



Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Movements of Sonic Tagged Razorback Suckers between Davis and Parker Dams (Lake Havasu) 2007–2010



May 2012

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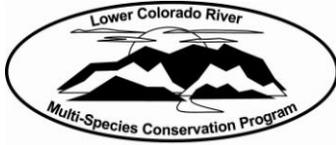
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Lower Colorado River
Multi-Species Conservation Program
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INTRODUCTION

A great deal has been learned about the razorback suckers stocked into Lake Havasu as part of a multiagency effort to augment or reestablish endangered fish populations in this section of the Colorado River. These stockings were part of the Lake Havasu Fish Improvement Project. Undoubtedly, this population represents the most successful reintroduction effort of a riverine population of razorback suckers in the Colorado River basin (Wydoski and Mueller, 2006). The U.S. Bureau of Reclamation, U.S. Geological Survey, and California Fish and Game conducted a study to monitor the survival of these repatriated razorback suckers from 1999 to 2005. Over this time period a continued decline in catch per unit effort was observed during trammel net surveys. It became obvious that this effort was catching fish as they went to or from their spawning area and they were not spawning in the areas being sampled. In 2005, a radio tagged male led to a major spawning site in the Colorado River just upstream of the Highway 95 Bridge in Needles, California. Discovery of this spawning site seems to allow us to effectively monitor this population of razorback suckers. We developed sampling protocols to monitor the razorback sucker population using this spawning site in 2006 and 2007. These protocols used visual counts from boats and fish captured by electrofishing (marked recapture techniques) to calculate populations (Mueller, et. al., 2008). This telemetry study was designed to provide information on whether razorback suckers stocked into Lake Havasu have geographically consolidated their spawning activities, determine the effectiveness of the monitoring effort and provide guidance to improve future monitoring efforts.

OBJECTIVES

- 1) To determine if there is a geographic bias in the distribution of Razorback Suckers that could negatively influence current monitoring efforts. Recapture data from our previous work has shown that fish utilizing the Needles spawning bar were originally stocked into the riverine section of the Colorado River and upper Lake Havasu. However, fish released into lower Lake Havasu haven't been well represented in our samples. Currently, it is unclear of the fate of the fish stocked into the lower portion of the reservoir. It is possible that they may have established another spawning site or maybe they didn't have as good of survival as fish stocked upriver.
- 2) Locate other major razorback spawning sites that may exist between Davis and Parker dams. Currently, it is not known whether the spawning area at Needles is the only major spawning site between Davis and Parker Dams or one of many. Radio tagged fish led us to the Needles site. It is anticipated that long term tags implanted in the fish may lead us to other spawning aggregates in Lake Havasu or the riverine portion of the study site upstream of Lake Havasu.
- 3) Do razorback suckers living between Davis and Parker dams exhibit spawning site fidelity?

STUDY AREA

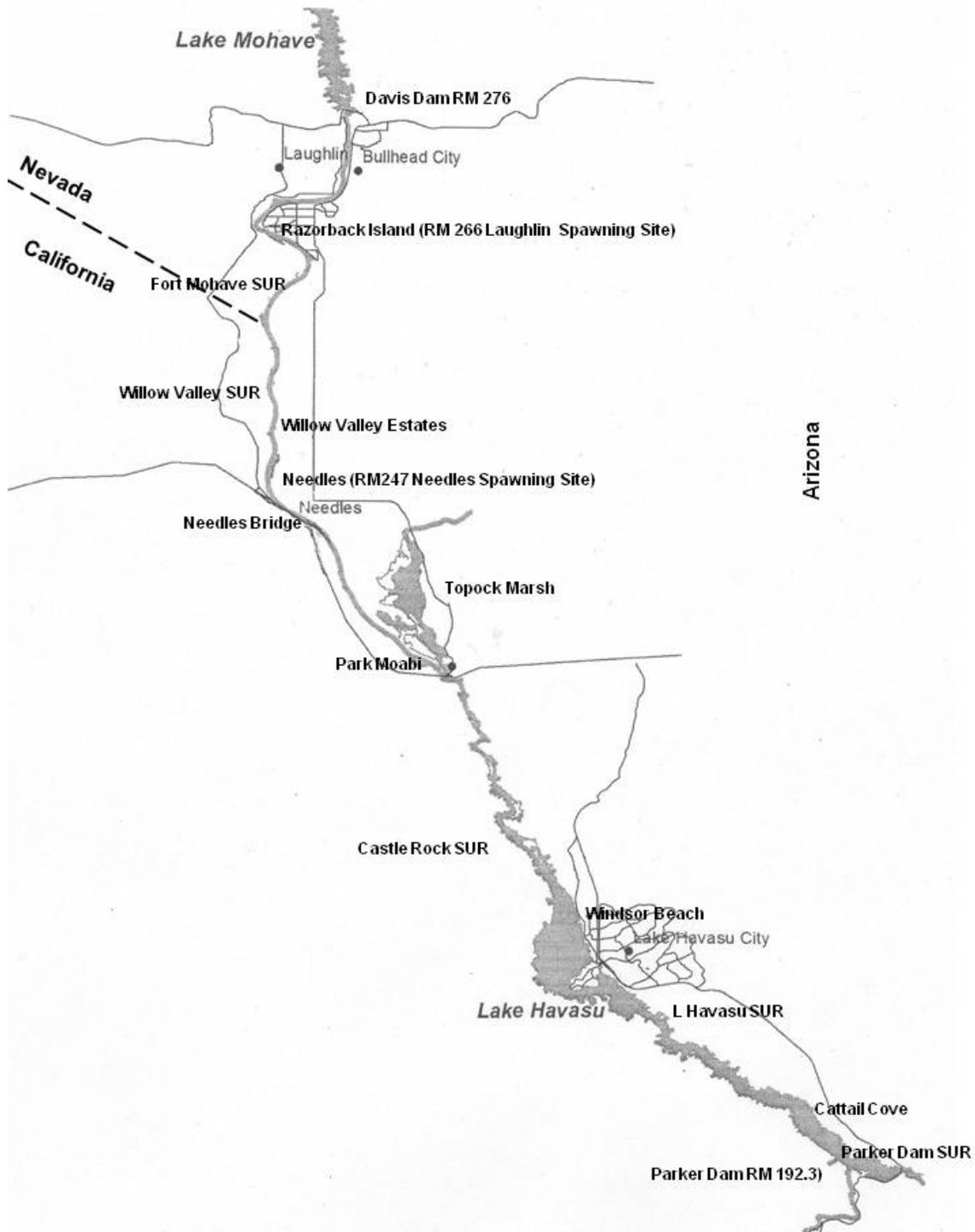


Figure 1: Map of study area on the Colorado River between Davis Dam and Parker Dam. U.S. Bureau of Reclamation River Miles (RM) are used throughout this report (Parker Dam = RM 192.3 and Davis Dam = RM 276).

METHODS

This study consisted of two components. The first was to determine movements of razorback suckers utilizing known spawning sites. The second was to look for additional spawning sites between Davis and Parker Dams.

Adult male razorback suckers were captured from known spawning locations with the use of a boat mounted electrofishing unit to determine movements of razorbacks utilizing known spawning sites. Thirty six month sonic transmitters were surgically implanted into fifteen razorback suckers between December 20, 2006 and February 27, 2007. Tags were implanted into ten males caught December 20, 2006 at the Needles spawning site and into five males captured at a smaller spawning site located near Laughlin (Razorback Island) which is across the river from Boy Scout Camp (four fish were implanted on February 1, 2007 and one on February 26, 2007). (Table 1)

Table 1: Tag information, release date and location, total length and weight of razorback suckers caught at the known spawning sites between December 20, 2006 and February 27, 2007.

	Sonic Tag PIT Tag	Date	Release Location	Total Length	Weight
Needles Fish 1	3-3-3 257C60EF9C	12/20/2006	Jack Smith Park	580 mm	2760 g
Needles Fish 2	3-3-4 257C60CA02	12/20/2006	Jack Smith Park	620 mm	2905 g
Needles Fish 3	3-3-3-4 257C60EC5D	12/20/2006	Jack Smith Park	570 mm	2250 g
Needles Fish 4	3-4-3-8 4254751D61	12/20/2006	Jack Smith Park	580 mm	2270 g
Needles Fish 5	3-4-5-8 257C60D5FE	12/20/2006	Jack Smith Park	575 mm	2250 g
Needles Fish 6	3-4-6-4 445861C55	12/20/2006	Jack Smith Park	590 mm	2590 g
Needles Fish 7	3-4-7-4 4455601A2E	12/20/2006	Jack Smith Park	600 mm	2405 g
Needles Fish 8	3-5-4-5 257C60C172	12/20/2006	Jack Smith Park	620 mm	2765 g
Needles Fish 9	3-5-4-6 42552D2564	12/20/2006	Jack Smith Park	565 mm	2140 g
Needles Fish 10	3-5-8-4 257C609373	12/20/2006	Jack Smith Park	580 mm	2160 g
Laughlin Fish 1	3-6-5 257C60B246	02/01/2007	Big Bend Park	554 mm	2136 g
Laughlin	6-7-8	02/01/2007	Big Bend Park	604	2327 g

Fish 2	42526F763D			mm	
Laughlin	6-6-7-8	02/01/2007	Big Bend Park	560	1960 g
Fish 3	257C60E1D9			mm	
Laughlin	7-7-8	02/01/2007	Big Bend Park	555	2883 g
Fish 4	257C61072E			mm	
Laughlin	3-6-3-6	02/27/2007	Big Bend Park	622	N/A
Fish 5	257C6116E7			mm	

In 2008, ten adult male razorback suckers were released into Lake Havasu to search for additional spawning sites in Lake Havasu (Table 2). Five fish were captured by trammel net from Yuma Cove on Lake Mohave in December 10, 2007. The sonic tags were surgically implanted into the fish on December 21, 2007. They were held in a tank at Willow Beach for about four weeks prior to their release at Cattail Cove on January 2, 2008. Five fish reared at Willow Beach National Fish Hatchery had sonic tags surgically implanted on November 21, 2007. These fish were released at Standard Wash on December, 11, 2008.

Table 2: Tag information, release date and location, total length and weight of razorback suckers released into Lake Havasu to search for other spawning locations.

	Sonic Tag PIT Tag	Date	Release Location	Total Length
Lake Havasu Fish 1	2-2-3 257C609103	01/02/2008	Cattail Cove	512 mm
Lake Havasu Fish 2	2-2-4 257C60E357	01/02/2008	Cattail Cove	495 mm
Lake Havasu Fish 3	2-2-5 257C60A3DD	01/02/2008	Cattail Cove	480 mm
Lake Havasu Fish 4	2-2-6 257C60DE41	01/02/2008	Cattail Cove	475 mm
Lake Havasu Fish 5	2-2-7 257C60D5FD	01/02/2008	Cattail Cove	472 mm
Lake Havasu Fish 6	3-8-8 257C621A54	12/11/2008	Standard Wash	436 mm
Lake Havasu Fish 7	4-4-5 257C5F5C38	12/11/2008	Standard Wash	426 mm
Lake Havasu Fish 8	4-7-8 257C6023E8	12/11/2008	Standard Wash	427 mm
Lake Havasu Fish 9	5-8-7 257C62BC6F	12/11/2008	Standard Wash	440 mm
Lake Havasu Fish 10	5-8-8 257C6022BD	12/11/2008	Standard Wash	434 mm

Three adult male razorback suckers caught in the upper end of Lake Havasu were implanted with sonic tags in January, 2010 (Table 3). These fish were caught with trammel nets implanted with a transmitter, and immediately released in the vicinity of their capture.

Table 3: Tag information, date and location, total length, and weight of razorback caught in the upper end of Lake Havasu in January, 2010.

	Sonic Tag PIT Tag	Date	Release Location	Total Length	Weight
Windsor Fish 1	3-8-7 1C2C38C573	1/5/2010	Windsor Beach	552	1803
Windsor Fish 2	3-5-5 1C2D695219	1/6/2010	California Shore near Inflow	566	2006
Windsor Fish 3	4-4-4 1C2D69415D	1/6/2010	California Shore near Inflow	581	1965

We followed surgical procedures described by Hart and Summerfelt (1975), Mueller, Marsh, and Knowles (1998) and Tyus (1987). Fish were anesthetized in a tub containing approximately 60 liters of river water with 0.1grams/liter of tricaine methanesulfate (MS-222) and 0.1grams/liter of baking soda dissolved into the river water. When the fish lost its equilibrium, it was positioned in a specially designed surgical cradle. Water was passed over its gills during the surgery with a turkey baister to provide oxygen and keep the body moist (Figure 2). Water from the anesthetic bath was used for the first half of the surgery and fresh river water was used in the second half of the operation to minimize the effect of anesthesia.



Figure 2: Anesthetized razorback sucker ready to have a sonic tag surgically implanted into it.

Sonotronics coded sonic transmitters (CT-05-36-I) were used in this study. These tags are 62 mm in length, 16 mm diameter, and weighed 22 grams in air or 10 grams in water. The minimum weight of fish recommended for these tags is 1100 grams (2% of air weight), which is well below the weights of fish (1960-2905 grams) used in this study (Bidgood, 1980). These tags have an expected lifetime of 36 months.

Transmitters were sterilized in a mixture of 90% isopropyl alcohol (70 % solution) and 10% betadine. A 30 to 40 mm, medio-lateral incision was made slightly anterior of the pelvic fin. The transmitter was inserted toward the posterior of the abdominal cavity so that it rests on the pelvic girdle. The incision was sutured with 4-5 knots using 3-0 Ethilon monofilament nylon and a FS-1 cutting needle (Figure 3).

The total surgical process required 7-15 minutes for each fish. This includes 2-4 minutes for the anesthesia to take effect, 3-5 minutes for surgery, and 1-5 minutes for the fish to recover from the anesthesia. Fish were released when they regained their motor skills.



Figure 3: Surgical incision is almost closed on this razorback sucker.



Figure 4: Finished Surgery just prior to the razorback sucker's release back into the river.

Fish movements were monitored by both mobile boat searches for tagged fish and deployment of fixed submersible underwater receivers (SUR's) placed at strategic locations to automatically record detections.

A broad range Sonotronics Receiver (Model USR-5W) was used to locate tagged fish. This receiver detected a signal from all frequencies simultaneously. After locating a signal, we used a Narrow Band Sonotronics Receiver (Model USR-96) to determine tag code. This receiver only receives a signal from one frequency at any given time and was extremely valuable when more than one signal could be detected from one location. A directional hydrophone (Sonotronics DH-4) was used with both of these receivers.

The study area was broken into three reaches for the mobile boat searches. From the security boom below Davis Dam downstream to Needles, CA, we listened for fish as the boat floated downstream. This was the only practical method to insure contact with tagged fish in this section of river due to background noise from the current. From Needles, CA downstream to the Lake Havasu Delta search points were established every quarter mile to listen for tagged fish. Field testing with test tags indicated that this spacing was sufficient to insure tag detection in this stretch of river. In the reservoir

portion of the study site we used a grid of search points spaced one half mile apart. This spacing provided good coverage on the reservoir. After a signal was located we homed in on it to get the specific location of the fish. We also periodically listened from shore between Davis Dam and security boom.

Sonotronics Submersible Underwater Receivers (SUR's) were used to passively monitor fish passage. Receivers were deployed in strategic locations such as known spawning sites and along suspected travel corridors (Figure 1). Due to equipment failure and theft, they were deployed for different periods of time at each location.

RESULTS

Nine of the fifteen sonic transmitters implanted into razorback suckers captured from known spawning sites during the 2007 study year remained active in 2009. Three transmitters (333, 3334, and 788) became stationary during the summer of 2007. It is unclear if these stationary tags were a result of tag expulsion or fish mortality. Contact with one transmitter (3-4-6-4) was lost after the fish moved downstream following its capture via electrofishing in 2007. The last two transmitters (3636 and 6678) disappeared almost immediately after the fish were released following surgery. It was unclear whether these tags failed or were removed from the river.

Of the active transmitters, all razorback suckers remained at their spawning site of initial capture for the spawning season in 2007. Between 2008 and 2010, all razorbacks which were known to be alive after the summer of 2007 returned to the same spawning site where they were initially captured (Figures 5 and 6). Some returned to the spawning site as early as August, and all returned by December. However, one tagged sucker moved downstream between the Laughlin and Needles spawning sites during the 2008 spawning season. This same fish again moved downstream between the spawning sites in 2009 and 2010. No tagged suckers moved upstream between spawning sites. Outside of the spawning season very little differences in movements were observed between 2007 and 2009. Individual fish went to specific areas to spend the summer.

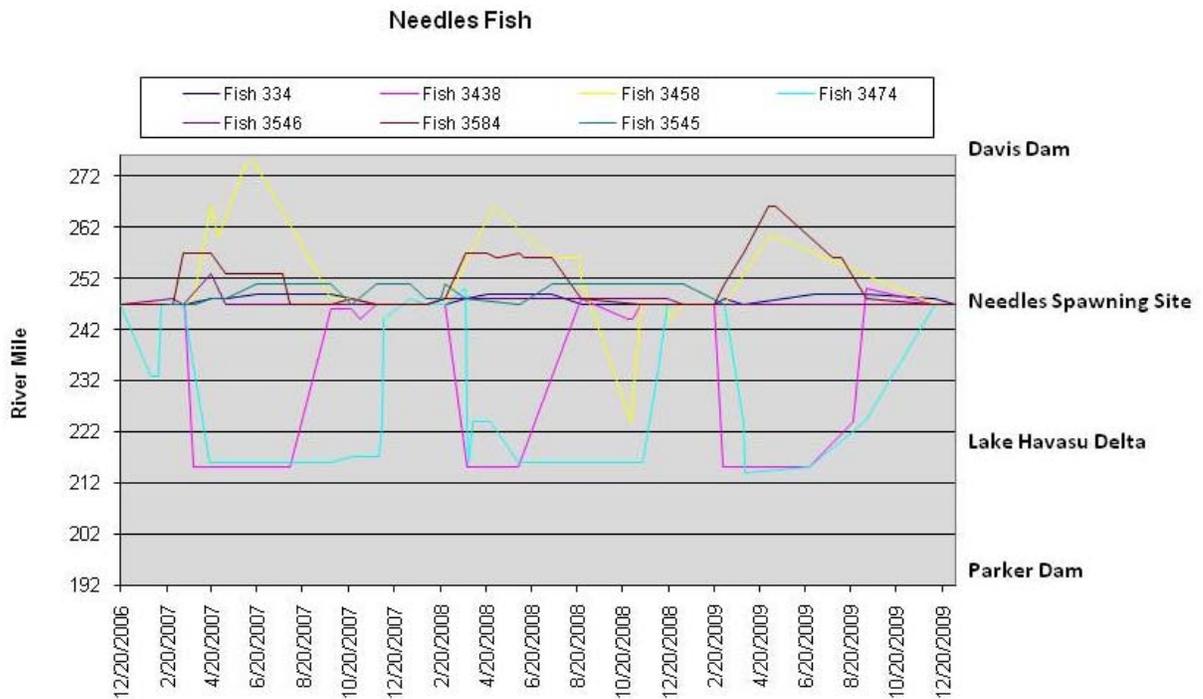


Figure 5: Movements of seven razorback suckers caught at the Needles spawning site.

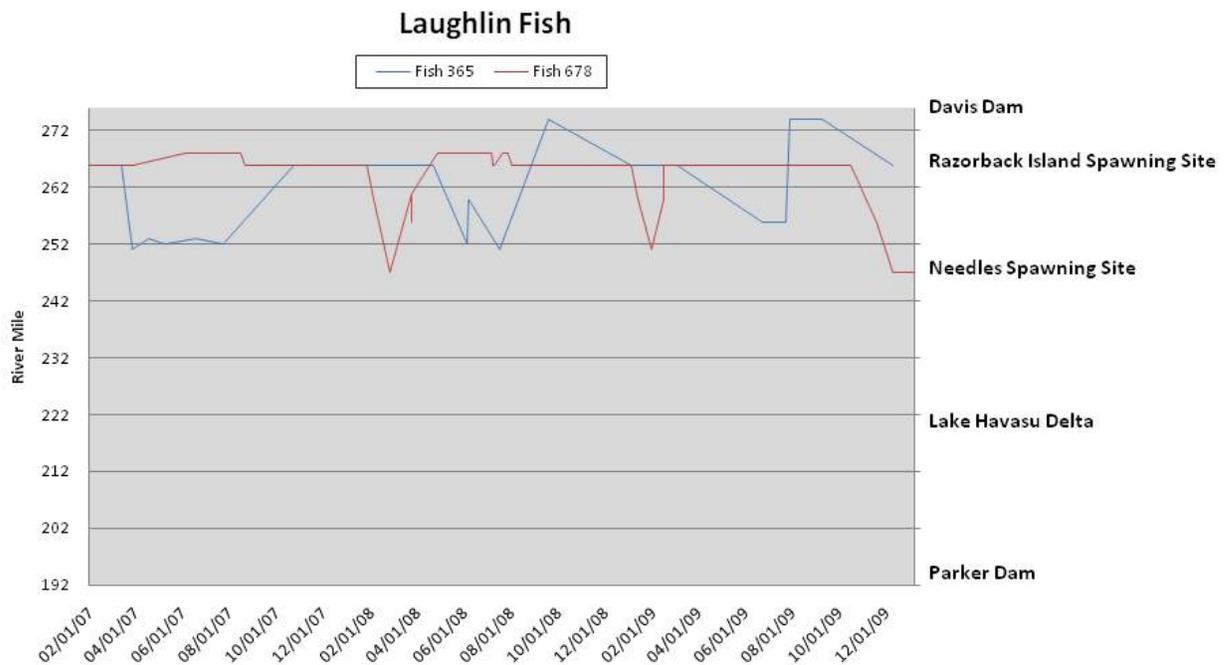


Figure 6: Movements of two razorback suckers caught at the Laughlin Spawning site.

Of the fish released on January 2, 2008 at Cattail Cove, one remained alive at the end of 2008. This fish had joined the spawning group at Needles about a month after its release. This represents about a 47 mile upstream movement. Toward the end of the spawning season in 2008, this fish moved upstream between the Needles and Laughlin spawning sites. This represents another 20 mile upstream movement. Although we did not locate this fish during the summer of 2008, it appears as though it spent the summer in the backwaters between Topock Gorge and the Lake based on SUR detections. It had returned to Needles by the middle of December, 2008. This fish used the Needles spawning site during the entire spawning season in 2009. Like 2008, it was not located during the summer or fall, but, had returned to Needles by the middle of December, 2009.

Another fish released at Cattail Cove on January, 2, 2008, moved to the upper end of the reservoir and then upstream to the Topock Gorge area before going downstream to the Bill Williams River. During the spawning season, this fish was contacted near Mesquite Bay where Arizona Game and Fish personnel have routinely contacted razorback suckers during the annual Lake Havasu Razorback Roundup. This fish died within four months of its release in the Bill Williams River. Two of the remaining fish released at Cattail Cove appeared to have died shortly after their release in the lower end of the reservoir. All three of these mortalities were likely a result of predation. Contact with the last tag was lost almost immediately. It was unclear whether the tag failed or the fish was removed from the system.

Of five fish released into Lake Havasu on December 11, 2008 at Standard Wash, two had moved to the upper end of the Lake within a week. One of these fish was located at the Needles spawning site within a month. This fish appeared to die in Topock Gorge during the summer following the spawn. The other fish utilized the upper end of the Lake through the spring and summer. This fish traveled upstream to Laughlin in the fall before joining the Needles spawning group by the end of 2009. The remaining three fish released at Standard Wash moved downstream after their release. All three fish appeared to die within two months.

The three adult male razorback suckers captured and sonic tagged in Lake Havasu near the Delta in early January, 2010 moved upstream and joined the spawning group at Needles within one month of release.

Movements of individual fish can be found in appendix A

DISCUSSION

Our data suggested that razorback suckers are quite mobile, but also exhibit unique seasonal fidelity to specific locations. Most notably, individual transmitters were found at specific spawning sites each year, and following the spawn these fish either remained in the riverine portion (ranging five miles or less), or moved downstream to the upper end of Lake Havasu (more than 35 miles). The fish which remained in the river typically moved off of the spawning grounds and into slower moving habitats. Regardless of

where they went, it became obvious that these fish were not selecting the backwater habitats found within Topock Marsh. This is consistent with trammel net data collected during spring and fall surveys which typically contact younger sexually immature individuals (Wydoski et. al., 2005). Following their summer respite, the timing of their return to the spawning grounds varied among individual suckers, but individual fish returned approximately the same time each year (August – December). Similar unique movements of individual fish were also reported by Mueller, Marsh and Knowles during their work on Lake Mohave (Mueller et. al., 1998).

Fish tagged from either the Needles or Laughlin spawning sites did not utilize Lake Havasu downstream of Pittsburg Point during this study. This indicates that as stocked razorback suckers mature and establish their home ranges, they are not vulnerable to entrainment into the water distribution structures of Lake Havasu.

Of the ten mature male fish released at the lower end of the lake (Cattail Cove and Standard Wash), only three survived and the remaining seven either died or disappeared. All three of the surviving fish moved upstream immediately following their release and were eventually found at the Needles spawning sites in either 2009 and/or 2010. One of these fish is the only individual which was assumed to be using the backwaters between Topock Gorge and the Lake following the spawn, this assumption was made based on SUR detections and not manual tracking. The fact that these three fish moved upstream through the entire lake before joining the Needles spawning group indicates that Lake Havasu and the river upstream to Needles are not being utilized by razorback suckers for spawning; and that there is a much higher incident of predation on fish which remain in the Lake.

In the past, larval razorbacks have been contacted throughout the backwaters of Topock Gorge and well into the lake proper. It is possible that these larval fish are the result of younger stocked fish which have yet to integrate themselves into the larger spawning aggregations and they are instead opportunistically participating in isolated spawning events within backwaters or along the lake shore. Alternatively, the presence of larvae downstream of Needles may simply be the result of larval fish drifting and being distributed into backwaters are the lake proper.

The discovery of spawning sites used by razorback suckers allows us to effectively monitor their populations. Physical characteristics such as depth and clarity in this stretch of the Colorado River are ideal for biologists to monitor razorback sucker populations at the known spawning sites. Due to low water demand downstream, water levels in the river remain low while razorback suckers are spawning (January-March); in addition water clarity remains very good year round (Figure 7).



Figure 7: Low water flows and good water clarity during the razorback sucker spawning season result in ideal conditions for biologist to monitor their populations in this stretch of river.

During 2006 and 2007, we developed sampling protocols to monitor the razorback sucker population using this spawning site. These protocols used visual counts from boats and fish captured by electrofishing (marked recapture techniques) to calculate populations (Mueller et. al., 2008). However, it was unclear whether monitoring the Needles and Laughlin spawning sites accurately represented the razorback sucker spawning population in this stretch of river. This telemetry study suggests that razorback suckers stocked into Lake Havasu have indeed geographically consolidated their spawning activities at these sites. Yearly monitoring of these spawning sites provides us a unique opportunity to monitor long term survival of stocked razorback suckers, and evaluate the potential impacts that release site and release size have on the survival of stocked razorback suckers.

RECOMMENDATIONS FOR FUTURE WORK

It is apparent that the razorback suckers stocked as part of the Lake Havasu Fish Improvement Project have consolidated the spawning effort to two primary locations (Needles and Razorback Island near Laughlin). Continued sampling of the river between

Laughlin and Needles at a minimal level (one week a year) will provide us with a great opportunity to contact a significant number of individuals from which we can get a good population estimate and well as information on survival of stocked fish. An expanded sampling effort (two or three weeks a year) would allow us more opportunities to look at things like impacts release size and release location has on survival of stocked fish. In order to maximize contacts with individual fish this should be done between mid January and the end of February.

The annual Lake Havasu Roundup has been ongoing since 2000. This multiagency effort samples from Park Moabi downstream to Parker Dam during early February. This effort should continue because it provides us with a long term picture of native fish communities in Lake Havasu. It also provided us an opportunity to look for additional spawning sites that could be created by MSCP fish as they mature.

It is recommended that the MSCP continues to study habitats used by stocked razorback suckers. After being in Lake Havasu for around ten years the LHFIP fish seem to only use the river and upper end of Lake Havasu; there is little evidence that they use most of the lake or backwaters. The more recently stocked young fish have been observed using backwaters after stocking, with an apparent preference for some backwaters over others. It is unclear why some habitats are preferred, but investigations to determine these preferences would be beneficial to guide the MSCP during construction of any additional backwaters.

An effort to look for recruitment from the fish using the Needles spawning site would also be valuable. A higher than expected rate of non-PIT tagged razorbacks have been encountered during our monitoring efforts over the past several years. It has been assumed that these were stocked fish which expelled their tags, but it is possible these fish were recruited from the Needles spawning site.

In the past, larval fish surveys have been conducted sporadically and with mixed results. A more intensive survey could identify additional spawning sites. This information would allow us to better monitor the razorback population.

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Appendix – A

Seasonal Movements of Individual Razorback Sucker

Needles Fish #3-3-4 (Figure 8) was detected eight times at the Needles spawning site (Needles) from January 30 to March 15, 2007. After the spawning season, this fish moved upstream about 2 miles spending the summer in the slower moving relatively deep water downstream of Willow Valley Estates. This fish had returned to Needles by the end of November.

This fish was detected four times at Needles from January 10 to March 25, 2008. After the spawning season it was found seven times downstream of Willow Valley Estates. It returned to Needles by mid November.

It was located five times at Needles from January 9 to March 30, 2009. During the summer of 2009, it was found twice downstream of Willow Valley Estates in the same locations as previous years. It had returned to Needles by mid October. Each year the total distance traveled was about two miles.

It was located twice in February, 2010 at Needles. All of the sonic tags implanted into the Needles fish in late 2006 appeared to be failing by early 2010.

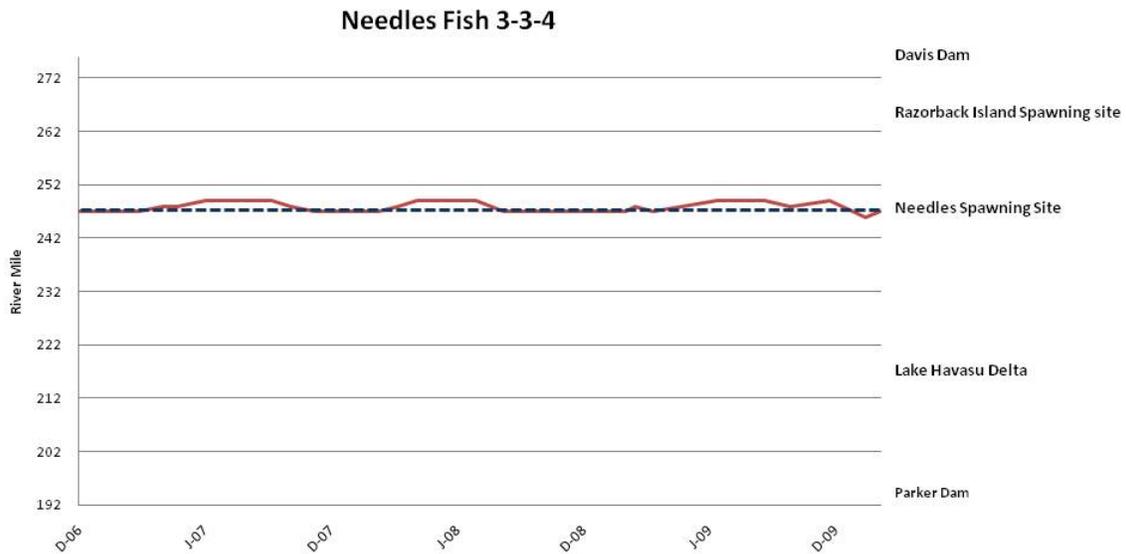


Figure 8: Needles fish 3-3-4

Needles Fish # 3-4-3-8 (Figure 9) was detected eleven times at Needles from January to March, 2007. It had moved about 35 miles downriver into Lake Havasu by mid April. It remained in the lake about one and a half miles west of Windsor Beach until mid summer. It moved upstream about 34 miles by early August. It remained in the slower moving water just downstream of the Needles Bridge until November. It had returned to Needles by the end of November.

This fish was contacted three times at Needles from January 10 to February 26, 2008. By March 26, 2008, it had returned to Lake Havasu where it was located four times during the spring and summer. It was located at Needles on August 26, 2008 where it remained the rest of 2008.

He was located three times at Needles from January 9 to February 5, 2009. It was contacted three times in Lake Havasu near Windsor Beach from March 3 to June 25. On August 24, 2009 it was detected on a SUR near Castle rock moving upstream. He was located upstream of Needles near Willow Valley Estates on September 10, 2009. It had returned to Needles by mid October.

He was contacted three times between January 7, 2010 and February 23, 2010 at Needles. It was detected by a SUR at Castlerock on March 2, 2010 traveling downstream toward Lake Havasu. On March 3, 2010, it was located in Lake Havasu near Windsor Beach in the same area where he had spent the last three summers.

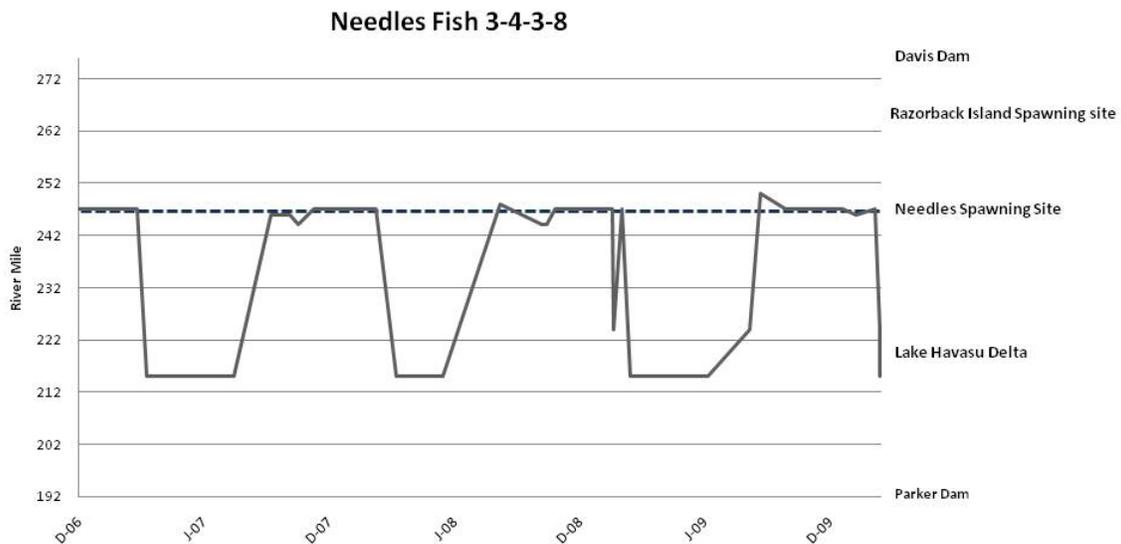


Figure 9: Needles Fish 3-4-3-8

Needles Fish #3-4-5-8 (Figure 10) was detected thirteen times at Needles during the winter of 2007. After the spawning season, this fish slowly worked its way upstream to below Davis Dam (28 miles) by mid June. Shortly afterward it slowly worked its way downstream. He was back at Needles by the end of November.

This fish was found three times at Needles between January 10 and February 26, 2008. At the end of April, it was found just downstream of Razorback Island, but, it was never detected by a SUR deployed at the actual spawning site. It was located three times upstream of Willow Valley Estates during the summer of 2008. On October 30, 2008, it was detected about 23 miles downstream of Needles near the entrance to Castle Rock. It returned to Needles by mid-November. This fish used at least a 42 mile section of the river in 2008.

He was located four times at Needles from January 9 to March 4, 2009. During the summer of 2009, it was found twice near the Fort Mohave ruins. By mid October, he had returned to Needles.

He was located once in January 2010 at Needles.

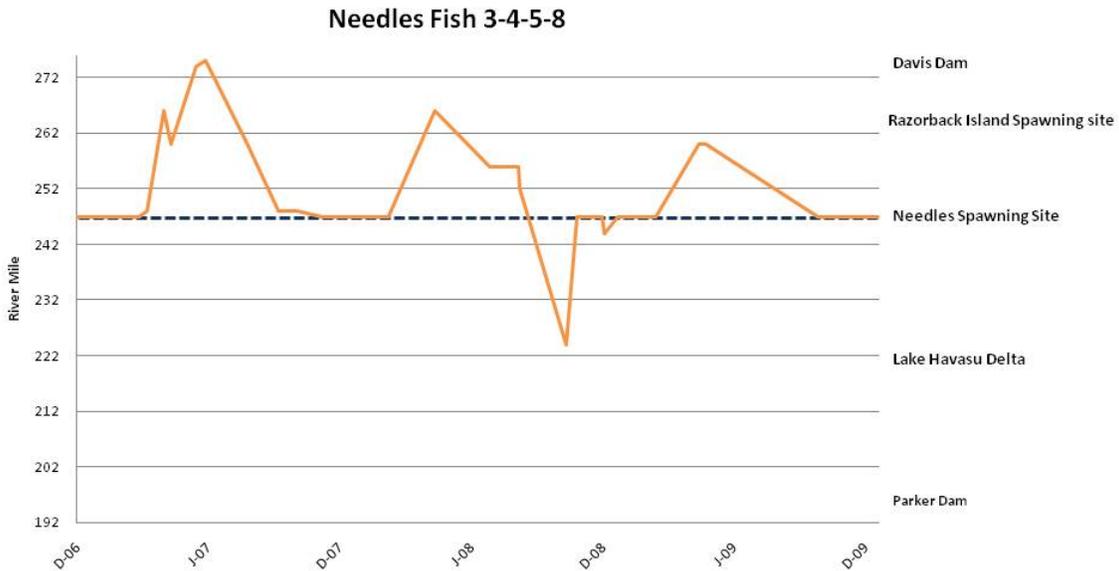


Figure 10: Needles Fish 3-4-5-8

Needles Fish #3-4-7-4 (Figure 11) was detected seven times at Needles from January to mid March, 2007, including one contact via electrofishing (Figure 12). By mid April it had moved about 35 miles downstream to the upper end of Lake Havasu near Windsor Beach. Over the course of the summer it worked its way westward toward the Chemehuevi Indian Casino at Havasu Landing where it remained until the end of November. In early December, we were able to track upriver movement of this fish to Needles on SUR's. This fish passed SUR's at Castle Rock on December 3, in Topock Gorge on December 4, and near Needles on December 5. This upstream movement was over 30 miles in two days. This fish was detected on the Topock SUR on January 30, 2007 moving downstream after being captured electrofishing a few hours earlier. On February 8, 2007, it was detected on the same SUR moving upstream as it returned to Needles.

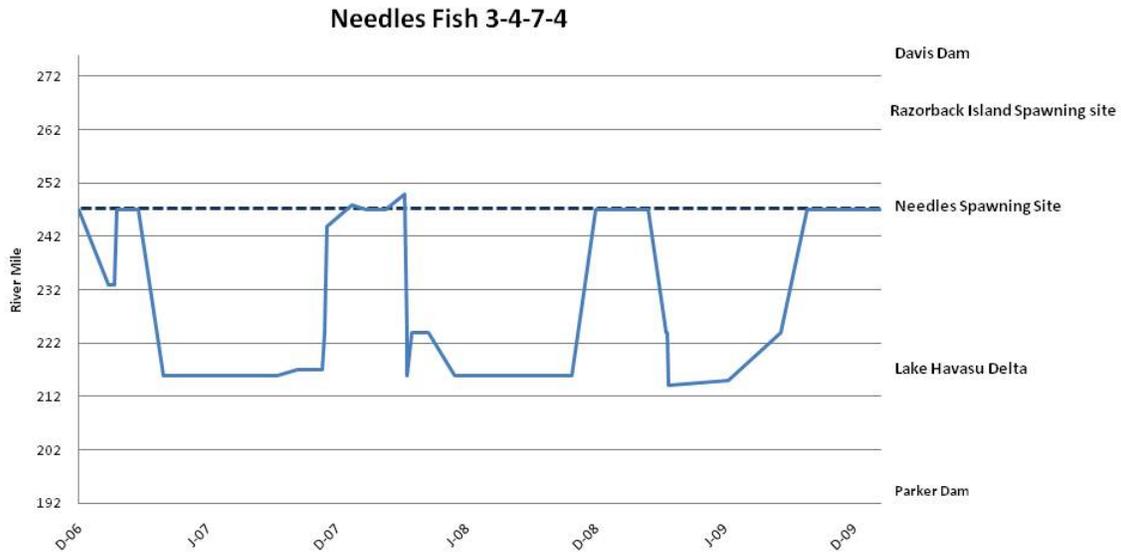


Figure 11: Needles Fish 3-4-7-4



Figure 12: The surgical incision on Needles Fish #3-4-7-4 showing healing five weeks after surgery. This fish was captured January 30, 2007 while electrofishing at the Needles spawning site.

This fish was located three times at Needles from January 10 to February 26, 2008. This fish was found near Willow Valley Estates on March 25, 2008 before traveling to Lake Havasu by March 28. It was also detected seven times by a SUR near the entrance to Castle Rock (RM 224) in the month of April. It was located five times in Lake Havasu during the summer and fall of 2008. He had returned to Needles by December 19, 2008.

This fish was located four times at Needles from January 9 to March 15, 2009. On March 29, he was detected moving past Castle Rock toward Lake Havasu. He was found twice in Lake Havasu during the summer of 2009. Once on the California side near the casino and the other time on the Arizona side near Mesquite Bay. It was detected by a SUR moving upstream on September 8. He was located at Needles by mid October where he remained the rest of 2009.

This fish was located twice in January, 2010 at Needles.

Needles Fish #3-5-4-5 (Figure 13) ranged about four miles in 2007. It was detected five times at Needles. In April, it moved upstream to the gravel bar below Willow Valley Estates. It stayed in this section of the river for the remainder of the year. This is a secondary spawning site used by some razorbacks.

This fish was located twice downstream of Willow Valley Estates on January 10 and January 31, 2008 at the gravel bar. He was also located at Needles on February 26 and March 25, 2008. It was located three times just downstream of Willow Valley Estates during the summer and fall in the same locations utilized in 2007. He returned Needles by December 19.

He was located three times at Needles between January 9 and March 4, 2009. On March 30, he was found at the gravel bar just downstream of Willow Valley Estates where it remained through the summer and fall. It had returned to Needles by mid December.

He was located three times at Needles in January and February, 2010.

This fish ranged about four miles each year and was the only tagged fish from Needles that was found at another spawning site.

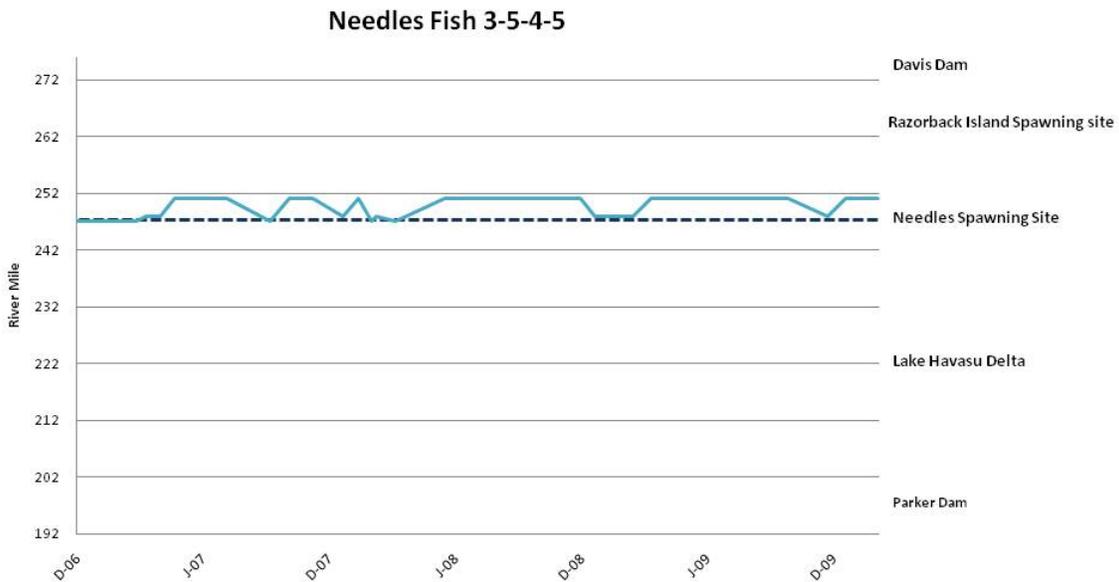


Figure 13: Needles Fish 3-5-4-5

Needles Fish #3-5-4-6 (Figure 14) only ranged about a four miles in 2007, including multiple detections at Needles. Outside the spawning season, it was intermittently detected upstream in the deep swift moving water out from Fenders RV Park and once near Willow Valley Estates in April. Background noise from the river current made it difficult to detect this fish.

This fish was located seven times in 2008 at Needles. On December 19, he was located about a mile upstream of Needles near River Palms Resort. This fish appeared to range about one mile in 2008.

He was found seven times in 2009 near Needles. Like 2008, he ranged less than one mile in 2009.

This fish was located once at Needles in January, 2010.

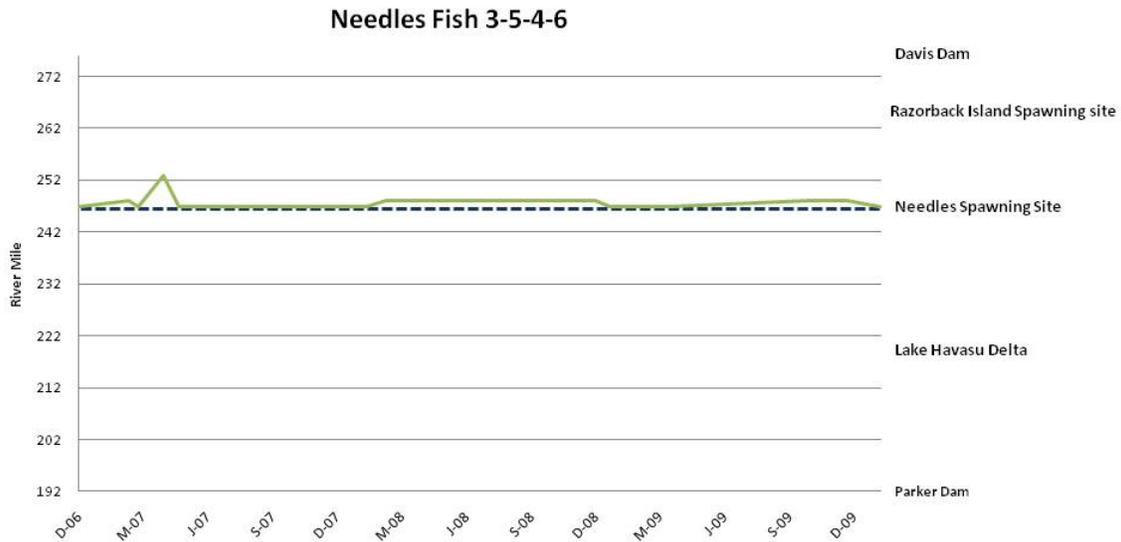


Figure 14: Needles Fish 3-5-4-6

Needles Fish # 3-5-8-4 (Figure 15) was detected nine times at Needles in January and February. By mid March, it moved upstream about 10 miles where it spent the summer in deeper relatively slow moving water in the channelized portion of the river downstream of the Avi. He had moved back to Needles by early August.

This fish was detected three times between January 10 and February 26, 2008 at Needles. By March 25, 2008, he had moved upstream about 10 miles utilizing the same locations as 2007. It was detected eleven times in this area. It had returned to Needles by December 19.

He was found three times at Needles from January 9 to February 19, 2009. On March 4, it was located at the gravel bar downstream of Willow Valley Estates. He moved upstream to a channelized portion of the river downstream of the Avi by March 30. It remained in this section of river through the summer being located four times. On September 10, he was located about a mile upstream of Needles near the River Palms Resort. He returned to Needles by mid October.

He was found twice at Needles in January, 2010.

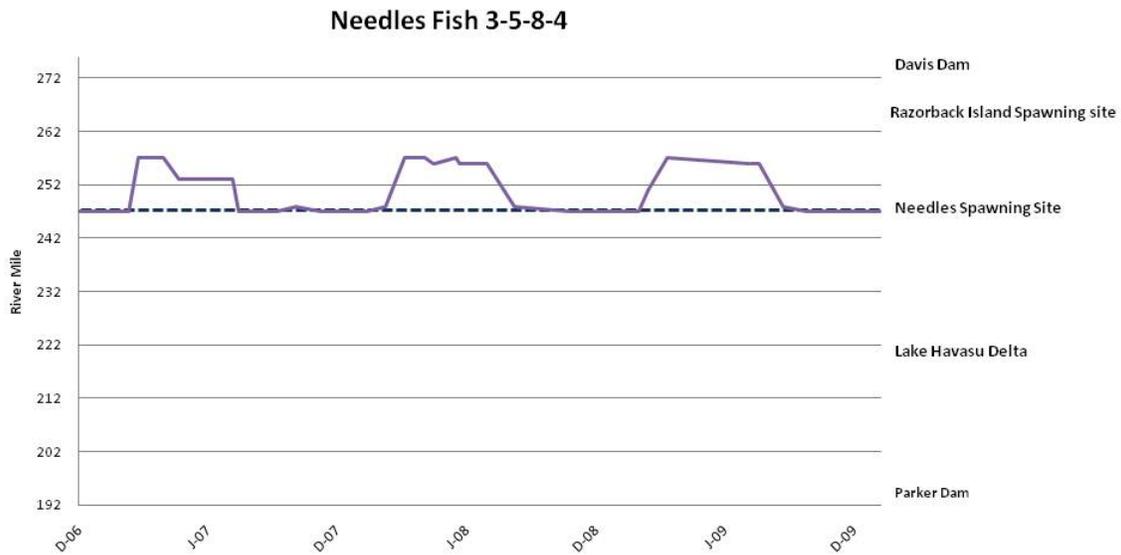


Figure 15: Needles Fish 3-5-8-4

Laughlin Fish #3-6-5 (Figure 16) was detected fifteen times at the Laughlin spawning site (Razorback Island) across the river from Boy Scout Camp from February to mid March. It was detected on a SUR by the Fort Mohave ruins March 19 moving downstream. It was found at Needles in mid April. In May, it was found in the deeper relatively slow moving channelize portion of river upstream of Willow Valley Estates where it remained through the summer. It had returned to the Razorback Island by the

end of October. However, upstream movement of this fish was not detected as it passed the SUR by the Fort Mohave Ruins.

This fish was detected almost daily at Razorback Island between January 10 and April 23, 2008. It was located three times upstream of Willow Valley Estates during the summer. On September 20, 2008, he was located near the Laughlin Bridge. By mid December, he had returned to Razorback Island.

In 2009, he was detected daily from early January to mid April at Razorback Island. It was located four times utilizing deeper relatively slow moving water downstream of Avi in June and July. He was found near the Laughlin Bridge on July 29 and September 9. He had returned to Razorback Island by October 15 where he was routinely detected by a SUR until the end of the year.

In 2010, this fish as located three times at Razorback Island in January and February.



Figure 16: Laughlin Fish 3-6-5

Laughlin Fish #6-7-8 (Figure 17) was detected seventeen times at Razorback Island between the end of February and mid March. It was detected eight times on a SUR deployed in Laughlin Lagoon during the summer. It had returned to Razorback Island by the end of August.

This fish was located three times in January 2008 at Razorback Island. On February 5, he was detected by a SUR deployed near the Fort Mohave ruins apparently moving downstream to Needles where he was located on February 26, 2008. On March 25, he was located just below Willow Valley Estates on a mobile search. Later that day, he was detected on SUR's deployed upstream of Willow Valley Estates apparently moving upstream. On March 26, he passed the SUR deployed near the Fort Mohave ruins. On April 28, 2008, he was located near the entrance to Laughlin Lagoon where he remained until the end of July. Between end of April and end of July, he was detected on a SUR deployed in Laughlin lagoon nineteen times apparently moving in and out of the lagoon. By early August, he moved back to Razorback Island where he remained the rest of the year.

This fish was detected twice at Razorback Island in early January, 2009. On January 14, he was detected by SUR heading downstream. On January 31, he was located at the gravel bar downstream of Willow Valley Estates. This is a secondary spawning site upstream of the main Needles spawning site which is also frequented by Needles fish 3545. He was detected moving upstream February 16 by two SUR's (Fort Mohave and Razorback Island). This fish remained in the vicinity of Razorback Island until mid November being detected numerous times by SUR and mobile searches. He was detected moving downstream on November 19. It was located at Needles on December 11.

In January, 2010 he was located twice at Needles. He was detected by SUR moving upstream on January 25, 2010. In February, 2010, this fish was located twice at Razorback Island.

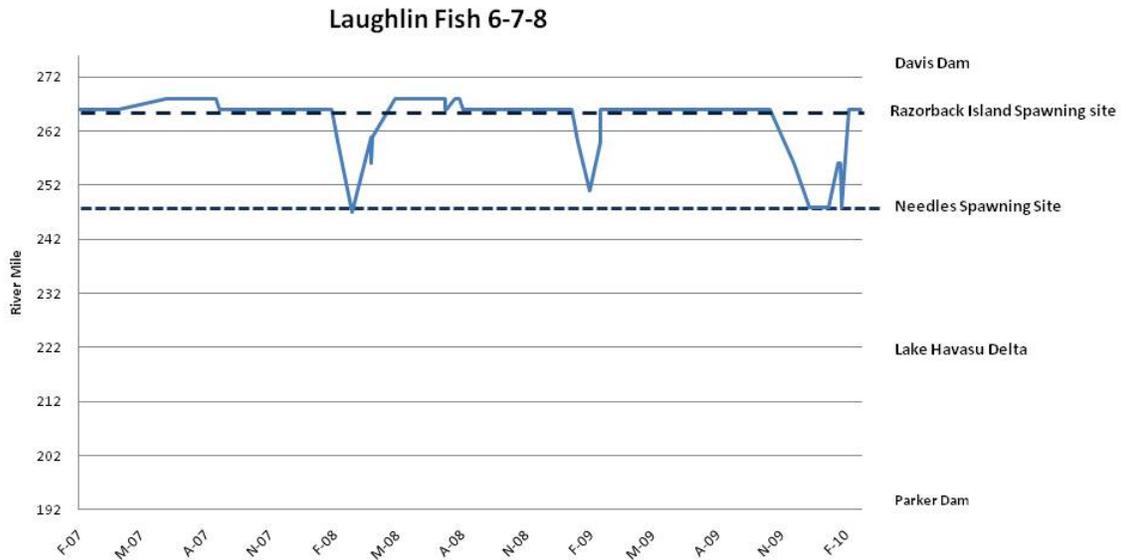


Figure 17: Laughlin Fish 6-7-8

Havasu Fish #2-2-6 (Figure 18) was released at Cattail Cove on January 2, 2008. In January it was located three times in the lower end of the reservoir between Cattail Cove and the Bill Williams Delta. On February 17, 2008, it was detected by a SUR deployed near the entrance to Castle Rock (RM 224) apparently moving upstream. It was located at Needles on February 26, 2008 and March 25, 2008. On March 26, it was found near Willow Valley Estates. By March 30, 2008, it was found at Razorback Island where it remained for about ten days. On April 14, it was detected by a SUR deployed near the entrance to Castle Rock apparently going downstream. It wasn't detected again until it returned to Needles in early December. Based on the lack of detection during our mobile searches of the river or lake, it is assumed he spent the summer in the backwaters near the Lake Havasu delta. Aquatic vegetation could have made it difficult to locate this fish in the backwaters near the delta.

He was located 5 times from January 9 to March 30, 2009 at Needles. He was not detected during the summer. On October 24, 2009 it was detected by the SUR deployed at Castle Rock apparently heading upstream. He had returned to Needles by mid December.

This fish was located at Needles three times during January and February, 2010.

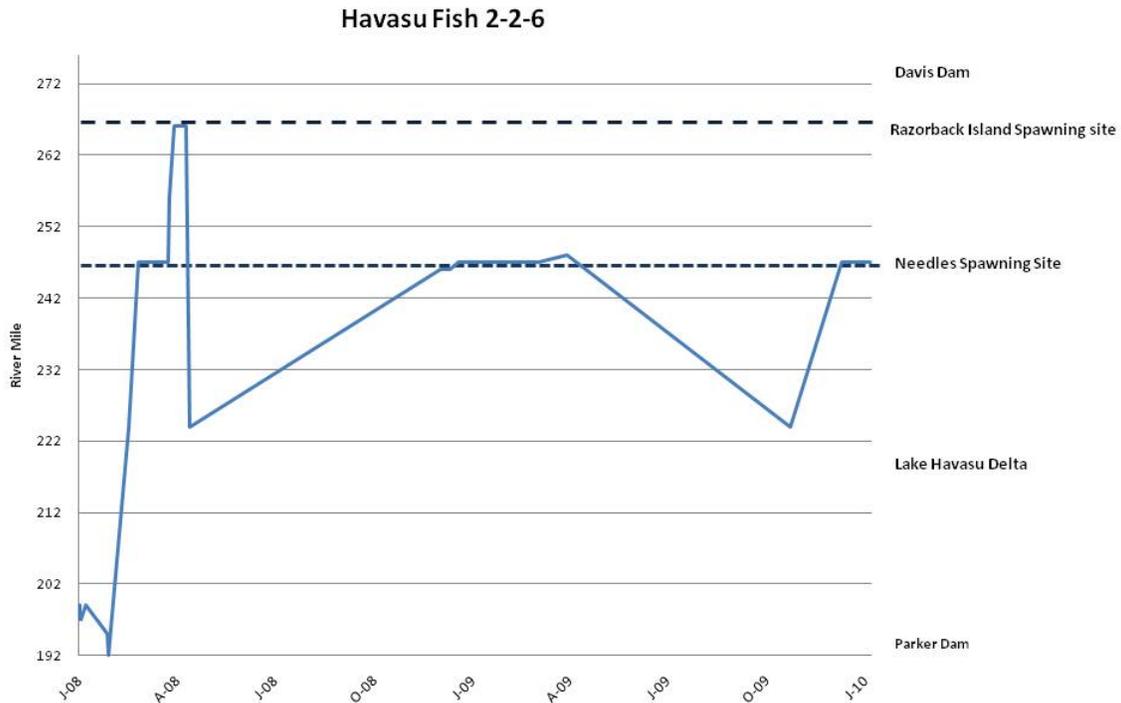


Figure 18: Havasu Fish 2-2-6

Havasu Fish #2-2-5 was located three times in the lower end of Lake Havasu between Cattail Cove and the Bill Williams Delta in January, 2008. It was located in the upper end of Lake Havasu off the north point at Upper Mesquite Bay on February 29. This is the same location where razorback sucker are occasionally caught during the Lake Havasu Razorback Roundup by the Arizona Game and Fish. It was detected on April 14 by a SUR deployed near Castle Rock (RM 224) and by a SUR deployed near Parker Dam on April 19. The tag was located on April 29 under the U.S. Highway 95 Bridge at the Bill Williams River. No movement of the tag was found afterward. Apparently, this fish died sometime in late April.

Sonic tags implanted into **Havasu Fish #2-2-3 and #2-2-4** became stationary within a couple of weeks after their release on January 2, 2008. It was unclear what killed these two fish.

Contact with the sonic tag implanted into **Havasu Fish #2-2-7** was lost three days after its release on January 2, 2008. It was unclear whether the tag failed or if the fish left the system.

Havasu Fish #3-8-8 (Figure 19) apparently moved to the upper end of Lake Havasu shortly after its release into Lake Havasu at Standard Wash on December 11, 2008. It was located three times near Mesquite Bay and once near Havasu Landing between December 18, 2008 and April 1, 2009. During this time period, he also was periodically traveling up the river because he was detected on six occasions by the SUR deployed near Castle Rock. He was not located during the summer. On October 15, this fish was found near Razorback Island approximately 25 miles upstream. He had moved downstream to Needles by mid December.

This fish was located three times at Needles in January and February, 2010.

Havasu Fish 3-8-8

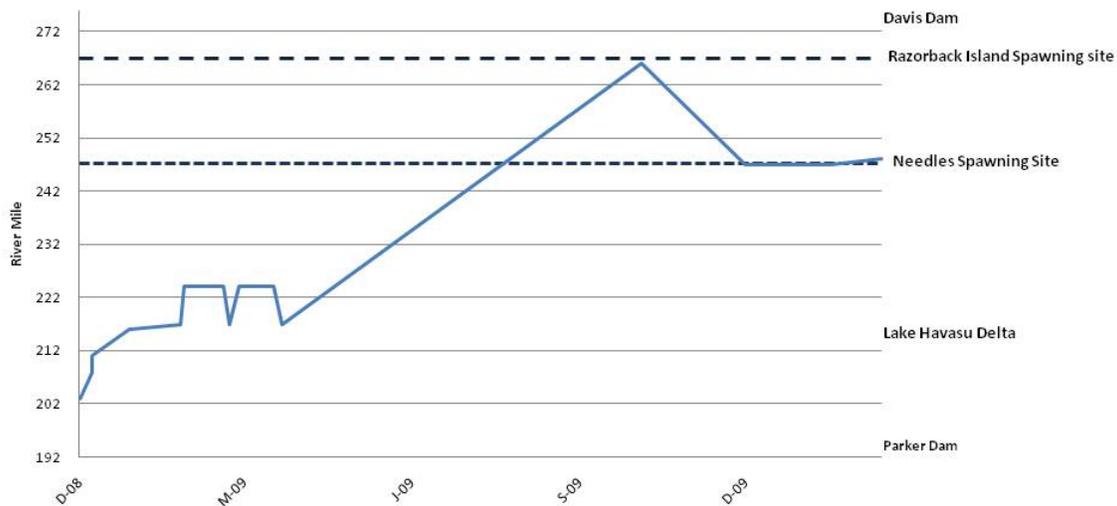


Figure 19: Havasu Fish #3-8-8.

Havasu Fish #5-8-8 (Figure 20) moved to the upper end of Lake Havasu shortly after its release into Lake Havasu at Standard Wash on December 11, 2008. He was located near the State Law Enforcements Docks on December 18. He was detected by a SUR deployed near the Needles Bridge on December 24. It was located three times at Needles in spawning groups of razorbacks in February and March. On June 25, the tag was located in the back of the backwater at Pulpit Rock. No movement was observed afterward. It was unclear whether this fish died or the tag was expelled.

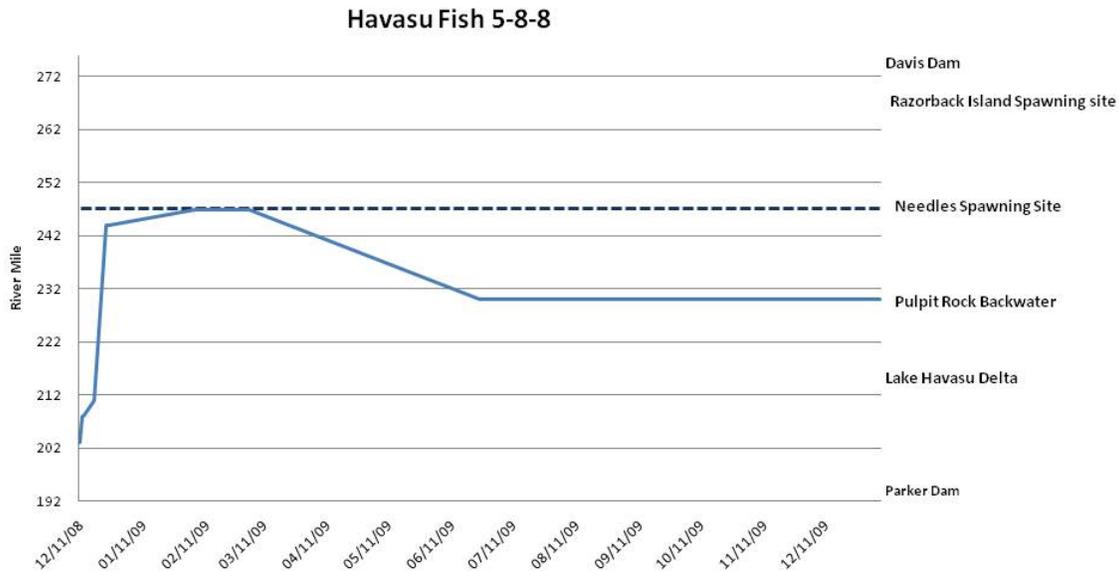


Figure 20: Havasu Fish #5-8-8

Sonic tags implanted into **Havasu Fish #4-4-5, #4-7-8, and #5-8-7** became stationary in the lower end of the lake within two months of their release on December 11, 2008. It was unclear what killed these three fish.

Windsor Fish 3-8-7 (Figure 21) had a sonic tag implanted into it after being captured by trammel net on the Arizona side of Lake Havasu about half way between Lower Mesquite Bay and Windsor Beach on January 5, 2010. This fish was released by the MSCP in Laughlin Lagoon in November, 2007. He was detected by a SUR at Castle Rock moving upstream on January 21, 2010 moving upstream. This fish was located at Needles twice in February.

Windsor Fish 3-5-5 (Figure 21) was captured in Lake Havasu along the California shoreline near the inflow of the Colorado River on January 6, 2010 in a trammel net. A sonic tag was surgically implanted into him prior to its release. This fish was located in the river near the sand bar at Blankenship Bend on January 27. He was located at Needles three times between January 31 and March 2, 2010.

Windsor Fish 4-4-4 (Figure 21) was also captured in Lake Havasu along the California shoreline near the inflow of the Colorado River on January 6, 2010 in a trammel net. He

was detected by a SUR at Castle Rock moving upstream on January 13. It was located four times between January 23 and March 2, 2010 at Needles. In addition, he was also detected by a SUR deployed near the Fort Mohave Ruins on February 17.

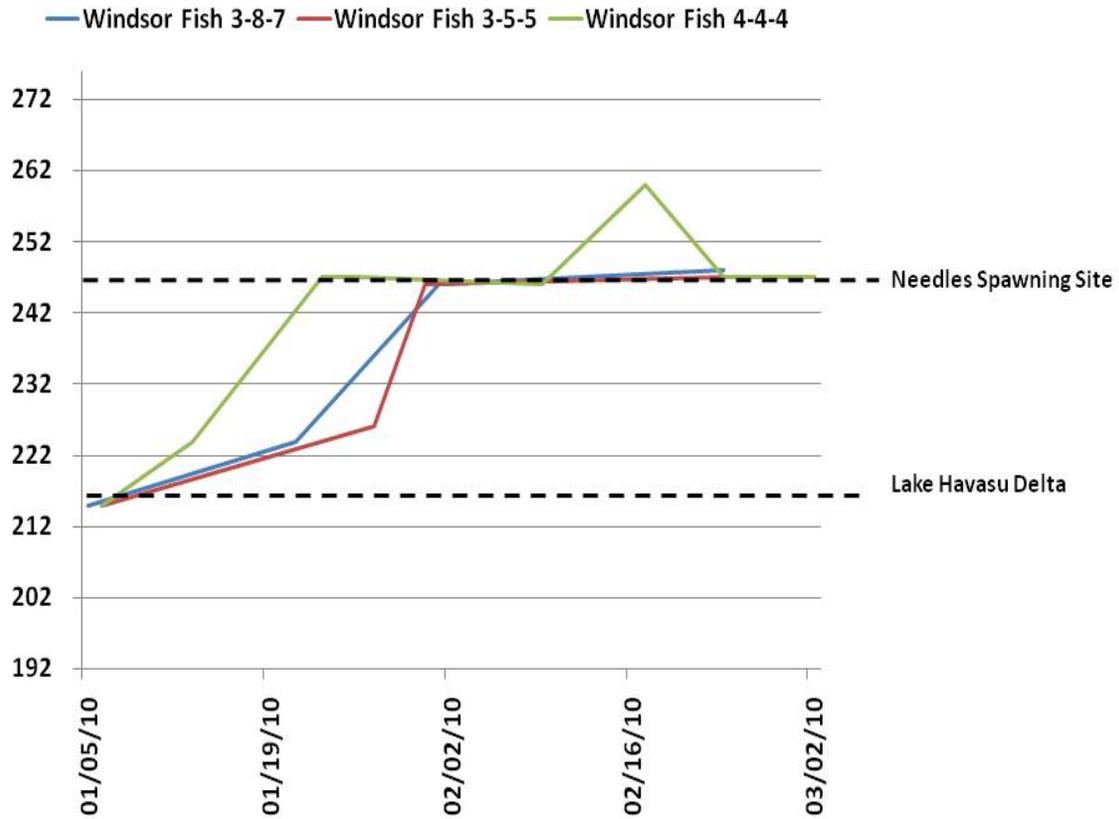


Figure 21: Windsor Fish #3-8-7, #3-5-5, and #4-4-4