Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Investigations of Flannelmouth Sucker Habitat Use, Preference and Recruitment Downstream of Davis Dam, in the Lower Colorado River (LCRMSCP Work Task C-15)

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

August 2007

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Lower Colorado River
Multi-Species Conservation Program

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Lower Colorado River
Multi-Species Conservation Program Office
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EXECUTIVE SUMMARY

This is the first year of a five-year study funded by the Lower Colorado River Multi-Species Conservation Plan (MSCP) that will advance information on flannelmouth sucker habitat use, preference, and recruitment below Davis Dam. This information will ultimately be used to develop management needs and strategies for the species. Work accomplished in 2006 is representative of conservation measures FLSU-2 and FLSU-3 of the MSCP Final Implementation Report.

Population dynamics of flannelmouth suckers downstream of Davis Dam were examined in 2006. All life stages were captured: 6 larvae, 4 juveniles and 350 adults. The majority of fish were captured in the Bullhead City area (RM 264); however, sampling and telemetry indicates the fish range downstream to below the California, Arizona, and Nevada State line (RM 255). The population numbers about 2,437 adults (95% CL = 1,440 to 4,440). Telemetry equipment provided information on movement and habitat use, and led investigators to new spawning locations. Sampling techniques included larval light traps, trammel nets, fyke nets, and electrofishing. Trammel nets have been standard sampling protocol; however, we also experimented with fyke nets and electrofishing. Fyke nets proved ineffective, capturing only one adult. However, electrofishing, especially at night, proved four times more effective (2 fish/hour of labor vs. 0.5 fish/hour of labor) than trammel netting. Flannelmouth suckers disperse along the river shoreline after dark, making them susceptible to electrofishing. Electrofishing presents managers with an effective method of capturing native suckers while avoiding untargeted organisms (e.g., game fish, water fowl, and aquatic mammals) and conflicts with recreationists which are common with trammel nets. We also experimented with aerial photography and float counts to help monitor population trends. Digital still and video imagery was taken from a helicopter and results were mixed due to problems with wind and glare. This approach will be further refined and tested in 2007. A population estimate (1,440) based on float counts fell within the confidence limits (95%) of mark/recapture estimates. Future work will be expanded to identify and delineate habitat preference and use.

INTRODUCTION

Habitat degradation and the proliferation of nonnative fish species have resulted in the listing of 7 of the 9 Colorado River native species as endangered under the Endangered Species Act. Flannelmouth sucker (*Catostomus latipinnis)* is one of 2 native species not currently listed as threatened or endangered but is a species of special concern to the MSCP. Flannelmouth suckers were not historically common in the lower Colorado River below Davis Dam (Minckley 1973). In 1976, Arizona Game and Fish successfully transferred 611 flannelmouth suckers captured at the confluence of the Colorado and Paria Rivers at Lee's Ferry, Arizona to the Colorado River below Davis Dam and led to their successful reintroduction (Mueller and Wydoski 2004). Mueller and Wydoski (2004) reported that flannelmouth suckers had established an impressive expanding community of over 2000 fish based on mark-recapture estimates. This is remarkable in view of the limited success of 25 years of stocking more than 2.1 million bonytail (*Gila elegans*) and 12 million razorback suckers (*Xyrauchen texanus*) into areas where these species were historically common (Minckley and Deacon 1991). Thus far, this population represents the first and only successful introduction of a native, mainstem fish species in the lower river basin.

The purpose of these investigations is to gather data and evaluate flannelmouth sucker habitat use, preference, and recruitment downstream of Davis Dam (Reach 3) as per conservation measures FLSU-2 and FLSU-3 (Lower Colorado River Multi-Species Conservation Program, 2004). At the terminus of this work we will be able to provide the MSCP with a management plan for flannelmouth suckers that outline management recommendations and possible threats to the population in Reach 3.

Our goals for 2006 were to: 1) examine community structure, relative abundance, and distribution of flannelmouth sucker, 2) examine flannelmouth sucker seasonal movements and preferred habitats with the aid of sonic telemetry, 3) refine and improve non-intrusive monitoring techniques, and 4) determine physical and biological factors contributing to their success.

METHODS

Active Sampling

The study reach extends from Davis Dam (River Mile [RM] 276, River Kilometer [RK] 444 [Lujan, 1990]) to the confluence of the California, Arizona, and Nevada state line (RM 257.5, RK 412) (Figure 1). Sampling targeted various life stages and habitats occupied by flannelmouth suckers. Adult and juvenile fish were measured (mm TL), weighed (g) and flannelmouth suckers >200 mm that were unmarked were injected with a passive integrated transponder (PIT) (125 kHz).

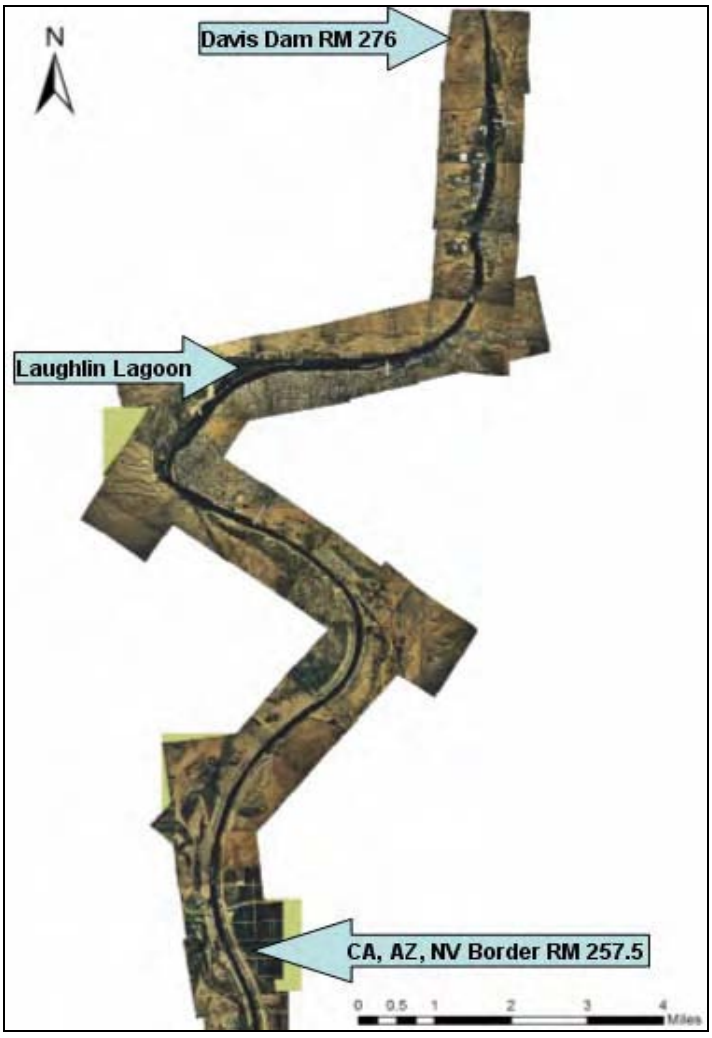

Figure 1. Map of study area showing the lower Colorado River between Davis Dam and the state line.

Sampling gear included small (2 m X 22 m X 1.2 cm or 2.5 cm) and large (2 m X 50 m X 3.7 cm) trammel nets and larval light traps. We utilized smaller meshed (1.2 and 2.5 cm) nets to target juvenile flannelmouth suckers and document recruitment. Light traps were used to determine the presence of flannelmouth sucker larvae. Trammel nets and light traps were set in backwaters and below jetties in the evening and pulled the following morning. Fish length and weight were recorded and larvae were preserved in 5% formalin, and later identified in the lab.

Electrofishing was conducted while boating downstream after dark to take advantage of flannelmouth suckers congregating near shore. Three different electrofishing boats were used: 1) Coffelt RF-10 voltage regulator (Reclamation), 2) Smith-Root GPP-5.0 Electrofisher (California Fish and Game Department), and 3) Smith-Root GPP-7.5 Electrofisher (Reclamation).

Fyke nets were designed to sample channel habitats. Fyke nets were constructed of 2.4-cm mesh formed over a 1 m x 0.5 m rectangular lead hoop constructed of 0.95 cm diameter solid round stock and three 1-m diameter hoops. The traps contained two throats, were 5 m long and had a zipper installed for easy fish removal. Nets had 15 or 25 cm diameter throats. A buoy was affixed with a 10-m length of rope. Nets were held in place with 22-kg anchors and deployed in the main river channel adjacent to flannelmouth sucker congregations (Figure 2). The plan was to place a gravid female flannelmouth sucker in half of the net sets to determine if they attract males. Fyke nets were set early in the week and allowed to fish 2 to 3 days before being pulled. Visual inspections of the fykes were conducted daily to check for captured fish.

Telemetry

Study Fish

Fifteen adult male flannelmouth were selected for sonic tag implantation. Fish were collected by electrofishing and trammel nets. Fish collected in trammel nets were surgically implanted with transmitters that day. Fish collected from night electrofishing were held overnight and surgeries were performed the following day. Fish were released at various sites between Boy Scout Camp (RM 265.6, RK 427.5) and the Davis Dam buoy line (RM 275.6, RK 443.5).

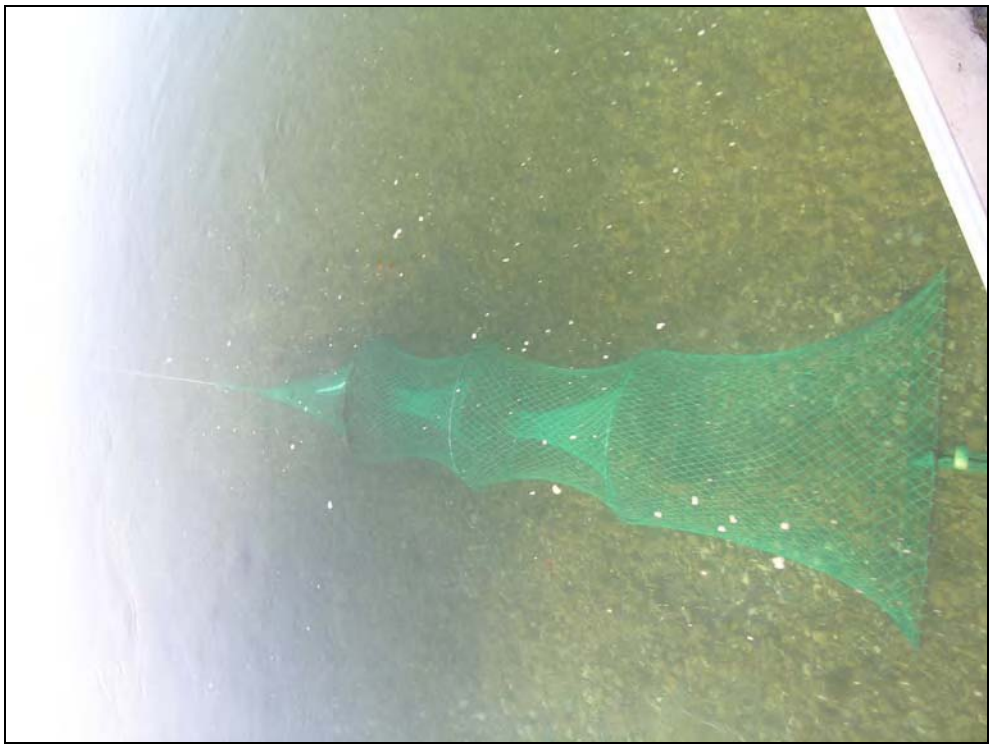

Figure 2. Fyke net deployed in the river channel.

Telemetry Equipment

Telemetry equipment consisted of Sonotronics transmitters and receivers. Utilizing the "two percent" rule (P. Marsh, ASU, personal communication, Winter, 1996) to determine the appropriate transmitter size, a 20 gram (weight in air), 53 X 16 mm sonic transmitter (Sonotronics model CT-82-2-I, life span 14 months) was deemed appropriate for fish larger than 1000 grams.

Fifteen transmitters were used; each had a unique frequency (69 to 83 kHz) and pulse code (e.g. Code 234 would sound 2 pulses-pause, 3 pulses-pause, 4 pulses-pause, repeat). Transmitters had a maximum detection range in our river environment of approximately 200 meters.

Tracking was accomplished using two Sonotronics USR-5W wide band receivers with DH-4 directional hydrophone (manual), or a DH-3 omni-directional hydrophone (manual) and two SUR-1-2D submersible ultrasonic receivers that allowed for fixed deployment and manual on-site download via laptop (Figure 3).

Figure 3. Stand-alone submersible ultrasonic receiver (Photo courtesy of Sonotronics Inc.).

Surgical Procedure

Sonic transmitters were surgically implanted following techniques described by Hart and Summerfelt (1975), Mueller et al. (1998), and Tyus (1987). Transmitters and surgical instruments were sterilized in 70% isopropyl alcohol. Prior to surgery, fish were placed in an anesthetic bath (0.1 g/L mixture of tricaine methane sulfonate) and monitored until they lost equilibrium (about 4-6 minutes). Fish were then placed upside down in a specially designed cradle lined with a wet towel. The area of incision was sterilized with 10% betadine. A 3 to 4 cm abdominal incision was made about 3 to 4 cm from the mid-ventral line, anterior to the pelvic fin. The sonic transmitter was then inserted and positioned laterally in the abdominal cavity. Four sutures closed the incision (4-0 Ethicon absorbable monofilament with FS-1 cutting needle). During the first half of the procedure, anesthetic bath was passed over the gills and body, while fresh water was used the second half to speed recovery from anesthesia (Figure 4).

Surgery time ranged from 4 to 10 minutes, averaging 6 minutes. Fish were then placed in a holding tank until they recovered (about 3 minutes), after which they were released.

Figure 4. Surgical cradle and anesthetic bath over gills.

Tracking Design

Mobile (boat) tracking was conducted biweekly from January through April and monthly surveys thereafter.

When available, two boats were used and navigators floated opposite sides of the river and associated backwaters with hydrophones in the water listening for transmitter signals. Surveys required two days with a single boat in order to effectively cover both shorelines of the river. When fish were detected, the signal was triangulated until an accurate (+/- 50 m) global positioning system (GPS) waypoint could be acquired. In addition to recording the waypoint, landmarks and estimated location in the river channel were noted.

Two submersible ultrasonic receivers (SUR) were tethered at RM 259 (RK 417; ~2.5 km upstream of the Avi Casino) and RM 233 (RK 375; ~1 km upstream of the Reclamation gauging station). The SURs recorded the passage of transmittered fish, which aided tracking efforts.

Remote Sensing

Float Counts

Visual surveys were conducted to provide another method of estimating population size other than mark-recapture approaches (Mueller and Wydoski 2004). These surveys were possible due to the clarity of the water (>4 m). This allowed fish to be identified and counted by observers who were standing on the bow of the boat. Individual surveys were limited to 15 minutes while the boat was driven downstream at speeds of 4 to 6 km/hr. Fish densities (fish/m^2) were quantified by using a GPS to measure the distance traveled and the estimated radius that the observer could accurately count and identify fish. Density estimates were then used to calculate population size by measuring the average width of the river and the length of the study area surveyed.

Aerial Photography/Video

High resolution still and video cameras mounted on a Reclamation helicopter were used to determine if video and/or images could effectively be used as a cost effective tool to generate accurate population data on flannelmouth suckers. Flights were scheduled for February and March in an effort to experiment with techniques and camera settings to assist with development of a protocol to be tested in 2007.

A special mount was designed that allowed for video and still cameras to be mounted inside the cabin of the helicopter and oriented downward through an opening. Both cameras were linked to separate laptops that acted as a viewfinder and medium for downloading digital frames, imagery, GPS waypoints, camera settings, time and date. A third video camera was mounted on the nose of the helicopter and oriented downward. This camera's monitor assisted the pilot in orienting the helicopter over areas that were to be photographed. The cameras were operated by two technicians sitting in the rear of the cabin. The still camera was a Nikon D2X digital

equipped with a 28-mm lens. The camera had an image resolution of 12.7 mega-pixels which equates to an image of 4,288 by 2,848 pixels in size. The digital camera operated from a time delay, taking still pictures every 4 seconds which allowed for download to a laptop computer. The video camera was a Sony HVR-Z1U. This wide-angle camera was equipped with a zoom lens and a polarized lens filter to reduce glare. The electronic files were downloaded to DVDs and viewed with Moonlight DVD recorder software that allowed a viewer to see associated GPS waypoints along with the time and rendered the ability of a frame to be grabbed and magnified.

A flight plan was developed with the pilot prior to each flight. All passengers were previously certified in helicopter safety training and all safety concerns were reinforced by the pilot before each flight.

Flights were conducted on February 16th and March 22nd, 2006. The initial flight in February consisted of two flights over the study area at a speed of 40 knots and at an elevation of 150 meters. The western half of the river was photographed on the first transect and the eastern half of the river on the second transect. During the first trip, the still camera was set at a shutter speed that ranged between 1/80 to 1/125 sec, with an ISO of 250 and aperture priority of 7.1.

The second flight did not fly any set patterns but first located and then made several passes over suspected groups of fish while varying elevation, speed, camera settings, lens filters, and zoom. The March flight shutter speed was set at 1/250 and an ISO of 400, aperture was set on ‘auto’, and the lens was set on infinity focus.

The video camera settings were the same for both flights: shutter speed was 1/500 second, aperture was set on ‘auto’, ND filter was set on ‘off’, gain set on 18 db (H), and the lens was set at about 40% full wide angle for the first trip and set full-wide angle with various levels of zoom used when fish were encountered during the second trip.

DIDSON Camera

A dual frequency identification sonar (DIDSON) camera was used to determine possible differences in diurnal fish activity. The imagery system uses sound waves instead of light, providing the ability to record fish at night or in turbid conditions. The intention was to set the remote-controlled

rotating camera on the substrate among a spawning group. The camera would be activated during the day and at night, and counts would be made periodically by scanning the group of fish.

RESULTS

Active Sampling

Seven sampling trips were conducted from December 2005 through April 2006, overlapping the flannelmouth sucker spawning season. We collected adult (n=350), juvenile (n=4), and larval (n=6) flannelmouth suckers by employing several sampling techniques.

One hundred forty-three trammel net sets over 14 nights yielded 488 fish representing 13 species. Adult (n=102) and juvenile (n=2) flannelmouth suckers were captured. Females comprised 77% of the total flannelmouth sucker trammel net catch. Flannelmouth suckers (21.3%) were the most common species captured, followed by carp (20.7%) and largemouth bass (14.5%). Species composition and fish/1,000m² of trammel net are shown in Table 1. Population estimates derived from electrofishing and trammel netting recapture data (Peterson single-census method, Ricker 1975) in aggregate was 2,437 flannelmouth suckers (95% CL= 1,440-4,400).

Two juvenile flannelmouth suckers were captured in trammel nets: one (135 mm) at Laughlin Lagoon (RM 267, RK 430) and the other (226 mm) at VFW Cove (RM 265.5, RK 427). This represented a juvenile CPUE of 2.4 fish/1000 m² utilizing the smaller square mesh.

Electrofishing consisted of seventeen sampling events for an average of 2,584 (324 – 4800) generator seconds/sample. A total of 263 flannelmouth suckers were collected with electrofishing gear (not including multiple recaptures). Females represented 65% of the catch. Catch per unit effort (CPUE) for electrofishing was 2 fish/hour of labor and by-catch was limited.

To increase catch probability, fyke nets were set in the main river channel where flannelmouth sucker congregations were observed. A total of 324 netting hours yielded only one flannelmouth sucker.

Light traps were deployed eight times between January and April for a total of 128 trapping hours. A total of six larvae were collected, all of which were flannelmouth sucker. Five larvae were collected in an eddy pool near the Fort Mojave Ruins on April 20th and a single larva was collected in an eddy pool downstream of a known spawning group at RM 263 (RK 423) on April 19th.

Table 1. Species composition and relative abundance (fish/1,000 m²) of fish captured using trammel nets between Davis Dam and AZ, CA and NV State Line from December 2005 through April 2006.

Species	Number caught	Percent (%)	Fish/1000 m² of trammel net
Flannelmouth sucker	104	21.3	11.2
Common carp	101	20.7	10.9
Largemouth bass	71	14.5	7.7
Bluegill	31	6.3	3.3
Redear sunfish	42	8.6	4.5
Channel catfish	32	6.5	3.5
Striped bass	14	2.9	1.5
Rainbow trout	64	13.1	6.7
Green sunfish	3	0.6	0.3
Smallmouth bass	10	2.2	1.1
Threadfin shad	14	2.9	1.5
Goldfish	1	0.2	0.1
Tilapia	1	0.2	0.1
Total	**488**	**100**	**52.4**

Telemetry

Fifteen adult male flannelmouth suckers were surgically implanted with sonic transmitters and released between January 25th and March 9th. Fish averaged 536 mm in total length (390 to 573 mm) and 1,924 grams (640 to 2,333 g). Fish were released at various backwaters: two at Boy Scout Cove (RM 266.3, RK 428.5), seven at Big Bend boat ramp (RM 265.3, RK 427), four at the Riverside Casino boat ramp (RM 275.3, RK 443), and two in Laughlin Lagoon (RM 267.2, RK 430).

All flannelmouth suckers tagged initially moved downstream after release. Eleven fish provided us with sufficient data to determine that 63% (n=7) had either began a holding pattern or made upstream movements within four weeks and 91% (n=10) within six weeks of release. Seventy-eight detections of tagged fish were acquired by manual tracking. All fish locations were representative of channel, near shore, and eddy pool habitats. No tagged fish were encountered in backwaters or side channel habitats. Table 2 provides general tracking data including release site, range of movement and number of contacts.

Table 2. General tracking data for flannelmouth suckers for 2006.

Fish #	Date tagged	Release site (RM)	# Contacts manual tracking	# Dates detected by SUR	*Range of movement (miles)
1	3/8/06	274	2	0	0
2	3/9/06	268	5	1	3
3	3/7/06	267	6	0	2
4	3/7/06	267	5	0	0
5	1/26/06	266	0	0	0
6	3/7/06	267	6	0	2
7	3/9/06	268	6	0	9
8	1/26/06	266	6	2	5
9	3/7/06	267	6	0	2
10	3/7/06	274	4	2	3
11	3/8/06	274	9	0	4
12	1/25/06	267	1	1	0
13	3/7/06	267	5	1	6
14	3/7/06	267	7	1	4
15	3/7/06	274	10	0	4

*Data does not include release site or detections within 14 days of release.

Remote Sensing

Float Counts

We conducted 44 fifteen-minute transects within the study reach between December 2005 and April 2006. We observed 22 hectares (ha) and recorded 437 fish representing seven species. Sixty-six adult flannelmouth suckers

were observed. Several single fish and a large group of over 60 flannelmouth suckers were observed and locations recorded. Table 3 provides population estimates for all fish species encountered during counts.

Table 3. Estimates of common fish species based on 15-min visual surveys (boat) on the Colorado River channel between Davis Dam and the Nevada State line. (22 ha observed)

Species	**Number**	**Fish/ha**	**Population estimate***
Common carp	250	11.4	5472
Striped bass	102	4.6	2208
Razorback sucker	5	0.2	96
Flannelmouth sucker	66	3.0	1440
Largemouth bass	1	0.1	48
Smallmouth bass	3	0.1	48
Rainbow trout	10	0.5	240

* Population based on a study site surface area of 150 m X 32,000 m = 480 ha.

Aerial Photography/Video

Suspected flannelmouth sucker congregations were observed by the crew and filmed during the initial flight. A total of 499 still frames and 35 minutes of video were taken in February. Three large groups (approximately 50 individuals) of suspected flannelmouth sucker were observed by the crew. Observers later analyzed data and could only locate a single group.

Simultaneous analysis of both video and still frames allowed for comparison of imagery. We determined that still frames lacked complete coverage with four seconds between frames. It was estimated that about 50 meters of shoreline was not recorded between each picture.

In March, rather than taking imagery on the entire reach of river, we first located fish and then tried different elevations and camera settings. A total of 59 still frames and 15 minutes of video were taken. Several groups of fish ranging from approximately 12-25 individuals were observed and filmed. Fish locations were surveyed by boat later that day and determined to be carp. Review of imagery at a later date failed to provide resolution capable of distinguishing species.

DIDSON

The opportunity did not arise to use the DIDSON; we were not able to locate a filmable pod of suckers during the period that we had the camera in our possession. A suitable school was later located and a second attempt is planned for the 2007 field season.

DISCUSSION

Flannelmouth sucker congregations between Davis Dam and the state line are often found in 3 to 5 m deep runs and riffles. This portion of the river is characterized by cooler water temperatures, rocky substrates, and higher gradients. Their lower relative abundance in the 40 km of river upstream of Lake Havasu is attributed to their avoidance of a reach dominated by drifting sand, warmer temperatures, and numerous backwaters (Mueller, 2003).

In March and April, we observed that flannelmouth sucker congregations on spawning bars would swell to numbers in excess of 100 individuals. As concentrations of flannelmouth suckers dispersed after the spawning season, single fish and small groups (<12) were a common sighting. Post-spawn locations of flannelmouth suckers appear to be unpatterned as flannelmouth suckers were tracked or observed in a wide range of habitats.

We found that boat electrofishing at night was an effective way to collect flannelmouth suckers in the river. In March, both electrofishing and trammel netting efforts were emphasized. Ninety-three percent of flannelmouth sucker captured with trammel nets were females compared to 76% with electrofishing gear during this time. We believe this to be a result of females seeking resting areas (in backwaters, where nets were set) between spawning events while males tend to stay in the main river channel. Catch per unit effort (CPUE) for electrofishing was very high in comparison to trammel netting (2 fish/hour of labor vs. 0.5 fish/hour of labor) and by-catch was limited.

In an attempt to increase the representation of male flannelmouth suckers in our sampling, we designed large fyke nets to sample the mainstream channel. Problems experienced with the fyke nets did not allow for us to adequately test the effectiveness of this technique. High water velocities in

mid-channel caused excessive wear on equipment, as nets were commonly dragged downstream or torn completely loose from anchors. Net fabrics were quickly damaged, requiring extensive repair that delayed further deployment. The unpredictability of how well nets would hold in the current raised concerns of fish well-being and led to us abandoning attempts of paired (female vs. no female) baited tests. With the success of electrofishing we feel that the future testing of fyke nets is not warranted and those resources will be redirected towards other aspects of the study. A synopsis on the fyke net testing can be found in Appendix A.

Twenty-three overnight sets of smaller mesh (1/2 and 1 inch) trammel nets yielded two juveniles. Both were captured near the back of coves. One fish was associated with bulrush (*Shoenoplectus spp*.) while the other was captured in a cove with a concrete-armored shoreline. We expected juveniles to be more abundant, especially with such a healthy population of flannelmouth sucker adults. Mueller and Wydoski (2004) reported that an annual recruitment of 15% of the spawning cohort (age 3-4) is adequate to maintain a population experiencing low adult mortality. Since the proportion of juveniles appears rather small, we plan on increasing our sampling effort and refining our techniques.

While conducting routine tracking of fish in June, several juvenile fish were observed along shore adjacent to where a large group of spawning suckers was located earlier in the season. In July, six passes with a seine produced two small (45 mm) flannelmouth suckers and approximately 15 more were observed. In August, the crew made another attempt to collect juveniles with seines and a backpack electroshocker, but was unable to capture or observe any juveniles at that time. We plan to incorporate beach seining and backpack electroshocking in future work.

Males were selected for the telemetry study because they exhibited greater site fidelity than did females during the spawning season (Mueller 2003). It was our hope that males would remain on spawning beds, allowing us to locate spawning congregations. All but one fish were detected at least once during the field season. Although some fish were only relocated a few times, eleven fish assisted us in locating two separate congregations that were not previously known. Telemetry proved effective in leading us to large groups of fish that were not observable during the day. With this information we were able to focus night-time electrofishing efforts to areas where there were tagged fish and increase our capture efficiency.

With known locations of flannelmouth sucker throughout the season, we feel we have the ability to gain valuable information on seasonal use of mesohabitats that may prove valuable in adding to a life history database and aid in habitat suitability criteria that could possibly be applied to other reaches of the river. Figure 5 shows flannelmouth sucker spawning congregations and how they were located. Seasonal detections of individual fish can be viewed in Appendix B. Male flannelmouth suckers appeared to randomly disperse both up and downstream following the spawn. Tracking data in 2007 should determine if movements are round trip (males spawn every year).

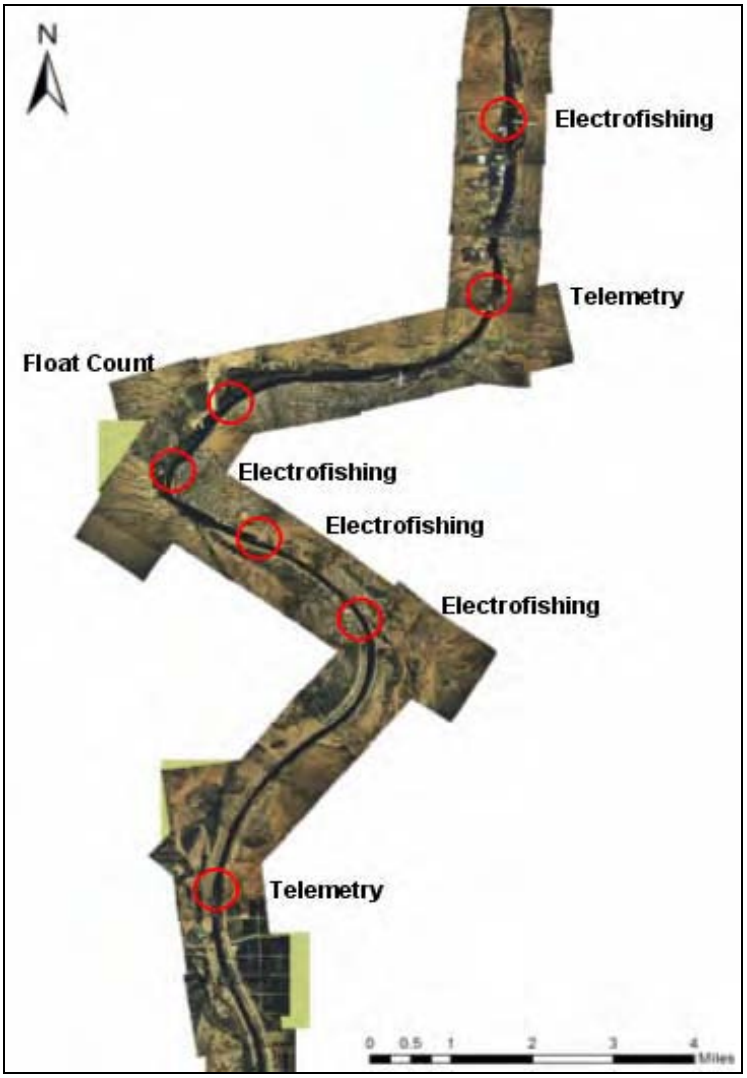

Figure 5. Map of known flannelmouth sucker congregations and how they were located.

Surgical stressors, inexperience, or technique may have had adverse effects on fish recovery and consequently may have altered fish behavior. This concern was raised after the recapture of several sonic-tagged fish (7 recaptures of 5 fish). Three of these fish appeared to be healing nicely (closed wound with little or no sign of infection), while two others had prematurely lost their sutures (probably due to the use of absorbable sutures) and their surgery wound remained open. One of these fish in particular was recaptured three times after surgery. These fish may have been more vulnerable to electrofishing gear because they were oriented along shore (possibly recovering) or their mobility was impaired to the point that they could not avoid collection gear. All recaptured sonic-tagged fish were located adjacent to active spawning groups of flannelmouth sucker.

Float counts showed promise even though many counts were hindered by wind that distorted the surface and made it difficult to see fish. Observers could generally identify fish 3 to 10 m from the boat depending upon sun glare, current, and wind conditions. In addition, as the observer's field of view decreased, there was a greater chance of missing fish due to boat avoidance.

Wind caused several surveys to be canceled or cut short. Remaining data proved to be adequate as population estimates for flannelmouth sucker (n=1,440) fell within the confidence interval of population estimates derived from mark-recapture (95% CL = 1,440 to 4,400). It is suspected that future data will prove more representative as we only observed one of several large groups of flannelmouth sucker during our counts. If float count estimates remain consistent with those generated from mark recapture work throughout the study duration, it would then be possible to adjust them with a coefficient to obtain accurate population estimates. In addition, population estimates for other species were also generated. It is important to note the inherent bias from our technique. Counts were conducted in the main river channel and did not include backwaters. Observations were not weighted equally between particular habitat types and were conducted randomly. This technique is more appropriate for large fish and estimates for smaller fish are certainly underestimated. Future counts will be further standardized and refined.

Aerial surveillance video proved more effective than still pictures during the review process. Sequential frames allow the viewer to observe the river from different angles, providing windows in the water column where the bottom can be seen clearly without glare. Still pictures are very large files and require time to download and observe. Coupled with incomplete coverage and only one view of a selected area, this proved very labor-intensive.

Video of suspected flannelmouth sucker congregations were observed by the crew and filmed during the initial flight in February; unfortunately, time constraints did not allow for on-the-ground confirmation. Flight conditions were fair but wind gusts often distorted the river's surface and increased glare. Video resolution was poor and species were undistinguishable at distances of 150m and air speed of 40 knots. Large congregations of fish were discernable, but single fish were overlooked because of the difficulty of distinguishing fish from bottom debris.

Still camera photos were blurred due to a combination of slow shutter speeds and high helicopter speed. Imagery was inadequate to identify fish and the four-second time delay left gaps in image coverage.

In March, we modified our approach. We first spotted fish and then did several passes, varying flight speed (5-30 knots), elevation (20-60 m) and camera zoom to determine which conditions worked best. Shutter speed of the still camera was increased to 1/250 to sharpen images. Few fish were observed due to high water levels (18,000 cfs), and those observed were oriented in groups near shore. It became apparent that elevations <60 m actually startled fish causing them to flee to deeper water. Elevations of <30 m caused severe prop-wash that distorted our vision. The greatest success was achieved at an elevation of 60 m and a speed of ~5 knots. Later in the afternoon, some fish congregations were identified as schools of common carp. Species differentiation was difficult when reviewing imagery.

Flannelmouth sucker congregations between Davis Dam and the state line are often found in 3 to 5 m deep runs and riffles resulting in a dark background that made it more difficult to distinguish fish. This in aggregate with high winds and glare are the limiting factors to effectively counting flannelmouth suckers in this reach. In addition to adhering to the developed protocol, the factors above should be taken into consideration and be employed during times of low flow (February).

FUTURE WORK

Active Sampling

Proposed activities for 2007 include the continued monitoring and research actions that took place in 2006 (minus fyke net tests). In addition, we intend to drift monofilament trammel nets, modify electrofishing arrays to better shock at depths, and standardize techniques for better replication. We will incorporate beach seining and backpack electroshocking techniques to focus on numbers and distribution of juvenile life stages.

Telemetry

Telemetry activities will include sonic tagging an additional 20 flannelmouth suckers. Additional submersible ultrasonic receivers have been purchased and will be deployed in backwaters to track pre-spawn backwater use. Tracking will be conducted monthly until the battery life of tags ends.

Remote Sensing

Float Counts

Surface counts will be refined in an attempt to better track with mark-recapture population estimates. Float counts will also be attempted at night with the use of additional 1,000-watt halogen lights. We plan to utilize the Boulder City dive team to assist with data lacking in areas of the river where fish are known to reside but are too deep to be observed or contacted with collection gear.

Aerial Photography/Video

Efforts will be focused on known congregations of flannelmouth sucker. Buoys will be placed adjacent to pre-located groups of flannelmouth sucker prior to flights and will act as a reference during the flight and when reviewing pictures and video. Any suspected groups of flannelmouth sucker observed from the air will be confirmed by boat as soon as possible. Detailed notes were very helpful when looking back at pictures and video. Notes assisted with site location and comparisons of fish observed by the

crew and those recorded. Onboard audio recording will be employed next year to further assist with data translation.

DIDSON Camera

Test deployment of the DIDSON camera was attempted from an anchored boat several times in January while attempting to film razorback suckers. Although we were successful, deployment proved to be awkward as a result of the large, heavy base that the camera was set upon and the two cables that controlled the camera and rotator from the boat. We determined that a shoreline deployment in shallower water would probably be the preferred technique. Unfortunately, in 2006 we did not locate spawning flannelmouth suckers near shore until after the camera was required for another project. We plan to use the camera to look at spawning behavior and attempt to quantify day vs. night flannelmouth sucker densities on spawning bars. We are optimistic that our knowledge of flannelmouth sucker spawning groups will assist us in expediting DIDSON tests next year.

Habitat Preference

We plan to investigate the value of stomach content analysis as a tool to detail habitat requirements of different life stages of flannelmouth sucker. We will be meeting with a USGS hydrologist this winter to discuss the collection of habitat parameters needed to complete habitat suitability models. The modeling process would include 1) collecting aerial photographs in the form of digital ortho quarter quads (DOQQ), 2) geo-referencing aerial photography with habitat types, 3) classifying habitat parameters, and 4) calculating areas for unique combinations of fish habitat parameters. This information will be combined with population structure and distribution data to determine habitat preference and needs.

SCHEDULE

Seven sampling trips from January through August are currently scheduled. Early efforts will focus on collecting and tagging fish (January emphasis will be to collect suitable flannelmouth suckers for sonic tags), as well as float counts while water levels are low. An aerial survey will be planned for the second week in February. As the season progresses into the breeding season, efforts will shift towards collection of larvae and juveniles and

telemetry tracking. Tracking fish within the study area will be conducted monthly.

ACKNOWLEDGMENTS

We wish to thank the Nevada Department of Parks for the use of their Big Bend Facility for equipment storage and river access. USBR staff at Davis Dam provided assistance and river access at their facility. Collection permits were issued by Nevada Division of Wildlife, Arizona Game and Fish Department, US Fish and Wildlife Service, and California Department of Fish and Game. Special gratitude goes to the Fort Mohave Indian Tribe that allowed river access.

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Appendix - A

Synopsis of fyke net trials

Appendix A.

Synopsis of the use of Modified Fyke Nets as a Tool to Collect Two Native Suckers (Flannelmouth and Razorback) from Fluvial Habitats on the Lower Colorado River Below Davis Dam.

Introduction: Past sampling of native suckers of the Lower Colorado River system have shown that females are vulnerable to capture during spawning periods with standard sampling techniques (trammel nets) used in backwaters. Population estimates derived from this sampling may be low due to sexual bias. Flannelmouth and razorback suckers typically spawn mid-channel of the river. It is believed that females tend to rest along shorelines, in eddies, or in backwaters between spawning events, while male fish remain in mid-channel. Fyke netting showed promise as a pilot test with a single net baited with two females produced a single male flannelmouth sucker. We believed sexually active males may be enticed by female pheromones.

Purpose: There is a need for development of a collection technique that would target adult suckers in a riverine environment. The ability to reduce spatial and sexual bias from collection techniques would foster more accurate monitoring of native fish of the Colorado River.

Objective: The goal of this work is to test the effectiveness of modified fyke nets set proximate to spawning groups of native suckers. We plan to explore the use of pheromones in the form of gravid females as an attractant to lure male suckers into nets. The objective is to increase monitoring accuracy, reduce impacts to target fish, and reduce non-target species by-catch.

Study Area: Flannelmouth sucker trials were conducted between river miles 252 (near Ft. Mojave) and 269 (adjacent to Laughlin Lagoon). Razorback sucker trials focused on a large spawning bar between river miles 246 (Highway 95 Bridge north of Needles) and 252 (Willow Valley Estates).

Methods: Six fyke nets were constructed with trailing leads. Nets consisted of a 1 m x 0.5 m rectangular lead hoop constructed of 0.95-cm diameter solid round stock, three – 1-m hoops. The nets were double throated, 5-m long and had a zipper installed in the cod end for easy fish removal. Netting

consisted of 2.4-cm UV treated mesh. Trap entrance was 15 cm for four of the six nets and later modified so all nets had an entrance of 25 cm. A buoy was affixed with a 10-m rope.

Nets were held in place with 22-kg anchors and deployed in the main river channel adjacent to flannelmouth and razorback sucker congregations. Gravid females were added to the net compartment while it was being immersed. Fyke nets were set early in the week and allowed to fish 2-3 days under good conditions. Visual inspections of the nets were conducted daily to look for captured fish.

Results: Nets were set for razorback sucker the weeks of January 30th (8 net nights), February 13th (16 net nights) and February 27th (12 net nights). The experiment consisted of a total of 36 overnight sets. Twelve of the 36 net sets were baited with females; the remaining were set empty. Even though nets were set in close proximity to spawning razorback suckers, no fish were captured in either baited or empty traps.

Flannelmouth sucker trials consisted of a total of 27 overnight sets. Nets were set during the weeks of December 19th (12 net nights), January 23rd (6 net nights), April 3rd (5 net nights), and April 17th (4 net nights). A single female flannelmouth sucker was captured the week of December 19th in an unbaited net, set at river mile 266 that fished for a 36-hour period.

Discussion: Setting nets proved difficult as river levels fluctuated with the need for power generation. Often nets would be set during low flows only to be swept downstream as flows ramped up, causing the net to tightly twist and become damaged. In areas where flannelmouth congregations were found, problems with net sets were magnified during April, as there were drastic changes in flow (from 4500 cfs to 18,000 cfs in less than 10 hours). The stretches of river that contained known spawning groups of flannelmouth suckers are characterized by narrow shorelines that quickly drop into deep channels. Paired testing of baited and empty nets for flannelmouth sucker was cancelled in April, as we were not confident we would be able to secure nets and we were concerned about harming fish.

Four of the six nets were equipped with smaller (15 cm vs. 25 cm) throat openings that may have discouraged suckers from entering. Throat opening diameters were modified after January; however, later trials still did not

capture fish. The two flannelmouth suckers captured during the pilot study and in the December trials were in traps outfitted with large throat openings.

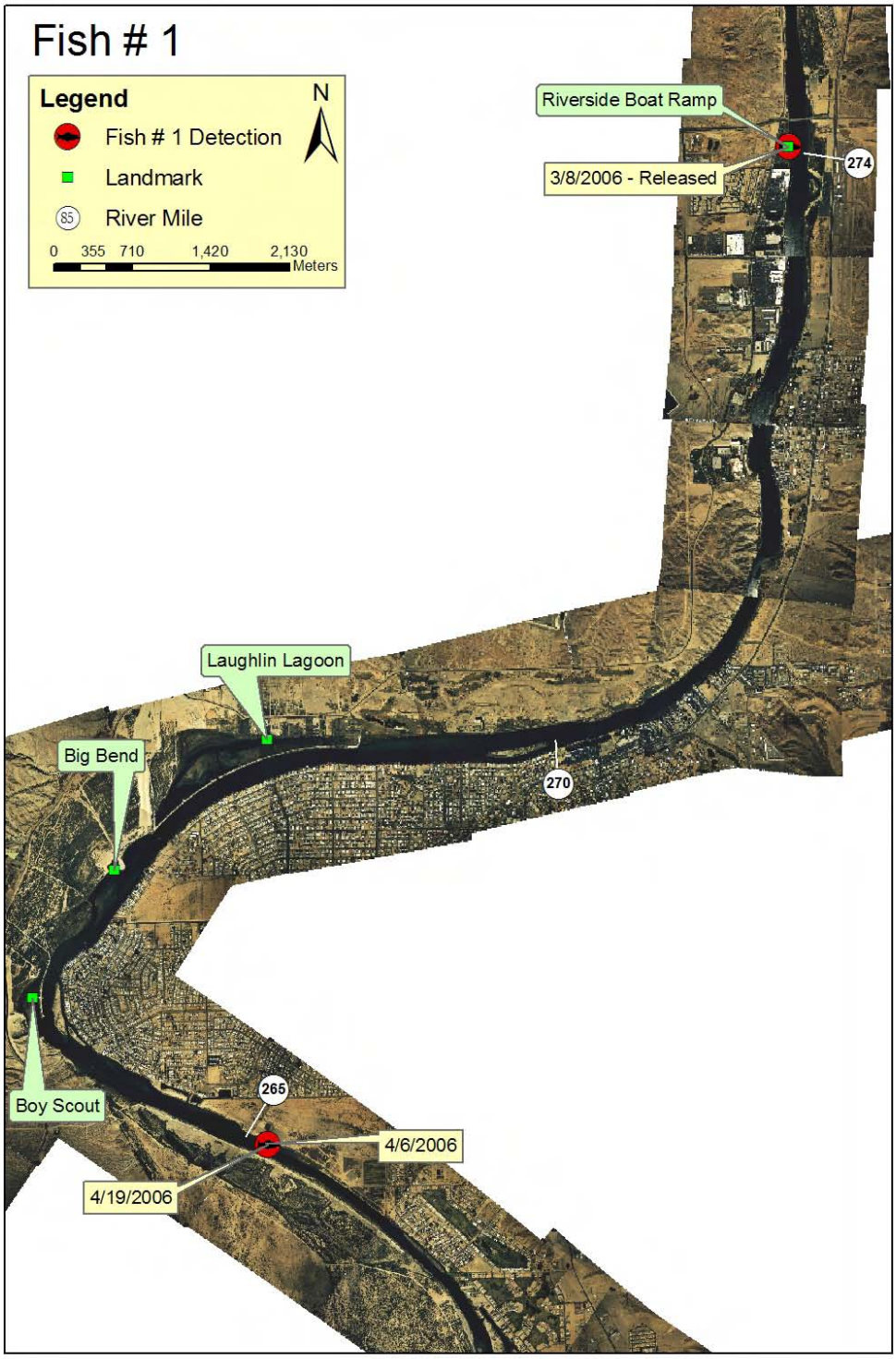
We estimated that a 40-kg anchor would be required to adequately secure nets. This size anchor would only further inhibit setting and retrieving the cumbersome nets. The nets would also need to be reinforced around hoops as nets became heavily worn from the rigors of being set, deployed, and retrieved in the swift current.

While the use of this technique is limited in a large river system such as the Lower Colorado River, we feel that it may be worthwhile to investigate their value in a system without flow such as Lake Mohave.

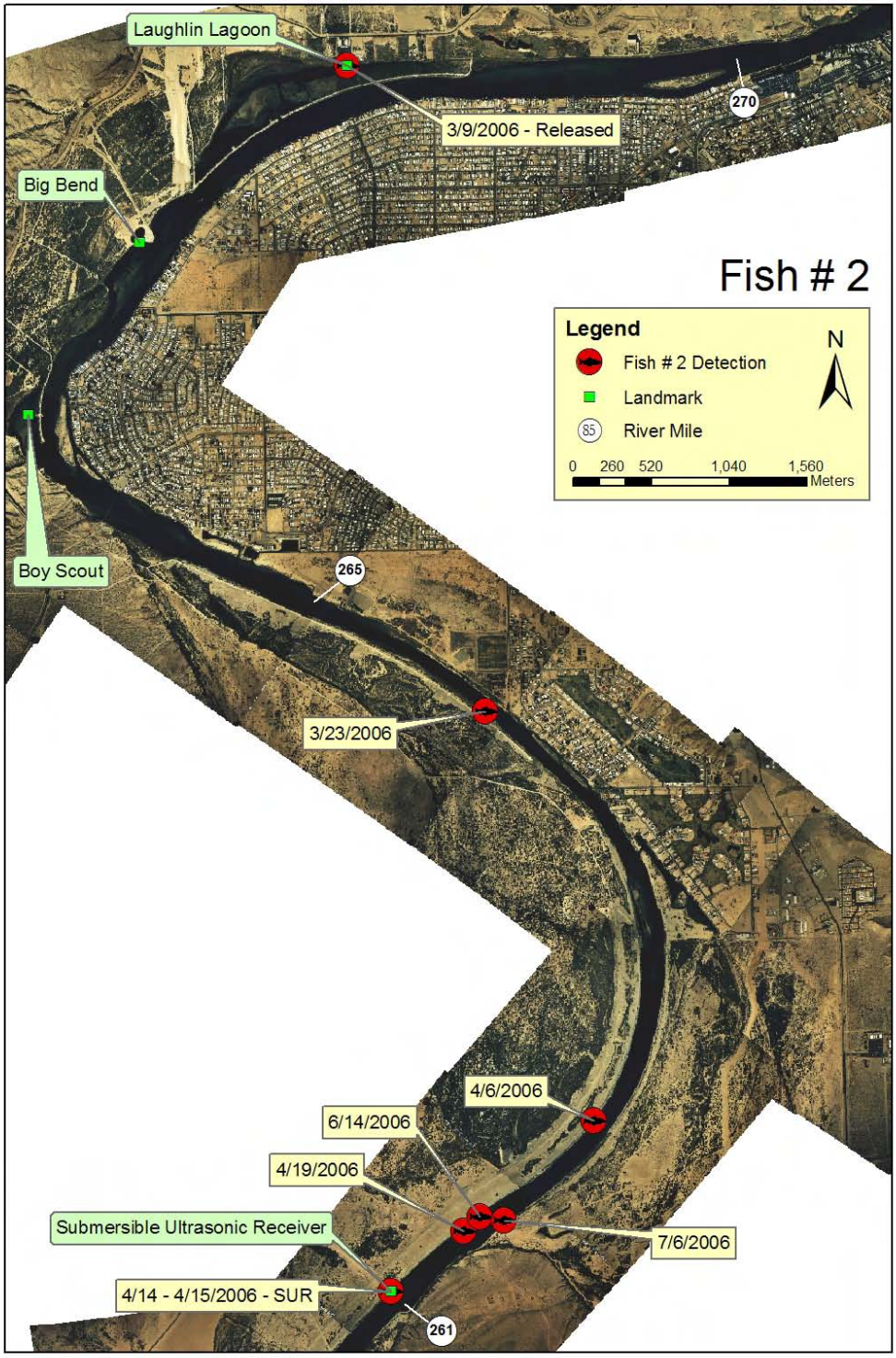
Appendix - B

Detection maps of sonic tagged flannelmouth sucker

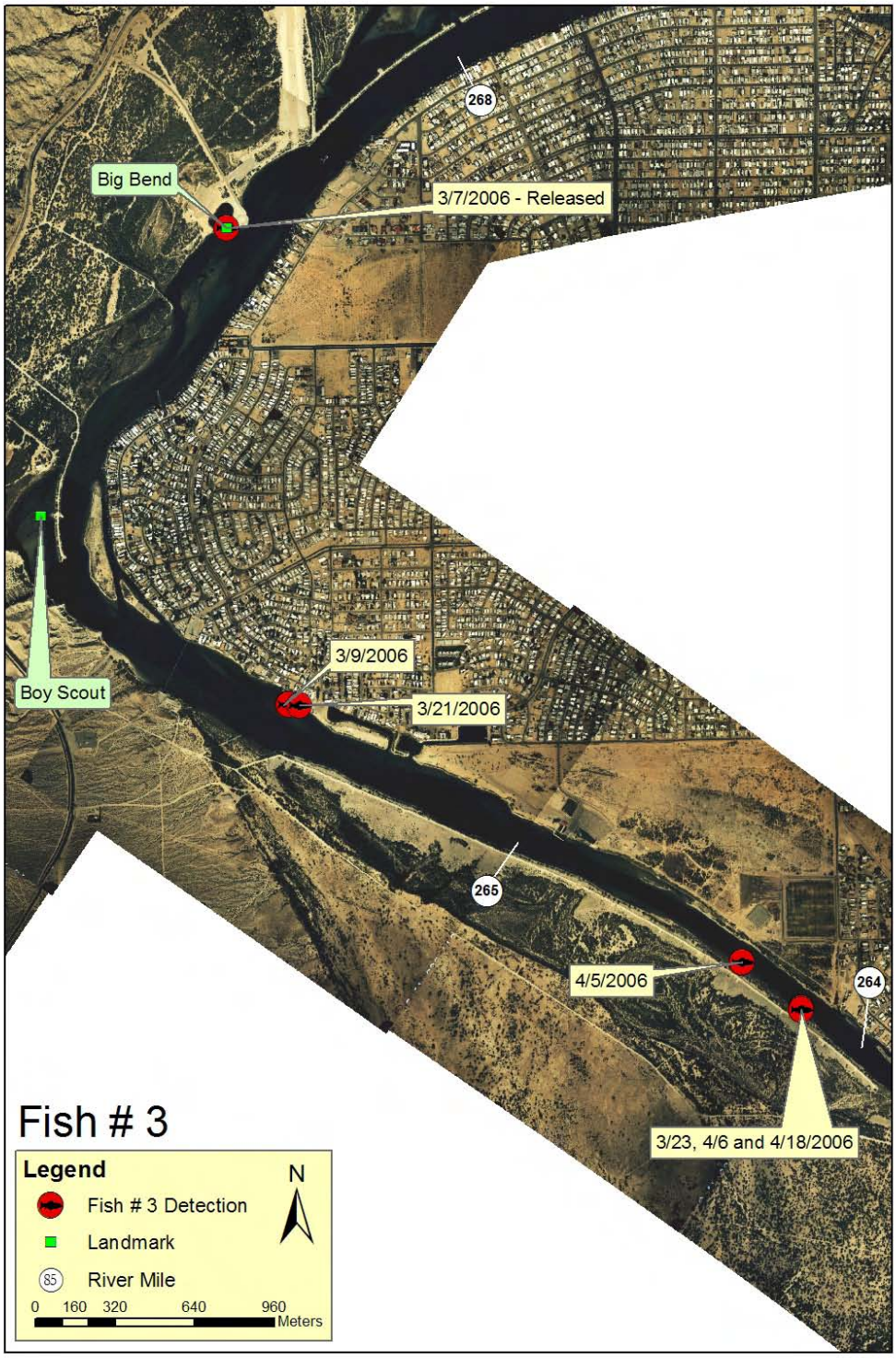
Appendix B-1. Detection map for fish # 1.



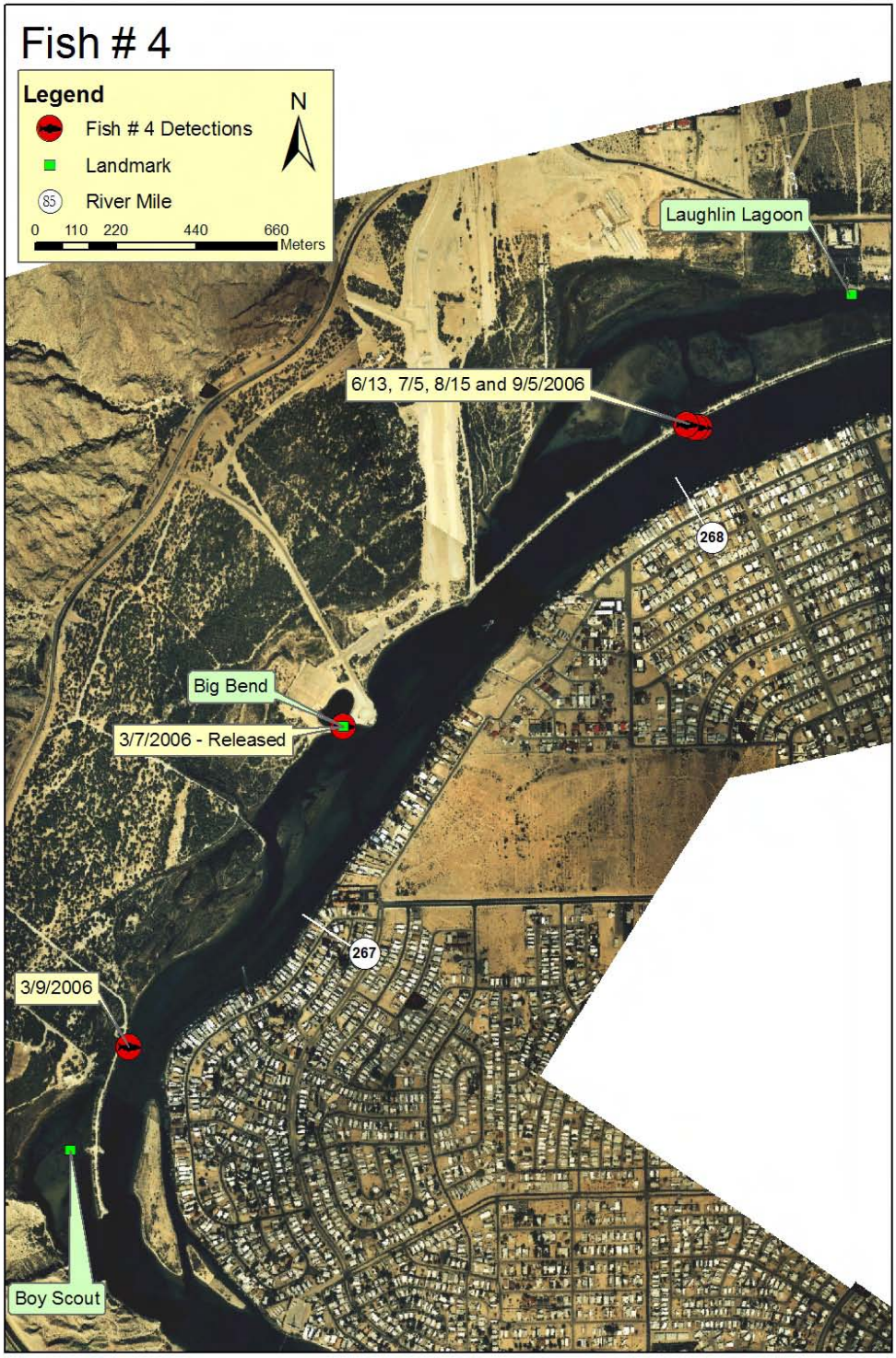
Appendix B-2. Detection map for fish # 2.



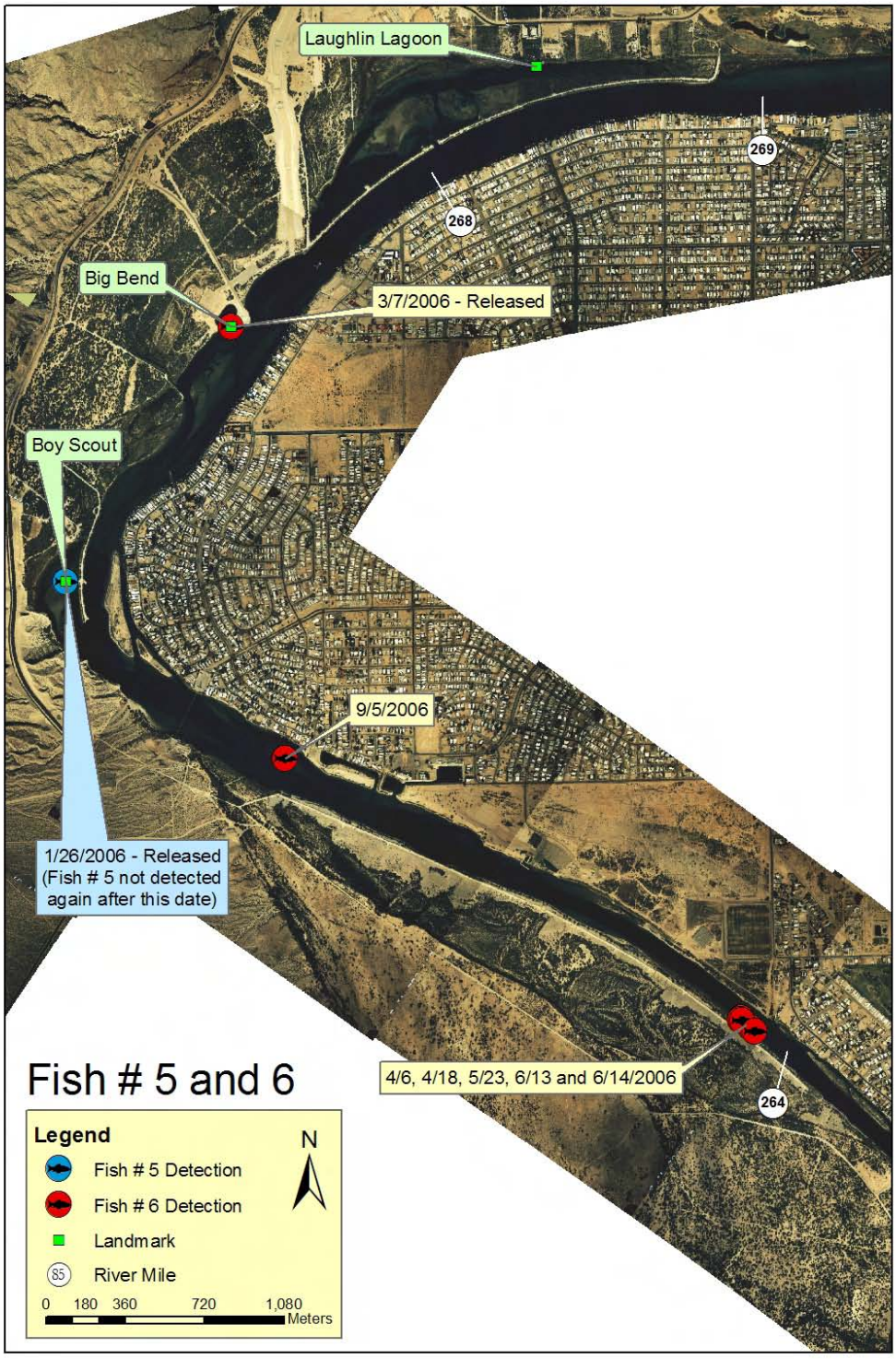
Appendix B-3. Detection map for fish # 3.



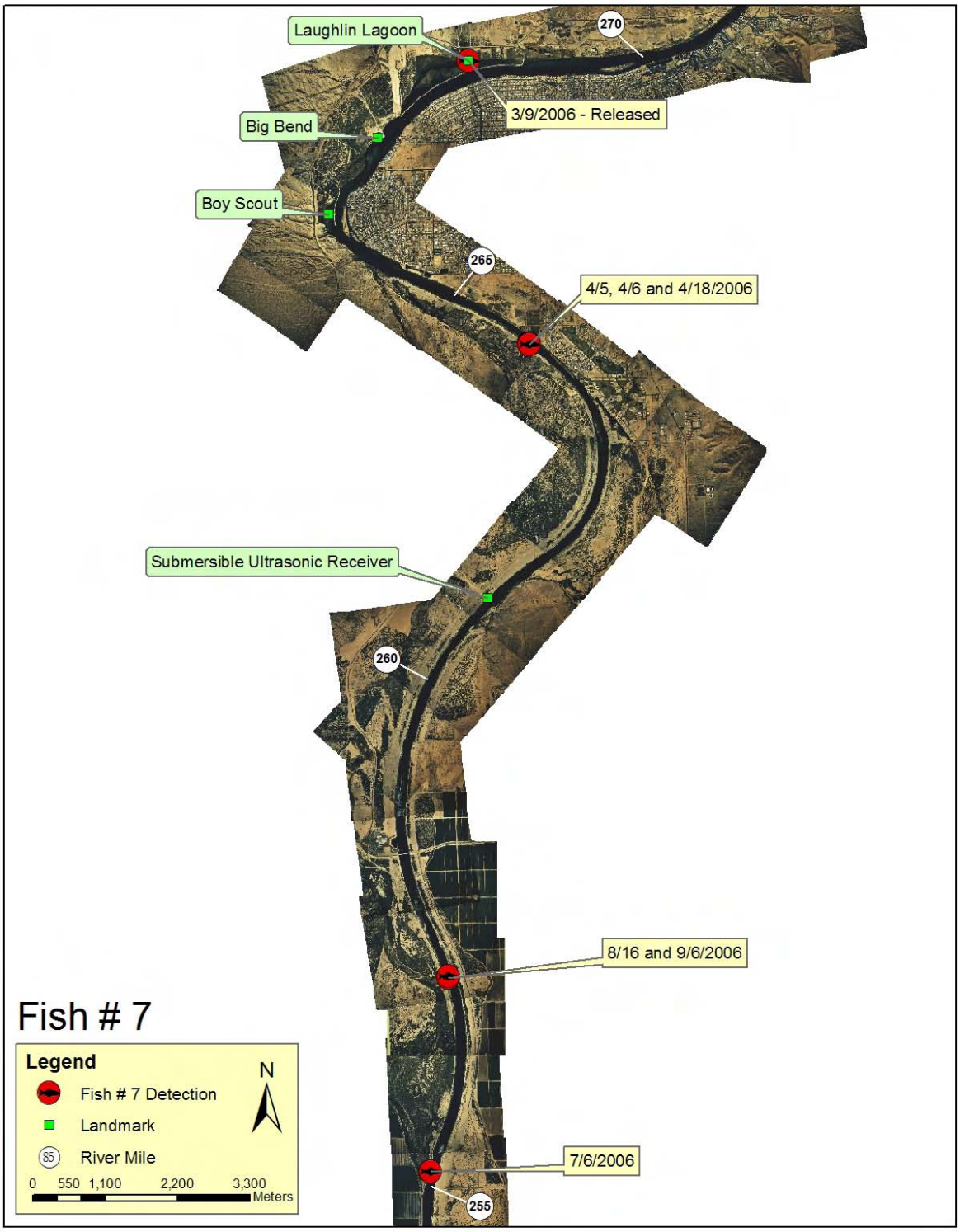
Appendix B-4. Detection map for fish # 4



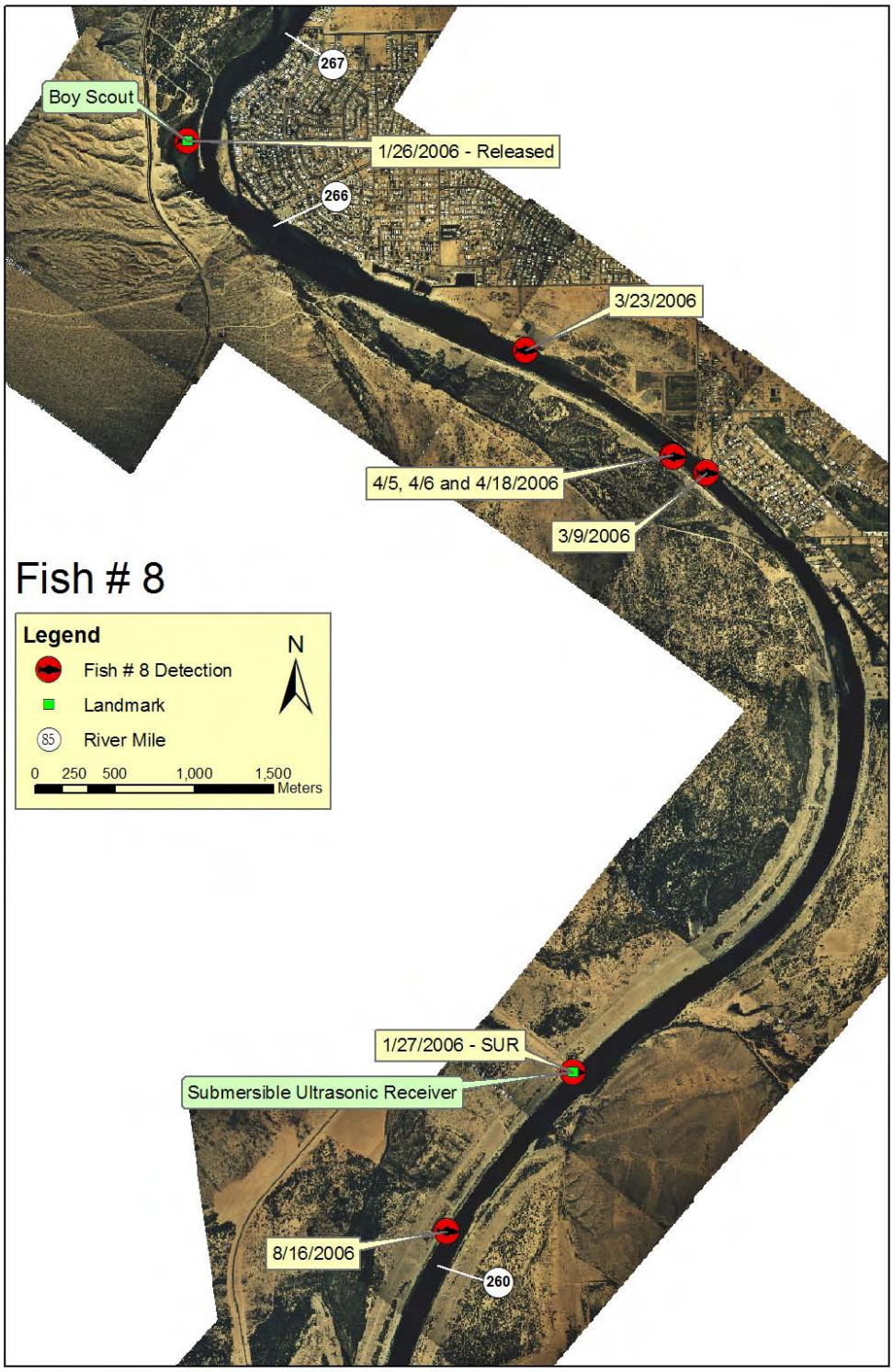
Appendix B-5. Detection map for fish #'s 5 and 6



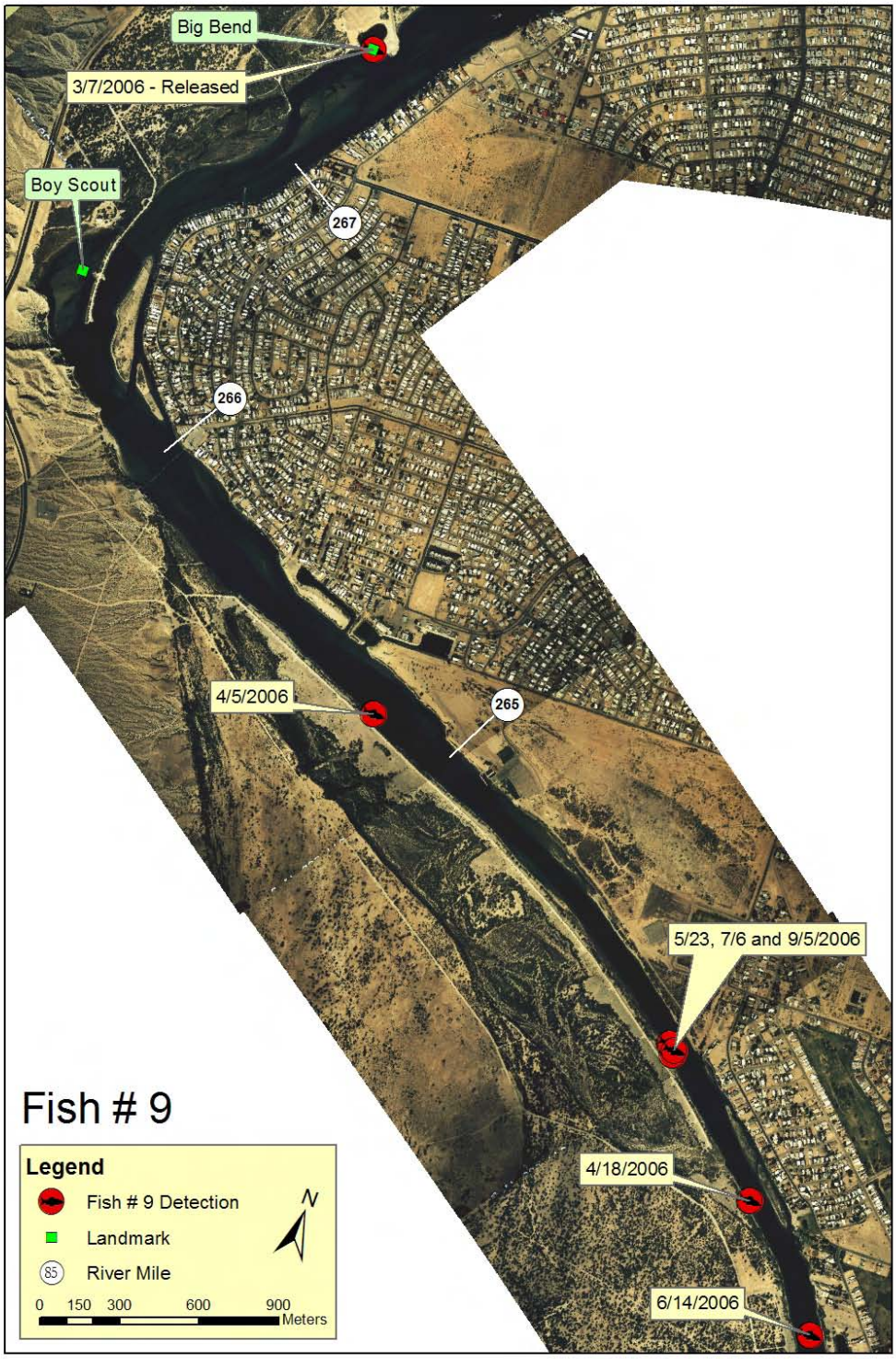
Appendix B-6. Detection map for fish # 7



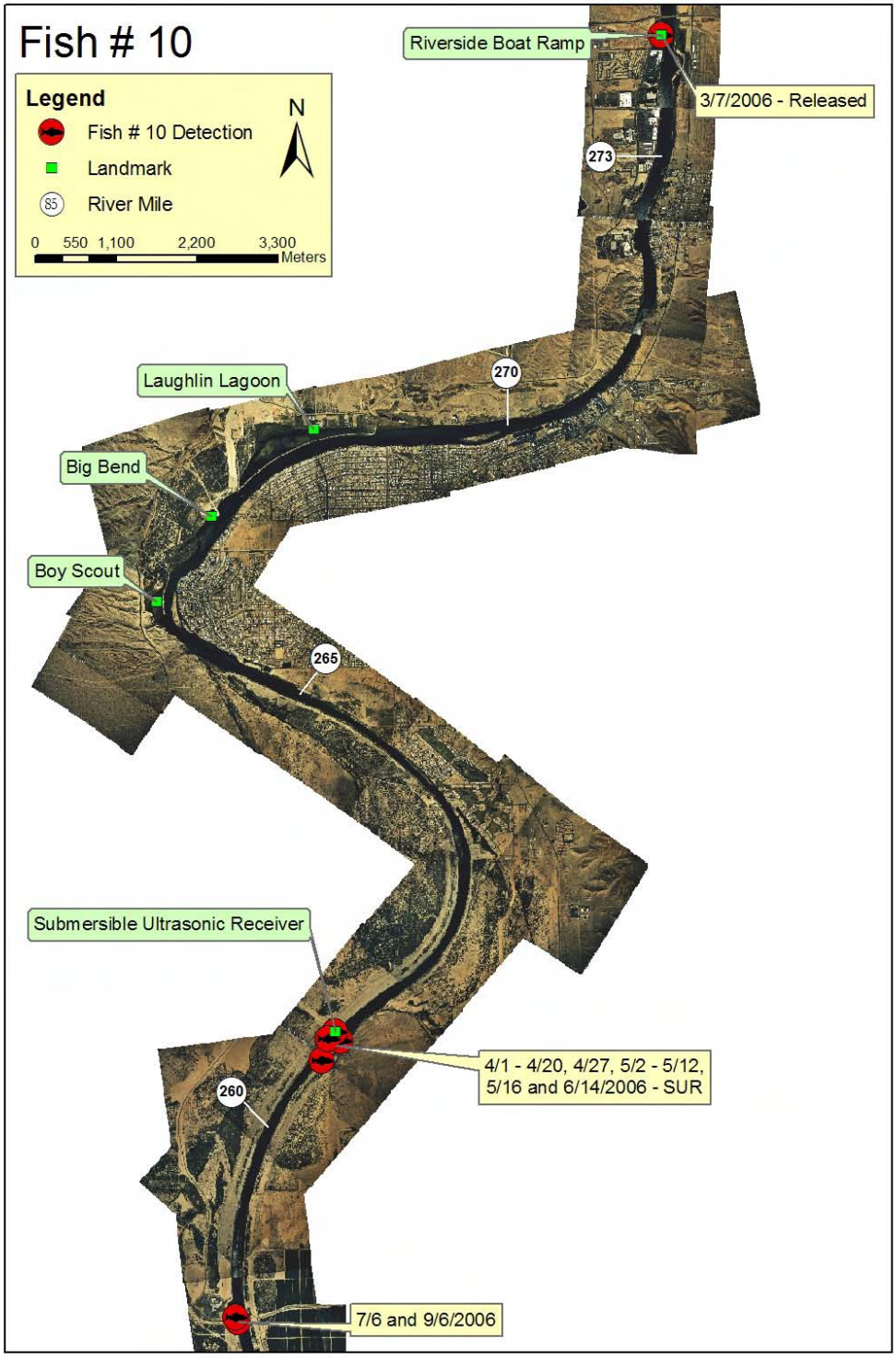
Appendix B-7. Detection map for fish # 8



Appendix B-8. Detection map for fish # 9

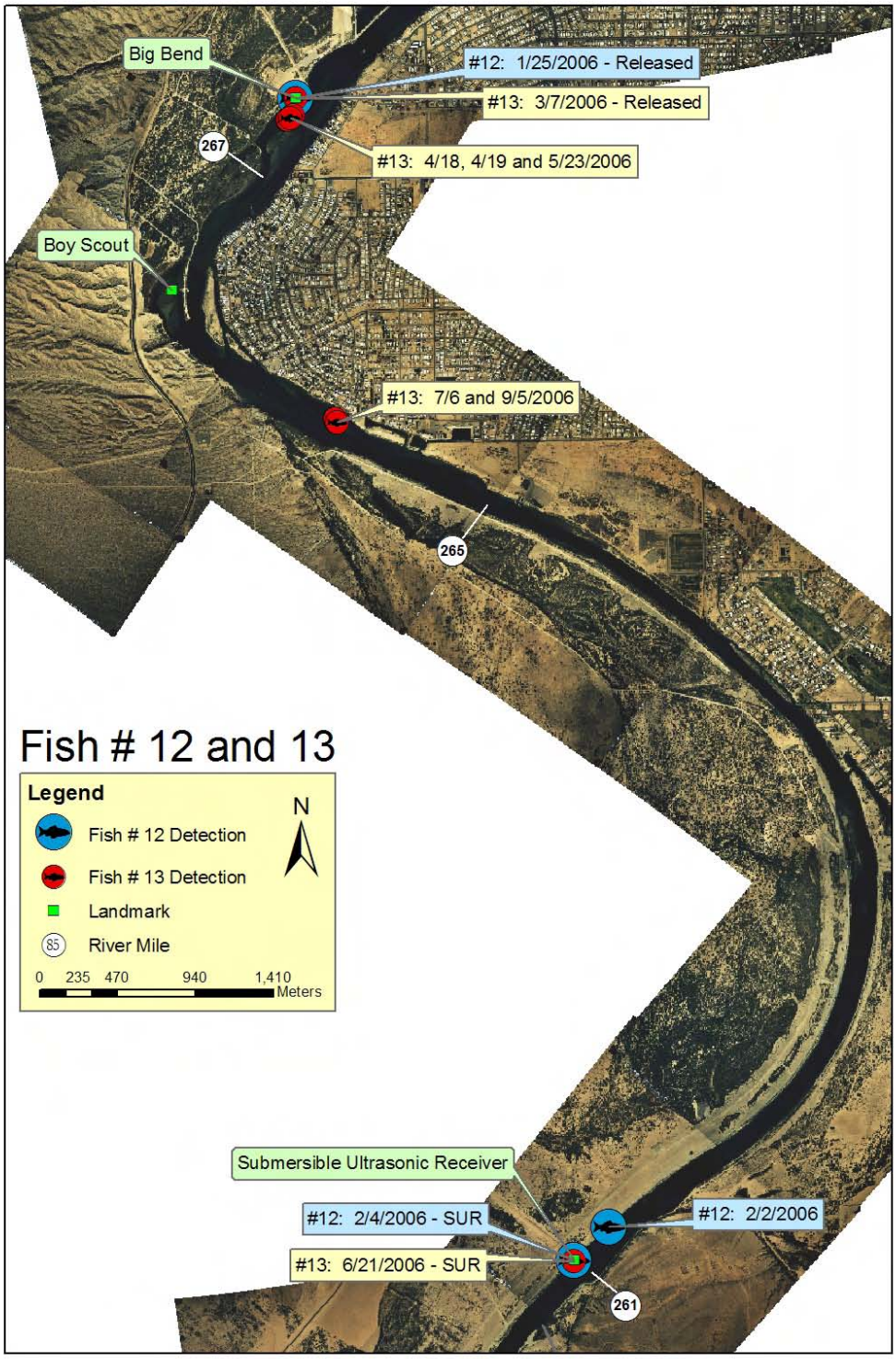


Appendix B-9. Detection map for fish # 10

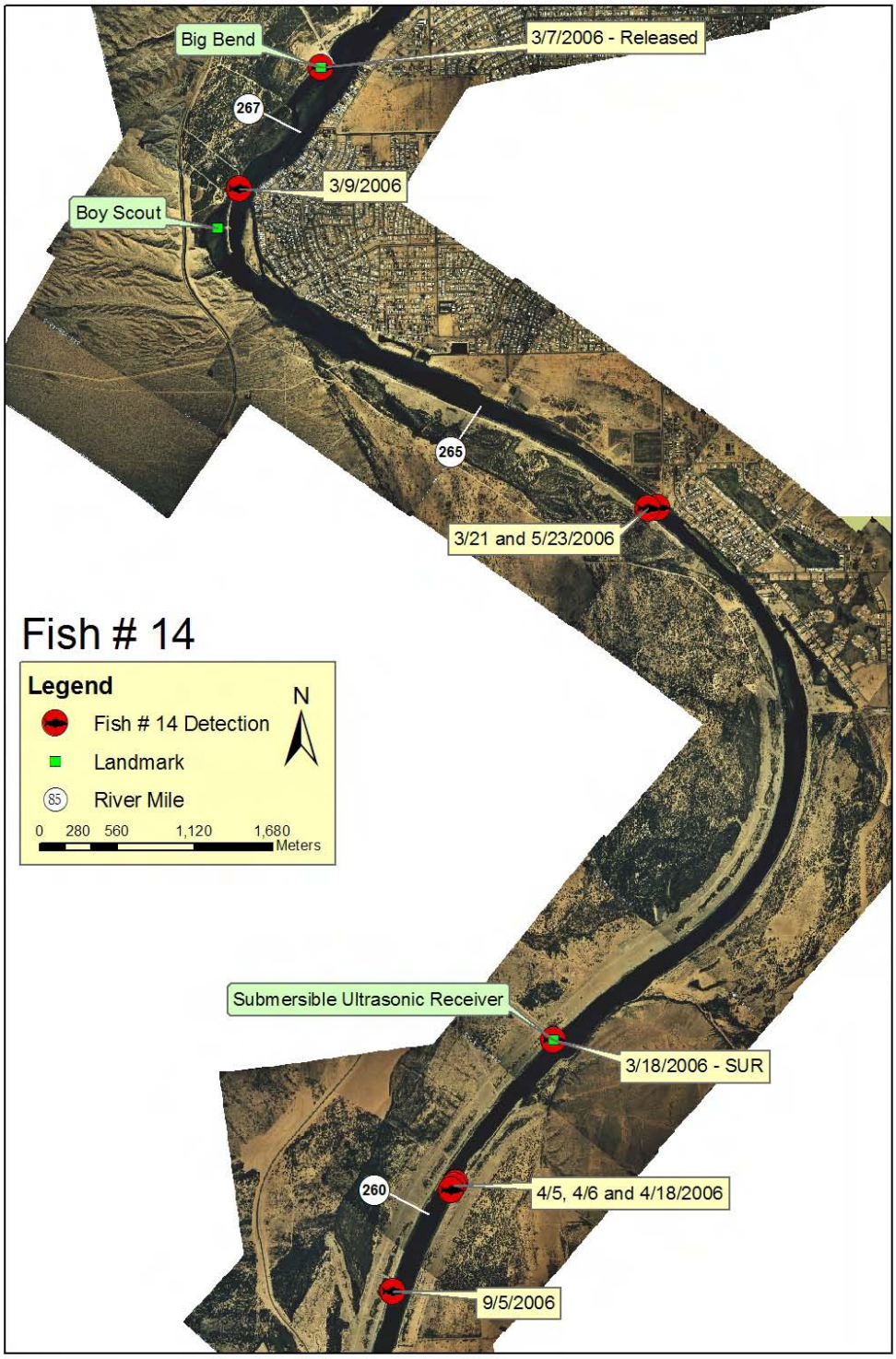


Appendix B-10. Detection map for fish # 11

Appendix B-11. Detection map for fish #'s 12 and 13



Appendix B-12. Detection map for fish # 14



Appendix B-13. Detection map for fish # 15