

**AUGMENTATION OF COLORADO PIKEMINNOW  
IN THE SAN JUAN RIVER: 2005**

**Interim Progress Report**  
(Final)

Submitted By:

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## EXECUTIVE SUMMARY

Between 2002 and 2005, a total of 975,381 Colorado pikeminnow (n = 968,616 age-0 fish; n = 1,505 age-1 fish; n = 5,260 age-2 fish) have been stocked into the San Juan River. This constitutes an overall shortfall of 174,619 (15.18%) over the first four years of the eight-year augmentation effort (2002-2009), based on the numbers specified in the 2003 augmentation plan and its 2002 draft predecessor. However, in 2005, the target of stocking  $\geq$  300,000 age-0 fish was met for the first time, when a total of 302,270 age-0 fish were stocked. This was a surplus of 2,270 fish (0.75%) for 2005.

In early 2005, an addendum to the Colorado pikeminnow augmentation plan (Ryden 2005a) was finalized. This addendum specifies that in addition to the annual target of  $\geq$  300,000 age-0 Colorado pikeminnow, the SJRIP will have an annual target of stocking  $>$  3,000 age-1 (or age-1+) Colorado pikeminnow, beginning in the fall of 2006. Even though this addendum is not supposed to be in effect until 2006, a total of 500 age-1 and 4,041 age-2 Colorado pikeminnow were stocked in 2005. So essentially, not only was the upcoming goal of stocking  $\geq$  3,000 age-1 (or age-1+) fish met in 2005, a year ahead of schedule, but it was exceeded by a surplus of 1,541 fish (51.37%) in 2005.

No wild Colorado pikeminnow, of any life-stage, were collected in 2005. However, numerous Colorado pikeminnow that had been stocked as part of augmentation efforts were recaptured on sampling trips for nine different studies throughout the San Juan River (i.e., from RM 177.95 downstream to Lake Powell) during 2005. Juvenile fish numerically dominated 2005 collections. A total of 2,546 YOY (age-0) and juvenile (age-1 through age-3) fish were collected during 2005. In comparison, only three adult Colorado pikeminnow were collected during 2005. Two of the adult Colorado pikeminnow that were recaptured in 2005 had been stocked as adult fish on 11 April 2001. The other adult Colorado pikeminnow collected in 2005 did not have a PIT tag at the time of recapture, but based on its size it was likely a survivor from the 1996 (or possibly 1997) stockings of age-0 fish by UDWR. However, there is also a chance that this was a wild fish spawned between 1994 and 1996 (1989-1997 at the outside).

The 2,549 Colorado pikeminnow collected during all studies in 2005 represents the second highest number of Colorado pikeminnow ever scientifically-documented in the San Juan River. Total CPUE for Colorado pikeminnow during the fall 2005 Adult Monitoring trip was also the second highest ever observed (1.49 fish/hr of electrofishing) since riverwide sampling began in 1996. The observed decline in Colorado pikeminnow total CPUE between 2004 and 2005 is likely related to the comparatively high spring discharge that occurred in 2005, an event that has not been duplicated or matched in the last several years.

The majority (n = 75 fish) of the 127 Colorado pikeminnow collected during the fall 2005 Adult Monitoring trip were age-1 fish. There were also 50 age-2 fish and two age-3 fish collected on this trip. This distribution of year-classes very closely mirrors that observed in 1998 when both the 1996 and 1997 year-classes of fish (both stocked by UDWR) were clearly discernable in a length-frequency histogram.

Very few age-3 fish (from the fall 2002 stockings of age-0 fish) were collected during the 2005 Adult Monitoring trip. Based on the fall 2005 Adult Monitoring collections, as well as collections and

analysis by other researchers, it appears as if the age-0 Colorado pikeminnow that were stocked in 2002 did not survive into their age-2 and age-3 year as well as had been hoped for. It appears that the retention/survival of this group of age-0 Colorado pikeminnow was generally lower, almost from the moment of stocking, than survival of similar groups of age-0 fish stocked in 1996, 1997, 2003, and 2004.

Age-1 Colorado pikeminnow collected during the fall 2004 Adult Monitoring trip were visibly larger than their age-1 counterparts in either 1998 or 2005. The most likely explanation for the observed differences in sizes of the age-1 fish among these three years would be the spring discharge regimes of those particular years. Both 1998 and 2005 had comparatively higher and later spring runoff flows than did 2004, which peaked at a much lower level and considerably earlier in the calendar year. The higher, later spring flows in 1998 and 2005 would act to suppress water temperatures later into the summer in both of those years, almost certainly causing the age-1 Colorado pikeminnow in the river at those times to grow more slowly. Conversely, in 2004, flows stayed comparatively low and peaked very early, causing the river to achieve higher water temperatures earlier in the year, thus increasing the growing season for age-1 fish during 2004, which in turn led to larger age-1 fish being collected on the fall 2004 Adult Monitoring trip.

Looking at the relative sizes of recaptured Colorado pikeminnow stocked as age-0 fish from 2002-2004, it appears that a large degree of the variability in size seen among these various groups of fish during their age-1 year-class tends to disappear by they reach age-2. Although there is some variation in growth among year-classes, for the most part, the growth rates observed for age-0 fish stocked in the fall of 1996 and summer of 1997 seem to be generally consistent with those observed among age-0 fish stocked in the fall of 2002, 2003, and 2004 (Figures 3 and 4). There appears to be little growth among stocked juvenile Colorado pikeminnow from November through March. Most of the growth observed among stocked juvenile Colorado pikeminnow takes place between April and October.

The observed growth rate for Colorado pikeminnow stocked as age-0 fish is initially rapid from age-0 through age-2, then gradually declines as fish approach maturity. Length at maturity is considered to be  $\geq 450$  mm TL (USFWS 2002). Based on this growth curve, age-0 fish being stocked in the fall as part of the augmentation efforts, should recruit into the adult population in either their age-4 or age-5 year-class.

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# INTRODUCTION

Colorado pikeminnow is a federally-listed endangered fish native to the San Juan River (Ryden 2003). The capture of low numbers of Colorado pikeminnow of all life stages over the past fifteen years has confirmed that a small, but reproducing population of Colorado pikeminnow is still extant in the San Juan River (e.g., Platania 1990, Ryden 2000). In 1996, experimental stocking of Colorado pikeminnow into the San Juan River was undertaken by the Utah Division of Wildlife Resources' (UDWR) Moab field station. The purpose of this effort was to evaluate dispersal and retention of stocked juvenile Colorado pikeminnow as well as determining the availability, use, and selection of habitats by early life stage Colorado pikeminnow. Between 1996 and 2000, approximately 832,000 larval and age-0 Colorado pikeminnow were stocked into the San Juan River by the UDWR (Table 1). In addition, 197 adult Colorado pikeminnow were stocked into the San Juan River, 49 in 1997 and 148 in 2001 (Table 1). To date, several hundred of those stocked juvenile and adult Colorado pikeminnow have been recaptured during either seining or electrofishing efforts. A handful of the individuals stocked in 1996 and 1997 have been documented as having recruited into the San Juan River's adult Colorado pikeminnow population (Jackson 2003, 2004). Based on data collected from these experimentally stocked fish, it is apparent that stocked, hatchery-reared, juvenile Colorado pikeminnow can survive in the San Juan River and can provide a viable method of supplementing the numbers and expanding the range of the wild San Juan River Colorado pikeminnow population.

The need for artificial propagation and augmentation of this species in the San Juan River is apparent for several reasons. Augmentation of Colorado pikeminnow would increase population numbers, provide more individuals for research purposes, add genetic diversity to the existing gene pool, and provide a riverine refugia population that would, hopefully, remain stable until further research can identify factors limiting successful recruitment of this species in the San Juan River. The San Juan River Long Range Plan identifies the need to assess the feasibility of, and then implement the augmentation of Colorado pikeminnow. In January 2003, **An Augmentation Plan For Colorado Pikeminnow In The San Juan River** (Ryden 2003) was finalized. This augmentation plan provides the necessary guidance for augmentation efforts as well as directly fulfilling objective 5.3.8.2 of the San Juan River Long Range Plan (San Juan River Recovery Implementation Program Biology Committee 1995).

The objectives of this workplan were as follows:

## Objectives:

- 1.) Coordinate with Dexter National Fish Hatchery (NFH) to procure and stock fish according to guidelines set forth in **An Augmentation Plan For Colorado Pikeminnow In The San Juan River** (Ryden 2003).
- 2.) Provide a report that gathers information from various sources on fingerling production, numbers of fish stocked, subsequent recaptures during various sampling efforts (other than the intensive monitoring effort), and makes recommendations (if necessary) for modifying methods being employed for Colorado pikeminnow augmentation efforts.

Table 1. Experimental stockings of Colorado pikeminnow in the San Juan River, 1996-2001.

Date	Number Stocked	River Mile Stocked At	Mean Total Length (mm)	Range Of Total Lengths (mm)	Responsible Entity <sup>a</sup>
Experimental stockings of juvenile fish: 1996-2000					
11/04/1996	50,000	148.0	55	25-85	UDWR-Moab
11/04/1996	50,000	52.0	55	25-85	UDWR-Moab
08/15/1997	62,578	148.0	45	35-55	UDWR-Moab
08/15/1997	54,300	52.0	45	35-55	UDWR-Moab
07/02/1998	10,571	148.0	24	18-28	UDWR-Moab
07/07/1999	500,000	158.6	"Larvae"	Unspecified	UDWR-Moab
06/11/2000	105,000	141.9	"Larvae"	Unspecified	UDWR-Moab
Experimental stockings of adult fish: 1997 and 2001					
09/23/1997	49	180.2	644	550-753	USFWS-CRFP
04/11/2001	148	180.2	540	442-641	USFWS-CRFP

a: UDWR-Moab = Utah Division of Wildlife Resources - Moab Field Station, Moab, UT; USFWS-CRFP = U. S. Fish and Wildlife Service - Colorado River Fishery Project, Grand Junction, CO

## METHODS

All Colorado pikeminnow that were stocked by the UDWR between 1996 and 2000 (Table 1) were progeny of either the "1981 broodstock" or the "1991 broodstock" being held at the USFWS's Dexter National Fish Hatchery and Technology Center (DNFH&TC). These two broodstocks were identified as appropriate sources for use in augmentation efforts for Colorado pikeminnow on the San Juan River (Crist and Ryden 2003, Ryden 2003). As was stated in the 2003 Colorado pikeminnow augmentation plan (Ryden 2003), the continued use of these two broodstock lots is anticipated for the duration of the current eight-year augmentation effort (2002-2009).

### 2005 Stocking Activities

#### Fish Stocked In July 2005

On 7 July 2005, a total of 1,991 age-1 and age-2 Colorado pikeminnow were stocked en masse at RM 180.2, just downstream of the Animas River confluence. The first group, consisting of 500 age-1 fish, from DNFH&TC, had a mean TL of

201 mm (range = 114-256 mm TL) and were stocked by personnel from DNFH&TC with the assistance of personnel from the Bureau of Indian Affairs (BIA-NIIP) office in Farmington, NM. These 2004 year-class fish, produced at DNFH&TC, were progeny of the "1991 broodstock." The second group, consisting of 1,491 age-2 fish, from the Colorado Division of Wildlife's (CDOW) J. W. Mumma Native Species Hatchery in Alamosa, CO (Mumma), had a mean TL of 204 mm (range = 121-281 mm TL) and were stocked by personnel from Mumma, again with the assistance of personnel from BIA-NIIP. These 2003 year-class fish, produced at DNFH&TC, were also progeny of the "1991 broodstock." The fry produced from the 2003 paired matings were transferred from DNFH&TC to Mumma on 2 June 2003. These age-2 fish had been reared at Mumma from June 2003 through July 2005. These age-2 fish were excess fish to the Colorado pikeminnow stocking efforts that are ongoing in the Upper Colorado River Basin. This was the third year that excess fish from Mumma were made available to the San Juan River Recovery Implementation Program (SJRIP).

#### Fish Stocked In October 2005

On 20 October 2005, a total of 134,550 age-0 Colorado pikeminnow were transported from DNFH&TC to the San Juan River via stocking trucks. These fish had a mean TL of 55 mm (no range recorded). After being tempered for a minimum of two hours, fish were transferred onto rafts, placed into aerated live-wells, and transported downstream. Fish were stocked into two distinct river sections, each roughly ten river miles (RM) long (RM 180.2-170.5 and RM 158.6-148.5).

The most downstream stocking section allowed age-0 Colorado pikeminnow to be stocked downstream of all major water diversion structures, thus minimizing the potential for loss through entrainment at such structures. The most upstream stocking section, while prone to loss from diversion structures (Archer et al. 200; L. Renfro, pers. comm.), was chosen to allow age-0 Colorado pikeminnow to be stocked as far upstream in their designated Critical Habitat (USFWS 1994) range as possible. It was hoped that stocking fish 22 miles farther upstream would also increase retention, given the large-scale downstream displacements observed among age-0 Colorado pikeminnow, post-stocking, during UDWR's 1996-2000 experimental stocking efforts (Archer et al. 2000, Jackson 2001). It was also hoped that some of these age-0 Colorado pikeminnow would retain and recruit in the section of river upstream of the PNM Weir (RM 166.6) thus facilitating an expansion in range for this species in the San Juan River. It was anticipated that spreading fish to numerous low-velocity habitats would allow them to acclimate better than immediately entering main channel habitats upon stocking, thus reducing post-stocking downstream displacement. In addition, spreading young fish out into many habitats should help reduce the risk of potential predation or other catastrophic loss that may occur in any single location.

Throughout these two river sections, age-0 fish were stocked into numerous low-velocity habitats (mostly backwaters and embayments). However, fish were free to leave these habitats and enter the main channel at any time. A total of 114,550 age-0 Colorado pikeminnow were stocked in this manner on 20 October (80,550 from RM 180.2-170.5 and 34,000 from RM 158.6-148.5). All 114,550 of these fish were stocked by personnel from the USFWS's Colorado River Fishery Project Office in Grand Junction, CO (USFWS-CRFP).

Also on 20 October 2005, 20,000 age-0 Colorado pikeminnow were stocked into holding pens at RM 175.8 (n = 6,000) and between RM 167.5 and RM 167.4 (n = 14,000; M. Golden, pers. comm.). These fish, stocked by personnel from BIO-WEST, Inc. from Logan, UT (under a separate SJRIP workplan), were progeny from the same paired matings of "1991 broodstock" as the other age-0 fish from

DNFH&TC stocked in 2005. These fish were frequently monitored both during the initial holding phase and after their release to see if acclimating age-0 fish in holding pens would increase post-stocking survival/retention.

On 3 November 2005, another 167,720 age-0 Colorado pikeminnow were transported from DNFH&TC to the San Juan River via stocking trucks. Tempering, transport, and distribution of these 167,720 age-0 fish followed the same procedures used on 20 October 2005. On 3 November 2005, a total of 52,600 age-0 fish were stocked from RM 180.2-170.5 and 115,120 age-0 fish were stocked from RM 158.6-148.5. All 114,550 of these fish were stocked by USFWS-CRFP personnel.

#### Fish Stocked In November 2005

On 10 November 2005, another group of age-2 Colorado pikeminnow from Mumma, totalling 2,550 fish, was stocked en masse at RM 180.2, just downstream of the Animas River confluence. These 2,550 fish had a mean TL of 167 mm (range = 121-281 mm TL) and were stocked by personnel from Mumma, once again assisted by personnel from BIA-NIIP. Like the age-2 fish stocked on 7 July 2005, these 2003 year-class fish, produced at DNFH&TC, were progeny of the "1991 broodstock." The fry produced from the 2003 paired matings were transferred from DNFH&TC to Mumma on 2 June 2003. These age-2 fish had been reared at Mumma from June 2003 through July 2005. These age-2 fish were also excess fish to the Colorado pikeminnow stocking efforts that are ongoing in the Upper Colorado River Basin.

#### 2006 And Beyond

As stated above, the 2003 Colorado pikeminnow augmentation plan calls for a minimum of 300,000 age-0 Colorado pikeminnow to be stocked at roughly the same stocking locations for the next five years (i.e., through 2009).

At a meeting on 5 April 2005, the San Juan River Biology Committee decided to begin stocking a second group (n = 3,000) of older (age-1,  $\geq$  150 mm TL) Colorado pikeminnow concurrently with the annual stockings of age-0 Colorado pikeminnow that are scheduled to occur under the auspices of the 2003 Colorado pikeminnow augmentation plan. These age-1 fish (a.k.a. phase II fish) are scheduled to be produced and reared at Dexter NFH and it is anticipated that, beginning in the fall of 2006 (and continuing through 2009), these age-1 fish will be delivered to the San Juan River for stocking at roughly the same time as are the 300,000 age-0 fish. An addendum to the 2003 Colorado pikeminnow augmentation plan, specifying the details and rationale for this additional stocking effort was produced in 2005 (Ryden 2005a).

#### Monitoring Of Stocked Fish

As was the case between 1996 and 2000 (e.g., Archer et al. 2000, Jackson 2001), there was a study implemented in 2002 to intensively monitor Colorado pikeminnow stocked as part of the eight-year augmentation effort (e.g., see Golden et al. 2004, Golden and Holden 2005). In addition, numerous Colorado pikeminnow were collected opportunistically during sampling for other studies in 2004. Colorado pikeminnow collected during the fall sub-adult and adult large-bodied fish community monitoring study ("Adult Monitoring" for short) have been used to track catch per unit of effort (CPUE = number of fish per

hour of electrofishing) of stocked Colorado pikeminnow over the last several years. This will continue throughout the current eight-year augmentation effort (2002-2009).

Recaptures of Colorado pikeminnow stocked between 1996 and 2005 were used to track long-term growth of stocked age-0 fish. Age-at-length determinations for recaptured juvenile Colorado pikeminnow were based upon growth curves presented in USFWS (2002) and upon observed lengths among known-age juvenile Colorado pikeminnow recaptured from the San Juan River between 1997 and 2005 (Ryden unpublished data).

## RESULTS

### Stockings

As discussed in the METHODS section of this report, several different stocking efforts for Colorado pikeminnow occurred in 2005 under the auspices of the 2003 Colorado pikeminnow augmentation plan. In all, 306,811 age-0, age-1, and age-2 Colorado pikeminnow were stocked in 2005 (Table 2). The 302,270 age-0 fish stocked in 2005 exceeded the target number of 300,000 age-0 fish specified in the 2003 augmentation plan (Ryden 2003). Likewise, the 500 age-1 fish combined with the 4,051 age-2 fish stocked in 2005, exceeded the target number of 3,000 age-1 (or in this case age-1+) fish specified in the 2005 augmentation plan addendum (Ryden 2005a).

Technically, the augmentation plan addendum (Ryden 2005a) calls for the 3,000 supplemental age-1 fish to be stocked starting in the fall of 2006 and for all 3,000 of these fish to be reared at DNFH&TC. However, since there were > 3,000 age-1 fish (in this case 4,541 age-1+ fish) stocked in 2005 and since they all originated at DNFH&TC, it could be considered that for once the SJRIP's Colorado pikeminnow augmentation effort not only met the expected annual goal of 300,000 age-0 fish, but is a year "ahead of the game" in stocking the 3,000 age-1 fish (Table 3).

Between 2002 and 2005, a total of 975,381 Colorado pikeminnow (n = 968,616 age-0 fish; n = 1,505 age-1 fish; n = 5,260 age-2 fish) have been stocked under the auspices of the 2003 Colorado pikeminnow augmentation plan (Table 2). This constitutes an overall shortfall of 174,619 fish (15.18%) for all four years of the current augmentation effort combined.

Table 2. Stockings of Colorado pikeminnow into the San Juan River that have occurred under the auspices of the 2003 augmentation plan.

Dates	Number Stocked	River Miles Stocked At	Mean Total Length (in mm)	Range Of Total Lengths (in mm)	Responsible Agency <sup>a</sup>
10/24/2002	105,209	180.2	51	32-127	USFWS-CRFP
10/24/2002	105,209	158.6	51	32-127	USFWS-CRFP
11/06/2003	155,764	180.2-170.5 and 158.6-148.5	58	38-100	USFWS-CRFP
11/06/2003	20,164	188.4-180.7 and 163.7-159.2	58	Unknown	BIO-WEST
11/06/2003	1,005	180.2	180	125-280	CDOW-Mumma
06/09/2004	1,219	180.2	218	144-278	CDOW-Mumma
10/21/2004	30,000	178.6-169.5 and 163.7-159.2	50	Unknown	BIO-WEST
10/21/2004 & 10/28/2004	250,000	180.2-170.5 and 158.6-148.5	50	35-116	USFWS-CRFP (assisted by BIO-WEST)
07/07/2005	500	180.2	201	114-256	USFWS-Dexter
07/07/2005	1,491	180.2	204	121-281	CDOW-Mumma
10/20/2005	20,000	175.8, 167.5 and 167.4	55	32-151	BIO-WEST
10/20/2005 & 11/03/2005	282,270	180.2-170.5 and 158.6-148.5	55	32-151	USFWS-CRFP
11/10/2005	2,550	180.2	167	115-252	CDOW-Mumma

<sup>a</sup> USFWS-CRFP = U. S. Fish and Wildlife Service, Colorado River Fishery Project, Grand Junction, Colorado; BIO-WEST = BIO-WEST, Inc., Logan, Utah; CDOW-Mumma = Colorado Division of Wildlife, J.W. Mumma Native Species Hatchery, Alamosa, Colorado; USFWS-Dexter = U. S. Fish and Wildlife Service, Dexter National Fish Hatchery and Technology Center, Dexter NM

Table 3. Stockings of Colorado pikeminnow into the San Juan River in 2002-2005 versus the target number of fish specified in the 2003 Colorado pikeminnow augmentation plan.

Year	Number Of Fish Plan Calls For Annually	Number Of Fish Actually Stocked	Shortfall (-) Or Surplus (+) For the Year
2002	250,000 age-0	210,418 age-0	(-) 39,582
2003	300,000 age-0	175,928 age-0 1,005 age-1	(-) 123,067
2004	300,000 age-0	280,000 age-0 1,219 age-2	(-) 18,781
2005	300,000 age-0	302,270 age-0 500 age-1 4,041 age-2	(+) 6,811
2006-2009	300,000 age-0 3,000 age-1	N/A	N/A

#### Recaptures

Collections of wild Colorado pikeminnow continue to be extremely rare. No wild adult Colorado pikeminnow were collected in 2005. The last wild adult Colorado pikeminnow to be collected in the San Juan River was an 846 mm TL female that was captured on 25 July 2000 at RM 138.9. This fish had been captured in each of the previous two years - at RM 131.5 on 23 March 1999 and at RM 137.6 on 29 September 1998. Two wild larval Colorado pikeminnow were collected in 2004 (Brandenburg et al. 2005). These were the first wild Colorado pikeminnow larvae collected since 1991 (Brandenburg et al. 2005). However, no wild larval Colorado pikeminnow were collected in 2005 (H. Brandenburg, pers. comm.).

Colorado pikeminnow that had been stocked as part of augmentation efforts (Table 2) were recaptured on sampling trips for nine different studies throughout 2005 (Table 4). Juvenile fish numerically dominated 2005 collections. A total of 2,546 YOY (age-0) and juvenile (age-1 through age-3) fish were collected during 2005 (Table 4). In comparison, only three adult Colorado pikeminnow were collected during 2005 (Table 4). Numbers presented in Table 4 for larger juveniles (i.e., individuals with PIT tags) and adults represent first-time recaptures of unique individuals -- multiple recapture events of larger, individually identifiable fish have been eliminated from this data.

Only two Colorado pikeminnow that had been stocked as adult fish on 11 April 2001 were collected in 2005 (Table 4). One (TL = 538 mm; PIT tag # 7F7B1B0B31) was collected during nonnative fish removal efforts at RM 161.6 on 22 March 2005 (J. Davis, pers. comm.). This was the tenth recapture of this fish since it was stocked on 11 April 2001. The second (TL = 650 mm; PIT tag # 7F7D11472D) was recaptured in the PNM Fish Ladder (RM 166.6) on 2 August 2005 (A. Lapahie, pers. comm.). This was the fifth recapture of this fish since it was stocked on 11 April 2001 and its third time through the fish ladder.

Table 4. Collections of Colorado pikeminnow that occurred in the San Juan River in 2005.

Study	Responsible Entity <sup>a</sup>	Gear Type	Time Of Year Sampled	Number Collected In 2005 By Life-Stage (Lengths In mm) And RM Range Collected In
Sub-Adult And Adult Large-Bodied Fish Community Monitoring	USFWS-CRFP	Raft-Mounted Electrofish	September And October	Juveniles = 127 (range = 125-419 mm TL) RM 178.0-5.0
Hogback And Fruitland Canal Fish Surveys	UNM	Seining	October And November	Juveniles = 78 (< 184 mm TL) In The Hogback And Fruitland Canals
Nonnative Fish Removal: RM 52.9-2.9	UDWR-Moab	Raft-Mounted Electrofish	March Through August	Juveniles = 263 (range = 63-381 mm TL) RM 52.5 To Lake Powell
Nonnative Fish Removal: RM 166.6-147.9	USFWS-NMFRO	Raft-Mounted Electrofish	March Through November	Juveniles = 255 (range = 45-410 mm TL) Adults = 2 (TL = 538 mm, 603 mm <sup>b</sup> ) RM 166.6-149.0
PNM Fish Ladder	Navajo Nation	Selective Fish Passage Structure	April Through October	Juveniles = 8 (range = 104-379 mm TL) Adults = 1 (TL = 664 mm) RM 166.6
Small-Bodied Fish Community Monitoring	NMGF - Santa Fe	Seining And Backpack Electrofish	September And October	Juveniles = 3 (range = 166-289 mm TL) RM 107.3-45.3
Larval Endangered Fish Surveys	UNM	Seining	April Through July	Juveniles = 92 (range = 33-137 mm SL) RM 140.5-3.4
Monitoring Of Stocked Colorado Pikeminnow	BIO-WEST	Seining	March, July, And November	Juveniles = 1,715 (all ≤ 265 mm TL) RM 177.95-0.7
Monitoring Of Stocked Razorback Sucker	USFWS-CRFP	Raft-Mounted Electrofish	April	Juveniles = 7 (range = 181-349 mm TL) RM 146.0-89.0

a: BIO-WEST = BIO-WEST, Inc., Logan, UT; Navajo Nation = Navajo Nation, Department of Game and Fish, Window Rock, AZ; NMGF-SantaFe = New Mexico Department of Game and Fish, Santa Fe, NM; UDWR-Moab = Utah Division of Wildlife Resources - Moab Field Station, Moab, UT; UNM = University of New Mexico, Museum of Southwestern Biology, Division of Fishes, Albuquerque, NM; USFWS-CRFP = U. S. Fish and Wildlife Service - Colorado River Fishery Project, Grand Junction, CO; USFWS-NMFRO = U. S. Fish and Wildlife Service - New Mexico Fisheries Resource Office, Albuquerque, NM.

b: This Colorado pikeminnow, collected on 28 July 2005, was likely a long-term survivor of the 1996 or 1997 experimental stockings of age-0 fish by UDWR. However, this could have also been a wild-produced fish.

A third adult Colorado pikeminnow was collected on 28 July 2005 (J. Davis, pers. comm.) by nonnative fish removal crews (Table 4). It is unknown if this was a stocked fish or a wild fish. Its size (603 mm TL) at recapture would indicate that this fish was likely between 9-11 years old (8-16 years old at the outside; M. Trammel, pers. comm.). This would mean it was likely spawned between 1994 and 1996 (1989-1997 at the outside; M. Trammel, pers. comm.) and was very probably a long-term survivor of either the 1996 or 1997 experimental stockings of age-0 Colorado pikeminnow by UDWR (Table 4). However, this could have also been a wild-produced fish. This fish was implanted with a new (134 khz) PIT tag (# 3D91BF18D723B) before being released (J. Davis, pers. comm.).

The 2,549 Colorado pikeminnow collected in 2005 represents the second highest number of Colorado pikeminnow ever scientifically-documented in the San Juan River (n = 2,649 in 2004; Ryden 2005b). Total catch per unit effort (CPUE) for Colorado pikeminnow during the fall 2005 Adult Monitoring trip (i.e., CPUE for all life stages combined) was the second highest ever observed (1.49 fish/hr of electrofishing versus 1.78 fish/hr of electrofishing in 2004) since riverwide sampling (i.e., RM 180.0-0.0) began in 1996 (Figure 1; Ryden 2006). The observed decline in Colorado pikeminnow total CPUE between 2004 and 2005 is likely related to the comparatively high spring discharge that occurred in 2005 (peaked at 13,200 CFS on 25 May 2005 at the Shiprock USGS gage 09368000), an event that has not been duplicated or matched in the last several years (Ryden 2006). In comparison, spring runoff flows in 2004 peaked at 4,760 CFS on 5 April 2004 (at the Shiprock USGS gage 09368000) - in other words at a much lower level and considerably earlier in the calendar year (Ryden 2006).

#### Growth

A length-frequency histogram of Colorado pikeminnow collected on the fall 2005 Adult Monitoring trip (Figure 2) showed that while the majority (n = 75 fish; 59.1%) of the 127 Colorado pikeminnow collected during the fall 2005 Adult Monitoring trip were age-1 fish, there was also a second distinct group of age-2 fish present in collections (n = 50 fish; 39.4%; Figure 2; Ryden 2006). This distribution of year-classes very closely mirrors that observed in 1998 when both the 1996 and 1997 year-classes of fish were clearly discernable in a length-frequency histogram (Figure 2; Ryden 2006). Another thing apparent in the 2005 Colorado length-frequency histogram is that there are very few age-3 fish from the fall 2002 stockings of age-0 fish (Figure 2). It appears as if the fall 2002 stockings of age-0 fish had comparatively poor survival and/or retention when compared to the 2003 and 2004 stockings of age-0 fish. Data from other studies and analysis done by other researchers (e.g., Golden and Holden 2005; Mike Golden pers. comm.; S. Ross pers. comm.) seems to support this as well.

The largest group of recaptured Colorado pikeminnow during the fall 2005 Adult Monitoring trip (n = 64; 50.4%), were age-1 fish from DNFH&TC that were stocked (as age-0 fish) in the fall of 2004 (Figure 2; Ryden 2006). These age-1 fish were collected from RM 178.0-7.0 (Ryden 2006). Another 11 (8.7%) age-1 Colorado pikeminnow were also recaptured during the fall 2005 Adult Monitoring trip, but these were fish from DNFH&TC that had been stocked as age-1 fish on 7 July 2005 (and thus had been in the river only about three months, all of which was after high spring flows) at RM 180.2 (Ryden 2006). These 11 age-1 DNFH&TC fish were collected from RM 169.0-47.0, with 10 of the 11 being collected upstream of RM 115.0 (Ryden 2006).

# FISH PER HOUR OF ELECTROFISHING

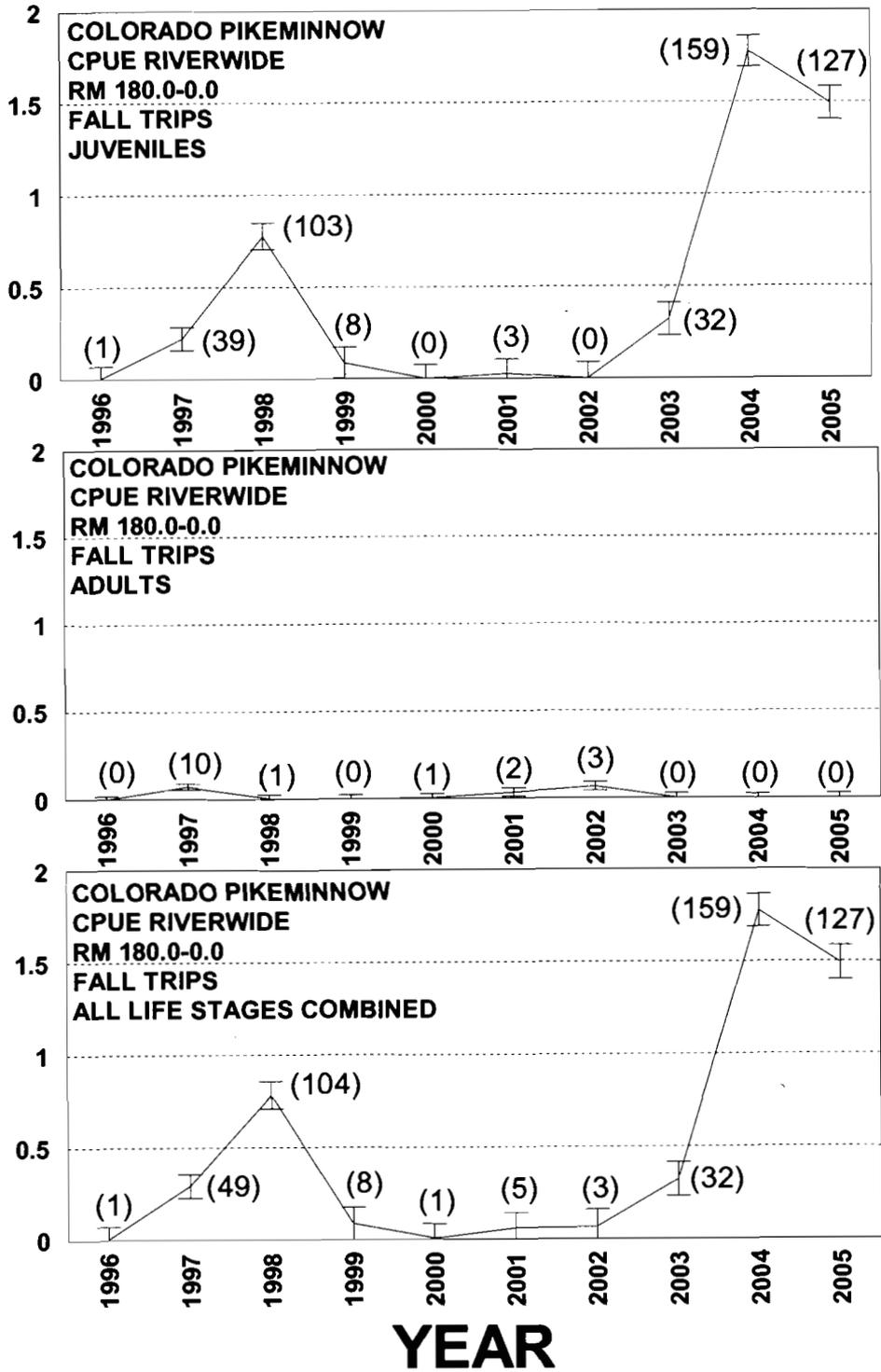


Figure 1. Colorado pikeminnow catch per unit effort (CPUE), by life stage, on fall Adult Monitoring trips, 1996-2005. Error bars represent one standard error. Numbers in parentheses indicate the number of Colorado pikeminnow collected.

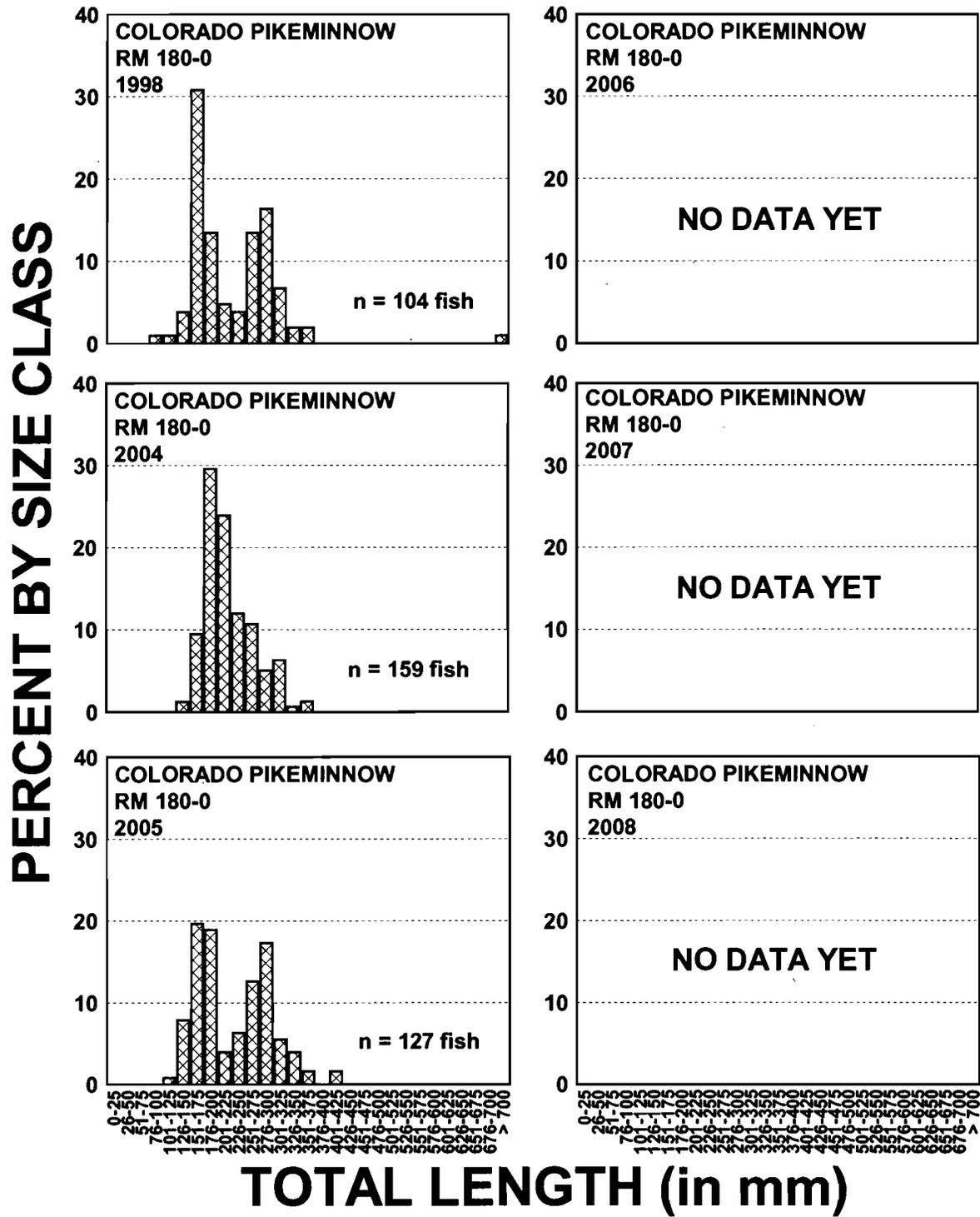


Figure 2. Length-frequency histograms for Colorado pikeminnow recaptured during the fall 1998, fall 2004, and fall 2005 Adult Monitoring trips. Large numbers of age-0 Colorado pikeminnow had been stocked in the fall for two or more consecutive years prior to each of these Adult Monitoring trips (i.e., 1996-1997, 2002-2003, and 2002-2004). These are the only three Adult Monitoring trips (these trips began in 1991) during which  $\geq 100$  Colorado pikeminnow were recaptured.

The second largest group of recaptured Colorado pikeminnow (n = 39; 30.7%) during the fall 2005 Adult Monitoring trip were age-2 fish from DNFH&TC that were stocked (as age-0 fish) in the fall of 2003 (Figure 2; Ryden 2006). These age-2 fish were collected from RM 178.0-16.0 (Ryden 2006). Another 11 (8.7%) age-2 Colorado pikeminnow were also recaptured during the fall 2005 Adult Monitoring trip, but these were fish from Mumma that had been stocked as age-2 fish on 7 July 2005 (and thus had been in the river only about three months, all of which was after high spring flows) at RM 180.2 (Ryden 2006). These 11 age-2 Mumma fish were collected from RM 178.0-124.0 (Ryden 2006).

The smallest group of Colorado pikeminnow recaptured during the fall 2005 Adult Monitoring trip were the age-3 fish (Figure 2). Only two age-3 Colorado pikeminnow recaptured in 2005. One of these (recaptured at RM 50.0) had been stocked in the fall of 2002 as an age-0 fish, while the other (recaptured at RM 59.3) had been stocked on 9 June 2004 as an age 2 fish from Mumma (Figure 2; Ryden 2006).

Based on the total numbers of Colorado pikeminnow stocked since the fall of 2002 and potentially available for recapture during the fall 2005 Adult Monitoring trip, the age-1 fish stocked as age-0 fish in the fall of 2004 made up 41.8% of all fish available to be recaptured, but accounted for 50.4% of the total catch in 2005 (Ryden 2006). The age-1 fish stocked as age-1 fish on 7 July 2005 made up just 0.07% of all fish available to be recaptured, but accounted for 8.7% of the total catch in 2005 (Ryden 2006). However, it should be noted that these fish had only been in the river between 74 and 93 days when they were sampled on the fall 2005 Adult Monitoring trip and hadn't had to undergo the rigors that the other groups of available Colorado pikeminnow had already experienced and survived. The age-2 fish stocked as age-0 fish in the fall of 2003 made up 26.2% of all fish available to be recaptured, but accounted for 30.7% of the total catch in 2005 (Ryden 2006). The age-2 fish stocked as age-2 fish on 7 July 2005 made up just 0.2% of all fish available to be recaptured, but made up 8.7% of the total catch in 2005 (Ryden 2006). Again, it should be noted that these fish had only been in the river between 74 and 93 days when they were sampled on the fall 2005 Adult Monitoring trip and hadn't had to undergo the rigors that the other groups of available Colorado pikeminnow had already experienced and survived. The age-3 fish stocked as age-0 fish in the fall of 2002 made up 31.4% of all fish available to be recaptured, but accounted for only 0.7% of the total catch in 2005 (Ryden 2006). The age-3 fish stocked as age-2 fish on 9 June 2004 made up just 0.2% of all fish available to be recaptured, but accounted 0.7% of the total catch in 2005 (Ryden 2006). So, if survival among stocked fish was a constant between years and among stockings (which we know that it is not), fish from five of the six different stockings collected on the fall 2005 Adult Monitoring trip were collected in somewhat higher proportions than might be anticipated, based strictly on the number of fish that were originally stocked. The only group that seemed to be proportionally under-represented were the fish stocked as age-0 fish in the fall of 2002. This is another piece of evidence that indicates that survival/retention among that particular group of stocked juvenile Colorado pikeminnow was poor when compared to other stockings.

Age-1 Colorado pikeminnow collected during the fall 2004 Adult Monitoring trip were visibly larger than their age-1 counterparts in either 1998 or 2005 (Figure 2; Ryden 2006). The age-0 Colorado pikeminnow stocked in 2003 were slightly larger at the time of stocking (mean TL = 58 mm; range = 38-100 mm TL) than were their 1997 and 2004 year-class counterparts (1997 age-0 fish mean TL = 45 mm {range = 35-55 mm TL}; 2004 age-0 fish mean TL = 50 mm TL {range = 35-116 mm TL}), although the ranges of total lengths stocked had considerable overlap (Tables 1 and 2). However, the more likely explanation for the observed differences in sizes of the age-1 fish among these three years would be the spring discharge regimes of those particular years (M.

Golden, pers. comm.). Both 1998 (peaked at 7,610 CFS on 4 June 1998 at Shiprock USGS gage 09368000) and 2005 (peaked at 13,200 CFS on 25 May 2005 at Shiprock USGS gage 09368000) had comparatively higher and later spring runoff flows than did 2004 (peaked at 4,760 CFS on 5 April 2004 at Shiprock USGS gage 09368000) which peaked at a much lower level and considerably earlier in the calendar year. The higher, later spring flows in 1998 and 2005 would act to suppress water temperatures later into the summer in both of those years, almost certainly causing the age-1 Colorado pikeminnow in the river at those times to grow more slowly. However, in 2004, flows stayed comparatively low and peaked very early, causing the river to achieve higher water temperatures earlier in the year, thus increasing the growing season for age-1 fish during 2004, which in turn led to larger age-1 fish being collected on the fall 2004 Adult Monitoring trip.

There appears to be little growth among stocked juvenile Colorado pikeminnow during the colder months of the year - November through March (Figure 3). Most of the growth observed among stocked juvenile Colorado pikeminnow takes place between April and October (Figure 3). Looking at the sizes of recaptured Colorado pikeminnow stocked as age-0 fish from 2002-2004, it appears that a large degree of the variability in size seen among various groups of age-1 fish from year to year tends to disappear by the time they reach age-2 (Figure 3). Although there is some variation in growth among year-classes, for the most part, the growth rates observed for age-0 fish stocked in the fall of 1996 and summer of 1997 seem to be generally consistent with those observed among age-0 fish stocked in the fall of 2002, 2003, and 2004 (Figures 3 and 4).

#### Anticipated Growth Among Stocked Age-0 Colorado Pikeminnow

The growth rate (i.e., increase in observed total length), based upon Colorado pikeminnow that were stocked as age-0 fish (either on 4 November 1996, mean TL = 55 mm; or 15 August 1997, mean TL = 45 mm) and subsequently recaptured since that time, is initially rapid from age-0 through age-2, then gradually declines as fish approach maturity (Figure 4). Length at maturity is considered to be  $\geq 450$  mm TL (USFWS 2002). Based on this growth curve, age-0 fish being stocked in the fall as part of the augmentation efforts, should recruit into the adult population in either their age-4 or age-5 year-class.

It should be noted that many of the Colorado pikeminnow being stocked into the San Juan River in the fall of the year are typically larger than (and in some cases can be almost twice as large as) wild fish would be at that time of year. Thus these stocked fish could potentially reach adulthood earlier than would wild fish of the same year-class.

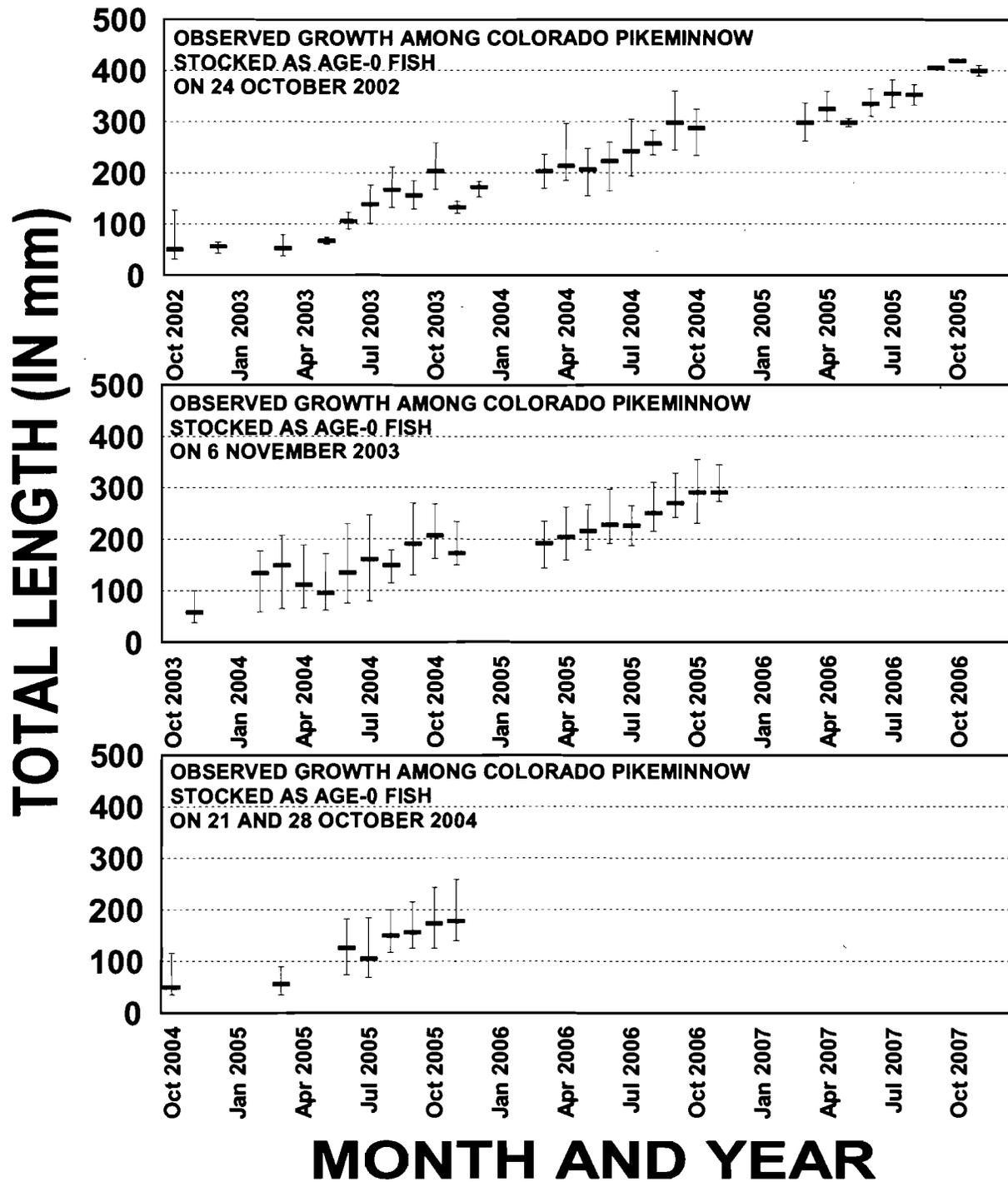


Figure 3. Mean total length in mm, by month, observed among recaptured Colorado pikeminnow that were originally stocked in the fall of 2002, 2003, or 2004. Vertical bars indicate minimum and maximum observed values.

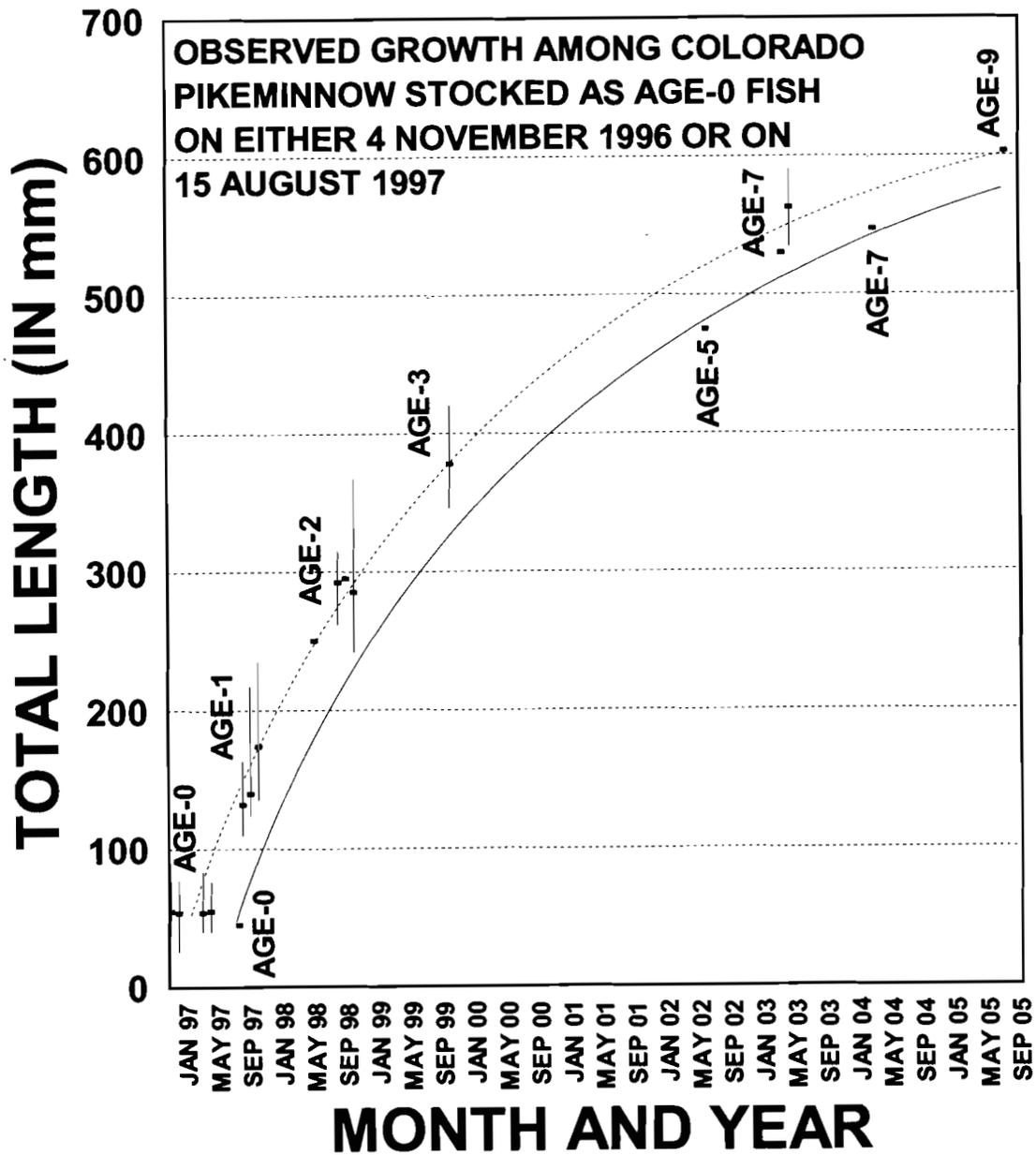


Figure 4. Mean total length in mm, observed among recaptured Colorado pikeminnow that were originally stocked on either 4 November 1996 (dashed line) or 15 August 1997 (solid line) and subsequently recaptured through the fall of 2005. Vertical bars indicate minimum and maximum observed values.

## DISCUSSION

Between 2002 and 2005, a total of 975,381 Colorado pikeminnow (n = 968,616 age-0 fish; n = 1,505 age-1 fish; n = 5,260 age-2 fish) have been stocked into the San Juan River. This constitutes an overall shortfall of 174,619 (15.18%) over the first four years of the eight-year augmentation effort (2002-2009), based on the numbers specified in the 2003 augmentation plan and its 2002 draft predecessor. However, in 2005, the target of stocking  $\geq 300,000$  age-0 fish was met for the first time, when a total of 302,270 age-0 fish were stocked. This was a surplus of 2,270 fish (0.75%) for 2005. It is anticipated that the target number of age-0 fish will continue to be met for remaining four years of this augmentation effort.

In early 2005, an addendum to the Colorado pikeminnow augmentation plan (Ryden 2005a) was finalized. This addendum specifies that in addition to the annual target of  $\geq 300,000$  age-0 Colorado pikeminnow, the SJRIP will have an annual target of stocking  $> 3,000$  age-1 (or age-1+) Colorado pikeminnow, beginning in the fall of 2006. Even though this addendum is not supposed to be in effect until 2006, a total of 500 age-1 and 4,041 age-2 Colorado pikeminnow were stocked in 2005. So essentially, not only was the upcoming goal of stocking  $\geq 3,000$  age-1 (or age-1+) fish met in 2005, a year ahead of schedule, but it was exceeded by a surplus of 1,541 fish (51.37%) in 2005. It is encouraging that the SJRIP is "ahead of the game" in its stocking of larger size-class (age-1+) Colorado pikeminnow. The addition of these older stocked fish, which should be able to survive and retain at a higher rate than their younger age-0 counterparts, should help to make up for previous years' shortfalls in numbers of stocked fish.

No wild Colorado pikeminnow, of any life-stage, were collected in 2005. This continued lack of wild fish being collected in the San Juan River is disheartening. It would now appear that the small number of wild adult Colorado pikeminnow that were being sampled with some regularity in the early 1990's are at best severely reduced in number, and at worst may now be completely extirpated. The 2004 collections of two wild-spawned larval Colorado pikeminnow may be evidence that a few of these older wild adults are still alive. However it more likely points to the fact that some of the age-0 fish stocked in 1996 and 1997 by UDWR have recruited into adulthood and are now spawning with at least some small success.

Numerous Colorado pikeminnow that had been stocked as part of augmentation efforts were recaptured on sampling trips for nine different studies throughout the San Juan River (i.e., from RM 177.95 downstream to Lake Powell) during 2005. Colorado pikeminnow range in the San Juan River has been successfully expanded (at least in the short-term) throughout their designated Critical Habitat (USFWS 1994) via augmentation. The increase in collections of Colorado pikeminnow in numerous habitat types and the ability of researchers to collect them throughout the year using numerous gear types points to the relative increase in their numbers over the last couple of years.

Juvenile fish numerically dominated 2005 collections. A total of 2,546 YOY (age-0) and juvenile (age-1 through age-3) fish were collected during 2005. In comparison, only three adult Colorado pikeminnow were collected during 2005. Two of the adult Colorado pikeminnow that were recaptured in 2005 had been stocked as adult fish on 11 April 2001. The other adult Colorado pikeminnow collected in 2005 did not have a PIT tag at the time of recapture, but based on its size it was likely a survivor from the 1996 (or possibly 1997) stockings of age-0 fish by UDWR. However, there is also a chance that this was a wild fish spawned between 1994 and 1996 (1989-1997 at the outside). The generalized lack of adult Colorado pikeminnow being

collected points not only to the fact that there is currently a very small extant adult population, but also to the need to continue with augmentation efforts for this species. The large numbers of juvenile fish that appear to be surviving and beginning to recruit is encouraging, but it is still unknown how successful these fish will be in bolstering the adult population.

The 2,549 Colorado pikeminnow collected during all studies in 2005 represents the second highest number of Colorado pikeminnow ever scientifically-documented in the San Juan River. Total CPUE for Colorado pikeminnow during the fall 2005 Adult Monitoring trip was also the second highest ever observed (1.49 fish/hr of electrofishing) since riverwide sampling began in 1996. The observed decline in Colorado pikeminnow total CPUE between 2004 and 2005 is likely related to the comparatively high spring discharge that occurred in 2005, an event that has not been duplicated or matched in the last several years. This same decline in relative abundance between 2004 and 2005 was observed among stocked razorback sucker as well, and again was likely flow-related (Ryden 2006 In Prep.) While the decline in relative abundance among stocked fish due to high flows is not necessarily the outcome we might have hoped for, it is not completely unexpected either. There is evidence to indicate that high flow events in the San Juan River (whether they be spring runoff or monsoonal storm spikes) tend to be strong selective factors, even among very fit wild-produced fish (Ryden 2004). Therefore, we would expect them to be even harder on populations of stocked fish. The interesting thing to me is not that the relative abundance of Colorado pikeminnow dropped between 2004 and 2005, but that despite the decline, relative abundance of Colorado pikeminnow in the San Juan River in 2005 was still the second highest ever observed. This means that either there were large enough numbers of young Colorado pikeminnow in the river that even with a flow-induced reduction, their numbers remained relatively high or that the relatively young fish that were in the river in late 2004 were fairly successful in weathering the high 2005 spring flows and retaining in the river. Either way, this could be viewed as positive.

The majority (n = 75 fish) of the 127 Colorado pikeminnow collected during the fall 2005 Adult Monitoring trip were age-1 fish. There were also 50 age-2 fish and two age-3 fish collected on this trip. This distribution of year-classes very closely mirrors that observed in 1998 when both the 1996 and 1997 year-classes of fish (both stocked by UDWR) were clearly discernable in a length-frequency histogram. It appears that we are now on the edge of establishing a relatively healthy, multi-year-class juvenile portion of the Colorado pikeminnow population. If the fish from the 2003 and 2004 year-classes continue to survive and recruit in good numbers and can be supplemented by subsequent successful cohorts of young fish, then the short-term outlook for the San Juan River Colorado pikeminnow population is positive.

Very few age-3 fish (from the fall 2002 stockings of age-0 fish) were collected during the 2005 Adult Monitoring trip. Based on the fall 2005 Adult Monitoring collections, as well as collections and analysis by other researchers, it appears as if the age-0 Colorado pikeminnow that were stocked in 2002 did not survive into their age-2 and age-3 year as well as had been hoped for. It appears that the retention/survival of this group of age-0 Colorado pikeminnow was generally lower, almost from the moment of stocking, than survival of similar groups of age-0 fish stocked in 1996, 1997, 2003, and 2004. Like various cohorts of wild-spawned fish, survival among various groups of stocked fish is going to be variable, sometimes highly variable. The poor survival/retention of the 2002 year-class of fish is disheartening, but again maybe not completely unexpected. In reality, survival of fish, wild or stocked, in a riverine situation cannot be measured in terms of constants like those used in the survival curve tables in augmentation plans (e.g., Ryden 2003). Thus good monitoring data and adaptive management will need to

be used to determine at the end of the ongoing eight-year augmentation effort whether or not the SJRIP can discontinue stocking and realistically expect the San Juan River's Colorado pikeminnow population to be self-sustaining or not.

Age-1 Colorado pikeminnow collected during the fall 2004 Adult Monitoring trip were visibly larger than their age-1 counterparts in either 1998 or 2005. The most likely explanation for the observed differences in sizes of the age-1 fish among these three years would be the spring discharge regimes of those particular years. Both 1998 and 2005 had comparatively higher and later spring runoff flows than did 2004, which peaked at a much lower level and considerably earlier in the calendar year. The higher, later spring flows in 1998 and 2005 would act to suppress water temperatures later into the summer in both of those years, almost certainly causing the age-1 Colorado pikeminnow in the river at those times to grow more slowly. Conversely, in 2004, flows stayed comparatively low and peaked very early, causing the river to achieve higher water temperatures earlier in the year, thus increasing the growing season for age-1 fish during 2004, which in turn led to larger age-1 fish being collected on the fall 2004 Adult Monitoring trip.

Looking at the relative sizes of recaptured Colorado pikeminnow stocked as age-0 fish from 2002-2004, it appears that a large degree of the variability in size seen among these various groups of fish during their age-1 year-class tends to disappear by the time they reach age-2. Although there is some variation in growth among year-classes, for the most part, the growth rates observed for age-0 fish stocked in the fall of 1996 and summer of 1997 seem to be generally consistent with those observed among age-0 fish stocked in the fall of 2002, 2003, and 2004. There appears to be very little growth among stocked juvenile Colorado pikeminnow from November through March. Most of the growth observed among stocked juvenile Colorado pikeminnow takes place between April and October.

The observed growth rate for Colorado pikeminnow stocked as age-0 fish is initially rapid from age-0 through age-2, then gradually declines as fish approach maturity. Length at maturity is considered to be  $\geq 450$  mm TL (USFWS 2002). Based on this growth curve, age-0 fish being stocked in the fall as part of the augmentation efforts, should recruit into the adult population in either their age-4 or age-5 year-class. If the preceding assumption is correct, then some of the Colorado pikeminnow that were stocked age-0 fish in the fall of 2002 could begin to recruit in 2006, probably in late summer or early fall. However, since survival among the 2002 year-class of fish was not comparatively good, then this number of recruiting adults should be expected to be small at best and possibly nonexistent at worst.

## LITERATURE CITED

- Archer, E., T. A. Crowl, and M. Trammel. 2000. Abundance of age-0 native fish species and nursery habitat quality and availability in the San Juan River, New Mexico, Colorado, and Utah. Utah State University, Logan, UT and Utah Division of Wildlife Resources, Moab, UT. Final Report to the San Juan River Recovery Implementation Program, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Brandenburg, W. H., M. A. Farrington, and S. J. Gottlieb. 2005. Colorado pikeminnow and razorback sucker larval fish survey in the San Juan River during 2004 (Draft). University of New Mexico, Albuquerque. 92 pp.
- Crist, L. W., and D. W. Ryden. 2003. Genetics management plan for the endangered fishes of the San Juan River. U. S. Fish and Wildlife Service, Grand Junction, CO. 45 pp.
- Golden, M. E., P. B. Holden, and S. K. Dahle. 2004. Retention, growth, and habitat use of stocked Colorado pikeminnow in the San Juan River: 2002-2003 draft annual report. BIO-WEST, Inc., Logan, UT. 66 pp.
- Golden, M. E., and P. B. Holden. 2005. Retention, growth, and habitat use of stocked Colorado pikeminnow in the San Juan River: 2003-2003 draft annual report. BIO-WEST, Inc., Logan, UT. 76 pp.
- Jackson, J. A. 2001. Evaluation of stocked larval Colorado pikeminnow into the San Juan River: 2000. Utah Division of Wildlife Resources, Salt Lake City, UT. 15 pp.
- Jackson, J. A. 2003. Nonnative control in the lower San Juan River: 2002. Interim Progress Report (Draft dated 31 March 2003). Utah Division of Wildlife Resources, Moab, UT. 16 pp. + Appendix.
- Jackson, J. A. 2004. Nonnative control in the lower San Juan River: 2003. Interim Progress Report (Draft dated 31 March 2004). Utah Division of Wildlife Resources, Moab, UT. 19 pp. + Appendix.
- Platania, S. P. 1990. Biological investigation of the 1987 to 1989 New Mexico - Utah ichthyofaunal study of the San Juan River. Museum of Southwestern Biology, University of New Mexico, Albuquerque. Final Report to the New Mexico Department of Game and Fish, Santa Fe, NM and the U. S. Bureau of Reclamation, Salt Lake City, UT. 143 pp.
- Ryden, D. W. 2000. Adult fish community monitoring on the San Juan River, 1991-1997. U. S. Fish and Wildlife Service, Grand Junction, CO. 269.
- Ryden, D. W. 2003. An augmentation plan for Colorado pikeminnow in the San Juan River. U. S. Fish and Wildlife Service, Grand Junction, CO. 63 pp. + appendices.
- Ryden, D. W. 2004. Long-term monitoring of sub-adult and adult large-bodied fishes in the San Juan River: 2003. Interim Progress Report (Draft). U. S. Fish and Wildlife Service, Grand Junction, CO. 67 pp. + appendices.
- Ryden, D. W. 2005a. An augmentation plan for Colorado pikeminnow in the San Juan River. Addendum # 1: Stocking age-1 fish to supplement ongoing augmentation efforts. U. S. Fish and Wildlife Service, Grand Junction, CO. 3 pp.
- Ryden, D. W. 2005b. Augmentation of Colorado pikeminnow in the San Juan River: 2004. U. S. Fish and Wildlife Service, Grand Junction, CO. 17 pp.
- Ryden, D. W. 2006. Long term monitoring of sub-adult and adult large-bodied fishes in the San Juan River: 2005. Interim Progress Report (Draft). U. S. Fish and Wildlife Service, Grand Junction, CO. 86 pp. + appendix.
- San Juan River Recovery Implementation Program Biology Committee. 1995. Long Range Implementation Plan: San Juan River Recovery Implementation Plan. U. S. Fish and Wildlife Service, Albuquerque, NM. 19 pp. + appendices.

- U. S. Fish and Wildlife Service. 1994. Determination of Critical Habitat for the Colorado endangered fishes: razorback sucker, Colorado squawfish, humpback chub, and bonytail chub. Dept. of the Interior, U. S. Fish and Wildlife Service, Federal Register, 21 March 1994, 59:13374-13400.
- U. S. Fish and Wildlife Service. 2002. Colorado pikeminnow (*Ptychocheilus lucius*) Recovery Goals: amendment and supplement to the Colorado Squawfish Recovery Plan. U. S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, CO. 71 pp. + appendices.