4	0.2	1.7	0.8	0.3	0.5
flannelmouth X bluehead X white sucker	0	0	0	0	0	<0.1	0	<0.1
razorback sucker hybrid	0	0	0	0	0	<0.1	0	<0.1
Utah sucker?	0	0	0	0	0	0	0	0
unidentified sucker	<0.1	0.1	<0.1	0	0	0.1	<0.1	0.1
black bullhead	0	0	0	0	0	<0.1	0	<0.1
channel catfish	0	0	0	0	0	<0.1	0	<0.1
northern pike	0.1	<0.1	0	0	0.3	<0.1	<0.1	0
plains killifish	0	0	<0.1	0	0	0	<0.1	0
Iowa darter	0	0.3	0	0	0	<0.1	<0.1	0
brook stickleback	0	0	<0.1	0	0	0	0	<0.1
green sunfish	<0.1	0.4	0	0	0.1	0.1	0	0
bluegill	1.0	0.2	<0.1	0	0	0	0	0
green sunfish X bluegill	0	<0.1	0	0	0	0	0	0
smallmouth bass	0	1.8	0.2	2.5	0	9.1	0.7	0.8
black crappie	0	<0.1	0	0	0	0	0	0
Total fish	3285	8660	11479	1863	2773	16297	14952	3595
Effort (samples)	25	91	44	33	19	93	45	21
# native species	4	5	6	5	3	6	6	7
% native species	18.5	28.8	7.6	6.7	21.5	23.9	41.8	31.7
# non-native species	9	13	11	6	9	14	11	9
% non-native species	79.9	70.4	92.0	93.0	76.8	75.2	56.6	67.6
% unidentified species	<0.1	<0.1	<0.1	0	0	<0.1	<0.1	<0.1
# hybrid combinations	3	2	2	1	2	5	2	4
% hybrid combinations	1.6	0.7	0.4	0.2	1.7	0.8	1.5	0.6

Smallmouth bass were not captured in Browns Park in 2007 or 2008, nor in 2009 or 2010, and were variably abundant in the remaining reaches in those latter two years. Relatively high bass abundance in Lodore Canyon in 2010 was from a relatively large sample of small bass that were collected from a single location. Observations in 2011 showed that age-0 smallmouth bass were very small, reduced in number, and were absent from several places that typically supported the species. The main change in those places was habitat alteration that connected side channels and eliminated deep pools where bass spawned in the past; alterations were due to high flows in 2011.

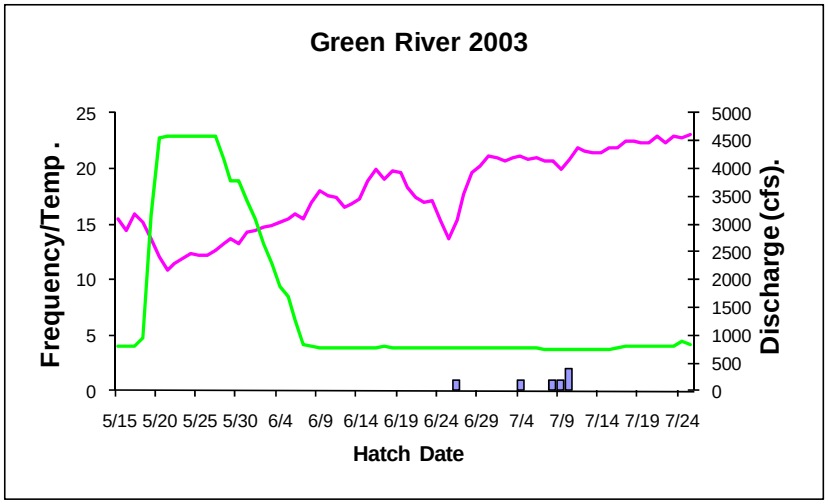
An additional task in this scope of work was to analyze otoliths from age-0 smallmouth bass captured in the Green River study area. This work will assist with understanding smallmouth bass spawning periodicity to assist with disruption of reproduction of that species via flow releases from Flaming Gorge Dam. Studies in other parts of the range of smallmouth bass have shown that weather-related water temperatures reductions or floods reduce their spawning success and number of offspring. Reduced water temperatures often result in abandonment of spawning nests by the guarding male bass, after which developing eggs and just-hatched young are susceptible to predation and other mortality factors. Sampling in the Green River and other areas has shown that higher stream flow, often coupled with increased water turbidity, sweeps weak-swimming young bass away from nests or quiet near-shore habitat, and results in high mortality.

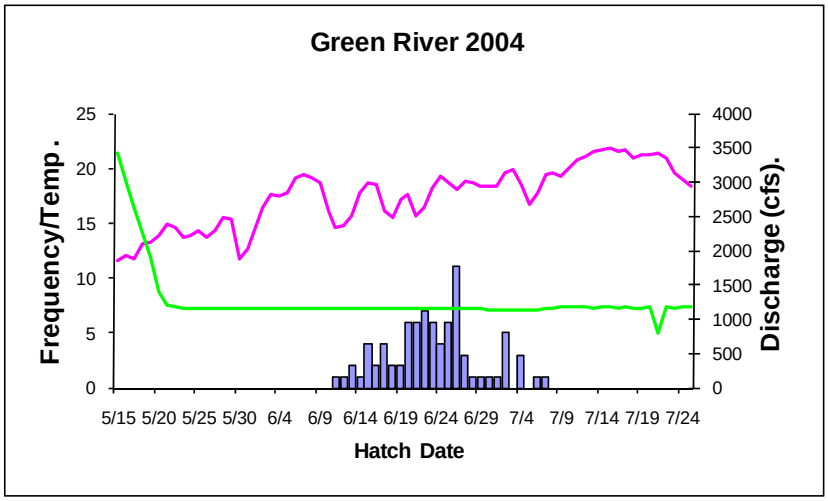
Portions of this work were reported at the January 2011 Researchers Meeting; we have since added data for 2009 samples and are nearing completion of 2010 samples. These results were also presented at the 2010 Larval Fish Conference in Santa Fe, New Mexico.

We found that smallmouth bass in the Green River-Lodore Canyon study area first hatched well after spring peak releases declined and just slightly after mean daily water temperatures regularly exceeded 16°C in the period 2003-2009 (Figure 3). Hatching date distributions were very similar in 2008 and 2009, reflecting the similar flow and temperature regimes in those years. In the Yampa River, onset of the smallmouth bass hatching period started just before mean daily water temperatures regularly exceeded 16°C. Peak hatching in the Green River occurred about 2-3 weeks after first bass hatched. The duration of the spawning season was relatively brief, usually about 4 weeks.

Drift net sampling documented high downstream displacement of small-bodied smallmouth bass during high turbidity and flow events in 2004 and 2007. Such flow and turbidity events may have been responsible for low abundance of smallmouth bass < 100 mm TL in summer 2004, and subsequent low number of Age-1 smallmouth bass in 2005 (data in RIP annual rpts. Badame et al. synthesis report; discussion in Bestgen et al. 2006; 2007).

We have finished analysis of otoliths of smallmouth bass collected from the Green River for 2009 and analysis of otoliths collected in 2010 (and Yampa, project 140) is nearly complete.





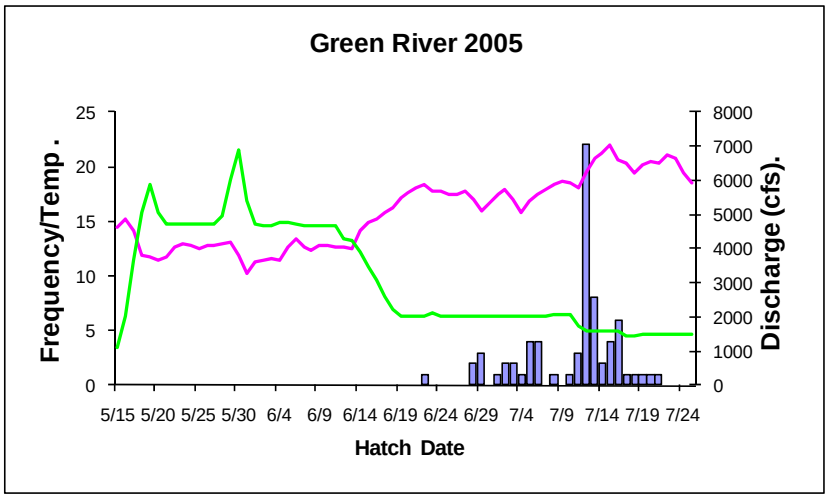
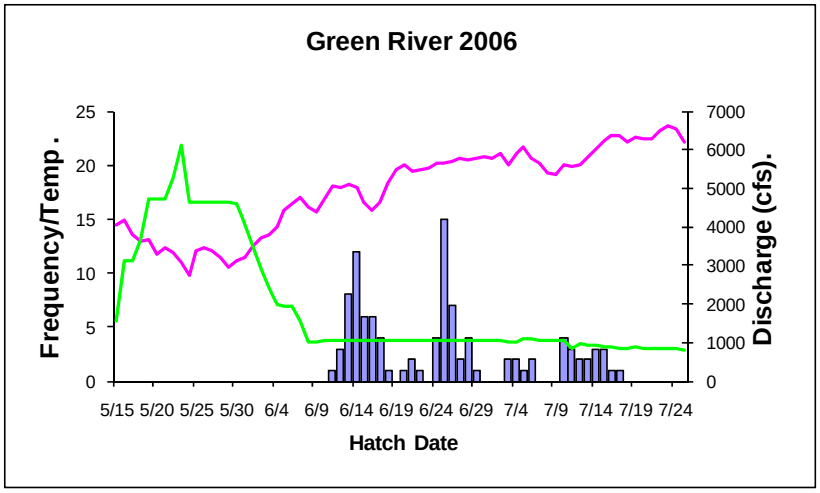
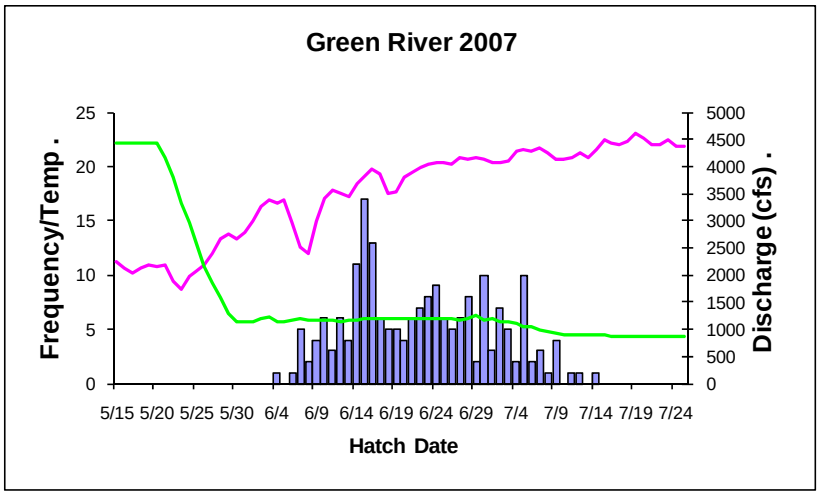


Figure 3 continued below.





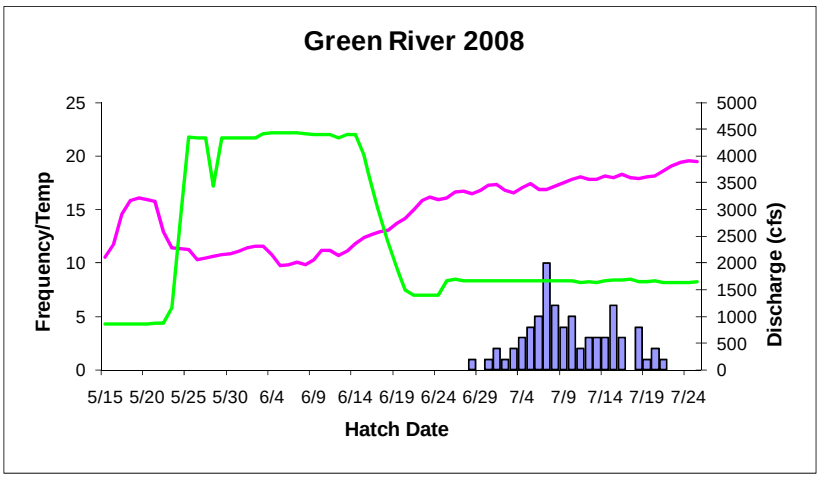


Figure 3 continued below.

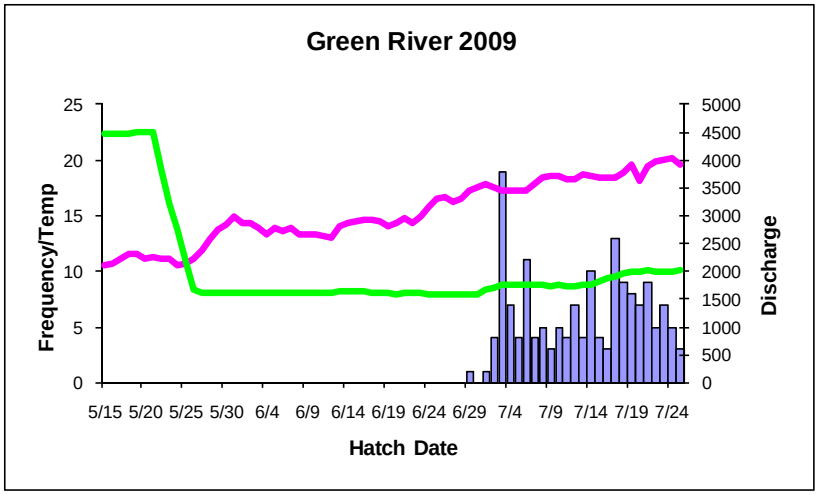


Figure 3.—Distributions of hatching dates of Age-0 smallmouth bass estimated by otolith daily increment analysis, 2003-2009. Bass were collected from the Green River in Lodore Canyon. Left vertical axis is the frequency of fish in the histograms or water temperature (increasing but variable trace through time, green if in color); right vertical axis is Green River discharge (in cubic feet per second and is depicted by a declining or stable line time, green if in color).

Task 4: Sample larval drift and process samples.

Drift samples were collected in the Green River just upstream of the Yampa River during summer 2010. Sampling was begun relatively late on 20 July compared to other years because Yampa River flows remained high. A total of 184 fishes were captured and were dominated by white sucker (n = 85), bluehead sucker (n = 45), and flannelmouth sucker (n = 29). Seven young smallmouth bass were captured including one on 6 August, that was 11 mm TL, which attested to late reproduction by bass in 2010. Of note, we also captured a single Colorado pikeminnow larva (11 mm TL) on 16 August, suggesting late reproduction by that species as well. That is the first reproduction detected by pikeminnow in Lodore Canyon since 2006, and represents only the second documented reproduction in that reach by pikeminnow since the closure of Flaming Gorge Dam.

Task 5: Process preserved samples of small-bodied fish (seine hauls).

We have completed identification of 2010 seine samples and are progressing with 2011 samples.

Task 6: Prepare and submit annual report.

This report.

VII. Recommendations:

• Continue to monitor abundance of native and non-native fishes in the study area in response to understand response to flow and temperature regimes and non-native fish removal activities.

We saw a strong fish community response to drought conditions in the study area in 2002 to 2004, with increased abundance of smallmouth bass and continued upstream dispersal of red shiners into Browns Park. In 2008-2010, data showed declines in abundance of non-native predaceous fishes, including smallmouth bass, declined perhaps due to reduced reproductive success as well as increased removal of bass in the Whirlpool Canyon reach. Observations and data based on sampling in 2011 show a continued declining trend of smallmouth bass and other non-native fishes but firm conclusions await final data compilation, including that for seine samples.

• Continue removal of non-native fishes at the level presently implemented in Lodore and Whirlpool canyons.

Because of ongoing fish community changes in Lodore and Whirlpool canyons, we will be recommending continued removal of non-native fishes and monitoring of the remainder of the fish community in that reach in 2012 and beyond.

• Continue drift net sampling.

Continued drift sampling is also recommended because of captures of early life stages of endangered fishes in 2006 and 2010, and because that technique documented downstream dispersal of young bass during higher flow and turbidity events.

• Continue or expand springtime northern pike removal sampling in Browns Park in 2012 and beyond.

The invasion sequence of northern pike since 1994-1996 and increased abundance of small northern pike in recent years may indicate an expanding population. Sampling data and otolith analyses underway will also allow better understanding of timing and success of pike spawning relative to flow and water temperature regimes, and assist in recommendations for continued management of flows in the Green River.

VIII. Project Status: Ongoing and on track.

IX. FY 2011 Budget Status

A. Funds Provided: $84,400
B. Funds Expended: $69,922
C. Difference: $14,478, these funds are needed to finish identification of samples collected in 2010 and 2011.
D. Percent of the FY 2011 work completed, and projected costs to complete: about 80% completed.
E. Recovery Program funds spent for publication charges:

X. Status of Data Submission (Where applicable): Copy of non-native fish data was sent to the database manager in November.

XI. Signed: Kevin R. Bestgen 14 Nov. 2011 (modified 1 December 2011)
Principal Investigator Date

BESTGEN, K. R., K. A. ZELASKO, R. I. COMPTON, AND T. CHART. 2006. Response of the Green River fish community to changes in flow and temperature regimes from Flaming Gorge Dam since 1996 based on sampling conducted from 2002 to 2004. Final report, Upper Colorado River Basin Endangered Fish Recovery Program, Denver, Colorado. Larval Fish Laboratory Contribution 144.

Bestgen, K. R., K. A. Zelasko, and C. T. Wilcox. 2007. Non-native fish removal in the Green River, Lodore and Whirlpool canyons, 2002-2006, and fish community response to altered flow and temperature regimes, and non-native fish expansion. Final report to the Recovery Implementation Program for Endangered Fishes in the Upper Colorado River Basin. U. S. Fish and Wildlife Service, Denver, CO. Larval Fish Laboratory Contribution 149.

Bestgen, K. R., K. A. Zelasko, R. I. Compton, and T. Chart. 2008. Survival, condition, habitat use, and predation on stocked bonytail in the Green River, Colorado and Utah. Southwestern Naturalist 53:488-494.