



# Lower Colorado River Multi-Species Conservation Program

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*Balancing Resource Use and Conservation*

## Colorado River Fishes Database Management, 2011 Final Report



December 2011

# Lower Colorado River Multi-Species Conservation Program Steering Committee Members

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U.S. Fish and Wildlife Service  
National Park Service  
Bureau of Land Management  
Bureau of Indian Affairs  
Western Area Power Administration

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Arizona Game and Fish Department  
Arizona Power Authority  
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## **Other Interested Parties Participant Group**

QuadState County Government Coalition  
Desert Wildlife Unlimited

## **California Participant Group**

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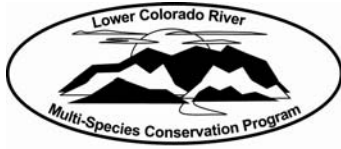
Colorado River Commission of Nevada  
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Hualapai Tribe  
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## **Conservation Participant Group**

Ducks Unlimited  
Lower Colorado River RC&D Area, Inc.  
The Nature Conservancy



# **Lower Colorado River Multi-Species Conservation Program**

## **Colorado River Fishes Database Management, 2011 Final Report**

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**Lower Colorado River  
Multi-Species Conservation Program  
Bureau of Reclamation  
Lower Colorado Region  
Boulder City, Nevada  
<http://www.lcrmscp.gov>**

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## SUMMARY -

The Colorado River Native Fishes Database maintains native fish stocking and PIT tag data for lakes Mead, Mohave and Havasu, and the river below Parker Dam. One of its primary purposes is to support periodic estimation of population abundance of razorback sucker (*Xyrauchen texanus*) in Lake Mohave on behalf of its conservation in the lower basin. Based upon mark-recapture data from 2010-2011, we estimate 13 fish comprise the wild adult population, while the repatriated population estimate was 2,966 fish, which represented 2% of 147,286 fish stocked to date prior to March 1, 2010. The database also serves as a central repository where up-to-date PIT tag data and individual fish capture histories can be accessed on-line by program partners and other interested parties.

## BACKGROUND AND DATABASE MANAGEMENT

Marsh & Associates LLC (M&A) assumed the role as a central repository of field data gathered by the lower Colorado River Lake Mohave Native Fish Work Group (NFWG), when the ecological portion of the Native Fish Lab (NFL) moved from Arizona State University (ASU) into the private sector in October 2008. The genetics branch of that program largely remains at ASU. The NFWG formed in 1990 with representation from Arizona Game and Fish Department (AZGFD), ASU, Biological Resources Division of U.S. Geological Survey (BRD-GS), Nevada Department of Wildlife (NDOW), U.S. Bureau of Reclamation (BR), U.S. Fish and Wildlife Service (FWS) and U.S. National Park Service (NPS). The primary mission of the NFWG is to capture and rear native lower Colorado River fishes for repatriation, in particular razorback sucker (*Xyrauchen texanus*) in preparedness of the imminent demise of wild populations. Larval collections occur annually during the winter-spring spawning season from the shallows along Lake Mohave's shorelines, and fish are reared in several off-site facilities including FWS Willow Beach National Fish Hatchery (NFH) and its satellite Achii Hanyo Fish Hatchery, both located in AZ. Some fish are (or were) stocked directly into the lake from these sites, while others are retained at Willow Beach NFH or transferred for grow-out at various locations, including predator-free lakeside backwaters such as Yuma and Davis coves in AZ, and Dandy and Chemehuevi coves in NV, Lake Mohave. Once they attain a size thought to be relatively safe from predation (initially 250 mm, now increased to 500 mm), fish are measured and marked with passive integrated transponder (PIT) tags prior to stocking into the lake.

In addition to capturing young, the NFWG continues to oversee Lake Mohave monitoring programs that periodically assess population status of wild adult and repatriated razorback suckers, and other components of the fish community. W.L. Minckley and ASU initiated these programs in 1968 with the help of volunteers and agency personnel. Members of the NFWG annually revisit the same localities at the same times of year deploying the same kinds of collection devices, capturing untagged and previously PIT tagged native fishes as well as many non-native species. Field expeditions typically occur in March (also referred to as the Razorback Round-up), May and November, generally targeting spawning, post-spawning and pre-spawning (staging) periods, respectively, and employing several fishing methods, primarily trammel netting and electrofishing. It is during these expeditions that we capture and/or recapture repatriates, generally as mature adults, as they co-mingle with other repatriates, or any remaining wild adults on spawning grounds, but also as juveniles at scattered locations. Additional collections are made independently at other times and locations as part of on-going or special programs and projects of group participants.

Members of the NFWG regularly provide field data from stocked repatriates and adult monitoring to M&A. We manually enter field data into electronic Excel (Microsoft® Excel 2003, © 1985-2003 Microsoft Corporation) spreadsheets or directly into an Access (Microsoft® Access 2003, © 1992-2003 Microsoft Corporation) database. Electronic field data files are in Excel. Data generally include collection or stocking date, collection location, stocking or rearing site with associated state and river mileage (north from Davis Dam, for Lake Mohave), Global Positioning System (GPS) coordinates in either Universal Transverse Mercator (UTM) units or in latitude/longitude degrees/minutes, agency, gear, PIT tag number, total length (TL in mm or cm), weight (g or lb), gender, status, and field comments. We define gender categories as "juvenile" (a young fish that has not attained sexual maturity and does not exhibit external secondary characters that allow reliable sex determination), male, female, and "unknown" (an adult fish whose gender cannot reliably be determined). Status refers to fish capture, recapture or stocking history, and field comments generally relate to fish health although they also may indicate mortality or involvement in an in-situ or hatchery research study.

All manually-entered PIT tag data are proofed using text to speech software (Zoom Text® 8.1, © 2003-2004 Ai Squared) before they are imported into the NFWG database maintained in Access. We sort electronic field data files for duplicates, but do not proof them. We maintain all razorback sucker data received from reservoirs Mead, Mohave, and Havasu and in the river below Parker Dam in this single

database, using a species/reservoir identification key to differentiate between reservoirs, and a record - identification number to identify each individual record regardless of reservoir. We initiate data queries based on information requirements and generically written to accommodate any reservoir.

While at ASU and now at M&A, we typically handled several dozen requests for specific searches each year from biologists working for a suite of state and federal entities until we made access to the database available via the internet. This made retrieval of fish capture histories easier and faster for NFWG members. We did this because the database in its entirety is generally no longer available to NFWG members in any software format due to its complexity and size. We manage the website on an externally hosted server ([www.hostmonster.com](http://www.hostmonster.com)). In 2007, we changed the formatting such that members could search up to three PIT tags at one time versus the previous format of searching only one tag at a time, and recently we made improvements such that now 10 PIT tags at a time can be searched.

In FY 2007, NFWG members began double-tagging fish such that fish captured with 400 kHz PIT tags generally received new 134.2 kHz PIT tags. In the Access database, we added a new field for these tags such that we amended its release and/or capture records to include this new tag. This allows NFWG members to search the online database for either tag, which returns the complete capture history associated with both tags frequencies as well as for fish with multiple 400 and 134.2 kHz PIT tags (i.e., more than one of each tag frequency). The decision to double tag fish was based on the need to assess remote PIT scanning technology for its ability to collect PIT tag data from razorback sucker in Lake Mohave without handling. This technology was developed for the 134.2 kHz tag, and the scanners could not read 400 kHz tags reliably. Although fish released since mid-2006 were tagged with the 134.2 kHz tag, a small percentage of the population at large by 2007 had the 134.2 kHz tag. Double tagging the adult population already in the lake was used to increase the proportion of 134.2 kHz tagged fish in the lake. By 2011, 134.2 kHz tagged razorback sucker outnumbered the 400 kHz tagged fish in Lake Mohave, and so it was recommended at the January 2011 Colorado River Aquatic Biologists meeting in Laughlin, NV that double-tagging be discontinued.

This report provides a summary and analysis of information on razorback sucker and an assessment of wild adult and repatriated population status for FY 2011. As used below, "short-term recapture(s)" are recaptures within 7-d of capture.

## RESULTS -

The comprehensive Lake Mohave survey on 14-18 March 2011 reported total captures of 194 razorback suckers of which 173 fish were PIT tagged (Table 1). We omitted 21 untagged fish (10% of total) from any further analysis because 400 kHz PIT tags may have been present but not detected by tag scanners. This process was initiated in 2007 when we began entering “repatriate” for fish captured without PIT tags or fish with PIT tags but without a tag history in the NFWG database because most young fish captured had a high probability of being repatriates with tag loss. The introduction of double-tagging with 134.9 kHz PIT tags made it difficult for the PIT tag scanners to read the 400 kHz tags when both types were present, potentially giving a false negative for tag presence.

Among the 173 PIT tagged fish, five fish were short-term recaptures and omitted from further analysis, which left 168 total fish comprised of 164 repatriated and four wild fish (Table 2). Amongst the repatriates, we found 103 females (63%) 59 males (33%) and two fish with unknown gender (1%). We found an unexpected female to male ratio of 1.7, unexpected because in previous years we generally saw the ratio skewed toward males. We omitted 11 repatriates with no release history from further analysis, yielding 153 fish for further reporting (Table 3).

Lakeside backwaters and off-site rearing facilities were the sources of 48 and 52% ( $N=73, 80$ ), respectively, of the total number of repatriated fish sampled, with both general rearing locations supplying fish with mean TL at release larger than 400 mm (Table 3). Actual mean release TL was 451 and 417 mm, respectively, by rearing location, with a mean release TL of 433 mm for all fish. Release year, excluding short-term recaptures, ranged from 1995 to 2011 with the mean time at large approximately three years (Table 4); the NFWG released the oldest fish 16 years ago. Length at release ranged from 253 to 597 mm TL with an overall mean of 433 mm.

### Wild Adult Population Size

For the fourth year since FY 2007, we recorded fish captured without PIT tags as repatriated fish in the database, whereas in previous years since the inception of the database, we noted these fish as wild fish, which may have inflated the actual wild adult population estimate. We estimated the wild adult population abundance in the lake using the Chapman modification of the Peterson single census method

(Ricker 1975) from 2010 and 2011 sample data, and report it as the previous year's estimate. Our - March 2010 population estimate was 13 wild fish based upon mark-recapture data (Appendix A). The 95% confidence interval ranged from four to 250 fish. This estimate is significantly less than the most recently published estimate of 2,698 in 2001 (Marsh et al. 2003) derived from all of March data in 2001 and 2002. It does confirm the dramatic population decline over the past decade when the estimate was near 44,000, which was still at that time substantially lower than historical estimates (see Minckley et al. 2003). For annual wild adult razorback sucker population estimates, see Appendix A.

#### Juvenile Repatriate Stocking and Repatriate Population Size

From October 1, 2010 through September 30, 2011, members of the NFWG stocked 5,284 PIT tagged razorback suckers into Lake Mohave (Appendix B); 445 fish had no release lengths and were not included in further analysis. Off-site and lakeside backwaters both contributed to the total, with Willow Beach NFH and Yuma Cove contributing 79% and 4% of the total, respectively ( $N=3,809$  and  $209$  fish, respectively). The mean TLs at release from these two rearing locations were 341 and 466 mm TL, respectively.

We estimated the repatriate population size using March-only captures (1 March to 31 March) from 2010 and 2011 without short-term recapture data, which we then applied to a modified Peterson method formula (i.e., Chapman modification; Seber 1973), and report it as the previous year's estimate. We excluded fish captured in March 2010 that were released in that same month ( $N=1$ ) and fish released after March 1, 2010 captured in March 2011 ( $N=41$ ). The current repatriate population estimate is 2,966 fish with a 95% confidence interval of 1,509 to 6,063 fish, which is almost 1,500 more fish when compared to the previous year's estimate of 1,439 fish with a 95% confidence interval of 753 to 2,805 fish (Appendix C); these results are discussed in detail by Kesner et al. (2011). This estimate represents 2% of 147,286 fish stocked prior to March 1, 2010. For annual repatriated razorback sucker population estimates, see Appendix C.



## CONCLUSIONS -

Since 1992, the program to replicate the dwindling Lake Mohave population of wild adult razorback suckers with juveniles has been successful in repatriating a population of about 2,966 as of March 2010. However, that number is far from the initial target of 50,000 repatriates, and the wild population now has dwindled from probable recent-historical levels in the hundreds of thousands to as few as 13 fish. Repatriate capture/recapture data demonstrate unequivocally that fish released at larger size have a higher survival probability than smaller fish.

Overall survivorship of repatriated razorback suckers in Lake Mohave is low and largely a result of predation by introduced sport fishes (Kesner et al. 2005, 2008, Karam and Marsh 2009). Our prediction that a substantial increase in survivorship would accompany an increase in size at stocking is only beginning to be reflected in the available capture data. This situation may change with the relatively recent (2007) increase to 500 mm (see Kesner et al. 2008).

## ACKNOWLEDGEMENTS

We thank NFWG members and others for their continuing logistic and programmatic support. We also extend our appreciation to all participants in field operations. Special thanks for their leadership roles goes to Tom Burke (BR, retired), Ty Wolters (BR), Gordon Muller (BRD-GS, retired), Chuck Minckley (FWS, retired), Mike Burrell (NDOW), Andy Clark (AZGFD), and Ross Haley (NPS). The Lower Colorado River Multi-Species Conservation Program through BR, Boulder City, NV, provided funding for this project.

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Table 1. Field data summary of razorback sucker collected 14-18 March 2011 in Lake Mohave, AZ-NV. Gender was determined in the field.

Sampling agency and gender	N fish (% Total; % Sum)		Sum (% Sum)
	Without PIT tags	With PIT tags	
BR	0	25 (14; 13)	25 (13)
FWS-AFWCO	20 (95; 10)	97 (56; 50)	117 (60)
M&A	0	13 (7; 7)	13 (7)
NDOW and NPS	1 (5; <1)	38 (22; 19)	39 (20)
Total (% Sum)	21 (11)	173 (90)	194
Female	20 (95; 10)	108 (62; 56)	128 (66)
Male	1 (5; <1)	63 (36; 32)	64 (33)
Unknown	0	2 (1; <1)	2 (1)
Total (% Sum)	21 (11)	173 (90)	194

Table 2. Summary of PIT tagged razorback sucker by gender and history status collected 14-18 March 2011 in Lake Mohave, AZ-NV. Classification into one of the three categories (wild adult, repatriate and unknown) depended upon information in the NFWG razorback sucker database; fish listed as unknown may have been recorded as "recaptures" in the field data, but had no information in the database to identify them as either wild adult or repatriate. Five fish omitted due their short-term recapture status.

Gender	N fish -			Sum (% Sum total) -
	(% Total; % Sum)			
	Wild adult	Repatriate	Unknown -	
Female	1 (25; <1)	103 (63; 61)	0	104 (62)
Male	3 (75; 2)	59 (36; 35)	0	62 (37)
Unknown	0	2 (1; 1)	0	2 (1)
Total (% Sum total)	4 (2)	164 (98)	0	168 -

Table 3. Rearing location summary by rearing type (lakeside vs. off-site), total length (TL, in mm) at release and collection, and gender at collection of PIT tagged repatriated razorback sucker collected 14-18 March 2011 in Lake Mohave, AZ-NV.

Rearing location	N Fish (% Total)	TL (mm)								Gender at collection		
		At release				At collection				Female	Male	Unknown
		Avg	SD	Min	Max	Avg	SD	Min	Max			
Lakeside backwater:												
Arizona Juvenile	7 (10)	384	82	260	465	583	82	465	685	6	1	0
Dandy Cove	11 (15)	443	62	265	485	532	59	450	613	8	3	0
Davis Cove	4 (5)	503	42	450	550	619	41	575	670	3	1	0
Nevada Larvae	2 (3)	370	78	315	425	649	87	587	710	1	1	0
North Chemehuevi Cove	14 (19)	444	72	278	500	537	56	469	638	8	6	0
Willow Cove	5 (7)	480	14	464	495	525	73	465	650	4	1	0
Yuma Cove	30 (41)	466	79	253	597	555	54	426	697	18	12	0
Total ( % Grand total)	73 (48)	451	75	253	597	555	63	426	710	48	25	0
Off-site facility:												
Achii Hanyo	16 (20)	455	18	425	480	563	21	522	596	12	4	0
Boulder City Golf Course Ponds	1 (1)	282	-	282	-	661	-	661	-	1	0	0
Boulder City Wetlands Park	6 (7)	385	38	340	450	612	44	575	675	2	4	0
Bubbling Ponds FH	16 (20)	475	47	405	550	575	41	498	643	11	5	0
Dexter NFH	2 (3)	420	28	400	440	547	48	513	581	1	1	0
Willow Beach NFH	39 (49)	385	35	325	460	536	58	340	630	22	15	2
Total	80 (52)	417	54	282	550	557	53	340	675	49	29	2
Grand total	153 <sup>a</sup>	433	67	253	597	556	58	340	710	97	54	2

<sup>a</sup>Grand total does not include 11 fish excluded from further analysis. See report text for more information.



Table 4. Release year and summary of total length (TL, in mm) at release and mean time at large of PIT tagged repatriated razorback sucker collected 14-18 March 2011 in Lake Mohave, AZ-NV. Time at large differentiated into days at large (DAL), months at large (MAL) and years at large (YAL).

Release year	N Fish (% Total)	TL at release (mm)				Mean time at large		
		Avg	SD	Min	Max	DAL	MAL	YAL
2011	2 (1)	368	32	345	390	69	2	0 -
2010	55 (36)	460	51	340	597	264	9	1 -
2009	50 (33)	449	46	330	550	532	18	1 -
2008	5 (3)	470	33	420	510	911	30	2 -
2007	4 (3)	533	27	505	560	1,330	44	4 -
2006	1 (<1)	480	-	-	-	1,604	53	4 -
2005	8 (5)	369	13	350	385	2,170	72	6 -
2004	6 (4)	373	49	325	465	2,458	82	7 -
2003	1 (<1)	410	-	-	-	2,792	93	8 -
2002	1 (<1)	260	-	-	-	3,086	103	8 -
2001	2 (1)	383	95	315	450	3,496	117	10 -
2000	4 (3)	384	48	340	450	3,892	130	11 -
1999	2 (1)	390	14	380	400	4,313	144	12 -
1998	3 (2)	395	36	355	425	4,553	152	12 -
1997	1 (<1)	295	-	-	-	4,899	163	13 -
1996	6 (4)	288	34	253	350	5,263	175	14 -
1995	2 (2)	313	44	282	344	5,614	187	15 -
Total	153 <sup>a</sup>	433	67	253	597	1,198	40 -	3

<sup>a</sup>Total does not include 11 fish excluded from further analysis. See report text for more information.

Appendix A. Wild adult razorback sucker population estimates in Lake Mohave, AZ-NV, 1980-2010. Estimates based on field data from all of March using annual single-census population estimate,  $N^*$  (Chapman modification of the Peterson Method; Ricker 1975) unless noted otherwise.

Marking year	Sampling year	$N^*$	95% CI		Source
			Lower	Upper	
2010	2011	13	4	250	NFWG database, unpublished data <sup>a</sup>
2009	2010	30	11	600	NFWG database, unpublished data <sup>a</sup>
2008	2009	60	27	400	NFWG database, unpublished data <sup>a</sup>
2007	2008	47	24	175	NFWG database, unpublished data <sup>a</sup>
2006	2007	218	107	1,092	NFWG database, unpublished data <sup>a</sup>
2005	2006	507	263	1,067	NFWG database, unpublished data <sup>a</sup>
2004	2005	429	266	730	NFWG database, unpublished data <sup>a</sup>
2003	2004	1,427	885	2,429	NFWG database, unpublished data <sup>a</sup>
2002	2003	1,694	1,094	2,750	NFWG database, unpublished data <sup>a</sup>
2001	2002	2,698	1,573	5,081	Marsh et al. 2003
2000	2001	2,872	1,965	4,392	Marsh et al. 2003
1999	2000	8,161	1,458	81,601	Marsh et al. 2003
1998	1999	4,506	2,627	8,489	Marsh et al. 2003
1997	1998	5,355	3,190	9,735	Marsh et al. 2003
1996	1997	6,678	4,780	9,661	Marsh et al. 2003
1995	1996	9,322	7,049	12,653	Marsh et al. 2003
1994	1995	13,517	10,281	17,774	Marsh et al. 2003
1993	1994	16,932	13,549	21,162	Marsh et al. 2003
1992	1993	20,853	17,060	25,491	Marsh et al. 2003
1991	1992	44,333	30,118	68,415	Marsh et al. 2003
1993-1980	-	73,500 <sup>b</sup>	-	-	Marsh 1994

<sup>a</sup>Unpublished data, subject to change. -

<sup>b</sup>Population estimate using Schumacher and Eshemeyer's multiple census (Minckley et al 2003). -

Appendix B. Rearing location by rearing type (lakeside vs. off-site) and total length (TL, in mm) at release of PIT tagged juvenile razorback suckers repatriated October 1, 2010 to September 30, 2011 in Lake Mohave, AZ-NV (N=5,284).

Rearing location	N fish (% Total; % Grand total)	TL at release (mm)			
		Avg TL	SD	Min	Max
Lakeside backwater:					
Arizona Juvenile	14 (3; <1)	445	39	400	517
Dandy Cove	136 (26; 3)	407	80	205	480
Davis Cove	11 (2; <1)	488	27	450	527
Nevada Larvae	2 (<1; <1)	367	23	380	413
North Chemehueve Cove	133 (25; 3)	457	25	400	515
Willow Cove	21 (4; <1)	420	20	368	446
Yuma Cove	209 (40; 4)	466	76	300	602
Total (% Grand total)	526 (11)	446	69	205	602
Off-site facility:					
Achii Hanyo	504 (12; 10)	398	47	300	520
Willow Beach NFH	3,809 (88; 79)	341	28	300	508
Total (% Grand total)	4,313 (89)	347	36	300	520
Grand total	4,839 <sup>a</sup>	358	51	205	602

<sup>a</sup>We excluded 445 fish with no TL at release in this analysis. All were from off-site facility, Willow Beach NFH and part of a growth study.

Appendix C. Repatriated razorback sucker population estimate in Lake Mohave, AZ-NV, 1999-2010. Estimates based on field data from all of March using annual single-census population estimate,  $N^*$  (Chapman modification of the modified Peterson Method; Seber 1973).

Marking year	Sampling year	$N^*$	95% CI		$N$ fish released to date prior to March 1 of marking year	% Estimated survival	Source
			Lower	Upper			
2010	2011	2,966 <sup>a</sup>	1,509	6,063	147,286	2	NFWG database, unpublished data <sup>b</sup>
2009	2010	1,439 <sup>a</sup>	753	2,805	128,695	1	NFWG database, unpublished data <sup>b</sup>
2008	2009	1,502 <sup>a</sup>	949	2,384	127,900	1	NFWG database, unpublished data <sup>b</sup>
2007	2008	1,232 <sup>a</sup>	662	2,318	126,562	1	NFWG database, unpublished data <sup>b</sup>
2006	2007	1,431 <sup>a</sup>	770	2,695	124,376	1	NFWG database, unpublished data <sup>b</sup>
2005	2006	4,221 <sup>a</sup>	954	35,071	108,155	4	NFWG database, unpublished data <sup>b</sup>
2004	2005	1,508	663	3,660	107,043	1	NFWG database, unpublished data <sup>b</sup>
2003	2004	1,358	750	2,494	91,637	1	NFWG database, unpublished data <sup>b</sup>
2002	2003	1,335	449	4,804	57,778	2	Marsh et al. 2005
2001	2002	1,813	835	4,113	46,999	4	Marsh et al. 2005
2000	2001	2,494	845	9,033	39,709	6	Marsh et al. 2005
1999	2000	1,017	418	2,700	23,479	3	Marsh et al. 2005

<sup>a</sup>Estimate adjusted to exclude fish captured in March of marking year that were released in March of marking year, as well as fish released after March 1 of marking year and captured in March of sampling year. -

<sup>b</sup>Unpublished data, subject to change. -