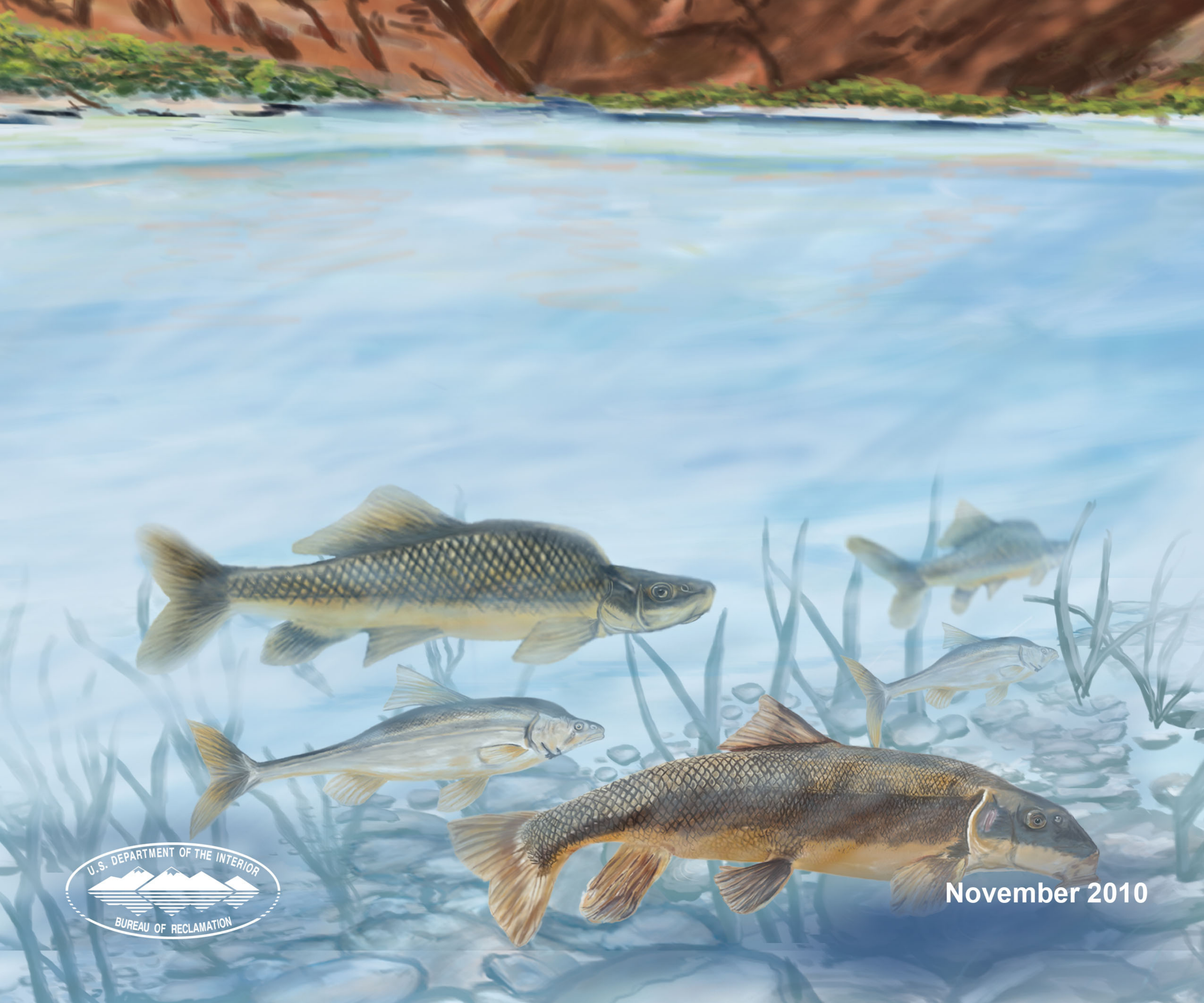
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Razorback Sucker Investigations at the Colorado River Inflow Area Lake Mead, Nevada and Arizona
2010 FINAL ANNUAL REPORT



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Lower Colorado River Multi-Species Conservation Program

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2010 FINAL ANNUAL REPORT

Prepared by: Brandon Albrecht, Ron Kegerries, Paul Holden, and Ron Rogers, BIO-WEST, Inc.

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

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EXECUTIVE SUMMARY

In 2010 the U.S. Bureau of Reclamation (Reclamation) initiated a project to evaluate razorback sucker (*Xyrauchen texanus* [Abbott]) use of the Colorado Inflow area of Lake Mead (CRI). The project is based on a Biological Opinion from the U.S. Fish and Wildlife Service (USFWS) that recommended Reclamation begin a project to "…examine the potential habitat in the lower Grand Canyon for the species, and institute an augmentation program in collaboration with FWS, if appropriate." (USFWS 2007). The project was also recommended in the comprehensive review report of 10 years of razorback sucker monitoring on Lake Mead (Albrecht et al. 2008a). Several of the recommendations from this report were highlighted by the Lake Mead Work Group (LMWG) for inclusion into its long-term management plan (Albrecht et al. 2009), and investigating the CRI for razorback sucker presence is the first item from that plan to be implemented. This report presents the results of efforts in 2010 to determine the status of razorback sucker in the CRI of Lake Mead.

Based on research during long-term Lake Mead razorback sucker investigations, our efforts involved tagging and releasing pond-reared razorback sucker into the CRI and tracking these fish using sonic-telemetry techniques. In 2010 eight captive, pond-reared, sonic-tagged razorback sucker were released into the Gregg Basin of the CRI and followed via active tracking (similar to long-term razorback sucker monitoring methods) and passive tracking (using submersible ultrasonic receiver [SUR] technology). Of the eight sonic-tagged fish released, seven remain active and have been detected 150 times actively and 9,201 times passively. One sonic tag failed shortly after the fish was released into Gregg Basin. Additionally, two fish sonic tagged in December 2008 (and stocked into other locations of the lake) were located via SUR and/or active tracking methods near the CRI. One of these fish was originally released in the Muddy River/Virgin River Inflow area and the other in Las Vegas Bay. At the end of the 2010 monitoring period, both fish were active in the CRI.

Using the sonic-tagged fish to locate potential spawning sites, we sampled for larvae on 23 nights during the 2010 spawning period. Larval sampling resulted in the capture of seven larval razorback sucker, one larval flannelmouth sucker (*Catostomus latipinnis*), and four larval fish thought to be either flannelmouth sucker or hybrid flannelmouth sucker x razorback sucker. Although, catch per unit effort was low, the identification of larval razorback sucker in the CRI helped confirm the presence of spawning adult razorback sucker and documented successful spawning in 2010.

Trammel netting was used to capture adults where concentrations of razorback sucker were suspected, and fin ray specimens were obtained from appropriate adult razorback sucker for aging purposes. From 30 net nights three wild razorback sucker, four razorback x flannelmouth sucker hybrids, and 52 flannelmouth sucker were captured. Of these fish one hybrid and five flannelmouth sucker were recaptured. All three razorback sucker were males expressing milt, which helped confirm spawning activities. Two of these individuals were 6-years old and one was 11-years old.

The goal to determine the presence or absence of razorback sucker in the CRI was met during 2010. This was accomplished by using sonic-tagged razorback sucker to locate wild razorback sucker, marking captured razorback sucker, sampling for larval fish, determining razorback sucker habitat use, and employing aging techniques to begin characterizing the age structure of the razorback sucker population in the CRI. Many questions still need to be addressed, and the study could be improved with increased sampling efforts at the CRI. Future goals for this study include continuing monitoring the razorback sucker population in the CRI using increased sonic tracking, larval sampling, and netting efforts. This increased effort will allow for better characterization of razorback sucker habitat in the CRI and location of additional groups of fish or spawning areas in the vicinity. Investigating razorback sucker use of the Colorado River proper, as well as other physicochemical and biological factors that allow for continued recruitment, is also of interest.

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INTRODUCTION AND BACKGROUND

The razorback sucker (*Xyrauchen texanus* [Abbott]) is one of four endemic, large-river fish species (Colorado pikeminnow [*Ptychocheilus lucius*], bonytail chub [*Gila elegans*], and humpback chub [*Gila cypha*]) of the Colorado River Basin presently considered endangered by the U.S. Department of the Interior (USFWS 1991). Razorback sucker was historically widespread and common throughout the larger rivers of the Colorado River Basin (Minckley et al. 1991). The distribution and abundance of razorback sucker are currently greatly reduced from historic levels, mainly due to the construction of mainstem dams and the resultant cool tailwaters and reservoir habitats that replaced a warm, riverine environment (Holden and Stalnaker 1975, Joseph et al. 1977, Wick et al. 1982, Minckley et al. 1991). Razorback sucker persisted in several of the reservoirs that were constructed in the lower Colorado River Basin; however, these populations were composed primarily of adult fish that apparently recruited during the first few years of reservoir formation. The population of long-lived adults then disappeared 40–50 years following reservoir creation and the initial recruitment period (Minckley 1983). Riverine populations in the Upper Colorado River Basin also have declined as recruitment has not occurred at significant levels since the construction of these mainstem dams. It is thought that predation by bass (*Micropterus* spp.), common carp (*Cyprinus carpio*), channel catfish (*Ictalurus punctatus*), sunfish (*Lepomis* spp.), and other nonnative species is the primary reason for the lack of razorback sucker recruitment throughout its original distribution (Minckley et al. 1991, Marsh et al. 2003).

It was widely believed that the same trends of razorback sucker decline were occurring in Lake Mead. Razorback sucker numbers, initially high in Lake Mead, noticeably decreased in the 1970s, and no razorback sucker were collected during the 1980s. However, in the early 1990s, the Nevada Department of Wildlife (NDOW) was informed by local anglers that the species was still present in two localized areas of Lake Mead: Las Vegas Bay and Echo Bay. Limited sampling efforts initiated by NDOW soon confirmed the presence of remnant populations of razorback sucker in Lake Mead. In 1996 the Southern Nevada Water Authority (SNWA), in cooperation with NDOW, initiated the Lake Mead studies to attempt to identify some of the basic population dynamics of razorback sucker in Lake Mead. BIO-WEST, Inc. (BIO-WEST) was contracted to design and conduct the study with collaboration from the SNWA and NDOW. Other cooperating agencies included Reclamation, the National Park Service (Park Service), Colorado River Commission of Nevada, and U.S. Fish and Wildlife Service (USFWS). This work eventually led to the discovery of several groups of spawning and recruiting wild fish in the reservoir, and currently represents the only known recruiting and expanding population within the entire Colorado River Basin (Albrecht et al. 2008a, Kegerries et al. 2009, Albrecht et al. 2010).

Larval razorback sucker were found in the CRI during 2000 and 2001, but despite opportunistic netting efforts no adult razorback sucker were captured at that time (Albrecht et al. 2008b). In 2008 the Arizona Game and Fish Department (AGFD) captured a large adult razorback sucker during annual gill netting efforts in Gregg Basin. The NDOW also captured two adult fish in the Virgin Basin. These captures emphasized the possibility that other razorback sucker populations may exist in areas of Lake Mead that are not being studied under the current Lake Mead razorback sucker monitoring program.

Most recently a comprehensive review evaluating the entire Lake Mead razorback sucker data set obtained from 1996–2007 was finalized (Albrecht et al. 2008b). This report provided a summary of the lessons learned, methods used, and cumulative findings regarding Lake Mead razorback sucker to date. The comprehensive review also provided recommendations for future monitoring and research on Lake Mead. These recommendations more recently have been incorporated into a long term management plan that serves as guidance for future razorback sucker studies on Lake Mead (Albrecht et al. 2009) and is used and updated by the Lake Mead Work Group, comprised of the various agencies involved in Lake Mead.

One of the major tasks of the management plan is to explore other locations in Lake Mead for existing razorback sucker populations. Based on the location of known populations, which occur in areas with some turbidity and, at times, vegetative cover, the Colorado Inflow area (CRI) was the most reasonable area to look at first. In addition, a Biological Opinion from the U.S. Fish and Wildlife Service (USFWS) on the proposed adoption of Colorado River interim guidelines for lower basin shortages and coordinated operations for Lake Powell and Lake Mead recommended Reclamation begin a project to "…examine the potential habitat in the lower Grand Canyon for the species, and institute an augmentation program in collaboration with FWS, if appropriate." (USFWS 2007). This report presents findings pertaining to investigative efforts in the CRI with the goal of identifying whether an unknown population exists within the upper end of Lake Mead. This is the first new task contained within the management plan that has been implemented to date and is the first step in meeting the Conservation Measure from the FWS in their 2007 Biological Opinion (USFWS 2007, Albrecht et al. 2009).

Based on previous success of locating razorback sucker in the Muddy River/Virgin River inflow area, it was determined that use of sonic telemetry was useful for locating "new" spawning aggregates (Albrecht and Holden 2005). Thus, we proposed initiating telemetry and sampling efforts in the CRI in 2010. This would allow us to better assess potential spawning habitat and could result in the confirmation of a new Lake Mead spawning aggregate. Combining stocking and tracking sonic-tagged razorback sucker, trammel netting, and larval sampling would increase the potential of finding a new spawning population of razorback sucker at the CRI. Recently there was an apparent surge in recruitment as the overall numbers of young, subadult fish increased at known spawning areas (Albrecht et al. 2008a and Kegerries et al. 2009). If this trend occurred at the CRI, the potential to successfully document razorback sucker would likely be very good at this time. Given the recent successes of monitoring fish implanted with improved sonic tags, we believed that renewing efforts in the CRI would help clarify whether an additional spawning population exists within Lake Mead (Albrecht et al. 2008b, Kegerries et al. 2009). In addition to potentially providing greater understanding of habitat use and movement patterns within Lake Mead, sampling an additional population could provide more information regarding the overall recruitment patterns of Lake Mead razorback sucker, which would undoubtedly help identify the conditions that are conducive to these unique recruitment events.

We also felt that the CRI holds potential information regarding the impacts, scale, and magnitude of lake-level and habitat changes in relation to razorback sucker recruitment. For example, the habitat at Echo and Las Vegas Bays has changed during our studies, especially during the last decade. As a result of receding lake levels, razorback sucker spawning habitat locations and spawning habitat use have changed. The CRI has changed during the past decade also, but at a much larger spatial scale. During 2001–2003, we sampled the Pierce Ferry and Grand Wash Bay areas, which were all accessible by boat. Currently, the lentic portion of Lake Mead only extends to the mouth of Iceberg Canyon; above that interface, miles of once-lentic habitats are now riverine and essentially part of the Colorado River proper. Thus the scale of change at the CRI has been fairly unique, compared with the remainder of Lake Mead (kilometers of habitat change compared with meters of change at the known spawning locations). This disparity provides a unique opportunity to evaluate razorback sucker use of an area that has been drastically modified. It may also provide insight as to what we can and should expect in terms of future spawning, particularly at the Muddy River/Virgin River inflow area and other known spawning locations within the lake—if lake levels continue to decline.

The overall goal of this project was to determine the presence or absence of a razorback sucker population within the CRI of Lake Mead. This goal was met during 2010 by accomplishing the following objectives:

- Using sonic-tagged razorback sucker to locate and capture various life stages of wild razorback sucker and tracking movement patterns of an existing population, should one be found.

- Marking captured juvenile and adult razorback sucker for individual identification using passive integrated transponder (PIT) tags.

- Using a combination of sonic-telemetry data, larval razorback sucker capture-location information, and juvenile/adult razorback sucker netting data to determine habitat use of this unique population.

- Using nonlethal aging techniques to characterize the age structure and potential recruitment patterns associated with a razorback sucker population in the CRI of Lake Mead.

This report presents the findings of the initial funding year and covers the intensive field efforts conducted from February–May 2010 as well as sonic telemetry data obtained through June 2010 in accordance with the results reported by Albrecht et al. (2008b), Kegerries et al. (2009), Albrecht et al. (2010), and other annual Lake Mead razorback sucker reports. Other information and data from previous studies are included, as applicable. This report not only presents efforts and findings from investigations conducted at the CRI of Lake Mead in 2010 but also serves as a companion report to the 2010 long-term Lake Mead razorback sucker monitoring report from efforts conducted at Las Vegas Bay, Echo Bay, and the Muddy River/Virgin River inflow area in 2010. Readers interested in the results of long-term Lake Mead razorback sucker monitoring efforts are encouraged to obtain and read the companion report (Albrecht et al. 2010).

STUDY AREAS

The 2010 CRI study activities occurred within Gregg Basin of Lake Mead and the Colorado River below the Pierce Ferry Rapid (Figure 1).

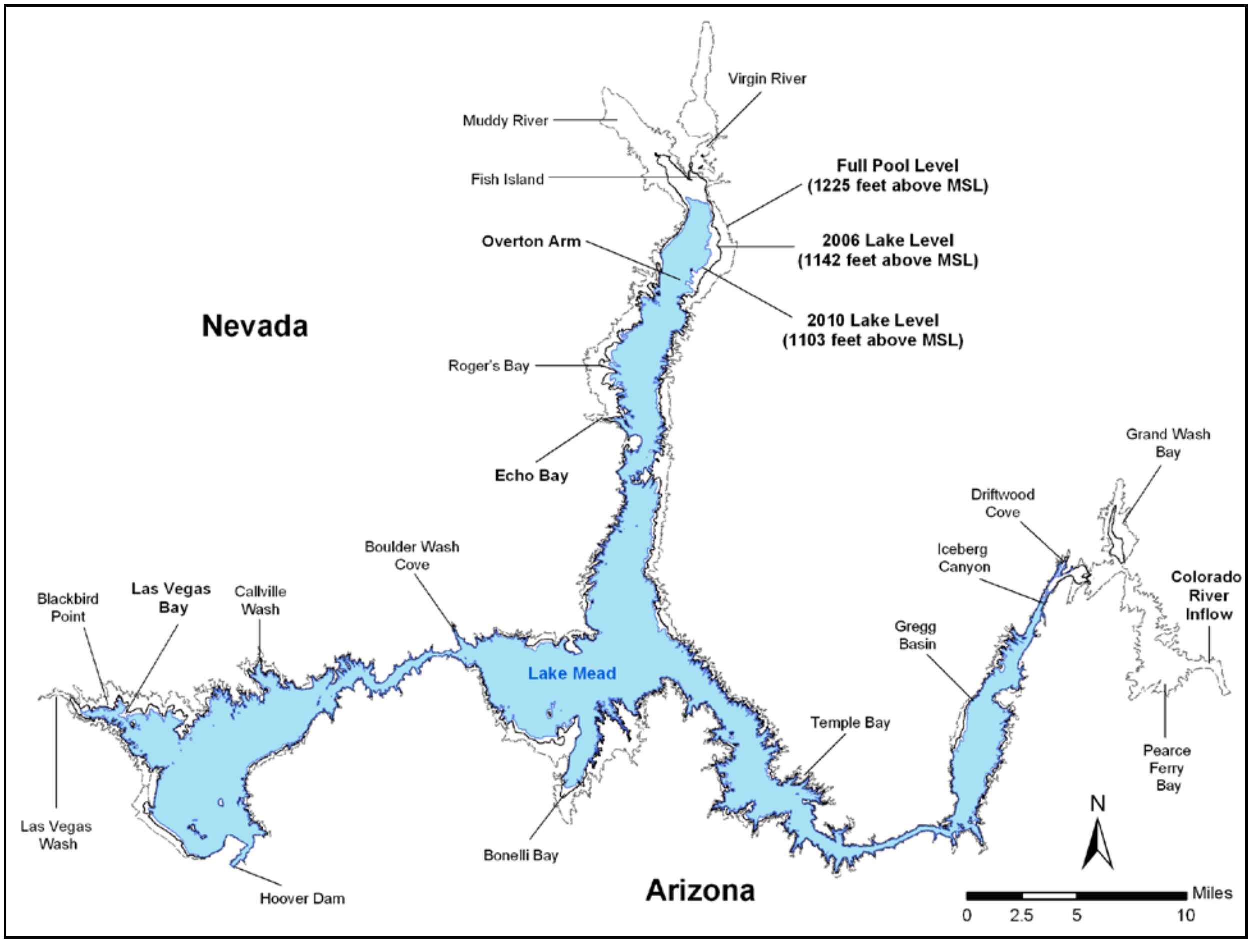

Figure 1. Lake Mead general study areas.

Most areas of Gregg Basin and the main Colorado River below the newly formed Pierce Ferry Rapid were searched using ultrasonic telemetry equipment. Larval sampling and trammel netting were performed primarily within the main lake, although some larval sampling and trammel netting were conducted within backwaters of the Colorado River.

Definitions for various portions of the CRI in which the study was conducted may be referred to using the following terms:

- Lake Mead proper begins where the flooded portion of the river channel widens and the velocity is reduced.
- Colorado River proper is simply the flowing river. Depending on conditions, this area may or may not be accessible by large boat.
- Interface, the area where the river proper meets the the lake proper. This area may or may not have flow, is typically turbid, and is transitory in nature.

METHODS

Lake Elevation

Month-end lake elevations for the 2010 field season (July 1, 2009–June 30, 2010) were measured in ft above mean sea level (amsl) and obtained from Reclamation's Lower Colorado Regional Office website (Reclamation 2010). The effect of fluctuating lake levels on razorback sucker habitat was documented by written observations and/or photographs during sampling trips to the CRI.

Sonic Tagging

Razorback sucker held in ponds at Floyd Lamb State Park were captured using trammel nets on the morning of February 23, 2010. The Nevada Department of Wildlife (NDOW) provided hauling equipment to transport the razorback sucker from Floyd Lamb State Park to the CRI South Cove boat ramp on Lake Mead. Sonotronics Model CT-05-48-I (48-month) tags were implanted in seven male and one female adult razorback sucker after a short rest period from the three hour trip from Floyd Lamb State Park. The 48-month tags used in 2010 had an air weight of 29 g (14.5 g water weight) and measured 79 mm long by 16 mm in diameter. The tags used frequencies of 70, 71, 72, 73, 74, and 75 kHz. Since each tag had a unique code, individual fish could be readily distinguished.

The following surgical protocol was established from procedures developed by Valdez and Nilson (1982), Kaeding et al. (1990) and Valdez and Trinca (1995) for humpback chub; Tyus (1982) for Colorado squawfish (pikeminnow); and Valdez and Masslich (1989) for Colorado squawfish (pikeminnow) and razorback sucker. A transmitter air weight to fish weight of 2% (Bidgood 1980, Marty and Summerfelt 1990) was used as a guideline to ensure that the tags were not too large for the fish being tagged. Surgery was performed on shore and involved three people: a surgeon and two assistants. The assistants recorded data, captured pertinent photographs, and monitored fish respiration. Dr. Chris Bunt of BIOTACTIC, Inc., assisted with the surgeries, demonstrated current surgical practices, and provided instruction on updated tagging methodologies to the field biologists. Prior to surgery each fish was placed in a live well containing fresh lake water. All surgical instruments were cold sterilized with iodine and 90% isopropyl alcohol and allowed to air dry on a disposable sterile cloth. Razorback sucker were initially anaesthetized in 30 L of lake water with a 50 mL/L_{-1} clove oil/ethanol mixture (0.5 mL clove oil [Anderson et al. 1997] emulsified in 4.5 mL ETOH). After anesthesia was induced (post-opercular movement cessation), total length, fork length, standard length, and weight were recorded. Fish were then placed dorsal-side down on a padded surgical cradle for support during surgery. Head and gills were submerged in 20 L of fresh lake water with a maintenance concentration of 25 mL L^{-1} clove oil/ETOH anesthetic (Bunt et al. 1999). Following fish introduction to the maintenance anesthetic, the surgeon made a 3–4 cm incision on the left side, posterior to the left pelvic fin. The sonic transmitter was inserted through the incision and pushed between the pelvic girdle and urogenital pore. The incision was closed with 2–4 sutures using 3-0 Maxon absorbable polygluconate monofilament suture with an attached PH 26 curved cutting needle. Surgery times typically ranged from 2–5 minutes per fish.

Fish were allowed to recover in an aerated live well containing fresh lake water (until equilibrium was maintained) and monitored after surgical procedures were completed. Once fully recovered, tagged fish were taken by boat to two predetermined release points within Gregg Basin. Upon arrival (approximately 10 minute trip), fish were re-examined for signs of stress and then released. Tracking ensued immediately after release and continued intensively for 48 hours; detailed tracking continued for weeks following surgery (see Sonic Tracking section below).

Active Sonic Telemetry and Tracking

During the intensive field season associated with the spawning period (February–May) sonic-tagged fish were located on a weekly (or sometimes daily) basis, depending on the field schedule and weekly project goals. During the remainder of the year, sonic-tagged fish were typically located monthly. Fish searches were largely conducted along shorelines with listening points of approximately 0.5 mile (0.8 km), depending on shoreline configuration and other factors that could impact signal reception (sonic equipment is line-of-sight and any obstruction can reduce or block a signal, and the effectiveness of sonic telemetry signal is often reduced in shallow, turbid environments). Once a signal was found, the directional capabilities of the hydrophone, volume of the transmitter, and triangulation techniques were used to pinpoint the actual location of the fish, which was then noted using a GPS unit.

Passive Sonic Telemetry and Submersible Ultrasonic Receiver Data-Collection Efforts

Along with the active tracking methods, submersible ultrasonic receivers (SUR) were deployed in various locations throughout the CRI. The advantage to using these SURs is the ability to record continuous telemetry data without field crews. With an 8-month battery life and the ability to detect manual tracking transmitters, these receivers save valuable field time while collecting additional telemetry data.

Three SURs were deployed in the CRI at different times during 2010 field season. The first SUR was deployed on the upstream end of the Virgin Narrows on February 24, 2010, to track fish moving in and out of Gregg Basin. After determining that the SUR successfully detected sonic tags and was a feasible means of tracking, two additional SURs were deployed on May 12, 2010, one just downstream of the Colorado River interface and the other approximately 0.25 miles upstream in the river. Exact SUR locations are presented in the Results section.

Each of the SURs was programmed to detect implanted, active sonic tag frequencies using Sonotronic's SURsoft software. The SURs were then secured to an anchor (rock, anchor, block) using approximately 18 in of rope from which the SUR was allowed to suspend (they are semibuoyant). A long lead rope was secured to the anchor as the SUR was deployed and allowed to sink to the bottom. The lead rope was tied off securely on shore and concealed. The SURs were checked weekly by pulling the SUR into the boat and downloading the data via Sonotronic's SUR software. These data were then processed through Sonotronic's SURsoftDPC software to ascertain the time, date, and frequency of positive sonic-tagged fish detections.

Adult Studies

The primary gear used to sample adult fish were 300-ft (274.4-m) long by 6-ft (1.8-m) deep trammel nets with an internal panel of 1-, 1.5-, or 2-in (2.54-, 3.81-, or 5.08-cm) mesh and external panels of 12-in (30.48-cm) mesh. Nets were generally set with one end near shore in 5–30 ft (3.05–9.15 m) of water, with the net stretched out into deeper areas. All trammel nets were set in late afternoon (just before sundown) and pulled the next morning (shortly after sunrise). Netting locations were selected based on the locations sonic-tagged fish used, the location or presence of concentrated larval fish, and ancillary knowledge of previous adult razorback sucker capture locations.

Fish were taken from nets, and live fish were held in large, 100-quart (94.6-L) coolers filled with lake water. Razorback sucker were isolated from other fish species and held in aerated live wells. All but the first five common carp (*Cyprinus carpio*) and gizzard shad (*Dorosoma cepedianum*) were enumerated and returned to the lake, while other species (including five common carp and five gizzard shad) were identified, measured for total length, weighed, and released at the location of capture. Razorback sucker, flannelmouth sucker, or suspected razorback sucker x flannelmouth sucker hybrids were scanned for PIT tags, PIT tagged if they were not recaptured fish, measured (including standard length and fork length), weighed, and released at the point of capture. Native sucker species that were selected for age determination, were anesthetized with MS-222 and then placed dorsal-side down on a padded surgical cradle for support while a segment of the second pectoral fin ray was collected. Due to the presence of suspected hybrid suckers at the CRI, genetic material was also removed from many of the native suckers (including suspected hybrids); a small bit of material was obtained from the caudle fin and preserved in 95 percent ethanol in case of future need.

It should be noted that boat electrofishing was also experimented with as an alternative capture method during the 2010 efforts at the CRI. The U.S. Bureau of Reclamation’s (Reclamation) Smith-Root electrofishing boat was used to investigate the feasibility and effectiveness of capturing razorback sucker in CRI coves and the Colorado River proper. Sampling efforts occurred during 2 nights in areas frequented by sonic-tagged razorback sucker. Overall, electrofishing within the lake and river proper was largely ineffective. Deep, turbid conditions, coupled with debris-laden habitats, resulted in no razorback sucker captures and very few captures of any fish species overall. However, these efforts did result in the capture of two flannelmouth sucker, the data from which were lumped with flannelmouth sucker data obtained from trammel netting efforts for this report. Given these results, this relatively minimal and largely unproductive experimental electrofishing effort will not be further analyzed.

Larval Sampling

Our larval sampling methods followed those developed by Burke (1995) and other researchers on Lake Mohave. The procedure uses the positive phototactic response of larval razorback sucker to capture them. After sundown, two 12-volt “crappie” lights were connected to a battery, placed over each side of the boat, and submerged in 4–10 in (10.2–25.4 cm) of water. Two “netters” equipped with long-handled aquarium dip nets were stationed to observe the area around the lights. Larval razorback sucker that swam into the lighted area were dip-netted out of the water and placed into a holding bucket. The procedure was repeated for 15 minutes at each location, and 4–12 sites were customarily sampled on each night attempted. Larvae were identified and enumerated as they were placed in the holding bucket and then released at the point of capture when sampling at a site was completed.

Since other native sucker species are present at the CRI, suspected larval razorback sucker were preserved in 95 percent ethanol for microscopic verification using the key to Catostomid fish larvae developed by Snyder et al. (2004). Razorback sucker larvae were originally identified in the field and later verified by BIO-WEST under laboratory conditions using the Catostomid key (Snyder et al. 2004). Additionally, D.E. Snyder confirmed all larval razorback sucker, flannelmouth sucker, and hybrid sucker (razorback x flannelmouth sucker) captured at the CRI (D. E Snyder, Larval Fish Taxonomist, Colorado State University, personal communication).

Spawning-Site Identification

We have found that multiple methods are needed to identify and pinpoint annual spawning sites in Lake Mead. The basic, most effective spawning-site identification procedure has been to track sonic-tagged fish and identify the most frequented areas. Once a location is identified as being heavily used by sonic-tagged fish, particularly during crepuscular hours, trammel nets are typically set in an effort to capture adult razorback sucker. Captured fish are then evaluated for signs of ripeness indicative of spawning. After the initial identification of a possible spawning site through sonic-tagged razorback sucker habitat use and other, untagged subadult or adult trammel-net captures, larval sampling is conducted to validate whether successful spawning occurred. Examples of the effectiveness of these techniques are evident in the descriptions provided by Albrecht and Holden (2005) regarding the documentation of a new spawning aggregate near Fish Island in the Overton Arm of Lake Mead. This same general approach was also used at the CRI in 2010.

Age Determination

We used a nonlethal aging technique using fin ray sections developed in 1999 (Holden et al. 2000a). As in past years, an emphasis of our 2010 CRI efforts involved collecting fin ray sections from razorback sucker for aging purposes. Specimens were also obtained from flannelmouth sucker and suspected hybrid suckers for age determination purposes.

During the 2010 spawning period, selected suckers captured via trammel netting were anesthetized and a single, approximately 0.25-in-long segment of the second left pectoral fin ray was surgically removed. Fish were anesthetized with a lake-water bath containing MS-222, NaCl, and slime coat protectant to reduce surgery-related stresses, speed recovery, and avoid accidental injury to fish that may thrash about during surgical procedures. During the surgery standard processing was conducted (weighing, measuring, PIT-tagging), and a sample was surgically collected using custom-made bone snips originally developed by BIO-WEST. This surgical tool consists of a matched pair of finely sharpened chisels welded to a set of wide-mouth Vise-Grips™ pliers. The connecting membrane between rays was cut using a scalpel blade, and the section was placed in a labeled envelope for drying. All surgical equipment was sterilized before use, and subsequent wounds were packed with antibiotic ointment to minimize postsurgical bacterial infections and promote rapid healing. All native suckers undergoing fin ray extraction techniques were immediately placed in a recovery bath of fresh lake water containing slime-coat protectant, allowed to recover, and released as soon as they regained equilibrium and appeared recovered from the anesthesia. Vigilant monitoring was conducted during all phases of the procedure.

In the laboratory, fin ray segments were embedded in thermoplastic epoxy resin and heat cured. This technique allowed the fin rays to be perpendicularly sectioned using a Buhler isomet low-speed saw. Resultant sections were then mounted on microscope slides, sanded, polished, and examined under a stereo-zoom microscope. Each sectioned fin ray was aged independently by at least two readers. Sections were then reviewed by the readers in instances where the assigned age was not agreed upon. If age discrepancies remained after the second reading, the readers viewed the structure together and assigned an age. For further information regarding the evolution of our fin ray aging technique, please refer to Albrecht and Holden (2005), Albrecht et al. (2006b), Albrecht et al. (2008a) and other annual Lake Mead razorback sucker reports.

Population Estimates

Razorback sucker capture data collected by BIO-WEST during 2010 in the CRI augmented data used to calculate abundance estimates for razorback sucker populations in Lake Mead. However, because few razorback sucker were captured in the CRI in 2010 and few fish were recaptured there in general, we were unable to compile population estimates specifically for the CRI. Razorback sucker capture data stemming from the CRI were included in the lake-wide population estimate provided by Albrecht et al. (2010). Readers are encouraged to refer to that document for insights related to the overall Lake Mead razorback sucker population estimate.

RESULTS

Lake Elevation

From a starting elevation in January 2010 of approximately 1,100 ft (335.3 m) asl, lake levels increased during the month of February, peaking at 1,103 ft (336.2 m). Lake levels then dropped rather rapidly throughout the remainder of the spawning period (March-May). Lake Mead elevation at the end of May 2010 was approximately 1,094 ft (333.5 m) asl. This translated to an overall loss of nearly 9 ft (2.7 m) of depth during the spawning period (Figure 2). We observed the desiccation of the wetted, littoral area within the CRI between February and late May. The effects of water level declines on littoral zone habitat was perhaps more pronounced (based on visual observations) within the Colorado River proper and the interface area than at other locations within Lake Mead where razorback sucker occurred in 2010 (Albrecht et al. 2010).

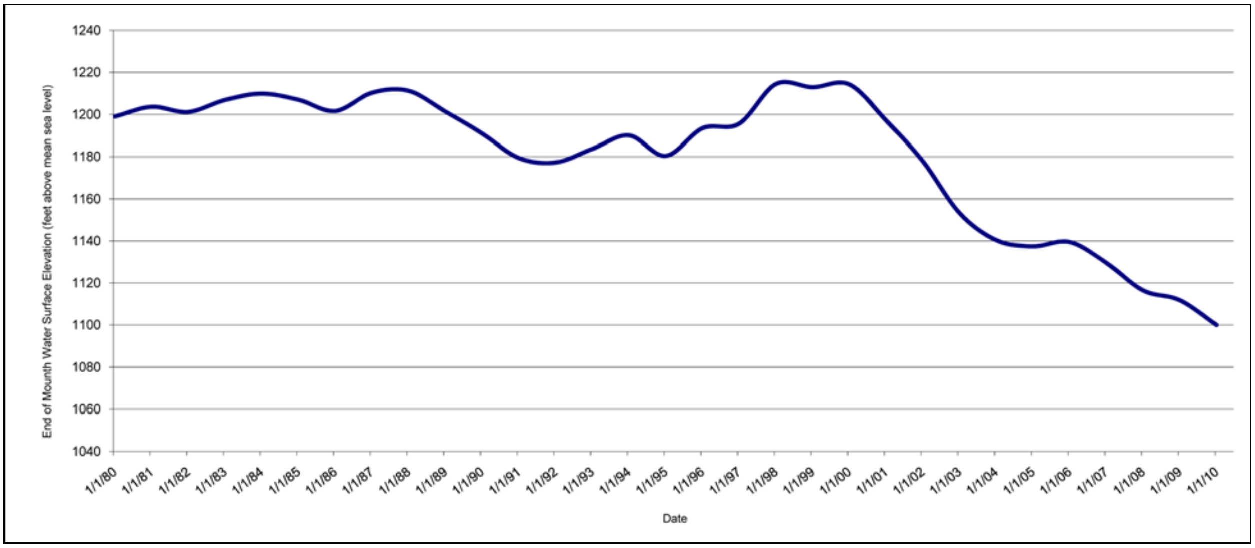

Figure 2. Lake Mead month-end elevations, January 1980–January 2010.

Active Sonic Telemetry and Tracking

On February 23, 2010 eight newly tagged razorback sucker were released into two locations within Gregg Basin; half of the fish were released near Scanlon Bay based on the AGFD’s recent capture of an adult razorback sucker at this area (G. Cummins, Native Fish Biologist, AGFD, personnel communication). The other four fish were released near the CRI at the river/lake interface, in likely razorback sucker spawning habitat. This location was selected based on our previous experiences with and results of razorback sucker studies in Lake Mead at the other, known spawning locations (e.g., Las Vegas Bay, Echo Bay, and the Muddy River/Virgin River inflow area) (Table 1, Figure 3).

Upon release, the sonic-tagged razorback sucker stocked into Scanlon Bay quickly joined the other newly tagged fish near the river/lake interface, validating our decision to stock newly tagged fish near the river/lake interface. Fish from both release sites also used the riverine habitat in the Colorado River. Some individuals began using this habitat within days of their release. Most of the tagged fish using the Colorado River spent several days in the riverine habitat and later returned to the lentic portions of Lake Mead. Particularly heavy use was observed at, or near, the interface of the Colorado River and Lake Mead.

During April most of the sonic-tagged fish began to aggregate and were often found in groups, particularly early or late in the day, which is indicative of possible spawning behavior. Most of these movement patterns appeared to be associated with a small island (at the time of sampling) that was located just south of the river/lake interface along the western shoreline of the main body of the lake. Based on this observation, trammel netting and larval sampling were focused on this area, particularly during sonic fish aggregations and probable spawning. As a result, three wild, unmarked razorback sucker, multiple suspected adult hybrid sucker, and a fairly robust number of flannelmouth sucker were captured. In addition, larval razorback sucker were

Table 1. Tagging and stocking information, location, date of last contact, and current status of the sonic-tagged fish released into the Colorado River Inflow area in 2010, as well as information pertaining to two fish from the 2008 tagging event (not shaded), that were found using Colorado River Inflow area habitats during 2010 (modified from Albrecht et al. 2010).

CAPTURE LOCATION [a]	DATE TAGGED	TAG CODE	TOTAL LENGTH (mm)	SEX [b]	STOCKING LOCATION [a]	LAST LOCATION [a]	DATE OF LAST LOCATION	CONTACTS MADE 2009-2010 [c]	CURRENT TAG STATUS
Fish Tagged in 2010									
FDLB	2/23/2010	227	486	M	GB	CRI	6/29/2010	674 total 14 active 660 passive	Alive
FDLB	2/23/2010	249	511	M	CRI	CRI	5/27/2010	5,510 total 29 active 5,481 passive	Alive
FDLB	2/23/2010	258	502	M	CRI	CRI	6/29/2010	2,347 total 21 active 2,326 passive	Alive
FDLB	2/23/2010	267	534	F	GB	CRI	2/24/2010	1 total 1 active 0 passive	Battery Failure
FDLB	2/23/2010	339	501	M	CRI	CRI	6/29/2010	269 total 21 active 248 passive	Alive
FDLB	2/23/2010	348	516	M	GB	CRI	5/24/2010	23 total 23 active 0 passive	Stationary
FDLB	2/23/2010	357	490	M	GB	CRI	5/27/2010	63 total 20 active 43 passive	Alive
FDLB	2/23/2010	485	517	M	CRI	CRI	5/18/2010	383 total 10 active 373 passive	Alive
Fish Tagged in 2008									
FDLB	12/02/08	365	496	M	EB	EB	4/19/2010	6 total 6 active 0 passive	Alive
FDLB	12/02/08	678	492	M	EB	EB	4/21/2010	17 total 17 active 0 passive	Alive

Table 1. (Cont.)

CAPTURE LOCATION [a]	DATE TAGGED	TAG CODE	TOTAL LENGTH (mm)	SEX [b]	STOCKING LOCATION [a]	LAST LOCATION [a]	DATE OF LAST LOCATION	CONTACTS MADE 2009-2010 [c]	CURRENT TAG STATUS
FDLB	12/02/08	3386	493	F	EB	MR/VR	2/03/09	0 total 0 active 0 passive	Unknown
FDLB	12/02/08	376	498	M	EB	EB	4/6/2010	16 total 16 active 0 passive	Alive
FDLB	12/02/08	345	515	M	MR/VR	MR/VR	12/07/08	0 total 0 active 0 passive	Unknown
FDLB	12/02/08	366	479	M	MR/VR	MR/VR	3/10/09	0 total 0 active 0 passive	Unknown
FDLB	12/02/08	488	534	F	MR/VR	MR/VR	6/23/09	0 total 0 active 0 passive	unknown
FDLB	12/02/08	3354	506	F	MR/VR	CRI	5/16/2010	62 total 11 active 51 passive	Alive
FDLB	12/03/08	3355	483	M	LVB	LVB	8/18/2009	1 total 1 active 0 passive	Alive
FDLB	12/03/08	377	479	M	LVB	LVB	6/23/09	0 total 0 active 0 passive	Unknown
FDLB	12/03/08	465	520	F	LVB	CRI	5/26/2010	19 total 0 active 19 passive	Alive
FDLB	12/03/08	677	529	F	LVB	LVB	6/28/2010	17 total 17 active 0 passive	Alive

[a] Locations: FDLB = Floyd Lamb State Park, EB = Echo Bay, MR/VR = Muddy River/Virgin River inflow area, LVB = Las Vegas Bay, CRI = Colorado River inflow area, GB = Gregg Basin near Scanlon Bay. [b] Sex: F = female, M = male.

[c] Number of contacts are presented using active sonic telemetry techniques, passive sonic telemetry techniques (i.e., SURs), and in total (the number of active and passive contacts combined). Please refer to the active and passive sonic-tracking methodologies in this report for details.

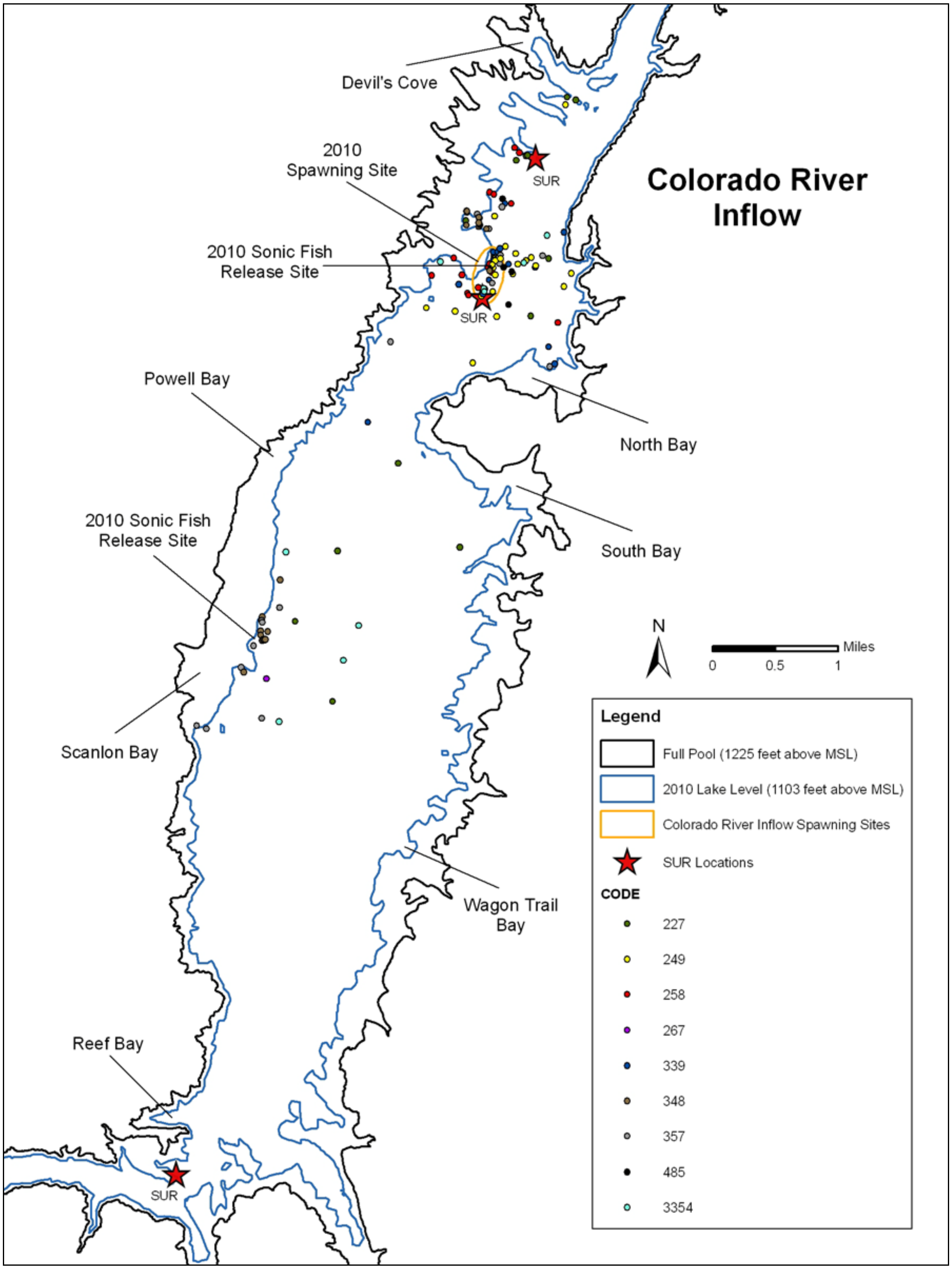

Figure 3. **Distribution of sonic-tagged fish in the Colorado River Inflow area, locations of initial stocking sites, locations of SUR deployment, and the primary razorback sucker spawning site identified within the Colorado River Inflow area in 2010.**

captured, along with suspected larval sucker hybrids (razorback sucker x flannelmouth sucker), and larval flannelmouth sucker, which confirmed successful spawning in the areas frequented by sonic-tagged razorback sucker (please see the Larval section below for further details). Despite fairly intensive netting efforts in the areas frequented by sonic-tagged fish, none of the sonic tagged fish were ever captured during the 2010. These findings confirm the overall utility of using sonic-tagged fish to locate wild razorback sucker spawning areas, understand razorback sucker habitat use and, perhaps most importantly, increase the effectiveness and efficiency of sampling efforts, particularly within unknown or understudied locations.

In all cases, when sonic-tagged fish moved into and used habitats within the riverine portions of the CRI, crews recorded the closest data point accessible by boat. As such, some of the points on Figure 3 may not fully display the range of sonic-tagged fish movements into the CRI's shallow, flowing portions, or other habitat features to which the boat had limited access. It is also worth noting that as fish moved to shallower, turbid, and flowing habitats, they became hard, if not impossible, to hear. Throughout the year large expanses of very shallow habitat formed at the CRI as the lake level declined. These habitats were in constant flux, depending on river flows and lake elevation changes. In 2010, sonic-tagged fish were using this dynamic, shallow environment fairly frequently and, therefore, our contact ability was limited in certain instances.

Crews conducting research in Lake Mead's CRI during 2010 also contacted sonic-tagged razorback sucker that were originally stocked into the Muddy River/Virgin River inflow area (one fish, code 3354) and Las Vegas Bay (one fish, code 465). These findings provide evidence that lake-wide movement of stocked razorback sucker in Lake Mead occurs; hence fish implanted with tags that were thought to have malfunctioned may in fact be using portions of Lake Mead that have not been sampled during long-term monitoring efforts. Specific details for the two fish (codes 3354 and 465) that moved into the CRI are presented below in the section on Fish Sonic Tagged in 2008.

Because sonic telemetry was a major focus of our 2010 efforts at the CRI, the following narrative details the active tracking history and habitat use of the razorback sucker implanted with sonic tags during 2010 and the movements of two fish from the December 2008 tagging event that were documented moving into the CRI from other portions of Lake Mead. Please refer to Table 1 for sonic-tagged fish origin, tagging, and current status information. Sonic data from February–June 2010 are presented below in an effort to remain consistent with data reporting for the long-term monitoring efforts conducted at the other known spawning areas in Lake Mead (e.g., Albrecht et al. 2010).

Fish Sonic Tagged in 2010

Fish 227

Active tracking efforts resulted in 14 contacts in the CRI during the 2010 (Table 1, Figure 3). Fish 227 was found in areas where depths ranged from 0–178 ft (nearly 0–54.3 m). Fish 227, a 486-mm male razorback sucker, was initially stocked at Scanlon Bay, where it remained through February 14, 2010. On February 25, 2010, fish 227 moved into the middle of Gregg Basin and continued in a northerly direction, arriving at the CRI on March 9, 2010. Fish 227 moved several times between the Colorado River proper and Lake Mead proper from March 9–11, 2010. From March 11–April 8, 2010, fish 227 spent considerable time in riverine habitats (mainly coves, backwaters, and eddies). This fish was last contacted in North Bay during active tracking efforts on June 29, 2010. Fish 227 is classified as alive/active, and we anticipate that it will continue to provide valuable habitat use data.

Fish 249

Contact was established with fish 249 during active tracking on 29 occasions during the 2010 CRI efforts. Fish 249, another male razorback sucker, was stocked into the CRI in 2010. This fish was found in areas where depths ranged from 0–85 ft (0–25.9 m). Fish 249 remained near its general release site through March 11, 2010. Riverine habitat use was common for fish 249 between March 11–30, 2010, although this was interrupted by frequent trips between the Colorado River proper and Lake Mead proper. On March 30, 2010, fish 249 was found near the small island/2010 CRI spawning area, and it was commonly found here—along with other sonic-tagged fish—through May 26, 2010. Finally, fish 249 was last contacted in North Bay on May 27, 2010. This fish is classified as alive/active, and it is anticipated to provide valuable data regarding future spawning sites and habitat use (Table 1, Figure 3).

Fish 258

Contact was established with fish 258 on 21 occasions during the 2010 CRI efforts (Table 1, Figure 3). Fish 258 is another male razorback sucker that was stocked into the CRI in 2010. This fish was found in areas where depths ranged from 0–27 ft (0–8.2 m). Upon release, fish 258 remained near its stocking location through March 4, 2010, when it moved into and began using riverine habitats. Riverine habitat use (again mainly coves, backwaters, and eddies) was common for fish 258 through March 24, 2010. On April 6, 2010, fish 258 was contacted near the small island/spawning site where it remained until April 27, 2010. Fish 258 was last contacted during active tracking efforts on June 29, 2010, in North Bay and is classified as active/alive.

Fish 267

After this female razorback sucker's (fish 267) initial release near Scanlon Bay, contact was established on only one occasion during 2010 field efforts at the CRI (Table 1, Figure 3). By February 24, 2010, the signal volume of fish 267's sonic tag had decreased dramatically since its release the previous day (February 23, 2010). The signal volume of fish 267's tag continued to fade while we were listening to it on February 24, 2010, which caused concern regarding tag status. Subsequent tracking efforts to find fish 267 were unsuccessful. Sonotronics was promptly contacted and confirmed our suspicions that tag 267 was subject to premature battery failure. Further contacts with fish 267 have not occurred.

Fish 339

Sonic fish 339, a male razorback sucker, was stocked near the CRI during 2010. Fish 339 was located via sonic telemetry on 21 occasions and was found in areas where depths ranged from 0–116 ft (0–35.3 m). Fish 339 stayed near its release location through March 9, 2010, when it moved into and was contacted using the river/lake interface on 10 March 10, 2010. Fish 339 appeared to have an affinity for the river/lake interface zone where it was contacted frequently through March 18, 2010. On March 23, 2010, fish 339 moved into and used riverine habitats (mainly coves and backwaters). This fish commonly moved between the river and the lake/river interface, with many documented fine-scale movements between the Colorado River proper and Lake Mead proper. On April 6, 2010, fish 339 moved near the small island/spawning site where it was commonly found through April 19, 2010, along with other sonic-tagged fish. For the purposes of this report, the last contact with this fish occurred on June 29, 2010, at North Bay. Fish 339 is classified as active/alive and we will continue to follow it throughout the summer and fall. We hope that tracking fish 339 will lead to locating razorback sucker aggregates during 2011 field efforts (Table 1, Figure 3).

Fish 348

Sonic fish 348, another male razorback sucker, was stocked near Scanlon Bay in 2010 and was found in areas where depths ranged from 0–20 ft (0–6.1 m) based on 23 active tracking contacts (Table 1, Figure 3). Fish 348 remained near its release site for 1 day, after which it slowly began moving northward (towards CRI) on February 25, 2010. Fish 348 reached the lake/river interface on March 9, 2010, where it remained until March 16, 2010, when it was contacted within the Colorado River proper (using mainly coves and backwater habitats). Fish 348 stayed within riverine habitats until March 30, 2010, when it moved back near its original release site in Gregg Basin. It has since been contacted many times along the western shoreline of Gregg Basin in the same location. For purposes of this report, fish 348 was last contacted on May 24, 2010, along the western shoreline of Gregg Basin.

Fish 357

Fish 357, a male razorback sucker, was stocked near Scanlon Bay in 2010. Fish 357 was contacted on 20 separate active tracking occasions and was found in areas where depths ranged from 0–116 ft (0–35.4 m). Almost immediately after its release, fish 357 moved north along the western shoreline of Gregg Basin. On March 11, 2010, fish 357 was contacted near the CRI where it began to use the river/lake interface area, staying there through March 17, 2010. On March 18, 2010, this fish was found within the Colorado River proper using primarily cove and backwater habitats proximal to other sonic-tagged fish. Fish 357 stayed within riverine habitats until March 25, 2010, when it moved back to the river/lake interface area. By April 6, 2010, fish 357 had moved near the island/spawning site where it remained until April 20, 2010. On May 11, 2010, fish 357 was located along the western shoreline of Gregg Basin and on the next day (May 12, 2010), it was contacted in the Colorado River proper, again using riverine habitats. The last contact with fish 357 (for purposes of this report) occurred on May 27, 2010. This fish is currently classified as active/alive and we look forward to learning more about the habitat use of razorback sucker at the CRI through continued monitoring of this rather mobile individual (Table 1, Figure 3).

Fish 485

Contact was established with fish 485 on 10 occasions during active tracking efforts at the CRI in 2010. Fish 485, another male fish stocked near the CRI, was found in areas where depths ranged from 0–58 ft (0–17.7 m). This fish remained near its original release site through March 11, 2010. It moved into riverine habitats on March 16, 2010, where it stayed until March 18, 2010. Fish 485 was not located for several weeks during our tracking efforts, but it was contacted on May 18, 2010, near the river/lake interface. Fish 485 is currently classified as active/alive and future efforts will be made to ascertain where this fish goes for extended periods, as its habitat use apparently extends beyond the general locations searched during active tracking efforts (Table 1, Figure 3).

Fish Sonic Tagged in 2008

Contact was made with two fish sonic tagged in 2008 (Table 1, Figure 3); one fish (fish 3354) was stocked into the Muddy River/Virgin River inflow area and the other (fish 465) was originally stocked into Las Vegas Bay (Kegerries et al. 2009). Only one of these fish (3354) was located during active tracking efforts at the CRI during 2010. Fish 446 was solely detected via passive tracking techniques with the SUR located near the suspected spawning location at the CRI. Neither fish was contacted during long-term monitoring efforts conducted at Las Vegas Bay, Echo Bay, or the Muddy River/Virgin River inflow spawning areas during 2010 (Albrecht et al. 2010).

In fact, fish 3354 (originally stocked into the Muddy River/Virgin River inflow area in 2008 and last contacted via active tracking techniques in the Overton Arm on February 26, 2009 during long-term monitoring efforts) was originally detected at the CRI near the small island/spawning area on February 14, 2010, in aggregate with fish tagged in 2010, as discussed previously. Fish 3354 remained near the CRI spawning area through April 21, 2010, when it moved into and began using riverine habitats. Fish 3354 remained in the Colorado River proper until it was located on May 3, 2010 in the middle of Gregg Basin. Fish 3354 remained within Gregg Basin through May 27, 2010, where it was last contacted (for purposes of this report).

Prior to 2010, the last time fish 465 had been contacted during long-term monitoring efforts was on June 23, 2009, at Las Vegas Bay. Details regarding fish 465 are presented in the Passive Sonic Telemetry section below, as we have yet to establish contact with this fish during active tracking efforts at the CRI.

The 2010 detection of these two fish at the CRI suggests that fish from other tagging events may be active and may have incorporated themselves into other razorback sucker aggregates. At minimum, these fish demonstrate that some razorback sucker currently frequent locations outside of long-term monitoring sampling areas and underscore the importance of continuing Lake Mead razorback sucker monitoring and research efforts.

Passive Sonic Telemetry and Submersible Ultrasonic Receiver Data-Collection Efforts

Passive telemetry using three SUR units resulted in 9,201 sonic-tag detections during the 2010 season. It should be noted that detections were only recorded by SURs at the south end of Gregg Basin and CRI (Figure 3). The SUR placed in the river was buried within a week of deployment and never retrieved or downloaded. Seven unique sonic-tagged fish were detected from February–June 2010. As previously mentioned, two of these seven fish were from the 2008 tagging event; fish 3354, described in the previous section, and fish 465.

Fish 465 was originally released in Las Vegas Bay after sonic tag implantation in December 2008. This fish remained within the vicinity of the release site through June 2009, when it was last detected via active tracking (Kegerries et al. 2009). The next detection of this fish was on May 18, 2010, by the SUR near an island just south of the CRI in Gregg Basin. Interestingly, the fish was never detected by the downstream SUR (located at the south end of the Gregg Basin) or located via active tracking methods within Gregg Basin or the Colorado River suggesting that the fish may have moved into the basin before this SUR was deployed. Fish 465 was recorded twice by this SUR, on May 18 and May 20, 2010, confirming that the tag is still active, the fish is still alive, and razorback sucker will travel great distances (>60 mi) through the lake.

Sonic fish 3354 is another fish from the 2008 sonic-tagging event that was located in the CRI. Passive tracking results confirmed this fish's presence near the Colorado River confluence on May 16, 2010, and near the Virgin Narrows on May 19, 2010. Combined passive and active tracking data show that this fish appears to move within the confines of Gregg Basin. Similar to fish 465, fish 3354 was not detected by the southern most SUR within Gregg Basin or actively detected in the Colorado River prior to its detection near the Colorado River confluence.

Other interesting fish movement within Gregg Basin included sonic fish 357. This fish was released in Gregg Basin on February 23, 2010, near Scanlon Bay and it remained near the south end of the basin through April 24, 2010, when it was picked up by the SUR at the south end of Gregg Basin. Shortly thereafter this fish moved upstream and was detected by the SUR near the CRI on May 12, 2010. This fish was passively detected by this SUR throughout the remainder of the field season.

Sonic fish 249 was also documented moving between the SURs deployed within Gregg Basin. This fish was detected via SUR at the south end of Gregg Basin throughout April and early May 2010. On May 13, 2010, fish 249 was detected by the southernmost Gregg Basin SUR at 2:52 am and later recorded by the Colorado Inflow SUR at 12:43 pm. This fish traveled approximately 8 miles in 10 hours.

Adult Sampling

Trammel Netting

Trammel netting effort is presented as net nights within the CRI during 2010 (Table 2). One net night comprises a single net, set overnight. Trammel netting was conducted over 65.5 net nights in the CRI during 2010. Trammel netting efforts were concentrated along the western shoreline area of Gregg Basin, primarily at a small island that was located immediately south and west of the river/lake interface and proximal to the western shoreline of the main body of the lake. Trammel netting efforts were also conducted within other Gregg Basin locations (Figure 4).

Table 2. Trammel netting effort (net nights) within the Colorado River Inflow during 2010.

MONTH	COLORADO RIVER INFLOW
February	0
March	1
April	13
May	16
Total	**30**

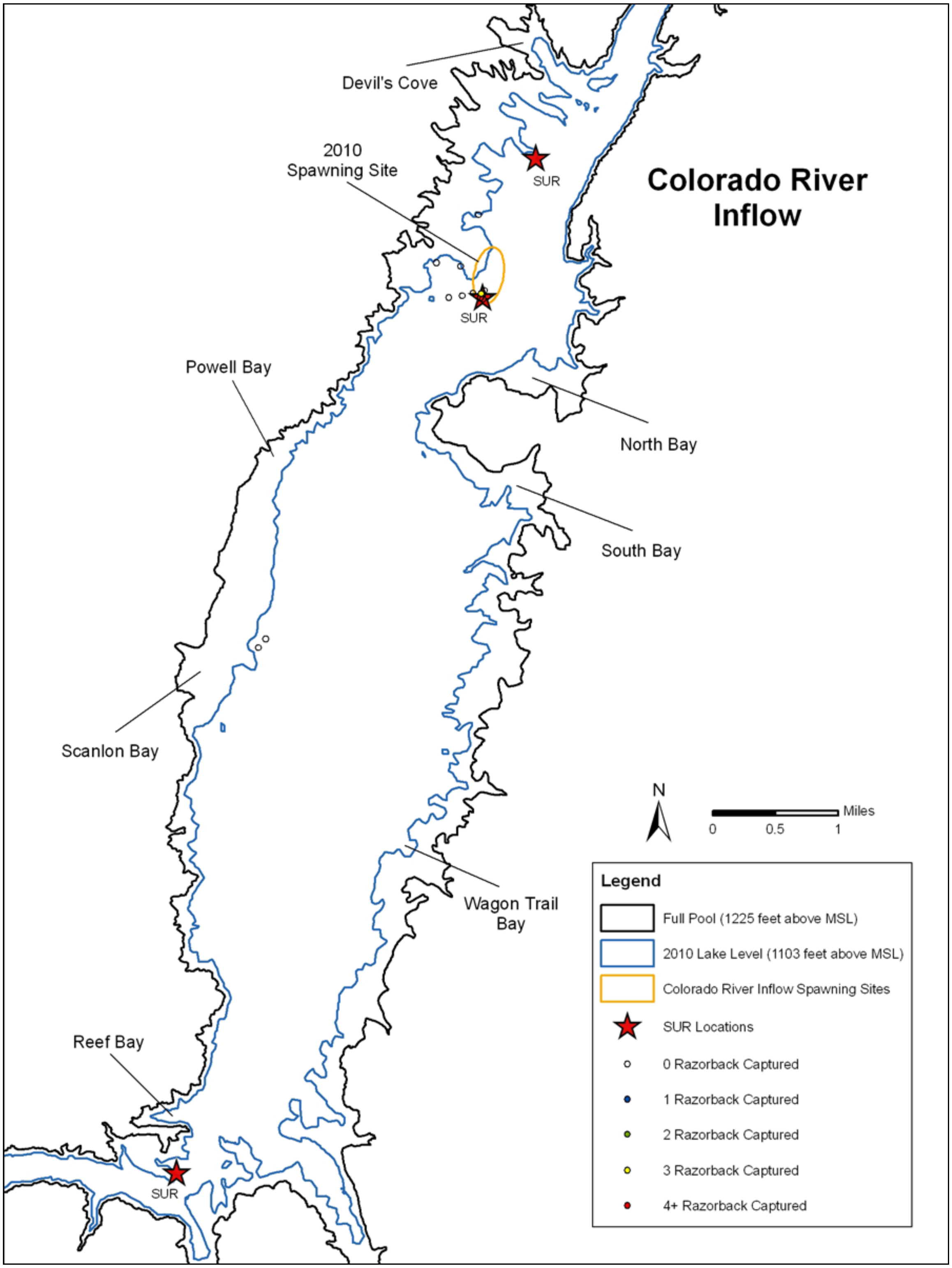

Figure 4. The Colorado River Inflow study area showing locations of trammel netting and numbers of fish captured, February 2010–May 2010.

The locations of net sets were mainly dictated by habitat use patterns of sonic-tagged fish. Trammel netting efforts occurred from March through the latter portion of May 2010 and, although netting was not initially conceived to be a large portion of our proposed methodology or efforts in 2010, this technique provided perhaps the most direct and striking evidence of razorback sucker spawning activity in the CRI.

Three male razorback sucker expressing milt were captured on April 20, 2010, in a single net set. These fish were located by placing nets within an area where sonic-tagged fish appeared to be aggregating (presumably to spawn). Although no sonic-tagged fish were recaptured during that, or any netting effort, all three wild, milting males were captured during that single netting event. No female razorback sucker was captured during the 2010 CRI investigations, although ripe, female flannelmouth sucker were observed. Furthermore, hybrid razorback sucker x flannelmouth sucker were captured at the CRI during the 2010 netting efforts. In all, 3 wild, adult, male razorback sucker, 52 flannelmouth sucker, and 4 razorback sucker x flannelmouth sucker hybrids were captured (Table 3).

It should be noted that none of the razorback sucker were recaptured individuals. During the 2010 sonic-tagging event, 10 razorback sucker from Floyd Lamb State Park were stocked into the CRI; eight of these fish were implanted with sonic tags and two were PIT tagged and released. Suspected hybrid sucker were captured on four occasions, and one fish was captured on two occasions during 2010 netting efforts at the CRI. This was the first time we detected hybrid sucker in Lake Mead. Finally, there were 52 flannelmouth sucker captured, five of which were recaptured individuals. Similar to finding hybrid sucker, 2010 was the first time we detected flannelmouth sucker during netting efforts on Lake Mead (see also Albrecht et al. 2010).

The razorback sucker catch rate from trammel netting conducted at the CRI in 2010 was 0.10 fish/net night. Catch rates for hybrid sucker were 0.13 fish/net night, while trammel netting catch rates for flannelmouth sucker were 1.73 fish/net night (Figure 5).

In summary, the rather minimal level of trammel netting conducted at the CRI in 2010 provided several interesting results, the following four need to be explored in greater detail through future research:

1. Razorback sucker are present in the CRI and can be found in spawning condition on/near appropriate spawning habitat during the spawning season. Actual numbers of razorback sucker at this location is not known.

2. The capture of wild, ripe razorback sucker in the CRI demonstrates the potential for unknown aggregates of razorback sucker to exist in other locations within Lake Mead.

Table 3. Date, PIT-tag, and size information for native and endangered suckers stocked or captured at the Colorado River Inflow area during 2010.

DATE	SPECIES	PIT-TAG NUMBER	SONIC CODE	DATE [a]	RECAPTURE/ STATUS	TL[b] (mm)	FL[c] (mm)	SL[d] (mm)	WT [e] (g)	SEX [f]
4/20/2010	Razorback Sucker	3D9.1C2D260A5A		4/20/2010	NO/NEW WILD FISH	563	525	482	1,865	M
4/20/2010	Razorback Sucker	3D9.1C2D26242D		4/20/2010	NO/NEW WILD FISH	508	469	432	1,420	M
4/20/2010	Razorback Sucker	3D9.1C2D26844B		4/20/2010	NO/NEW WILD FISH	568	525	485	1,965	M
2/23/2010	Razorback Sucker [g]	3D9.257C60F35D	249	2/23/2010	NO/STOCKED	511	469	420	1,740	M
2/23/2010	Razorback Sucker [g]	3D9.1C2D694DBC	258	2/23/2010	NO/STOCKED	502	472	423	1,590	M
2/23/2010	Razorback Sucker [g]	3D9.257C6089E5	267	2/23/2010	NO/STOCKED	534	497	454	2,020	F
2/23/2010	Razorback Sucker [g]	3D9.257C60DFD0	339	2/23/2010	NO/STOCKED	501	459	413	1,510	M
2/23/2010	Razorback Sucker [g]	3D9.257C60AA86	348	2/23/2010	NO/STOCKED	516	478	441	1,720	M
2/23/2010	Razorback Sucker [g]	3D9.257C60DDF2	357	2/23/2010	NO/STOCKED	490	452	413	1,420	M
2/23/2010	Razorback Sucker [g]	3D9.257C60B287	485	2/23/2010	NO/STOCKED	517	480	439	1,750	M
2/23/2010	Razorback Sucker [g]	3D9.257C60EB6A	227	2/23/2010	NO/STOCKED	486	447	405	1,530	M
2/23/2010	Razorback Sucker [g]	3D9.1C2D695D3A		2/23/2010	NO/STOCKED	485	445	402	1,250	M
2/23/2010	Razorback Sucker [g]	3D9.257C60DD60		2/23/2010	NO/STOCKED	498	456	413	1,590	M
4/7/2010	Hybrid [h]	3D9.1C2D266DF1		4/7/2010	NO/NEW WILD FISH	555	516	470	1,535	F
4/7/2010	Hybrid [h]	3D9.1C2D269A92		4/7/2010	NO/NEW WILD FISH	510	483	430	1,388	F
4/14/2010	Hybrid [h]	3D9.1C2D266DF1		4/14/2010	YES/WILD FISH	555	516	470	1,535	F
4/20/2010	Hybrid [h]	3D9.1C2D2687EE		4/20/2010	NO/NEW WILD FISH	510	473	421	1,350	M
4/8/2010	Flannelmouth Sucker	3D9.1C2D2733FB		4/8/2010	NO/NEW WILD FISH	485	461	404	955	U
4/8/2010	Flannelmouth Sucker	3D9.1C2D269E52		4/8/2010	NO/NEW WILD FISH	352	329	287	365	I
4/8/2010	Flannelmouth Sucker	3D9.1C2D26733D		4/8/2010	NO/NEW WILD FISH	460	434	379	860	U
4/8/2010	Flannelmouth Sucker	3D9.1C2D266CC1		4/8/2010	NO/NEW WILD FISH	477	450	395	990	U
4/8/2010	Flannelmouth Sucker	3D9.1C2D266788		4/8/2010	NO/NEW WILD FISH	470	436	383	980	F
4/8/2010	Flannelmouth Sucker	3D9.1C2D26300C		4/8/2010	NO/NEW WILD FISH	418	396	347	705	M

Table 3. (Cont.)

DATE	SPECIES	PIT-TAG NUMBER	SONIC CODE	DATE [a]	RECAPTURE/ STATUS	TL[b] (mm)	FL[c] (mm)	SL[d] (mm)	WT [e] (g)	SEX [f]
4/13/2010	Flannelmouth Sucker	3D9.1C2D26A569		4/13/2010	NO/NEW WILD FISH	380	360	325	540	I
4/13/2010	Flannelmouth Sucker	3D9.1C2D267703		4/13/2010	NO/NEW WILD FISH	482	452	415	905	U
4/13/2010	Flannelmouth Sucker	3D9.1C2D266CC1		4/8/2010	YES/WILD FISH	470	430	405	955	U
4/13/2010	Flannelmouth Sucker	3D9.1C2D265E72		4/13/2010	NO/NEW WILD FISH	360	335	300	410	I
4/14/2010	Flannelmouth Sucker	3D9.1C2D278698		4/14/2010	NO/NEW WILD FISH	449	421	380	695	U
4/14/2010	Flannelmouth Sucker	3D9.1C2D2729A4		4/14/2010	NO/NEW WILD FISH	350	325	296	355	I
4/14/2010	Flannelmouth Sucker	3D9.1C2D26A2D6		4/14/2010	NO/NEW WILD FISH	403	382	350	625	U
4/14/2010	Flannelmouth Sucker	3D9.1C2D2696AD		4/14/2010	NO/NEW WILD FISH	459	430	396	845	U
4/14/2010	Flannelmouth Sucker	3D9.1C2D2687FE		4/14/2010	NO/NEW WILD FISH	521	490	452	1,230	U
4/14/2010	Flannelmouth Sucker	3D9.1C2D267DAC		4/14/2010	NO/NEW WILD FISH	381	360	330	530	U
4/14/2010	Flannelmouth Sucker	3D9.1C2D2636AD		4/14/2010	NO/NEW WILD FISH	462	435	400	750	M
4/14/2010	Flannelmouth Sucker	3D9.1C2D2631F6		4/14/2010	NO/NEW WILD FISH	440	415	380	745	U
4/14/2010	Flannelmouth Sucker	3D9.1C2D261AD2		4/14/2010	NO/NEW WILD FISH	501	472	435	1,315	U
4/20/2010	Flannelmouth Sucker	3D9.1C2C983F6C		4/20/2010	NO/NEW WILD FISH	476	449	409	920	F
4/21/2010	Flannelmouth Sucker	3D9.1C2D269BCA		4/21/2010	NO/NEW WILD FISH	485	460	420	955	U
4/22/2010	Flannelmouth Sucker	3D9.1C2D269A9A		4/22/2010	NO/NEW WILD FISH	412	391	346	660	U
4/22/2010	Flannelmouth Sucker	3D9.1C2D268131		4/22/2010	NO/NEW WILD FISH	372	348	313	430	U
4/22/2010	Flannelmouth Sucker	3D9.1C2D267B8A		4/22/2010	NO/NEW WILD FISH	415	381	341	625	U
4/27/2010	Flannelmouth Sucker	3D9.1C2D268251		4/27/2010	NO/NEW WILD FISH	485	454	410	1,125	U
4/27/2010	Flannelmouth Sucker	3D9.1C2D2662E7		4/27/2010	NO/NEW WILD FISH	385	358	322	525	U
5/5/2010	Flannelmouth Sucker	3D9.1C2D267DDF		5/5/2010	NO/NEW WILD FISH	360	335	300	420	I
5/5/2010	Flannelmouth Sucker	3D9.1C2D262C75		5/5/2010	NO/NEW WILD FISH	405	380	346	625	M
5/13/2010	Flannelmouth Sucker	3D9.1C2D26935C		5/13/2010	NO/NEW WILD FISH	344	320	295	380	U
5/13/2010	Flannelmouth Sucker	3D9.1C2D268EB7		5/13/2010	NO/NEW WILD FISH	305	286	264	235	U

Table 3. (Cont.)

DATE	SPECIES	PIT-TAG NUMBER	SONIC CODE	DATE [a]	RECAPTURE/ STATUS	TL[b] (mm)	FL[c] (mm)	SL[d] (mm)	WT [e] (g)	SEX [f]
5/13/2010	Flannelmouth Sucker	3D9.1C2D266C71		5/13/2010	NO/NEW WILD FISH	422	391	364	675	U
5/20/2010	Flannelmouth Sucker	3D9.1C2D279A7B		5/20/2010	NO/NEW WILD FISH	445	415	380	740	U
5/20/2010	Flannelmouth Sucker	3D9.1C2D26973F		5/20/2010	NO/NEW WILD FISH	420	395	360	635	U
5/20/2010	Flannelmouth Sucker	3D9.1C2D267F3F		5/20/2010	NO/NEW WILD FISH	345	320	295	340	I
5/20/2010	Flannelmouth Sucker	3D9.1C2D267B4D		5/20/2010	NO/NEW WILD FISH	458	435	392	760	U
5/24/2010	Flannelmouth Sucker	3D9.1C2D680A10		5/24/2010	NO/NEW WILD FISH	374	348	302	445	U
5/24/2010	Flannelmouth Sucker	3D9.1C2D67F753		5/24/2010	NO/NEW WILD FISH	446	415	366	924	U
5/25/2010	Flannelmouth Sucker	3D9.1C2D278BD2		5/25/2010	NO/NEW WILD FISH	410	395	358	705	U
5/25/2010	Flannelmouth Sucker	3D9.1C2D26A357		5/25/2010	NO/NEW WILD FISH	371	352	313	470	U
5/25/2010	Flannelmouth Sucker	3D9.1C2D2687FE		4/14/2010	YES/NEW WILD FISH	518	488	443	1,160	U
5/25/2010	Flannelmouth Sucker	3D9.1C2D26062A		5/25/2010	NO/NEW WILD FISH	466	403	392	870	M
5/25/2010	Flannelmouth Sucker	3D9.1C2D25F68F		5/25/2010	NO/NEW WILD FISH	485	461	421	945	U
5/26/2010	Flannelmouth Sucker	3D9.1C2D748997		5/26/2010	NO/NEW WILD FISH	430	401	352	NA[i]	I
5/26/2010	Flannelmouth Sucker	3D9.1C2D745385		5/26/2010	NO/NEW WILD FISH	491	460	428	NA[i]	I
5/26/2010	Flannelmouth Sucker	3D9.1C2D67E48F		5/26/2010	NO/NEW WILD FISH	364	339	300	NA[i]	I
5/26/2010	Flannelmouth Sucker	3D9.1C2D67C4A7		5/26/2010	NO/NEW WILD FISH	482	460	408	NA[i]	I
5/26/2010	Flannelmouth Sucker	3D9.1C2D278BD2		5/25/2010	YES/WILD FISH	NA[i]	NA[i]	NA[i]	NA[i]	U
5/26/2010	Flannelmouth Sucker	3D9.1C2D26A357		5/25/2010	YES/WILD FISH	371	355	306	NA[i]	I
5/26/2010	Flannelmouth Sucker	3D9.1C2D267775		5/26/2010	NO/NEW WILD FISH	461	429	378	940	U
5/26/2010	Flannelmouth Sucker	3D9.1C2D26735D		5/26/2010	NO/NEW WILD FISH	487	456	410	1,000	U
5/26/2010	Flannelmouth Sucker	3D9.1C2D260A45		5/26/2010	NO/NEW WILD FISH	475	446	398	945	U
5/26/2010	Flannelmouth Sucker	3D9.1C2D26062A		5/25/2010	YES/WILD FISH	462	435	387	NA[i]	M

[a] Date originally stocked or originally captured. [b] Total length. [c] Fork length. [d] Standard length. [e] Weight. [f] F = female, M = male, I = immature, U = unidentified (sex not determined). [g] Razorback sucker from Floyd Lamb State Park stocked as part of the 2010 sonic-tagging event (i.e., not a wild CRI capture). [h] Suspected razorback sucker x flannelmouth sucker hybrid. [i] Not recorded, typically to avoid excessive handling stress.

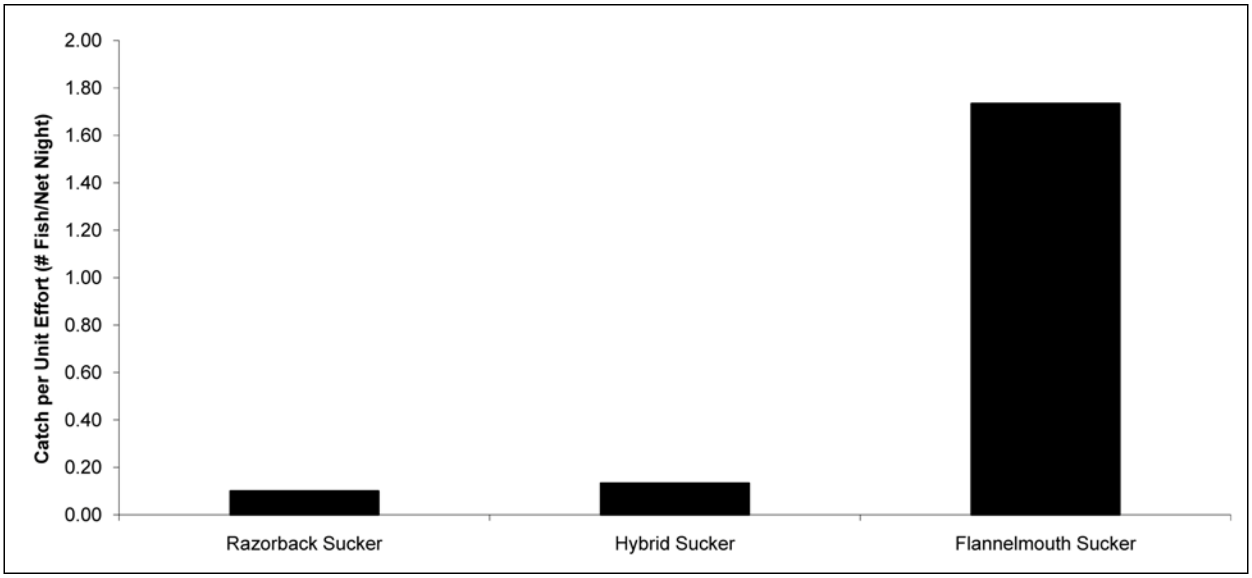

Figure 5. Trammel netting catch per unit effort values from the Colorado River Inflow study area, 2010.

3. The sonic-telemetry techniques used and described in this report, as well as in other Lake Mead razorback sucker reports, can be used as an effective tool for trammel net placement to help document razorback sucker habitat use in unknown areas of Lake Mead.

4. Razorback sucker and flannelmouth sucker habitat use overlaps at the CRI of Lake Mead. Hybridization of these native sucker species has been documented through direct capture of hybrid sucker. Trammel netting and larval sampling capture location information (larval sampling results are presented below) suggests that all sucker species and hybrids are likely using the more lentic portions of the CRI for spawning activities.

As more research is conducted in Lake Mead, we anticipate that conditions important for razorback sucker recruitment events—despite diminished lake levels—will be clarified though findings of this study and the long-term monitoring efforts described most recently by Albrecht et al. (2010) and discussed in depth by Albrecht et al. (2008a) during their comprehensive review of Lake Mead razorback sucker research.

Length and Growth Information

Given that no razorback sucker were recaptured in the CRI area or Gregg Basin in 2010, growth rates are not presented herein. However, razorback sucker captured at the CRI in 2010 ranged in size from 508-568 mm TL (N = 3). Hybrid sucker captured at the CRI ranged from 510-555 mm TL (N = 4). Finally, the more numerous flannelmouth sucker individuals captured during 2010 efforts in the CRI ranged from 305-521 mm TL (N = 52). Length-frequency distribution information from the 2010 CRI netting efforts is presented in Figure 6.

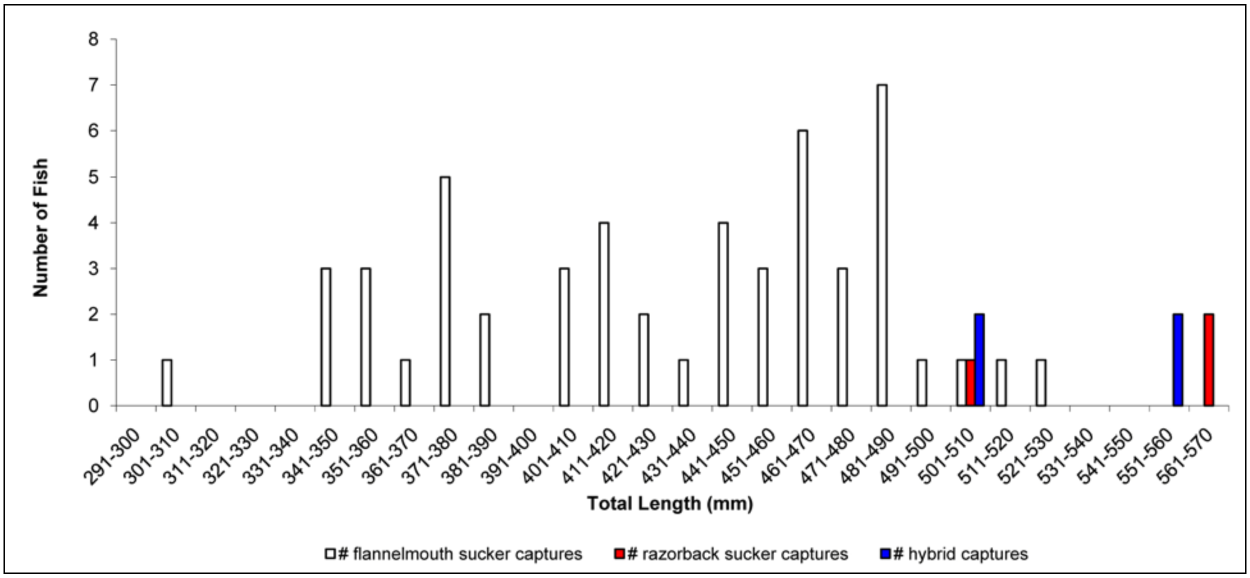

Figure 6. Length-frequency distributions for native suckers captured at the Colorado River Inflow area in 2010.

As more data are collected from razorback sucker in the CRI, we will assess whether growth rates for razorback sucker captured in this area follow the relatively high growth-rate trend observed in razorback sucker collected at the Las Vegas Bay, Echo Bay, and Muddy River/Virgin River study areas (Modde et al. 1996, Pacey and Marsh 1998, Albrecht et al. 2010). Future growth-rate findings for razorback sucker captured at the CRI will allow us to compare the overall size and age of aggregates in known spawning locations across study areas. Similarly, it will be interesting to see whether future efforts result in the capture of smaller, subadult razorback sucker, confirming recruitment in the CRI, as in the rest of Lake Mead.

Larval Sampling

Sampling for razorback sucker larvae was initiated at the CRI on March 9, 2010 (Table 4). Typically, four to eight sites at the CRI were sampled at least weekly (with few exceptions) during March, April, and May 2010. Razorback sucker larvae were first collected on April 13, 2010. Larval razorback sucker were captured on a gravel/cobble stretch of shoreline south of the lake/river interface and immediately west of the small island where adult razorback sucker were captured (Figure 7). As is evident in Table 4, razorback sucker larvae were captured in a relatively compressed time frame extending from April 13–14, 2010. Water temperatures during time of larval razorback capture ranged from 14–16° C. Adverse weather conditions (wind) effectively prevented productive sampling efforts both before and after those dates, and we may have missed opportunities to capture additional larval razorback sucker from this area. Despite adverse conditions, the capture of razorback sucker larvae confirmed this as a CRI spawning location in 2010. Larval sampling in the CRI yielded a catch of seven larval razorback sucker within 3,645 minutes of sampling, providing a catch per minute (CPM) value for razorback sucker of 0.002 (Table 4). For comparative purposes, note that CPM values of razorback sucker larvae collected at the CRI in 2010 fall within some of the initial CPM values observed at the

Table 4. Number of razorback sucker larvae collected at the Colorado River Inflow area of Lake Mead during 2010.

DATE	CRI SAMPLING SITES						
	Minutes Sampled	Razorback Sucker Larvae Collected	CPM [a]	Flannelmouth Sucker Larvae Collected	CPM [a]	Flannelmouth or Hybrid Sucker Larvae Collected	CPM [a]
3/9/2010	90	0	0	0	0	0	0
3/10/2010	105	0	0	0	0	0	0
3/11/2010	90	0	0	0	0	0	0
3/15/2010	180	0	0	0	0	0	0
3/16/2010	180	0	0	0	0	0	0
3/17/2010	180	0	0	0	0	0	0
3/18/2010	120	0	0	0	0	0	0
3/23/2010	180	0	0	0	0	0	0
3/24/2010	210	0	0	0	0	0	0
4/6/2010	150	0	0	0	0	0	0
4/7/2010	120	0	0	0	0	0	0
4/13/2010	180	4	0.022	0	0	0	0
4/14/2010	180	3	0.017	0	0	0	0
4/19/2010	270	0	0	0	0	0	0
4/22/2010	225	0	0	0	0	0	0
4/26/2010	180	0	0	0	0	0	0
4/29/2010	120	0	0	0	0	0	0
5/3/2010	120	0	0	0	0	0	0
5/4/2010	150	0	0	1	0.007	1	0.007
5/11/2010	225	0	0	0	0	3	0.013
5/18/2010	150	0	0	0	0	0	0
5/24/2010	120	0	0	0	0	0	0
5/25/2010	120	0	0	0	0	0	0
Totals	3,645	7	0.002	1.000	0.000	4.000	0.001

[a] CPM = Catch per minute.

Muddy River/Virgin River inflow area when that spawning aggregate was first identified and larval sampling initiated (Table 5).

In addition to positively identified larval razorback sucker, several other Catastomid larvae were collected and identified at the CRI in 2010, which corresponds with the 2010 CRI trammel netting captures and observation of both flannelmouth sucker and flannelmouth sucker x razorback sucker hybrids.We captured one flannelmouth sucker larvae, as well as four individuals that were identified as either additional flannelmouth sucker or flannelmouth sucker x razorback sucker hybrids (taxonomic verifications were conducted by BIO-WEST while in the field, by BIO-WEST under laboratory conditions, and by D. Snyder, Colorado State University, Larval Fish Lab). These findings, along with sonic-telemetry and trammel netting data, help

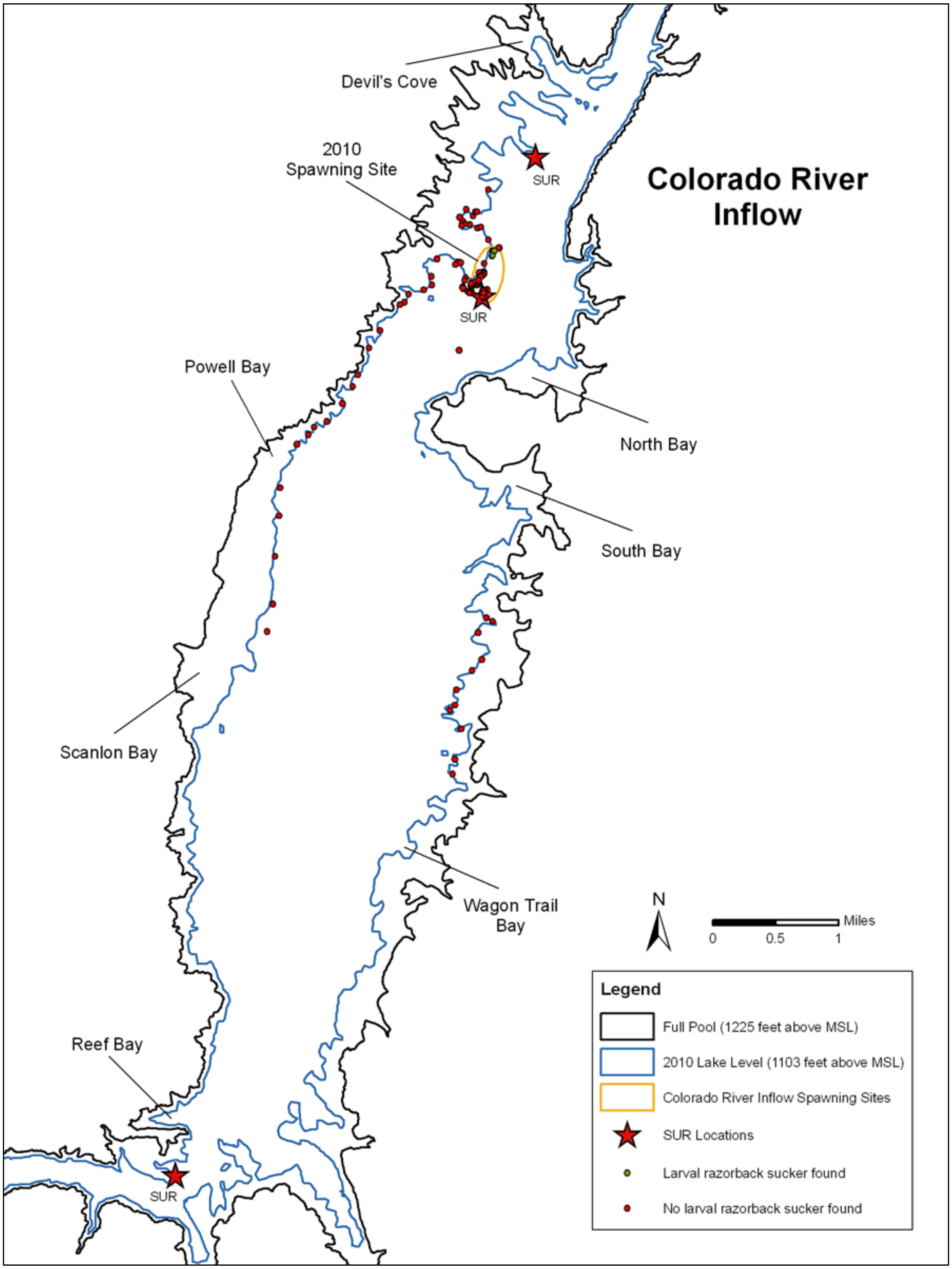

Figure 7. Colorado River Inflow area larval razorback sucker sample and capture locations, 2010.

Table 5. **Larval razorback sucker catch-per-minute comparisons by primary sampling location for 2006–2010 (modified from Albrecht et al. 2010 for comparative purposes).**

PRIMARY SAMPLING LOCATION	2006	2007	2008	2009	2010
Colorado River Inflow	--	--	--	--	0.002 [a]
Las Vegas Bay	0.012	0.390	0.430	0.342	0.093
Echo Bay	0.290	0.430	0.024	0.021	0.269
Muddy River/Virgin River Inflow	0.003	0.001	0.116	0.107	0.011

[a] Razorback sucker larvae data only.

confirm that the CRI provides spawning habitat for not only razorback sucker but also for flannelmouth sucker. Reasons for the relatively extensive hybridization will be explored as this study continues. Future efforts at the CRI will help clarify the importance of the CRI for all native sucker species.

Spawning-Site Identification and Observations

In comparison with Echo Bay, Las Vegas Bay, and even the Muddy River/Virgin River inflow area, very little is known regarding habitat use of spawning razorback sucker in the CRI. Similar to the original documentation of the Muddy River/Virgin River inflow area as a spawning site for razorback sucker in 2006, sonic-tagged fish movement patterns within specific CRI habitats that appeared to be potential spawning areas lead to the collection of ripe, wild, adult razorback sucker. These ripe, milting fish signified that spawning was likely occurring in this new Lake Mead study area. Furthermore, subsequent capture of larval fish confirmed successful spawning in the CRI. The 2010 CRI spawning site was approximately 500 m south of the Colorado River/Lake Mead interface, near a gravel/cobble island, along the western shoreline of the main body of the lake (Figure 7). Future efforts in this area of Lake Mead could yield information on the size and changes in size of the spawning aggregate, changes in spawning sites, and the degree to which successful spawning and recruitment are occurring in the CRI. An important goal for future investigations of this area will be to ultimately ascertain whether and how recruitment is occurring at this location and to what degree this recruitment impacts Lake Mead razorback sucker population dynamics as a whole.

Decreasing lake levels during the last 10 years influenced habitat conditions in all areas where razorback sucker sampling activities have occurred during Lake Mead study efforts (Albrecht et al. 2010). Typical shifts at the previously known razorback spawning areas have been linear, with fish following shoreline configurations as needed, apparently to accommodate declining lake levels and changing conditions (Albrecht et al. 2010). As of June 1, 2010, the lake elevation was approximately 1,094 ft (333.5 m) asl, compared with 1,097 ft (334.4 m) asl recorded the previous year on this same date (Figure 8). As a result of projected declines in lake levels, Lake Mead razorback sucker at the CRI are likely to change spawning site locations over the next several years to accommodate varying and highly dynamic conditions imposed by the declining lake and Colorado River dynamics. Given the relatively large inflow area and delta formed by

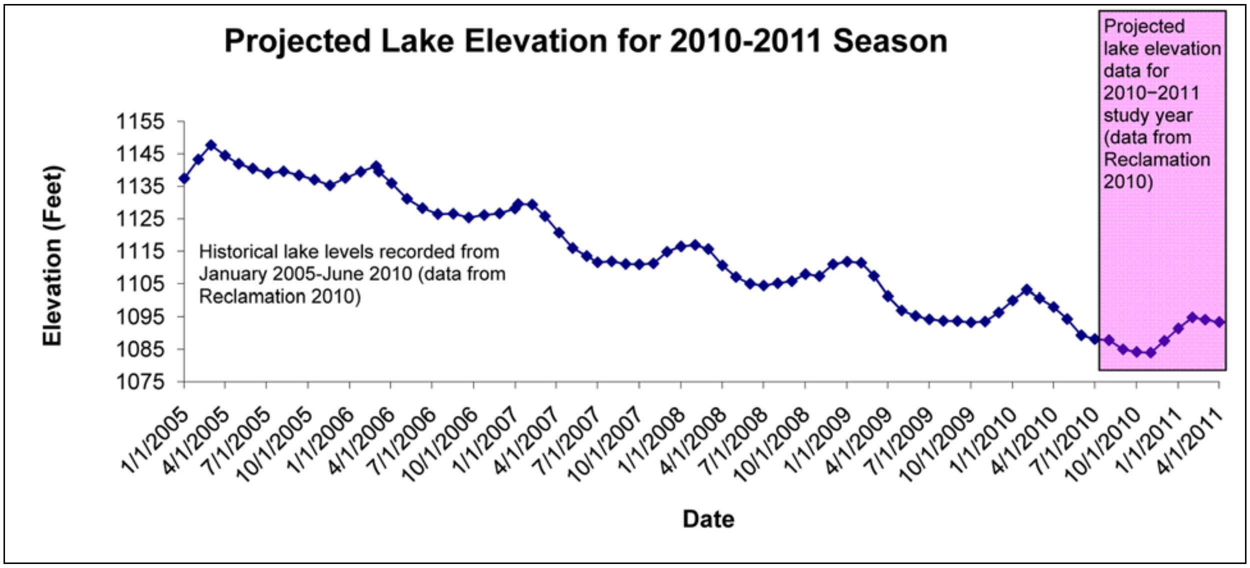

Figure 8. **Lake Mead elevations using a combination of actual, recorded, and historical lake elevation data, as well as projected lake elevations for the remainder of 2010–2011 study period.**

the Colorado River proper, as well as the magnitude of change that has occurred at the CRI since years of higher lake elevations (kilometers of change rather than meters of change typical at the known study areas), we hypothesize that dramatic shifts in spawning site location could occur at the CRI during future study years. These changes necessitate continued and careful monitoring of this relatively understudied razorback sucker spawning aggregate. What effects this potentially dramatic habitat change will have in terms of razorback sucker spawning success, and ultimately recruitment, at the CRI are unknown.

Razorback Sucker Aging

All three of the wild adult razorback sucker captured at the CRI in 2010 had fin ray sections surgically removed for age determination purposes. A definitive age was obtained for each individual fish (Appendix A and Figure 9). Two of the razorback sucker collected from the CRI were aged at 6 years old. Back-calculation places these two individuals as being spawned in 2004. The third razorback sucker was determined to be 11 years old, placing this fish as part of the successfully recruited individuals from 1999.

In addition to the three fish captured at the CRI in 2010, Figure 9 presents cumulative Lake Mead razorback sucker recruitment data as reported by Albrecht et al. (2010). Rational for presenting the larger aging and recruitment data set from Lake Mead along with the CRI aging data was to begin putting razorback sucker recruitment events into a more holistic data set. It is not our intent to imply that fish captured in the CRI stemmed from successful spawning and recruitment that may have occurred at the CRI; rather, our intent is to simply highlight the data obtained from the CRI in 2010 and put it into the larger context of lake-wide Lake Mead azorback sucker recruitment. It is our hope that continued efforts in all study areas will add to our knowledge pertaining to the unique razorback sucker recruitment occurring within Lake

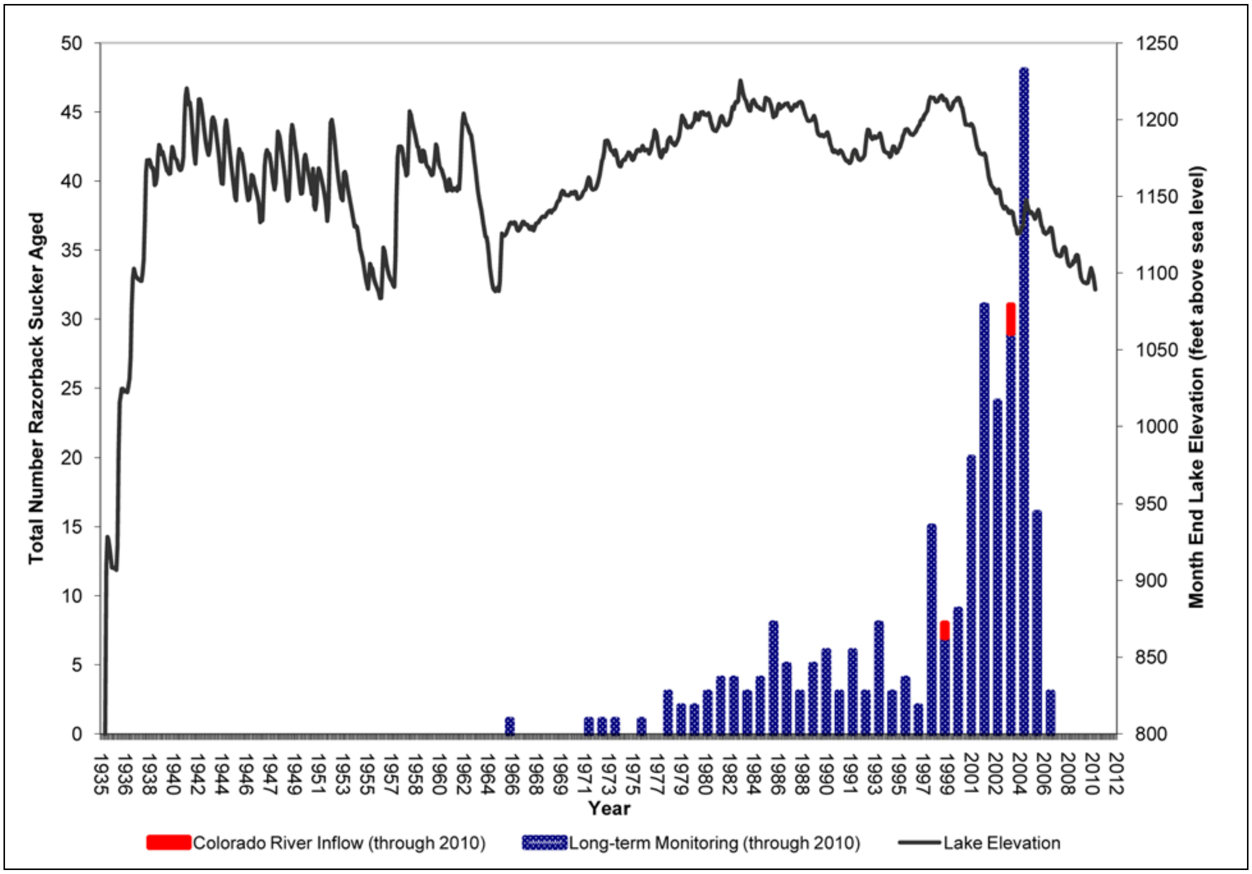

Figure 9. Lake Mead hydrograph from January 1935 to June 2010 with the number of aged razorback sucker that were spawned each year. Red bars depict razorback sucker captured at the Colorado River Inflow area in 2010, while textured bars are data from the cumulative long-term monitoring and aging efforts presented in Albrecht et al. (2010).

Mead. As is evident from the data presented in Figure 9, only in the last four study years have we aged fish that were spawned after 1999. This suggests a continued pattern of recruitment in Lake Mead despite relatively low and declining lake elevations (Albrecht et al. 2006b, Albrecht et al. 2007, Albrecht et al. 2008b).

To date, all of the aged fish were spawned between 1973–2007, with the exception of one fish that was spawned around 1966 (Appendix A). Until the last few seasons, the majority of fish aged were spawned during high lake elevations between 1978–1989 and 1997–1999 (Figure 9). However, our most recent data, now including aging data from CRI specimens, show Lake Mead razorback sucker recruitment occurring beyond 1999, which coincides with the steady decline in lake levels during recent years. Based on data obtained this season, 2001–2006 appears to be one of the better periods for Lake Mead razorback sucker recruitment, despite dropping lake levels (Figure 9)

Fin ray specimens from both flannelmouth and hybrid suckers were obtained using the methodologies described for razorback sucker. Specific ages obtained for the three hybrid sucker are given in Appendix B. Ages obtained for select CRI flannelmouth sucker are presented in Appendix C. Depending on the project scope and overall interest levels, as more data are collected from hybrid sucker and flannelmouth sucker captured during future efforts at the CRI, recruitment patterns of these native sucker species could also be investigated.

DISCUSSION AND CONCLUSIONS

Information collected during the 2010 field season at the CRI has expanded our knowledge of spawning behavior, habitat use, growth, and age of razorback sucker populations in Lake Mead. Sonic-telemetry, trammel netting, and larval-collection data confirm that razorback sucker do occur at the CRI and that they successfully spawned there in 2010. We do not know the size of the razorback sucker congregation at the CRI, or if recruitment occurs in this area.

Sonic Telemetry

Sonic telemetry proved valuable during the 2010 study year. We were able to maintain contact with fish from the February 2010 tagging effort as well as two fish tagged during 2008 long-term studies. Considering the size of the CRI, its dynamic nature, and the unknown status of razorback sucker using its habitats, the success of using pond-reared fish to locate new, wild individuals exceeded our expectations for the initial year of this study. Along with habitat and movement data, sonic-tagged fish provided crucial information regarding the general location of the razorback sucker population, thus greatly enhancing our ability to capture razorback sucker at the CRI.

These observations reinforce the importance of inflow areas to razorback sucker. It will be important to further investigate the use of shallow riverine areas within the Colorado River proper in 2011. Likewise, it will be important to continue to search for sonic-tagged fish to see whether they return to their 2010 spawning area or provide evidence of spawning habitat shifts.

Data stemming from the CRI sonic-tagged fish helped identify the 2010 spawning site location, illustrated movement patterns, and provided valuable information regarding razorback sucker habitat use not only within Lake Mead proper but also within the Colorado River proper. In addition, sonic-tagged fish helped determine the placement of trammel nets for the successful capture of wild razorback sucker. As the lake recedes (Figure 8), sonic-tagged fish will continue to provide valuable data in relation to changes in movement patterns, habitat use, and selected spawning sites.

In 2010 we were able to document one of the Muddy River/Virgin River sonic-tagged fish and one of the Las Vegas Bay sonic-tagged fish (codes 3354 and 465, both from the 2008 stocking event) using the Colorado River inflow area. Both of these fish apparently integrated into the newly identified CRI spawning aggregate (Albrecht et al. 2010). This suggests that stocked razorback sucker in Lake Mead navigate throughout the lake and can leave their original stocking location to integrate into other (potentially unknown) spawning aggregates. This finding also suggests that we should perhaps not cite tag failure or surgical complications if/when sonic-tagged fish are not immediately located during standard telemetry or monitoring efforts.

Passive telemetry was a valuable addition to sonic-telemetry methods in Lake Mead's CRI. Having limited knowledge of razorback sucker existence in the CRI, it was important to track the movement of released sonic-tagged fish to locate spawning aggregates. The SURs were placed strategically to try and capture any movement in or out of Gregg Basin and in or out of the Colorado River. However, the two sonic-tagged fish (codes 3354 and 465) from Las Vegas Bay and the Muddy River/Virgin River inflow were never detected on the SUR located furthest downstream of the CRI. One possible explanation was that these fish were able to swim past the SUR in such a manner (depth, distance, or behind cover) as to avoid detection. It is also possible that these fish were up river prior to SUR deployment and not detected until later in the season as they migrated to the lake. Last, it is possible that these fish were in an area of Gregg Basin that is not conducive to active sonic telemetry detection. All of these scenarios indicate limitations in our current sonic-telemetry methodologies that could be tested and perhaps resolved through additional feasibility studies. Although the SURs collected valuable data, the feasibility of maintaining them in the lake and deploying them in the river has yet to be determined. Issues with tampering and theft, as well as changing water levels and river conditions, still need to be resolved. Regardless, these receivers collected data without field crews, thereby increasing both efficiency and effectiveness.

Stationary SUR technology is limited by geographic placement. To obtain effective movement data, several SURs need to be located within a given basin. Although this was not the intent of this particular study, combining active and passive tracking methods allowed field crews to become more efficient and locate spawning razorback sucker more effectively. The SUR data also helped validate active tracking data. These receivers were valuable tools in the active search for sonic-tagged fish, as we were able to narrow the search area based on the most recently logged data. The SUR data provided insight into when razorback sucker move and how far they can potentially move in 24-hours or less. As more data are collected regarding interbasin fish movements in Lake Mead, SURs may help determine whether Lake Mead razorback sucker should be considered one population or managed as separate populations.

Finally, finding two sonic-tagged razorback sucker from 2008 that were stocked into Las Vegas Bay and the Muddy River/Virgin River inflow area using the CRI in 2010 raises the question of whether wild fish from populations at the long-term monitoring locations behave similarly. Such questions could be answered by sonic tagging wild Lake Mead razorback sucker similar to the efforts conducted during the earlier years of this study (e.g., Holden et al. 1997). Other questions suggested in this report could also be addressed by this effort, such as "What are the behaviors and habitat use of the juvenile/subadult wild razorback sucker in Lake Mead, and do they hold the key to recruitment success?" A sonic-telemetry study that uses wild fish of various size classes may provide useful insights as to whether the wild population displays large-scale movements similar to those observed with some of the stocked, pond-reared, sonic-tagged razorback sucker. This effort could become a paired study if similar numbers of wild, Lake Mead razorback sucker and pond-reared razorback sucker are implanted with sonic tags. If sufficient numbers of wild juvenile/subadult fish could be captured and tagged, such a study could provide valuable insight into the recruitment successes of Lake Mead razorback sucker. This would test the hypothesis that smaller, wild-spawned juvenile/subadult fish are able to escape predation in Lake Mead by using an unknown feature or area of the lake. Until such a study is implemented, we will continue to monitor sonic-tagged fish at the CRI and search throughout Lake Mead for other sonic-tagged fish with an “unknown” tag status.

Adult Sampling- and Spawning-Related Observations

Perhaps the most interesting conclusion from the information presented in this report is that razorback sucker successfully spawned at the CRI in 2010. It is important to note that since the conclusion of the 2010 CRI field season, the most recently identified spawning site has become desiccated. Continued monitoring of razorback sucker at the CRI through sonic telemetry, adult netting, and larval sampling will be invaluable in describing future habitat use and determining spawning sites, as well as understanding recruitment patterns at and within the CRI and within the context of the entire lake. It will be important to find other links that may help define and predict spawning-site preference, selection, and recruitment potential, such as water quality or littoral zone predator-abundance data. Based on physical changes observed at the CRI since 2001, this area may become the key to our general understanding of the effects of habitat change on razorback sucker recruitment.

Larval Sampling

Larval razorback sucker were captured in the CRI during the 2010 spawning season, thus confirming successful spawning of razorback sucker. The numbers and catch rates of larval razorback sucker in the CRI were intriguingly similar to those during the first two seasons of larval sampling in the Muddy River/Virgin River inflow area. Capture rates of larvae, sub adults, and adults in the Muddy River/Virgin River inflow area increased (Albrecht et al. 2010), and it will be interesting to evaluate whether similar trends occur in the CRI over time.

Larval razorback sucker captures during 2010 in the CRI occurred during a fairly compressed 2-day period (April 13–14). These dates are similar to larval capture data reported by Albrecht et al. (2008a) during their comprehensive review of Lake Mead razorback sucker investigations. Albrecht et al. (2008a) report that larval fish were captured at the CRI on April 29, 2000, as well as April 29, 2001. This information should be considered important for field crews working within the CRI in 2011.

In addition, larval flannelmouth sucker and larval hybrid sucker were captured at the CRI. Along with trammel netting results, these findings suggest the importance of the CRI as a spawning area for razorback sucker and flannelmouth sucker. The discovery of larval hybrid sucker, in addition to the capture of adult hybrid sucker, confirms species hybridization at the CRI; hence hybridization issues should be considered prior to any stocking/augmentation efforts there.

Larval sampling near any large river inflow may have implications in terms of capture efficiency. A slight current was visually identified near the 2010 spawning area during 2010 larval sampling efforts at the CRI. It is possible that this current may have affected larval catch rates for all sucker species. Other explanations for low larvae capture rate may include high spring winds, the possibility of larvae drifting into the lake from an unknown spawning area within the Colorado River, the dynamic nature of the river/lake interface, or insufficient numbers of adult razorback sucker to produce high numbers of larval fish. The latter explanation is not completely viable since many subadult and adult flannelmouth sucker were captured during trammel netting efforts at the CRI, yet only a single flannelmouth sucker larvae was collected and positively identified.

Aging

Determining ages of three CRI fish during the 2010 study year, as well as the 287 fish previously aged, helps verify that razorback sucker recruitment has occurred regularly in Lake Mead from 1974–2007. Based on data collected to date, the greatest recruitment occurred during 2001–2006, with a total of 170 razorback sucker resulting from those spawning events alone. These data suggest a strong recruitment trend in recent years. This strong pulse of young fish indicates that successful spawning and recruitment are indeed occurring at low lake levels and that razorback sucker recruitment has occurred in Lake Mead nearly every year since the 1970s. This year's aging data validate natural, wild recruitment within the Lake Mead razorback sucker population as recently as 2007 (Albrecht et al. 2010). Fish spawned during the 2008–2010 seasons should become susceptible to sampling gear within the next year or so (if recruitment is occurring for this age class). Finally, as more specimens are obtained from all areas of Lake Mead (including the CRI), we hope to identify conditions promoting recruitment and remain optimistic that capturing additional razorback sucker at the CRI will help clarify results from study efforts throughout Lake Mead.

So far, we have identified fish from two spawning years (2004 and 1999) in the CRI. It will be interesting to capture and age additional fish from the CRI to ascertain whether years of strong recruitment align with the rest of Lake Mead razorback sucker data.

Conclusions and Future Considerations

In 2010 BIO-WEST successfully documented razorback sucker in the CRI by capturing several adult razorback sucker (all wild, unmarked fish in spawning condition). This, along with the capture of larval razorback sucker, provides evidence that razorback sucker apparently spawned successfully in the CRI in 2010. BIO-WEST also captured a number of flannelmouth sucker and flannelmouth sucker x razorback sucker hybrids in the CRI.

These findings prompt a number of questions that extend beyond the scope of the original study, which was to investigate the CRI for presence/absence of razorback sucker. For example, how many razorback sucker use the CRI area and what is the spawning population's size? Do razorback sucker continually use the CRI and/or can they be found on an annual basis? Does this area of Lake Mead produce larval fish on an annual basis? Are there juvenile razorback sucker in the CRI area providing direct evidence of natural, wild recruitment as has been documented in other locations within Lake Mead? Can enough fin ray specimens be collected to begin understanding the age structure of the fish currently (and in the future) using the CRI area? How does the CRI relate to the other Lake Mead locations that are used by razorback sucker, and are the resulting recruitment patterns similar or distinct? Can sufficient numbers of razorback sucker be captured, marked, and recaptured to perform population estimates? Do razorback sucker use different habitats at the CRI area compared with the known populations in Lake Mead, and what (if any) is the long-term use of the lower portions of the Colorado River proper during both the spawning and nonspawning portions of the year? How does the recent discovery of razorback sucker in the CRI affect the overall size estimate of the Lake Mead population? How important is the CRI to the flannelmouth sucker life cycle? What is the extent of hybridization between flannelmouth sucker and razorback sucker at the CRI? Can we learn from the apparent natural recruitment success of Lake Mead razorback sucker and apply this information to other areas presently/historically occupied by razorback sucker throughout the Colorado River Basin?

Most of the questions above would benefit from a greater field presence and increased sampling efforts at the CRI during the next several years. Hence we strongly recommend increasing field work at the CRI in 2011 to help address these questions. The information presented above, along with findings from the long-term monitoring areas (Albrecht et al. 2010), suggests that the Lake Mead population is generally young, growing, and self-sustaining. This demonstrates the uniqueness of the Lake Mead razorback sucker population and provides one of the few positive stories for a rare species.

2010–2011 RECOMMENDED COLORADO RIVER INFLOW WORK PLAN

1. Increase overall efforts at the CRI, including tagging and tracking efforts. We recommend tagging additional razorback sucker from Floyd Lamb State Park in hopes of (1) identifying the 2011 CRI spawning location(s); (2) better understanding razorback sucker habitat use within the Colorado River proper; and (3) potentially identifying other, new spawning sites as dictated by tracking sonic-tagged fish. Apply increased sampling effort to larval sampling, adult trammel netting, and fin ray collection and aging techniques, with particular emphasis on PIT-tagging and aging subadult and adult razorback sucker. Use data stemming from increased sampling efforts to further assist with understanding the size and habitat use of razorback sucker at the CRI, help document further exchanges of tagged fish between sites, identify problems or habitat shifts associated with the CRI spawning aggregates, and identify lake-wide recruitment patterns.

2. Tag additional Floyd Lamb State Park razorback sucker using dual function radio/sonic tags and stock these newly tagged fish into the CRI in 2010/2011 in an effort to better understand habitat use in the Colorado River proper and other shallow, turbid habitats within the CRI. Given the fairly extensive use of the shallow, turbid, flowing portions of the Colorado River proper in 2010, coupled with the difficulty in tracking/hearing sonic tagged fish in such conditions, we strongly recommend that the utility of dual function tags be investigated at the CRI in 2010/2011. This tagging event would be used as an experiment to assess the utility and reliability of this tag type in Lake Mead and to gain a more robust understanding of razorback sucker use of the Colorado River proper. We recommend implanting four Floyd Lamb State Park razorback sucker with dual tags during 2010/2011. Depending on tracking efforts at the CRI through December 2010, additional Floyd Lamb State Park razorback sucker (up to four additional fish) may also be implanted with the standard, proven sonic tags that are currently used in Lake Mead. This would help facilitate field crew success and promote continued, seamless data collection efforts in 2011 by allowing for continued presence of fish tagged with not only

the proven sonic only tags but perhaps also a new tool. This measure is included in our recommended CRI work plan in case dual-function tags are problematic in 2011 to provide redundant razorback sucker presence prior to the 2011 spawning period in the CRI. Finally, we recommend continuing with the combination of active and passive sonic-telemetry techniques. This will continue to be important since movement was documented from both Las Vegas Bay and the Muddy River/Virgin River inflow area to the CRI via telemetry data obtained in 2010 using a combination of active and passive tracking techniques. Furthermore, given that studies are now being conducted by field crews in both the CRI and the long-term monitoring locations, these methods could help indicate routine movement of razorback sucker between the long-term study locations and the CRI. Sonic-tagged fish may help illuminate the degree to which spawning aggregates in both areas may be intermixing. Such understanding would help identify future research and guide management actions pertaining to razorback sucker within the CRI and lake-wide.

3. Continue to investigate the physicochemical and biological factors that allow continued razorback sucker recruitment. This research item was originally posed by Albrecht et al. (2008a) and is part of the Lake Mead razorback sucker management plan (Albrecht et al. 2009). Ultimately, we believe it is important to investigate and try to understand why Lake Mead razorback sucker continue to recruit despite the nonnative fish pressures and habitat modifications that are common throughout the historical range of the species. We recommend initiating a study to determine these factors while Lake Mead razorback sucker continue to recruit and function in their current, largely unaltered form. Based on the findings of razorback sucker studies in the CRI in 2010, this should be one of the areas included in such a study.

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APPENDIX A: RAZORBACK SUCKER AGING DATA

Table A-1. Ages determined from razorback sucker pectoral fin ray sections collected from Lake Mead (all sites).

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
	LAS VEGAS BAY		
5/10/1998	588	10 [a]	1987
12/14/1999	539	13	1986
12/14/1999	606	17+	1979–1982
12/14/1999	705	19+	1977–1980
1/8/2000	650	18+	1978–1981
2/27/2000	628	17+	1979–1982
1/9/2001	378	6	1994
2/7/2001	543	11	1989
2/22/2001	585	13	1987
12/1/2001	576	8–10	1991–1993
12/1/2001	694	22	1979
12/1/2001	553	10	1991
2/2/2002	639	16	1985
3/25/2002	650	22	1979
3/25/2002	578	10–11	1990–1991
3/25/2002	583	22–24	1977–1979
3/25/2002	545	20 [a]	1982
3/25/2002	576	20	1982
5/7/2002	641	15	1986
6/7/2002	407	6	1995
6/7/2002	619	20 [a]	1982
6/7/2002	642	20 [a]	1982
12/3/2002	354	4	1998
12/6/2002	400	4	1998
12/6/2002	376	4	1998
12/19/2002	395	4	1998
1/7/2003	665	16	1986
1/22/2003	494	4	1998
2/5/2003	385	4	1998
2/18/2003	443	5	1997
3/4/2003	635	19	1983
3/20/2003	420	4	1998
4/8/2003	638	21 [a]	1982
4/17/2003	618	10	1992
4/22/2003	650	20–22	1980–1982
5/4/2003	415	3+ [b]	1999
3/3/2004	370	5	1998
2/22/2005	529	6	1998
2/22/2005	546	6	1998

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
3/29/2005	656	16	1989
1/26/2006	740	15	1991
2/21/2006	621	23	1983
3/23/2006	461	5	2001
3/23/2006	718	16	1990
3/31/2006	635	7	1999
3/31/2006	605	6	2000
4/4/2006	629	6	2000
4/25/2006	452	4	2002
4/25/2006	463	4	2002
1/30/2007	514	5	2002
2/6/2007	519	5	2002
2/6/2007	574	8	1999
2/13/2007	526	5	2002
2/16/2007	530	5	2002
2/20/2007	534	6	2001
2/21/2007	358	3	2004
2/21/2007	511	5	2002
2/27/2007	645	13	1994
2/27/2007	586	15	1992
2/27/2007	603	13	1994
2/27/2007	650	17	1990
3/6/2007	515	4	2003
3/6/2007	611	13	1994
3/6/2007	565	6	2001
3/13/2007	586	7	2000
3/13/2007	636	25	1982
3/13/2007	524	5	2002
4/2/2007	704	9	1998
4/9/2007	644	11	1996
2/12/2008	425	5	2003
2/12/2008	390	3	2005
2/12/2008	490	3	2005
2/12/2008	430	4	2004
2/12/2008	379	4	2004
2/12/2008	399	4	2004
2/12/2008	430	4	2004
2/12/2008	413	4	2004
2/12/2008	554	9	1999
2/12/2008	426	9	1999
2/18/2008	385	3	2005
2/25/2008	605	6	2002

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
2/25/2008	655	36	1972
4/3/2008	468	4	2004
4/3/2008	619	7	2001
4/3/2008	640	10	1998
4/3/2008	560	11	1997
4/8/2008	423	3	2005
4/8/2008	535	6	2002
4/10/2008	422	3	2005
4/10/2008	375	3	2005
4/10/2008	452	4	2004
4/10/2008	472	4	2004
4/10/2008	467	4	2004
4/10/2008	429	5	2003
4/23/2008	430	4	2004
2/12/2009	536	7	2002
2/12/2009	510	7	2002
2/20/2009	377	3	2006
2/24/2009	458	4	2005
2/24/2009	421	4	2005
2/26/2009	369	3	2006
3/3/2009	376	4	2005
3/3/2009	411	4	2005
3/3/2009	438	5	2004
3/3/2009	451	4	2005
3/3/2009	395	5	2004
3/3/2009	416	4	2005
3/13/2009	427	4	2005
3/11/2009	565	8	2001
3/11/2009	510	8	2001
3/17/2009	440	5	2004
3/17/2009	420	5	2004
3/17/2009	431	5	2004
3/17/2009	340	5	2004
3/17/2009	44	5	2004
3/24/2009	546	8	2001
3/24/2009	539	8	2001
4/8/2009	521	8	2001
4/13/2009	419	6	2003
4/13/2009	403	6	2003
4/13/2009	446	6	2003
4/13/2009	535	6	2003
4/15/2009	578	13	1996

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
4/15/2009	748	17	1992
4/15/2009	528	11	1998
4/15/2009	630	15	1994
2/2/2010	531	5	2005
2/2/2010	391	5	2005
2/2/2010	342	5	2005
2/11/2010	351	3	2007
3/3/2010	485	5	2005
3/3/2010	553	6	2004
3/3/2010	621	9	2001
3/23/2010	395	3	2007
3/23/2010	500	5	2005
3/23/2010	514	6	2004
4/20/2010	560	7	2003
ECHO BAY			
1/22/1998	381	5	1993
1/9/2000	527	13	1987
1/9/2000	550	13	1987
1/9/2000	553	13	1987
1/9/2000	599	12–14	1986–1988
1/27/2000	557	13	1986
1/27/2000	710	19+	1979–1981
2/9/2001	641	13	1988
2/24/2001	577	18+	1980–1982
2/24/2001	570	8	1992
2/24/2001	576	15	1986
2/24/2001	553	18	1983
12/18/2001	672	13	1988
2/27/2002	610	18–20	1982–1984
3/26/2002	623	16	1986
4/2/2002	617	35+	1966–1968
4/17/2002	583	20 [a]	1982
5/2/2002	568	18–19	1983–1984
11/18/2002	551	13	1989
12/4/2002	705	26	1976
1/21/2003	591	16	1986
2/3/2003	655	27–29	1974
2/3/2003	580	13	1989
4/2/2003	639	19–20	1982
4/2/2003	580	23–25	1978
4/23/2003	584	10	1992
5/6/2003	507	9+	1993

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
5/6/2003	594	20	1982
12/18/2003	522	20	1982
1/14/2004	683	14	1989
2/18/2004	613	10	1993
3/17/2004	616	19	1983
3/17/2004	666	17	1985
3/17/2004	618	9	1994
4/6/2004	755	17	1985
3/2/2005	608	15	1990
3/2/2005	624	8	1996
1/10/2006	630	12	1994
2/1/2006	705	16	1990
2/16/2006	601	22	1984
1/11/2007	535	5	2002
1/11/2007	493	5	2002
2/1/2007	637	7	2000
2/8/2007	609	12	1995
2/14/2007	501	4	2003
3/2/2007	590	11	1996
3/9/2007	660	12	1995
3/16/2007	691	21	1986
3/28/2007	564	13	1994
2/28/2008	640	25	1983
2/29/2008	635	8	2000
3/5/2008	653	24	1984
3/19/2008	532	6	2002
3/19/2008	510	7	2001
2/19/2009	602	7	2002
4/15/2009	662	16	1993
2/18/2010	520	7	2003
2/25/2010	465	5	2005
3/10/2010	535	7	2003
3/10/2010	530	9 [c]	2001
3/24/2010	451	4	2006
3/24/2010	465	5	2005
3/24/2010	466	5	2005
4/8/2010	470	5	2005
4/8/2010	540	8	2002
4/22/2010	538	7	2003
4/22/2010	489	8	2002
4/22/2010	460	9	2001

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
	MUDDY RIVER/VIRGIN RIVER INFLOW AREA		
2/23/2005	608	6	1998
2/22/2006	687	33 [d]	1973
2/22/2007	452	4	2003
2/22/2007	542	5	2002
2/22/2007	476	5	2002
2/22/2007	459	4	2003
2/22/2007	494	5	2002
3/1/2007	477	5	2002
3/1/2007	512	4	2003
3/8/2007	463	5	2002
3/8/2007	455	4	2003
3/15/2007	516	4	2003
4/3/2007	508	4	2003
4/11/2007	498	7	2000
2/27/2008	465	4	2004
2/27/2008	670	20	1988
3/25/2008	530	6	2002
3/25/2008	271	2 [e]	2006
3/26/2008	345	3	2005
3/26/2008	541	7	2001
3/26/2008	521	7	2001
3/26/2008	665	18	1990
4/1/2008	229	2	2006
4/1/2008	370	3	2005
4/1/2008	360	3	2005
4/1/2008	385	4	2004
4/1/2008	514	5	2003
4/1/2008	536	5	2003
4/1/2008	514	6	2002
4/1/2008	548	6	2002
4/1/2008	518	7	2001
4/1/2008	530	7	2001
4/1/2008	494	8	2000
4/1/2008	535	9	1999
4/1/2008	559	10	1998
4/22/2008	533	6	2002
4/22/2008	504	6	2002
2/4/2009	549	7	2002
2/13/2009	348	3	2006
2/13/2009	374	3	2006
2/13/2009	372	3	2006

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
2/17/2009	390	3	2006
2/17/2009	365	3	2006
2/17/2009	375	3	2006
2/18/2009	399	3	2006
2/18/2009	291	3	2006
2/18/2009	366	3	2006
2/24/2009	362	3	2006
2/25/2009	585	8	2001
3/3/2009	386	4	2005
3/3/2009	390	4	2005
4/6/2009	464	5	2004
4/8/2009	552	8	2001
4/15/2009	496	9	2000
4/15/2009	553	10	1999
4/15/2009	572	9	2000
4/15/2009	505	8	2001
2/3/2010	455	3	2007
2/3/2010	475	5	2005
2/3/2010	441	5	2005
2/3/2010	495	7	2003
2/3/2010	532	8	2002
2/9/2010	491	5	2005
2/9/2010	444	5	2005
2/9/2010	500	5	2005
2/9/2010	464	6	2004
2/9/2010	471	6	2004
2/17/2010	494	6	2004
2/17/2010	470	7	2003
2/17/2010	479	7	2003
2/17/2010	425	7	2003
2/17/2010	483	7	2003
2/24/2010	234	4	2006
3/17/2010	477	4	2006
3/17/2010	465	5	2005
3/17/2010	485	5	2005
3/17/2010	499	6	2004
3/17/2010	491	6	2004
3/17/2010	600	9	2001
3/18/2010	452	5	2005
3/18/2010	473	5	2005
3/25/2010	485	5	2005

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
	COLORADO RIVER INFLOW AREA		
4/20/2010	563	6	2004
4/20/2010	508	6	2004
4/20/2010	568	11	1999

[a] Fish stocked from Echo Bay larval fish captured in 1999 and raised at Nevada Department of Wildlife Lake Mead Fish Hatchery.

[b] Fish stocked from Floyd Lamb State Park ponds (1982 Dexter National Fish Hatchery cohort placed in Floyd Lamb State Park ponds in 1984).

[c] Fish stocked from Floyd Lamb State Park ponds (from an unknown 2001-2003 cohort stocking event).

[d] Fish was aged at 33 years of age, +/- 2 years.

[e] Fish was a mortality. Found dead in net, obvious net predation/wounds. Fin ray aging results validated using otoliths.

APPENDIX B: HYBRID SUCKER AGING DATA

Table B-1 Ages determined from hybrid sucker pectoral fin ray sections collected from the Colorado River Inflow area of Lake Mead, 2010.

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
COLORADO RIVER INFLOW AREA			
4/7/2010	555	9	2001
4/7/2010	510	6	2004
4/20/2010	510	6	2004
4/7/2010	555	9	2001

APPENDIX C: FLANNELMOUTH SUCKER AGING DATA

Table C-1 Ages determined from flannelmouth sucker pectoral fin ray sections collected from the Colorado River Inflow area of Lake Mead, 2010 [a].

DATE COLLECTED	TOTAL LENGTH (mm)	AGE	PRESUMPTIVE YEAR SPAWNED
COLORADO RIVER INFLOW AREA			
4/8/2010	418	13	1997
4/8/2010	477	11	1999
4/8/2010	460	14	1996
4/8/2010	470	10	2000
4/8/2010	485	9	2001
4/8/2010	352	5	2005

[a]Please note that not all 2010 flannelmouth sucker captured were aged.