Movements of Sonic Tagged Razorback Suckers Between Davis and Parker Dams (Lake Havasu)
Lower Colorado River Multi-Species Conservation Program
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- QuadState County Government Coalition
- Desert Wildlife Unlimited
Lower Colorado River
Multi-Species Conservation Program

Movements of Sonic Tagged Razorback Suckers Between Davis and Parker Dams (Lake Havasu)

Technical Memorandum No. 86-68220-10-08

Prepared by Rick Wydoski, Eric Best, and Jeff Lantow

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

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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 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 the fish as they traveled 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 allows us to effectively monitor this population of razorback suckers. We developed sampling protocols to monitor the razorback sucker population that used this spawning site in 2006 and 2007. These protocols used visual counts conducted 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.

The questions to be answered from this study include:

1) Determine whether 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 what happens to fish stocked into the lower portion of the reservoir. It is possible that they may have established another spawning site or it may be that they had lower survival than 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 is one of many sites. 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?
Figure 1: Map of study area on the Colorado River between Davis Dam and Parker Dam. 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 15 razorback suckers between December 20, 2006 and February 27, 2007. Tags were implanted into 10 males caught on December 20, 2006 at the Needles spawning site and into 5 males captured at a smaller spawning site located near Laughlin (Razorback Island) that is across the river from Boy Scout Camp (4 fish were implanted on February 1, 2007 and 1 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.

<table>
<thead>
<tr>
<th>Sonic Tag</th>
<th>PIT Tag</th>
<th>Date</th>
<th>Release Location</th>
<th>Total Length</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needles</td>
<td>3-3-3</td>
<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>580 mm</td>
<td>2760 g</td>
</tr>
<tr>
<td>Fish 1</td>
<td>257C60EF9C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needles</td>
<td>3-3-4</td>
<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>620 mm</td>
<td>2905 g</td>
</tr>
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<td>257C60CA02</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needles</td>
<td>3-3-3-4</td>
<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>570 mm</td>
<td>2250 g</td>
</tr>
<tr>
<td>Fish 3</td>
<td>257C60EC5D</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Needles</td>
<td>3-4-3-8</td>
<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>580 mm</td>
<td>2270 g</td>
</tr>
<tr>
<td>Fish 4</td>
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<td></td>
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<tr>
<td>Needles</td>
<td>3-4-5-8</td>
<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>575 mm</td>
<td>2250 g</td>
</tr>
<tr>
<td>Fish 5</td>
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<td>Needles</td>
<td>3-4-6-4</td>
<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>590 mm</td>
<td>2590 g</td>
</tr>
<tr>
<td>Fish 6</td>
<td>445861C55</td>
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<td>Needles</td>
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<td>12/20/2006</td>
<td>Jack Smith Park</td>
<td>600 mm</td>
<td>2405 g</td>
</tr>
<tr>
<td>Fish 7</td>
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</tr>
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<td>Needles</td>
<td>3-5-4-5</td>
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<td>Jack Smith Park</td>
<td>620 mm</td>
<td>2765 g</td>
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<tr>
<td>Fish 8</td>
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<td>Jack Smith Park</td>
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<td>Jack Smith Park</td>
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<td>2160 g</td>
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<td></td>
<td></td>
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<tr>
<td>Laughlin</td>
<td>3-6-5</td>
<td>02/01/2007</td>
<td>Big Bend Park</td>
<td>554 mm</td>
<td>2136 g</td>
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<td>Fish 1</td>
<td>257C60B246</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laughlin</td>
<td>6-7-8</td>
<td>02/01/2007</td>
<td>Big Bend Park</td>
<td>604 mm</td>
<td>2327 g</td>
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</table>
In 2008, 10 adult male razorback suckers were released into Lake Havasu in an attempt to locate additional spawning sites in Lake Havasu. Five fish were captured by trammel net from Yuma Cove in Lake Mohave on December 10, 2007. Sonic tags were surgically implanted into these fish on December 21, 2007. They were held in a tank at Willow Beach National Fish Hatchery (NFH) for about four weeks prior to their release at Cattail Cove on January 2, 2008. Five fish reared at Willow Beach NFH 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 locate other spawning locations.

<table>
<thead>
<tr>
<th>Sonic Tag</th>
<th>PIT Tag</th>
<th>Date Release</th>
<th>Location</th>
<th>Total Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>42526F763D</td>
<td>6-6-7-8</td>
<td>02/01/2007</td>
<td>Big Bend Park</td>
<td>560 mm</td>
</tr>
<tr>
<td>Fish 2</td>
<td>257C60E1D9</td>
<td></td>
<td></td>
<td>1960 g</td>
</tr>
<tr>
<td>Laughlin</td>
<td>7-7-8</td>
<td>02/01/2007</td>
<td>Big Bend Park</td>
<td>555 mm</td>
</tr>
<tr>
<td>Fish 3</td>
<td>257C61072E</td>
<td></td>
<td></td>
<td>2883 g</td>
</tr>
<tr>
<td>Laughlin</td>
<td>3-6-3-6</td>
<td>02/27/2007</td>
<td>Big Bend Park</td>
<td>622 mm</td>
</tr>
<tr>
<td>Fish 4</td>
<td>257C6116E7</td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
</tbody>
</table>
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 0.1 g/l of tricaine methanesulfonate (MS-222) and 0.1 g/l 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 baster to provide oxygen and keep the body moist. 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 in diameter, and weighed 22 grams in air or 10 grams in water. The minimum weight of fish recommended for these tags is 1,100 g (2% of air weight), which is well below the weights of fish (1,960-2,905 g) 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 30-40 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 rested on the pelvic girdle. The incision was sutured with 4-5 knots using 3-0 Ethilon monofilament nylon and an FS-1 cutting needle.

The total surgical process required 7-15 minutes for each fish. This included 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.
Fish movements were monitored by both mobile boat searches for tagged fish and deployment of fixed submersible underwater receivers (SURs) 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, California, 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 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 ensure 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.

The SURs 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

Needles Fish #3-3-4 (Figure 5) 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 two 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.

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

Figure 5: Needles fish 3-3-4.
Needles Fish #3-4-3-8 (Figure 6) was detected 11 times at Needles from January to March, 2007. The fish had moved about 35 miles downriver into Lake Havasu by mid-April. It remained in the lake about 1.5 miles west of Windsor Beach until midsummer, and had moved upstream about 34 miles by early August. It remained in the slower moving water just downstream of the Needles Bridge until November, and 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 during the rest of 2008.

This fish 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. It was located upstream of Needles near Willow Valley Estates on September 10, 2009, and had returned to Needles by mid-October.

![Figure 6: Needles Fish 3-4-3-8.](image)

Needles Fish #3-4-5-8 (Figure 7) was detected 13 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, and 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.

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

Figure 7: Needles Fish 3-4-5-8.

**Needles Fish #3-4-7-4** (Figure 9) was detected seven times at Needles from January to mid-March, 2007, including one contact via electrofishing. 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 SURs. This fish passed SURs 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 by electrofishing a few hours earlier. On February 8, 2007, it was detected on the same SUR moving upstream as it returned to Needles.
Figure 8: 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. The 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, and 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, it was detected moving past Castle Rock toward Lake Havasu. It was found two times 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. It was located at Needles by mid-October, where it remained during the rest of 2009.
Figure 9: Needles Fish 3-4-7-4.

**Needles Fish #3-5-4-5** (Figure 10) 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 and 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 two times downstream of Willow Valley Estates, on January 10 and January 31, 2008 at the gravel bar. It 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, and had returned Needles by December 19.

The fish was located three times at Needles between January 9 and March 4, 2009. On March 30, it 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. This fish ranged about four miles each year and was the only tagged fish from Needles that was found at another spawning site.

Figure 10: Needles Fish 3-5-4-5.
Needles Fish #3-5-4-6 (Figure 11) only ranged about 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, it was located about a mile upstream of Needles near River Palms Resort. This fish appeared to range about one mile in 2008.

The fish was found seven times in 2009 near Needles. As in 2008, it ranged less than one mile in 2009.

![Needles Fish 3-5-4-6](image)

Figure 11: Needles Fish 3-5-4-6.

Needles Fish #3-5-8-4 (Figure 12) 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. It 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, it had moved upstream about 10 miles utilizing the same locations as in 2007. It was detected eleven times in this area. It had returned to Needles by December 19.

The fish 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. It had 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, it was located about a mile upstream of Needles near the River Palms Resort, and had returned to Needles by mid-October.
Laughlin Fish #3-6-5 (Figure 13) was detected 15 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 channelized portion of river upstream of Willow Valley Estates, where it remained through the summer. It had returned to Razorback Island by the end of October. However, upstream movement of this fish was not detected as it passed the SUR near 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, it was located near the Laughlin Bridge. By mid-December, it had returned to Razorback Island.

In 2009, the fish 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. It was found near the Laughlin Bridge on July 29 and September 9. The fish had returned to Razorback Island by October 15, where it was routinely detected by a SUR until the end of the year.
Laughlin Fish #6-7-8 (Figure 14) was detected 17 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, it was detected by a SUR deployed near the Fort Mohave ruins, apparently moving downstream to Needles where it was located on February 26, 2008. On March 25, it was located just below Willow Valley Estates on a mobile search. Later that day, it was detected on SURs deployed upstream of Willow Valley Estates, apparently moving upstream. On March 26, it passed the SUR deployed near the Fort Mohave ruins. On April 28, 2008, the fish was located near the entrance to Laughlin Lagoon, where it remained until the end of July. Between end of April and end of July, it was detected on a SUR deployed in Laughlin lagoon 19 times, apparently moving in and out of the lagoon. By early August, the fish had moved back to Razorback Island, where it remained the rest of the year.

This fish was detected two times at Razorback Island in early January, 2009. On January 14, it was detected by SUR heading downstream. On January 31, it was located at the gravel bar downstream of Willow Valley Estates. This is a secondary spawning site upstream of the main Needles spawning site that was also frequented by Needles Fish #3-5-4-5. The fish was detected moving upstream on February 16 by two SURs (Fort Mohave and Razorback Island). This fish remained in the vicinity of Razorback Island until mid-November, and was detected numerous times by SUR and mobile searches. The fish was detected moving downstream on November 19. It was located at Needles on December 11.
Figure 14: Laughlin Fish 6-7-8.

**Havasu Fish #2-2-6** (Figure 15) 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 on March 25, 2008. On March 26, it was found near Willow Valley Estates. By March 30, 2008, the fish was found at Razorback Island, where it remained for about 10 days. On April 14, it was detected by a SUR deployed near the entrance to Castle Rock, apparently going downstream. The fish was not detected again until it returned to Needles in early December. During this time, the fish apparently spent the summer in the backwaters near the Lake Havasu delta, as we never located it during mobile searches of the river or lake. Aquatic vegetation could have made it difficult to locate this fish in the backwaters near the delta.

This fish was located five times from January 9 to March 30, 2009 at Needles. It was not detected during the summer. On October 24, 2009, it was detected by the SUR deployed at Castle Rock, apparently heading upstream. The fish had returned to Needles by mid-December.
**Figure 15: 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 suckers are occasionally caught during the Lake Havasu Razorback Roundup by the Arizona Game and Fish Department. The fish was detected on April 14 by a SUR deployed near Castle Rock (RM 224), and on April 19 by a SUR deployed near Parker Dam. The tag was located on April 29 under the U.S. Highway 95 Bridge over the Bill Williams River. No movement of the tag was found after this date; 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 the fish left the system.

**Havasu Fish #3-8-8** (Figure 16) 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, the fish also was periodically traveling up the river, because it was detected on six occasions by the SUR deployed near Castle Rock. This fish was not located during the summer. On October 15, the fish was found near Razorback Island, approximately 25 miles upstream, and had moved downstream to Needles by mid-December.
Havasu Fish #5-8-8 (Figure 17) moved to the upper end of Lake Havasu shortly after its release into Lake Havasu at Standard Wash on December 11, 2008. This fish was located near the State Law Enforcements Docks on December 18. It 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 17: 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.
DISCUSSION

Nine of the 15 sonic transmitters implanted into razorback suckers utilizing known spawning sites remained active in 2009. Three transmitters (333, 3334, and 788) became stationary during the summer of 2007. It is unclear whether 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.

Our data suggested that razorback suckers are quite mobile, but also exhibit seasonal fidelity to specific locations, particularly during the spawning season. Each sonic-tagged razorback sucker exhibited unique movement patterns after leaving the spawning site in the spring. Several razorback suckers remained in the vicinity of the spawning site through the course of the year, ranging 5 miles or less. Others ranged more than 35 miles downstream. One fish traveled upstream about 30 miles. Similar unique movements of individual fish were also reported by Mueller, Marsh, and Knowles during their work on Lake Mohave (Mueller et al., 1998).

All razorback suckers remained at their spawning site of initial capture for the spawning season in 2007. In 2008 and 2009, all razorbacks that were known to be alive after the summer of 2007 returned to the same spawning site where they were initially captured. Some fish returned to the spawning site as early as August, and all fish 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. No tagged suckers moved upstream between spawning sites.

Outside of the spawning season, very few differences in movements were observed between 2007 and 2009. Individual fish went to specific areas to spend the summer. Timing of their return to the spawning site varied among individual suckers, but individual fish returned approximately the same time each year.
Figure 18: Movements of seven razorback suckers caught at the Needles spawning site.

Figure 19: Movements of two razorback suckers caught at the Laughlin spawning site.
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 range, they are not very vulnerable to entrainment into the water outlet structures of Lake Havasu.

We released 10 fish implanted with sonic tags into lower Lake Havasu to locate additional spawning locations, particularly in the reservoir. Five fish were released on January 2, 2008 at the boat Ramp at Cattail Cove. Movements of these fish were monitored in 2008 and 2009. The other five fish were released on December 12, 2008 into the cove at Standard Wash. Movements of these fish were monitored in 2009.

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 that it spent the summer in the backwaters between Topock Gorge and the Lake based on SUR detections. The fish had returned to Needles by the middle of December, 2008. This fish used the Needles spawning site during the entire spawning season in 2009. As in 2008, the fish 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 apparently died during the summer after spawning in Topock Gorge. 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.

One fact to note is that 3 of 10 mature male fish released into lower Lake Havasu moved upstream and joined the Needles spawning group relatively quickly after their release. The remaining seven either died or disappeared. This seems to indicate that Lake Havasu
and the river upstream to Needles are not being utilized by razorback suckers for spawning.

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 allow 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 20).

Figure 20: 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 (mark-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. Results from this ongoing telemetry study suggest 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 with 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.

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