NEVADA DEPARTMENT OF WILDLIFE
STATEWIDE SPORT FISHERIES MANAGEMENT

FEDERAL AID JOB PROGRESS REPORT

F-20-49
2013

LAKE MEAD
SOUTHERN REGION

NEVADA DEPARTMENT OF WILDLIFE, FISHERIES DIVISION
JOB PROGRESS REPORT

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NEVADA DEPARTMENT OF WILDLIFE, FISHERIES DIVISION
ANNUAL PROGRESS REPORT

State: *Nevada*
Project title: *Statewide Fisheries Program*
Job title: *Lake Mead*
Period Covered: *January 1, 2013 to December 31, 2013*

SUMMARY

General Sport Fishing Evaluation

In 2013, a total of 73 days were expended conducting creel surveys on Lake Mead. A total of 563 anglers were contacted whose catch totaled 2,108 fish of multiple species for a catch rate of 3.74 fish/angler day and averaged 0.84 fish/angler hour. The observed 1,216 fish harvested provided a harvest rate of 2.2 fish/angler day and an average 0.45 fish/angler hour.

During the fall, NDOW, Arizona Game and Fish Department (AGFD), and U.S. Bureau of Reclamation cooperatively completed electroshocking and gill netting surveys. Electroshocking surveys were dominated by bluegill *Lepomis macrochirus*, green sunfish *L. cyanellus*, and largemouth bass *Micropterus salmoides*, while gill net surveys caught primarily gizzard shad *Dorosoma cepedianum*, striped bass *Morone saxatilis*, and largemouth bass.

Striped Bass Assessment

Striped bass CPUE in the gill net survey slightly increased from that of 2012, and angler interest in striped bass as a percentage of total angler preference decreased from that observed in 2012. Harvested striped bass sampled during the creel survey (January through June) averaged 16.6 inches (in) [423 millimeters (mm)] total length (TL), with an average weight of 1.5 pounds (lbs) [673 grams (g)] with an average condition factor ($K_{FL(fork\ length)}$) of 1.04, down slightly from last year's 1.05K_{FL}. From the gill net sample, striped bass averaged 14.6 in (372 mm) TL, weighed an average of 1.1 lbs (501 g), and had a condition factor of 1.13 K_{FL}. This is a 1.3 in (33 mm) decrease in total length over last year and a 0.19 K_{FL} increase in condition factor.

Black Bass Fisheries Assessment

Gill net surveys revealed little change in abundance for either large- or smallmouth bass *M. dolomieu*. Black bass harvest, as a percentage of the total harvest, increased in 2013 to 3.5%, a level not seen since 1991. The percentage of angler preference for black bass continues to increase at 14.8%, after a lull in preference seen between the years 2007-2011. Samples taken from tournaments revealed a smaller largemouth bass having an average total length of 15.6 in (396 mm), an average weight of 2.0 lbs (907 g), and a W_r of 90.4. Smallmouth bass had no change in length or

weight with an average total length of 15.8 in (401 mm), an average weight of 1.9 lbs (862 g), and a W_r of 85.1. Young-of-the-year (YOY) recruitment for both small- and largemouth bass appeared to be poor for 2013. This may be a result of dropping lake elevations during the spawning period.

Black Crappie Assessment

Black crappie *Pomoxis nigromaculatus* were found in small numbers in the fall gill netting, electroshocking, and creel surveys. However, hoop nets that were set in the Overton Arm area and were targeting the species failed to capture any black crappie.

Prey Base Studies

Threadfin shad *D. petenense* production was monitored during the spring/summer seasons in two basins of Lake Mead. A total of 35 standard transects were sampled in the Overton Arm and the Boulder Basin. The shad population exhibits a cyclical pattern with two to three years of poor production followed by a peak year in production. This year shad production was low in both the Boulder Basin and Overton Arm, although slightly elevated from that observed last year. Average peak production for Boulder Basin was 50.15 shad/3,531 cubic feet (ft^3) [100 cubic meters (m^3)] and 34.56 shad/3,531 ft^3 (100 m^3) for the Overton Arm. Overall average shad production was 42.35 shad/3,531 ft^3 (100 m^3).

Salmonid Fisheries Assessment

No rainbow trout *Oncorhynchus mykiss* were stocked in 2013.

Striped Bass Telemetry Study

The Lake Mead striped bass fishery has endured long-term drought conditions and recent invasions of quagga mussel *Dreissena bugensis* and gizzard shad *D. cepedianum*. It is unclear how these introduced species are affecting the striped bass fishery. The striped bass telemetry study will help us to understand striped bass habitat use during these changing lake conditions.

At the end of November 2011, 20 striped bass were surgically implanted with sonic transmitter tags, Sonotronics CT-05-36-I. These fish averaged 18.4 in (467 mm) TL and had an average weight of 2.1 lbs. (971 g). These fish were released back to the lake and sonic tracking initiated on December 2, 2011 and tracking ended on May 7, 2013.

Striped bass were found to utilize the entire lake. It appears they need to spawn in flowing waters January through March. Due to thermal constraints, adult striped bass need to occupy deeper areas during the spring and summer as water temperatures increase. The inflow areas, especially the Las Vegas Bay, are important for foraging, and food availability may have a strong influence on habitat use by striped bass. Mid-

channel areas and points are preferred to coves. A study that tracks striped bass movements in the evening hours using fish of different size classes may further expand the knowledge of striped bass habitat use at Lake Mead.

BACKGROUND

Lake Mead was created by the completion of the Hoover Dam in 1935. The newly formed impoundment was stocked with largemouth bass and sunfish *L.* spp. and soon became known for its excellent bass fishery. In the 1940s the bass fishery began to decline with reports of fish in poor condition. In 1954, threadfin shad were introduced to Lake Mead to provide additional forage. Initially there was some improvement in largemouth bass condition, but this was short-lived. In 1963, the construction of upstream impoundments reduced flow conditions with the filling of Lake Powell. This also changed historic water storage patterns to one of lower spring flows and higher winter flows, which cause drawdown during the black bass spawning season. Changes in temperature fluctuations and nutrient loading to Lake Mead were also noted after the construction of Lake Powell.

Because of the declining largemouth bass fishery, introductions of coldwater fish were made in 1969 to enhance the fishery and to fill a vacant niche. These fish included rainbow trout, cutthroat trout *O. clarkii*, hybrid bowcutt trout *O. mykiss* x *O. clarkii*, and silver salmon *O. kisutch*. Striped bass were also stocked at this time and up until 1972, at which time they were found to be naturally reproducing and stocking was discontinued. At the time of these introductions, the threadfin shad population had grown to become an over-abundant pelagic biomass mostly unavailable to littoral species. After ten years, however, striped bass had become well established in Lake Mead and they had depleted the threadfin shad population. Moreover, increasing evidence indicated that striped bass were negatively impacting the concurrently established salmonid fishery and contributing to the severe decline of the long established black crappie fishery. Trout stocking was discontinued in 1983 for a variety of reasons, including poor long-term returns and other demands on production capability. Poor condition factors persisted in both striped and black bass.

Since 2007, the management strategy for striped bass has been an attempt to manipulate the structure of the lake-wide population by encouraging anglers to harvest the large number of available fish in the smaller size ranges through increased possession limits. Increased harvest of the 12 to 15 in (305-381 mm) size cohort, primarily one and two year old fish, would decrease the impact on YOY shad, thus making more of the current shad production available to larger striped bass when they can feed upon them in late summer and early fall. Ideally, this should result in improved condition factors in larger fish. Similar regulations are now continuous throughout Lakes Powell, Mead, and Mohave, with an unlimited take of striped bass under 20 in (508 mm) and a 20 fish limit on striped bass over 20 in. Despite these regulation changes, abundant young cohorts of striped bass in Lake Mead are under-utilized because of many years of declining angler use.

Second to the popular striper fishery is the black bass fishery in Lake Mead. The largemouth bass population has remained stable over the past 10 years with a small increase in abundance seen over the past three years. Smallmouth bass, first detected in the creel survey in 1999, are now a large part of the tournament catch and are found lake-wide, although not quite as abundant as largemouth bass. The salmonid stocking program, reestablished in 1991, has been suspended as of March 2011 due to the Lake Mead Fish Hatchery closure.

The newest challenges to the Lake Mead fishery are invasive species. In 2007, two aquatic nuisance species (quagga mussel and gizzard shad) made their way to Lake Mead. The impact these species will have on the Lake Mead fishery is unknown at this time. So far, gizzard shad have been found to provide additional forage for striped bass; however, they grow rapidly to a size most fish cannot utilize as prey and could become competitors for food resources. Another recent invader, the New Zealand mud snail *Potamopyrgus antipodarum*, now inhabits the benthos with unknown effects to the fishery. Despite these invasions, Lake Mead continues to provide anglers with a variety of fishing opportunities.

OBJECTIVES and APPROACHES

Objective: To monitor angler use, catch, and fish population dynamics of the Lake Mead fishery.

Approaches:

- Evaluate angler success through at least 100 days of contact creel surveys at five angler access points on Boulder Basin and Overton Arm.
- Collect angler catch data from black bass tournaments.
- Conduct gillnetting and trammel net surveys lake-wide once in the fall in cooperation with AGFD.
- Conduct fall electroshocking surveys in cooperation with AGFD to evaluate changes in littoral zone fish species.
- Conduct summer black bass dive transects to assess impacts of reduced and variable lake elevations on black bass spawning and recruitment.
- Complete weekly meter net trawls during peak threadfin shad production.
- Conduct quarterly stomach content analysis of a minimum of 200 tournament caught striped bass to detect changes in their diet.
- Assess black crappie population status through up to 50 net nights of seasonal hoop netting in Overton Arm.
- Utilize creel, tournament, and monitoring data to assess sport fishery performance and changes, and develop estimates of sport fish availability and condition to inform anglers.

Objective: Lake Mead striped bass sonic telemetry study to better identify habitat requirements, habitat use and seasonal distribution of striped bass in Lake Mead.

Approaches:

- Surgically implant sonic transmitters in up to 20 adult striped bass.
- Track location, temperature, and depth of tagged striped bass throughout the year on a semi-weekly basis by locating fish through triangulation of the signal.
- Record location information via GPS and integrate that data into a GIS database.
- Habitat type and use will be validated via underwater observation when practical through SCUBA.

PROCEDURES

Creel Survey

A systematic creel survey was conducted on 73 separate creel days. A total of four landings were surveyed. Boulder Harbor and Hemenway were surveyed on a weekly basis, and Callville Bay and Echo Bay were surveyed less frequently from zero to three times a month. During the month of October, Lake Mead was closed due to a federal government shutdown. Limited creel surveys were conducted in November and December due to the vacant creel clerk position.

Creel survey contacts were made at boat landings on Lake Mead on a scheduled basis starting during the morning hours. Surveys were given for a continuous period of time, and information collected included total catch, unit of effort, bait type, species, angler origin, species preference, and presence of tags or marks on fish. Subsamples of harvested fish were weighed and measured to obtain length and weight data. Due to the vacant creel clerk position, fish samples were limited to January through June.

Black Bass Tournament Monitoring

Major largemouth bass fishing tournaments were monitored to evaluate weigh-in procedures, obtain any tag return data, and insure a proper release procedure was adhered to consistent with National Park Service (NPS) permitting. Additionally, from a subsample of the catch, species, length, and weight data were collected at eight selected tournaments after weigh-in and placement of fish in the live-release boat. Tournaments held in October were cancelled due to the federal government shutdown and subsequent closure of Lake Mead.

Gill Net Surveys

The gill net survey was carried out in the fall. Gill nets were set according to NDOW's Sport Fish Sampling Guidelines for Lakes, Ponds, and Reservoirs for gill netting warmwater species. An exception to the guidelines is the experimental gill nets

used by the NDOW on Lake Mead are multifilament experimental gill nets, 150 ft (46 m) in length, with five 30-ft (9 m) panels typically ranging in mesh size from 0.75 in to 3 in (19 to 76 mm). Nets were set overnight and not deeper than 40 ft. Fish were identified to species, weighed, measured, and released back to the lake.

Electroshocking Surveys

Sampling was done in the fall, during the evening hours using a boat equipped with a Coffelt shocking apparatus and a VVP-15B electrical box. Boat electroshocking methods described in NDOW's Sport Fish Sampling Guidelines for Lakes, Ponds, and Reservoirs were used. Fish were identified to species, measured, weighed, and released back to the lake.

Summer Dive Surveys

Dive counts were obtained by mask and snorkel. Observations were made at stratified random coves on the lake with cove selection dependent on visibility and clarity of water using methods described in NDOW's Sport Fish Sampling Guidelines for Lakes, Ponds, and Reservoirs for snorkeling. Dive transects were timed counts where all species were counted or estimated (e.g., threadfin shad schools), and black bass were further categorized into fry, fingerling, juvenile, or adult size classes.

Shad Trawls

Weekly meter net trawls for shad were conducted from May 13 to June 27, 2013. Samples were taken in the Boulder Basin and Overton Arm using established transects and procedures in accordance with a 1988 nutrient study protocols, but with reduced number of sample sites. The procedure for shad trawls, established in the 1988 protocol, consists of towing a cone-shaped net with an open end of 3.3 ft (1 m) in diameter and 0.06 in (1.6 mm) mesh screening. The net is 19.7 ft (6 m) in length, with a 10 in (25.4 cm) collecting cup on the end. The net is towed approximately 65.6 ft (20 m) behind the boat. The trawl lasts for 10 min at a boat speed of 2 knots (1,000 rpm engine speed) and is replicated three times to provide an average number. Flow is calculated using a flow meter at the mouth of the net that records water movement through the net such that flow through the hoop is calculated. Fish are counted and abundance is then converted to a value of fish/3,531.5 ft^3 (100 m^3) of water. This technique is efficient for small fish up to 0.8 in (20 mm) as larger fish tend to avoid the net and, therefore, is an estimate of reproductive success and does not represent a true recruitment value. In 1997 after eight years of trend data, sampling was streamlined to concentrate on weekly surveys during peak shad production. Peak production values are calculated as an average of the highest four or five weeks of shad production.

Hoop Net Survey

Hoop nets were set on March 13 and April 3 to assess the black crappie population. Seven hoop nets with a 2 ft (0.61 m) diameter were used with a 3.28-6.56 ft

(1-2 m) leader with a float and lead line. The nets were set according to NDOW's Sport Fish Sampling Guidelines for Lakes, Ponds, and Reservoirs for Frame Netting. Fish were identified to species, weighed, and measured and returned to the lake.

Striped Bass Telemetry Study

On November 21 and 29, 2011, striped bass were captured by hook and line in the Las Vegas Bay with the assistance of a licensed fishing guide. The fish were transported to the Lake Mead Fish Hatchery for implantation of sonic tags. On November 29, twenty striped bass were surgically implanted with sonic transmitters by NDOW's veterinarian Dr. Peregrine Wolff and assistant Chris Morris. The fish were held at the Lake Mead Fish Hatchery for a three-day post-anesthetic withdrawal period and then released to Lake Mead on December 2. Ten fish were released at Boulder Harbor in the Boulder Basin and nine fish were released at Echo Bay. There was one post-surgical mortality. Bi-weekly tracking efforts began December 7, 2011, and continued through May 7, 2013. During the months of June, July, and October, tracking efforts were postponed while general fisheries monitoring surveys were underway. Also, during times of windy weather, the tracking effort was reduced.

Tracking was done both actively and passively. Active tracking was accomplished with a Sonotronics Ultrasonic Receiver Model USR-08 and directional hydrophone. Initially, tracking sites would start in the mid channel of an area and progress in one-mile increments. If a tag was detected, efforts were made to pin point the location. Tag number, frequency, code, certainty of signal, time of day, water depth, temperature, location, and GPS coordinates were recorded. Passive tracking was attained through the use of seven submersible ultrasonic receiver (SUR) units placed throughout the lake. SUR data was downloaded to a laptop computer in the field and the SURs were reset.

FINDINGS

Creel Survey

A total of 73 days were expended conducting creel surveys on Lake Mead, contacting 563 anglers at four sites (Table 1). These anglers caught 2,108 fish of multiple species for a catch rate of 0.84 fish/angler hour. Anglers caught 3.92 fish/ angler day. By comparison, anglers had much better catch rates at 1.15 fish/angler hour and 5.25 fish/angler day in 2012. Of the 2,108 fish reported as captured, 1,216 were harvested. This resulted in a harvest rate of 0.45 fish/angler hour and 2.2 fish/angler day (compared to 0.72 and 3.5, respectively, in 2012). Species composition of harvested fish was led by striped bass at 91.37%, followed by channel catfish *Ictalurus punctatus* (4.61%), black bass (3.5%), bluegill (0.33%), and black crappie (0.16%) (Table 3). Angling effort (angler preference) for striped bass as a percentage of the total angling effort in 2013 was 80.2% of the total, with largemouth bass the second most sought after at 14.8% (Table 4). From samples of harvested fish, striped bass

averaged 15.6 in (395 mm) TL, 1.5 lbs (673 g), and had an average condition factor of 1.04 K_{FL}, with 29% in poor condition.

Table 1. Summary of docks surveyed for the 2013 creel survey.

Dock (Marina)	Days
Echo Bay	8
Callville Bay	9
Hemenway Harbor	20
Boulder Harbor	36
Total	73

Table 2. Lake Mead angler catch rate (fish/angler hour) by month, 2003-2013.

Month	Year										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	0.73	0.48	1.05	0.59	1.01	1.02	0.70	0.40	0.47	0.47	1.68
February	0.54	0.22	0.53	0.49	0.81	1.07	0.89	0.57	0.52	0.52	0.44
March	0.46	0.56	0.79	0.74	0.97	0.58	0.80	0.52	0.29	0.70	0.25
April	0.57	0.55	0.91	1.24	1.01	1.47	1.23	0.82	0.60	0.56	0.47
May	0.93	1.17	1.14	1.77	1.5	1.67	1.56	1.33	0.77	1.08	2.07
June	0.62	0.94	1.02	1.53	0.64	1.53	2.14	1.10	0.67	1.60	0.98
July	0.50	0.99	1.39	1.27	1.48	1.38	1.03	0.90	0.72	1.42	0.83
August	1.15	1.13	1.44	1.30	1.72	1.31	0.96	0.89	1.20	1.98	0.66
September	1.01	1.20	1.47	1.02	1.23	1.42	0.90	0.98	1.20	1.38	0.85
October	1.06	1.20	1.29	1.01	1.21	1.33	1.46	1.04	0.97	0.90	---
November	0.92	1.28	1.42	0.93	1.36	1.22	0.52	0.73	1.05	1.01	0.60
December	1.08	1.45	0.78	1.14	1.3	0.83	0.76	0.47	1.58	2.14	0.42
Average	0.80	0.93	1.10	1.08	1.19	1.24	1.08	0.81	0.84	1.15	0.84

Large- and smallmouth bass percent of observed harvest increased this year to 3.5% compared to 0.64% of the total harvest in 2012 (Table 3). This harvest figure represents only a portion of the angler use on Lake Mead for black bass because of the catch-and-release nature of this fishery, with 81.4% of black bass captured released back to the lake. Preference largemouth bass anglers as a percentage of all anglers continues to grow at 14.8% in 2013 (Table 4). Smallmouth bass are combined together with largemouth bass in the creel data in terms of harvest and preference.

Channel catfish was the second most harvested fish on Lake Mead in 2013 with a harvest rate of 4.61% of the total harvest (Table 3). Interest for catfish increased from

that seen in 2012 and was 1.8% of the surveyed angling effort (Table 4). A small number of bluegill were reported in the creel survey, making up 0.33% of the catch. A small number of black crappie were also observed in the creel survey at 0.16% of the catch. Black crappie were all captured in the Overton Arm area. Prior to 2013, black crappie had not been observed in the creel survey since 2003.

Table 3. Composition of catch by species (percentage of total harvest), 2003-2013.

Species	YEAR										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Black bass	0.57	0.99	0.55	0.47	0.24	0.28	0.72	0.43	0.98	0.64	3.5
Bluegill	0.20	0.03	0.19	0.14	0.11	0.06	0	0	0.78	0.53	0.33
Black crappie	0.22	0	0	0	0	0	0	0	0	0	0.16
Channel catfish	5.45	5.9	5.22	4.14	2.38	3.45	2.96	5.91	7.7	3.46	4.61
Rainbow trout	7.48	1.3	0.4	1.56	4.33	2.18	7.28	12.02	3.13	0	0
Striped bass	86.08	91.8	93.6	93.65	92.93	94.02	88.89	81.64	87.4	95.2	91.37

Table 4. Lake Mead angler effort by species preference (percent of total angler use), 2003-2013.

Species	Year										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Largemouth bass	15.3	23.4	16.6	16.9	6.1	5.4	8.0	5.1	8.7	11.2	14.8
Bluegill	0	0.1	0.1	0	0	0	0	0	0	0	0
Black crappie	0.5	0	0.2	0	0	0	0	0	0	0	0
Channel catfish	2.0	1.0	0.7	0.8	0.6	0.7	1.1	1.0	1.8	0.75	1.8
Rainbow trout	14.7	1.2	1.0	2.12	5.4	5.9	7.0	11.1	3.9	0	0
Striped bass	61.0	63.6	69.2	65.4	84.2	85.1	75.2	75.8	78.7	84.8	80.2
Multiple or any	6.5	10.7	12.4	14.8	3.6	2.8	8.7	7.0	6.6	3.0	2.9

In 2013, the percentage of out-of-state anglers increased from the past four years. Nevada anglers made up 77.6%, California 1.4%, Arizona 1.8%, and anglers from other states or countries made up 19.2% of angler use on Lake Mead. Angler use on Lake Mead in 2013 included anglers visiting Lake Mead from 26 states and 4 countries (Table 5).

Table 5. Angler origin by state of residence (percentage of total angler use), 2003-2013.

STATE	Year										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Nevada	87.4	85.3	75.9	74.2	78.5	75.5	86.0	88.6	84.8	87.0	77.6
California	0.5	2.3	3.7	6.6	3.0	3.4	2.1	1.1	2.3	1.4	1.4
Arizona	1.9	0.3	1.7	2.1	0.6	1.4	0.6	0.1	0.2	0.6	1.8
Other	10.2	12.2	18.7	17.0	17.9	19.5	11.3	10.2	12.7	11.0	19.2

The Mail-in Angler Questionnaire Survey is another source of data to track trends in angler use and fishing success. Angler use at Lake Mead has dropped since the late 1990s by 15,000 to 20,000 anglers from the high of 43,000 anglers in the late 1990s. Fishing success continues to be good with anglers catching over 3.5 fish/day in 2012 (Figure 1), which is consistent with the catch/day observed in the 2012 creel survey. The number of angler days has been fairly consistent at around 150,000 angler days since 2009 (Figure 2).

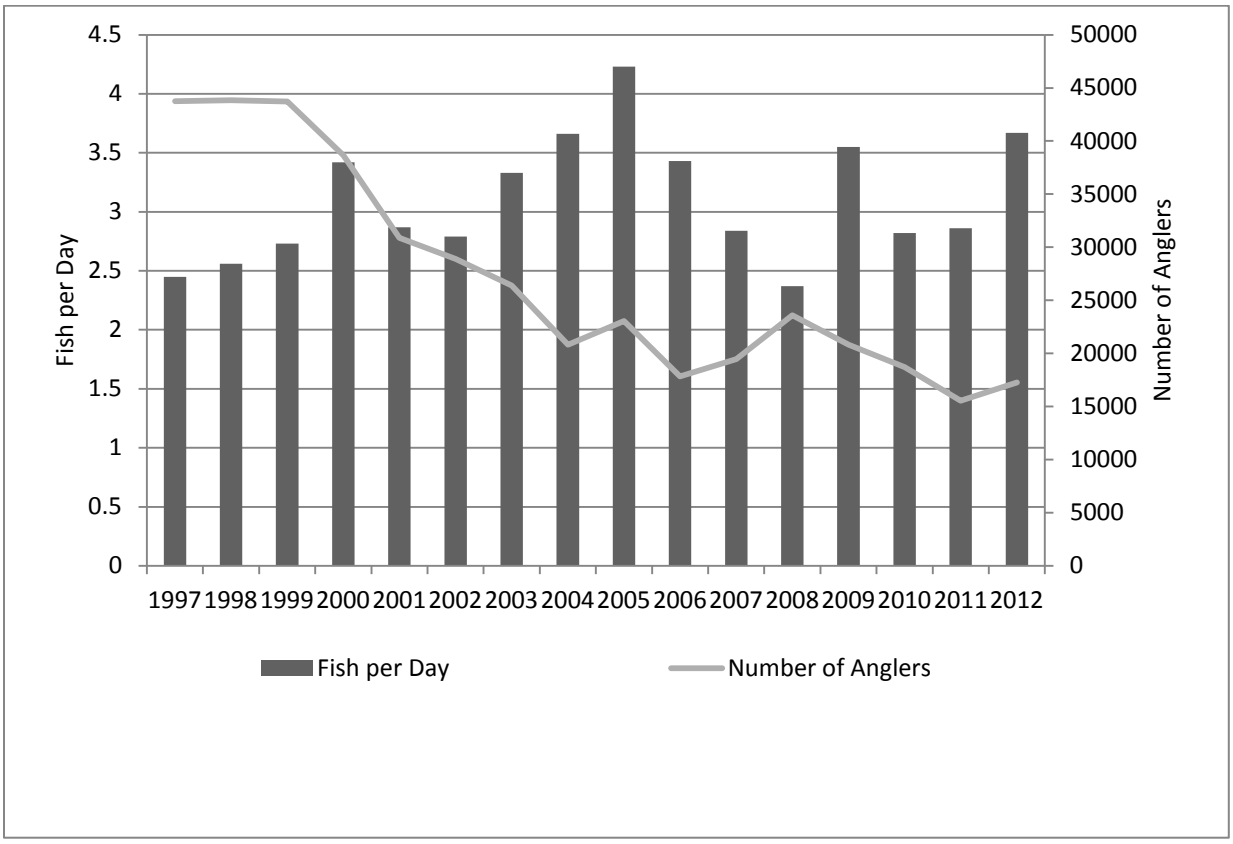

Figure 1. Number of anglers and fish per day from the 10% angler questionnaire data for Lake Mead, 1997-2012.

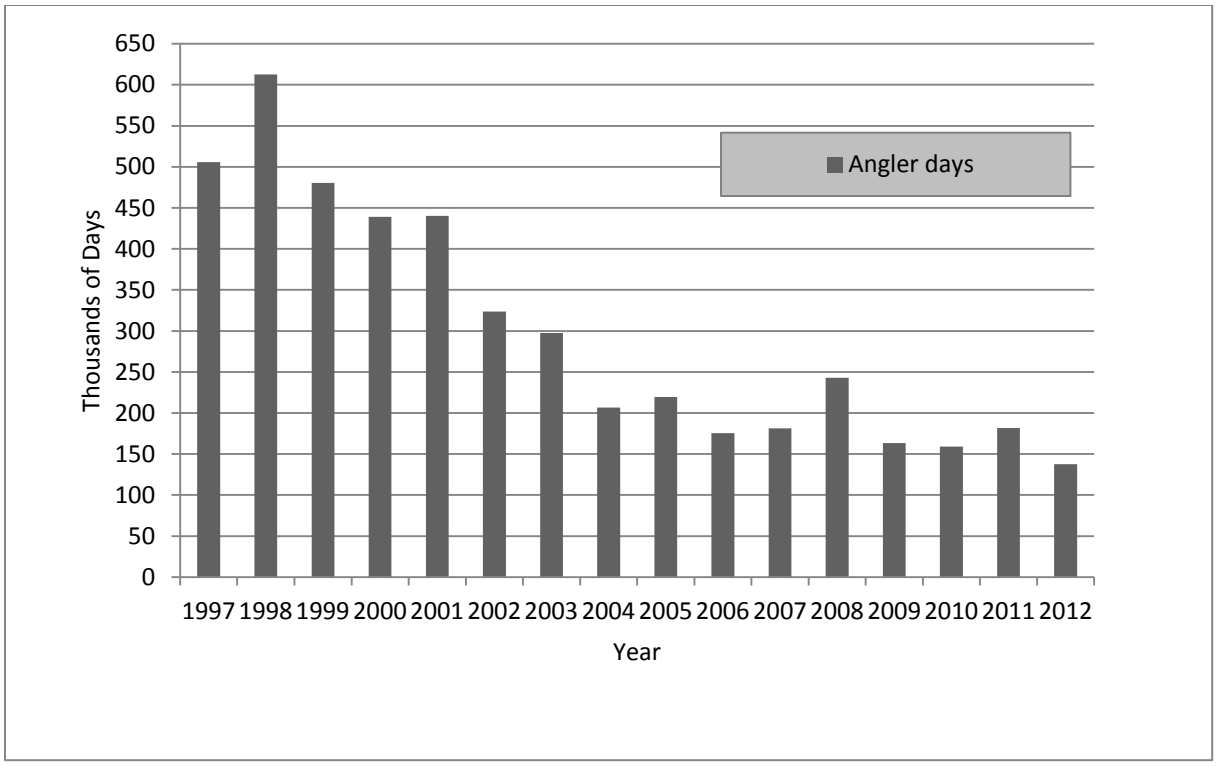

Figure 2. Angler days from the 10% angler questionnaire data for Lake Mead, 1997-2012.

Black Bass Tournament Monitoring

There were approximately 24 black bass tournaments permitted through the NPS on Lake Mead in 2013. Eight of those tournaments were attended to collect species, length, and weight data for investigating trends in the black bass fishery. From subsamples of the tournament weigh-in, 152 largemouth bass and 136 smallmouth bass were measured. Largemouth bass averaged 15.6 in (396 mm) TL and weighed an average of 2 lbs (907 g) with a W_r of 91.0. Largemouth bass condition has shown improvement over the past two years. The reasons for this increase in condition are unknown (Figure 3), although the peak in condition in 2012 does correspond to a drop in the gizzard shad catch-per-unit-effort (CPUE) during the same time. Smallmouth bass averaged 15.8 in (401 mm) TL and weighed an average of 1.9 lbs (862 g) with a W_r of 85.1. Smallmouth bass condition improved only a small amount over time compared to largemouth bass (Figure 3). The presence of smallmouth bass in the tournament catch remained similar to last year at 38%.

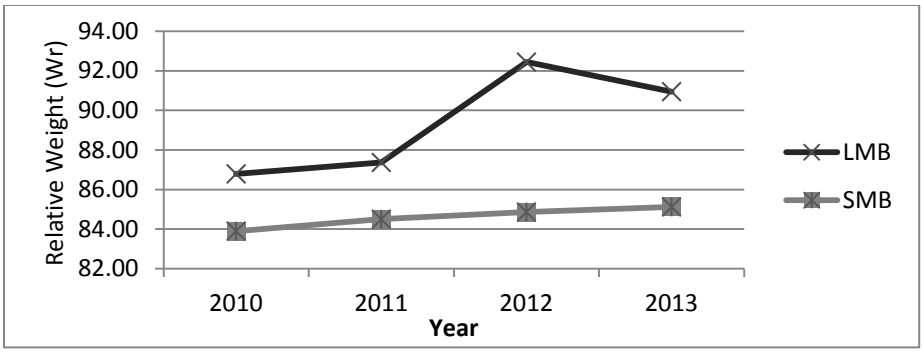

Figure 3. Black bass condition (relative weight) for largemouth bass (LMB) and smallmouth bass (SMB). Samples taken from the tournament catch, 2010-2013.

Summer Dive Surveys

Dive surveys were completed from July 8 to August 23, 2013. Mask and snorkel count times averaged 22 minutes (min)/diver/transect. From the 10 transects surveyed, 329 black bass were observed, of which 181 were largemouth bass and 148 were smallmouth bass. Both largemouth and smallmouth bass YOY abundance decreased in 2013, as seen in observations/30 min dive transect (Figure 4). Sub-adult largemouth bass abundance decreased as well; however, the sub-adult smallmouth bass abundance was similar for 2013 as it was in 2012 (Figure 5). Both adult largemouth and adult smallmouth bass had small increases in observations in 2013 over that of 2012 (Figure 6).

Overall, the rate of observation was 19.8 bass/30 min dive transect compared to 23.9 bass/30 min dive transect observed in 2012. The majority of the largemouth bass (57.5%) were fingerling, followed by 26.5% adult, and 16.0% juvenile. For smallmouth bass, 40.5% were fingerling, 40.5% juvenile, and 18.9% adult (Table 6). Lake level declines continued in 2013. After the lake elevation increased 50 ft (15.24 m) in 2011, the elevation has dropped 27.45 ft (8.37 m) since then. This has reduced the amount of flooded tamarisk *Tamarix* spp. and reduced the amount of available cover for largemouth bass.

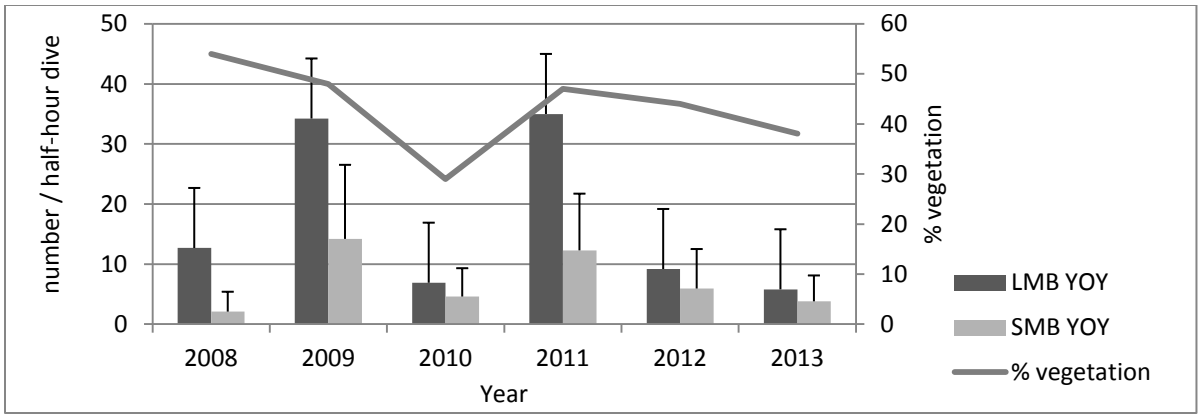

Figure 4. Black bass young-of-year dive observations and percent vegetative cover, 2008-2013 (LMB=largemouth bass, SMB=smallmouth bass).

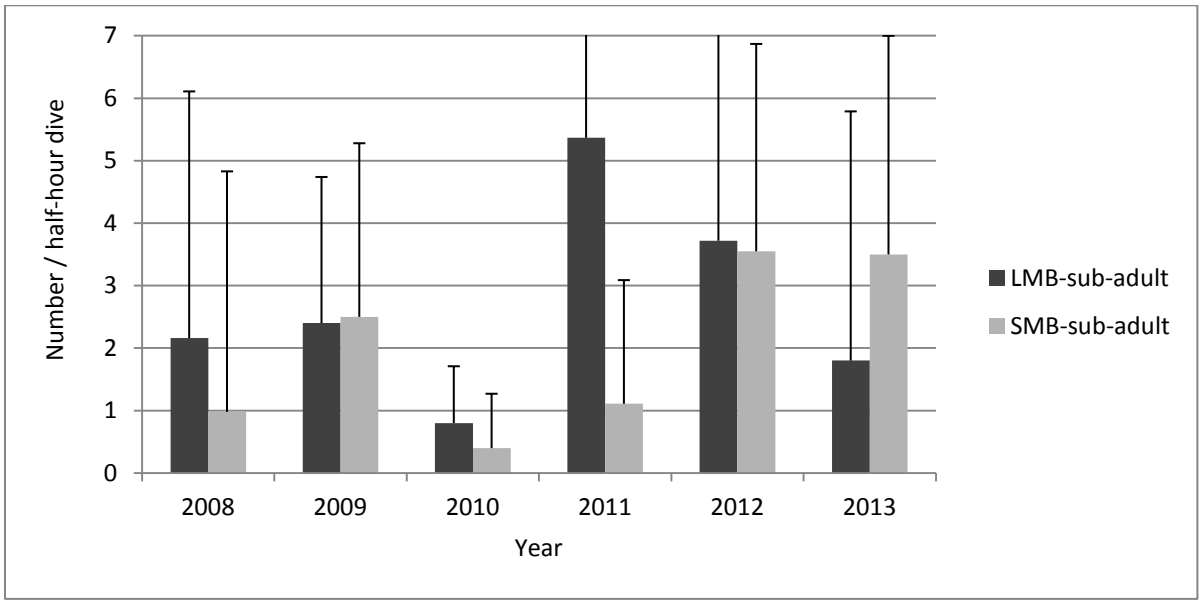

Figure 5. Black bass sub-adult dive observations, 2008-2013. (LMB=largemouth bass, SMB=smallmouth bass).

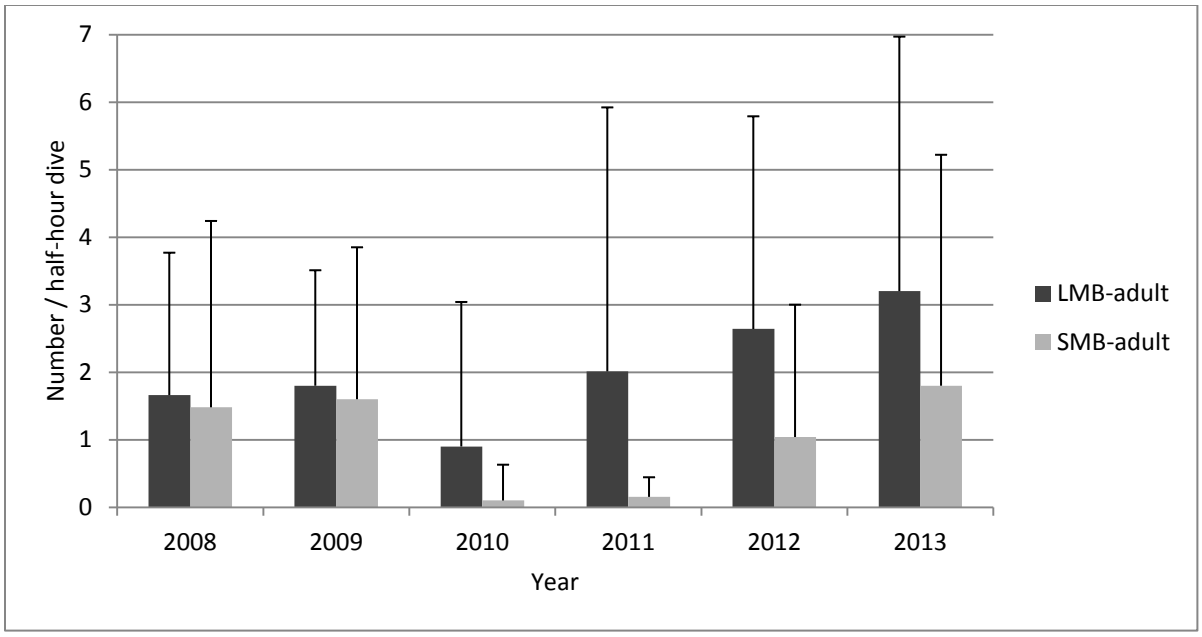

Figure 6. Black bass adult dive observations, 2008-2013 (LMB=largemouth bass, SMB=smallmouth bass).

Table 6. Black bass dive observations by percentage of age class, 2013.

Species	Class			
	Fry	Fingerling	Juvenile	Adult
Largemouth bass	0%	57.5%	16.0%	26.5%
Smallmouth bass	0%	40.5%	40.5%	18.9%

Electroshocking Surveys

The electroshocking survey was conducted from September 30 to October 17 in conjunction with the gill net survey. A total of 34 electroshocking sites were sampled (14 of those sites were sampled by NDOW) for 525 min of effort and a yield of 1,788 fish of 14 species. Bluegill and green sunfish were the most numerous in the catch, followed by largemouth bass, threadfin shad, and gizzard shad (Table 7).

Striped bass YOY CPUE remained low for the fifth year for reasons unknown. Largemouth and smallmouth bass CPUE increased in 2013 after low numbers in 2012. Bluegill CPUE was high for the second year following the lake elevation increase of 2011 that provided improved habitat conditions for the sunfish with inundated tamarisk for cover (Figure 7, Table 8).

Table 7. Lake Mead electroshocking survey sampling summary, 2013.

Species	Number of Fish	CPUE[a]	Percent Composition	Average TL inches (mm)	Average Weight lbs (g)
Black crappie	2	0.06	0.11	4.4 (112)	0.06 (20)
Bluegill	798	23.44	44.6	2.8 (72)	0.02 (11)
Bullhead catfish[b]	3	0.09	0.2	5.9 (151)	0.13 (57)
Carp[c]	65	1.91	3.6	22.2 (564)	6.01 (2724)
Channel catfish	6	0.18	0.3	10.9 (277)	0.99 (447)
Green sunfish	469	13.78	26.2	2.4 (61)	0.02 (8)
Largemouth bass	152	4.47	8.5	6.5 (165)	0.30 (135)
Striped bass	25	0.71	1.4	6.4 (162)	0.18 (81)
Smallmouth bass	40	1.18	2.2	5.2 (133)	0.11 (49)
Threadfin shad	120	3.53	6.7	3.2 (81)	0.02 (7)
Gizzard shad	90	2.64	5.0	6.9 (174)	0.39 (176)
Blue tilapia[d]	11	0.32	0.6	7.0 (179)	0.38 (172)
Mosquitofish[e]	2	0.06	0.11	1.9 (48)	0.004 (2)
Red shiner[f]	5	0.15	0.3	2.0 (51)	0.004 (2)
Totals	1,788	52.5	100		

[a]units in number of fish caught during 15 min of electroshocking (f/15 min)
[b]*Ameiurus* sp.
[c]*Cyprinus carpio*
[d]*Oreochromis aureus*
[e]*Gambusia affinis*
[f]*Cyprinella lutrensis*

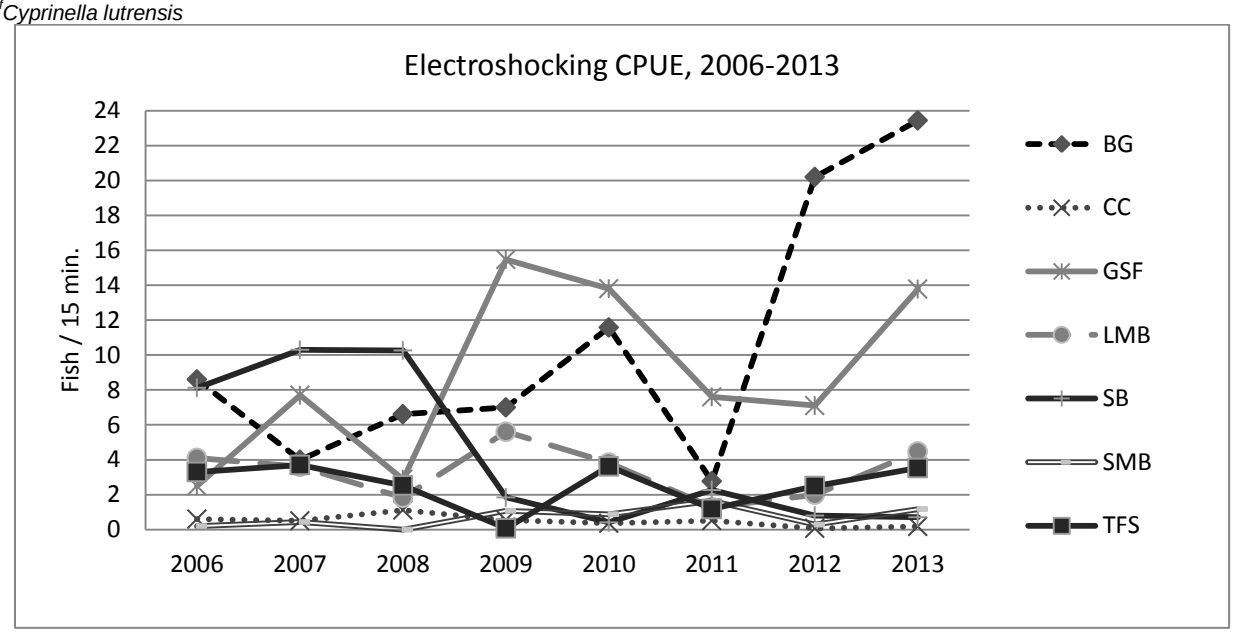

Figure 7. Lake Mead fall electroshocking survey CPUE, 2006 to 2013. (BG=bluegill, CC=channel catfish, GSF=green sunfish, LMB=largemouth bass, SB=striped bass, and SMB=smallmouth bass).

Table 8. Lake Mead electroshocking catch rates (f/15-min), 2008-2013.

Species	Year					
	2008	2009	2010	2011	2012	2013
Black crappie	0.14	0	0	0.3	0	0.06
Bluegill sunfish	6.61	7.00	11.58	2.77	20.2	23.44
Bullhead catfish	0	0	0.05	0	0.03	0.09
Carp	3.37	1.18	1.03	0.36	1.3	1.91
Channel catfish	1.12	0.55	0.36	0.51	0.07	0.18
Gizzard shad	0.07	1.92	1.96	0.62	0.24	2.64
Green sunfish	2.88	15.47	13.81	7.6	7.1	13.78
Largemouth bass	1.83	5.60	3.83	1.28	2.0	4.47
Red shiner	0	0.66	1.55	0	0.17	0.15
Smallmouth bass	0	1.07	0.98	1.64	0.28	1.18
Striped bass	10.26	1.84	0.41	2.26	0.8	0.71
Threadfin shad	2.53	0.07	3.62	1.18	2.49	3.53
Blue tilapia	0.07	0.99	0.57	0.1	0.07	0.32
Mosquitofish	---	---	---	---	---	0.06
Totals	28.89	36.35	39.66	18.43	34.8	52.5

Gill Net Survey

The annual fall gill net survey was conducted from October 1 through October 29. Random sites were selected from AGFD. A total of 83 nets were set for an average of 18 hrs each, totaling 124.7 net-nights of effort (NDOW's effort was 46 nets). A total of 1,939 fish were captured for a catch rate of 15.5 fish/net-night (Table 9). The most numerous fish captured was gizzard shad at 61.5% of the catch, followed by striped bass (10.2%), largemouth bass (6.2%), and carp (6.1%). Gizzard shad also comprised the majority of the biomass at 62.5%, followed by common carp (15.8%) and striped bass (8.1%).

Striped bass captured in this year's survey were an average of 14.6 in (372 mm), 1.1 lb (501 g). Compared to last year, striped bass average total length has decreased 1.3 in (33 mm) (Figure 8); however, the average weight was the same. Striped bass were found to be in good condition with K_{FL} factors averaging 1.13 (Table 10), with 22% having a condition factor K_{FL} less than 1.0 and considered to be in poor condition. By basin, striped bass in Overton Arm had the best condition, followed by Boulder and

Virgin Basin. Striped bass in Greggs Basin had the lowest condition factor with the highest percentage of fish in poor condition.

Table 9. Data summary for 2013 fall Lake Mead gill net sampling.

Species	Number of Fish	Fish / Net Night	Percent Composition	Average TL (mm)	Average Weight (g)	Percent Biomass
Black crappie	13	0.1	0.7	8.4 (213)	0.4 (178)	0.19
Blue tilapia	43	0.34	2.2	9.7 (246)	0.9 (428)	1.47
Bluegill	8	0.06	0.4	4.9 (124)	0.1 (56)	0.04
Bullhead catfish	8	0.06	0.4	10.4 (265)	0.6 (282)	0.16
Carp	119	0.95	6.1	18.4 (468)	3.6 (1634)	15.77
Channel catfish	87	0.70	4.5	16.7 (423)	1.7 (752)	5.33
Flannelmouth sucker[a]	7	0.06	0.4	15.9 (404)	1.4 (634)	0.36
Gizzard shad	1,193	9.57	61.5	13.7 (349)	1.4 (644)	62.49
Green sunfish	9	0.07	0.5	6.4 (163)	0.2 (110)	0.08
Largemouth bass	121	0.97	6.2	10.7 (271)	0.7 (314)	3.11
Razorback sucker[b]	2	0.02	0.1	22.4 (568)	4.6 (2100)	0.34
Smallmouth bass	83	0.67	4.3	11.5 (292)	0.8 (354)	2.45
Striped bass	197	1.58	10.2	14.6 (372)	1.1 (501)	8.14
Threadfin shad	49	0.39	2.5	4.1 (104)	0.03 (12)	0.05
Totals	1,939	15.5	100.0			100.0

[a]*Catostomus latipinnis*
[b]*Xyrauchen texanus*

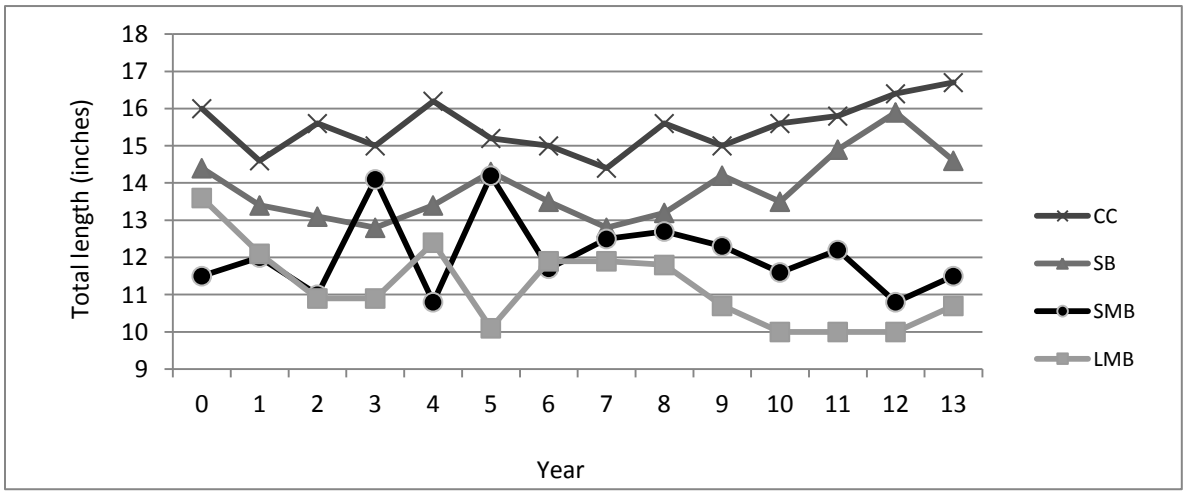

Figure 8. Mean TL (in) for fish captured during fall gill netting, 2000-2013. (CC=channel catfish, SB=striped bass, SMB=smallmouth bass, and LMB=largemouth bass)

Table 10. Average condition [relative weight (W*r*) and Fulton's K_{FL}] of fish captured during gill net surveys by basin, 2013.

	LMB[a] W_r	SMB[b] W_r	CC[c] W_r	SB[d] K_{FL}	SB % in poor condition ($K_{FL<1.0}$)
Boulder Basin	92.2	84.2	92.6	1.16	10.3
Overton Arm	90.5	84.0	94.3	1.17	16.7
Virgin Basin	86.6	87.3	95.6	1.14	9.1
Greggs Basin	91.5	83.6	90.5	1.05	42.0
Overall	91.0	84.5	93.5	1.13	22.2

[a]LMB=largemouth bass
[b]SMB = smallmouth bass
[c]CC = channel catfish
[d]SB = striped bass

The largemouth bass catch rate was slightly less than last year with a CPUE of 0.97 fish/net-night (Table 11, Figure 9). Mean total length increased to 10.7 in (271 mm) (Figure 8). Largemouth bass condition was considered average, with an average W_r of 91.0. Boulder Basin had the best-conditioned largemouth bass (Table 10). Smallmouth bass CPUE slightly increased from last year to 0.67 fish/net-night. Smallmouth bass average length increased by 1.3 in (33 mm) for a total length of 11.8 in (300 mm) (Table 11, Figure 8). The average smallmouth bass condition in W_r was 84.5, with the best-conditioned smallmouth bass located in the Virgin Basin (Table 10).

Channel catfish CPUE showed little change compared to last year at 0.7 fish/net-night. Their average size continues to increase to nearly 17 in (432 mm), the largest average length for catfish over the past 13 years (Figure 8). Channel catfish condition as W_r averaged 93.5, with Virgin Basin and Overton Arm having the most robust catfish (Table 10).

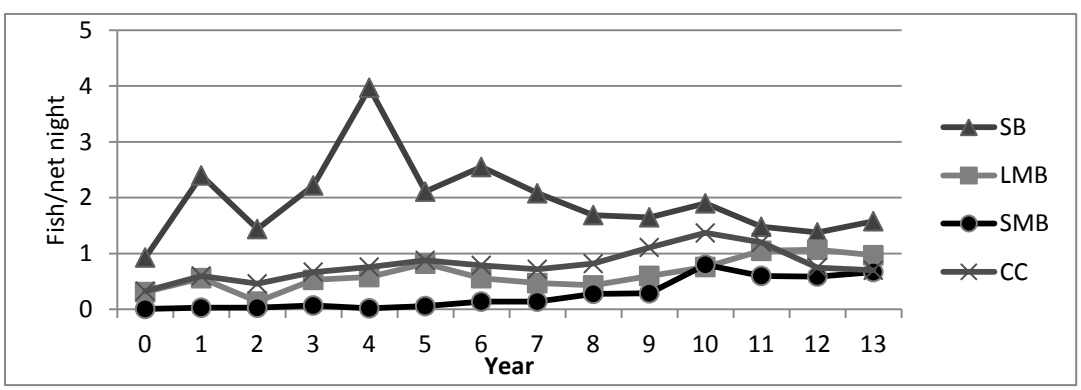

Figure 9. Fall gill net CPUE, 2000-2013. (SB=striped bass; LMB=largemouth bass; SMB=smallmouth bass; and CC=channel catfish)

Table 11. Average fish/net-night, Lake Mead fall gill net surveys, 2003-2013.

	Year										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
# of nets	97	78	91	93	94	95	91	87	93	77	83
Net Nights	176.3	123.6	170.4	140.3	133.6	145.3	140.4	136.1	140.4	111.4	124.7
Species											
Carp	1.1	1.47	1.13	1.93	1.2	1.76	1.30	1.42	0.98	1.64	0.95
Channel catfish	0.67	0.76	0.88	0.79	0.72	0.82	1.11	1.37	1.20	0.75	0.70
Black crappie	0.02			0.01	0.01	0.02	0.13	0.01	0.08		0.1
Bullhead catfish	0.02		0.01	0.01			0.01	0.4	0.21	0.06	0.06
LM bass	0.53	0.58	0.82	0.56	0.47	0.43	0.60	0.76	1.05	1.07	0.97
SM bass	0.07	0.02	0.06	0.14	0.14	0.28	0.29	0.80	0.60	0.59	0.67
Striped bass	2.22	3.97	2.11	2.55	2.08	1.69	1.65	1.90	1.48	1.38	1.58
Walleye[a]											
Threadfin shad	0.64	0.82	0.25	1.05	1.47	0.78	0.98	1.51	0.43	0.33	0.39
Rainbow trout											
Razorback sucker		0.02				0.02	0.03	0.04	0.01	0.03	0.02
Flannelmouth sucker				0.01				0.01		0.04	0.06
Blue tilapia	0.2	0.06	0.70	0.19	0.31	0.25	0.83	0.20	0.32	0.55	0.34
Bluegill	0.01	0.02	0.11			0.06	0.09	0.02	0.04	0.10	0.06
Green Sunfish	0.04	0.07	0.05	0.04	0.02	0.05	0.06	0.17	0.05	0.13	0.07
Gizzard shad					0.08	0.73	5.17	11.25	8.29	7.03	9.57
Total	5.52	7.78	6.12	7.27	6.53	6.89	12.24	19.5	14.75	13.72	15.5

[a]*Sander vitreus*

Gizzard shad became well established in Lake Mead reaching maximum CPUE in 2010 at 11.25 fish/net-night. By 2012, gizzard shad CPUE dropped to 7.03 fish/net-night. In 2013, the CPUE increased to 9.57 fish/net-night (Figure 10). Gizzard shad continue to be the most numerous fish in the gill net surveys. In 2010, the gizzard shad length frequency distribution showed the population was bimodal with half the population as larger adults and the other half as YOY, 5 to 10 in (127-254 mm). Since that time, the population has shifted to mostly larger individuals greater than 12 in (305 mm). In 2013, the proportion of smaller fish increased, yet the population is still mostly larger fish (Figure 11).

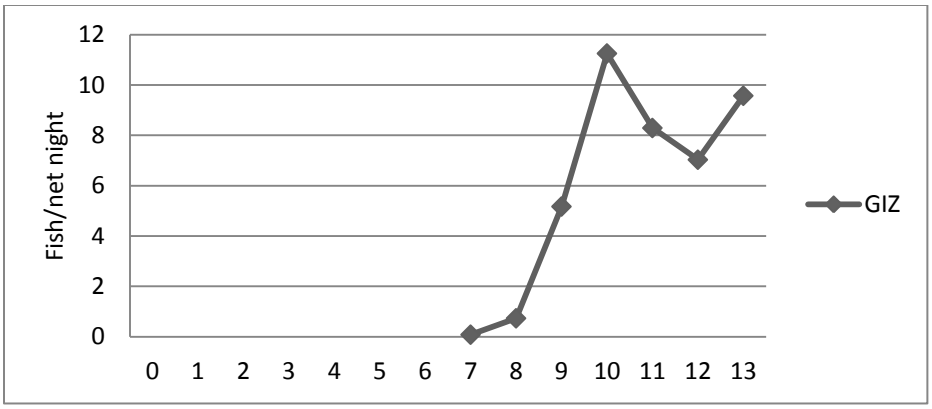

Figure 10. Fall gill net gizzard shad CPUE as fish/net-night, 2007-2013.

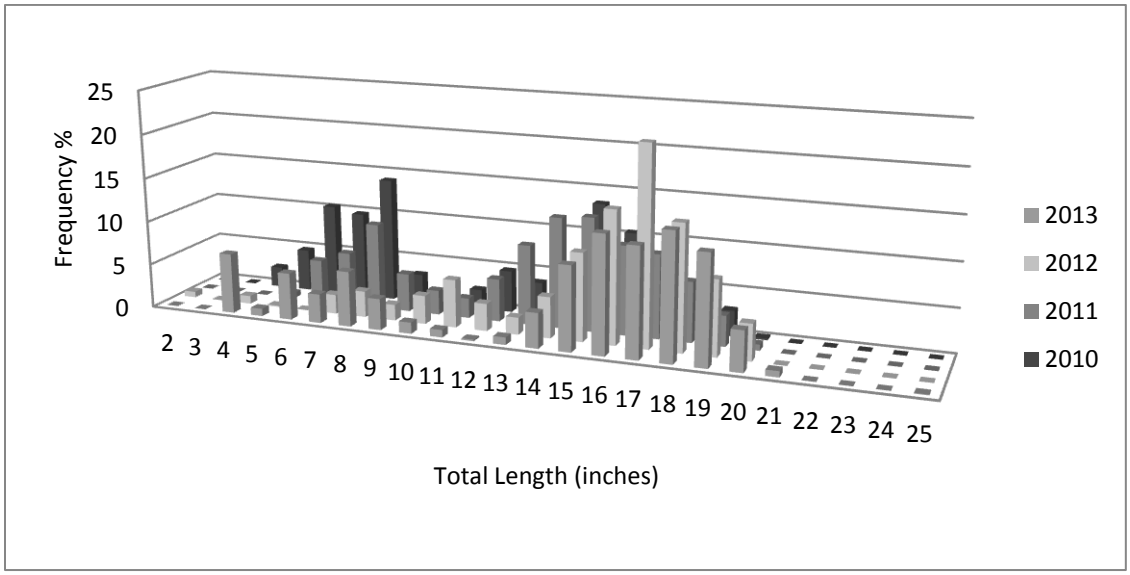

Figure 11. Fall gill net gizzard shad length frequency distribution, 2010-2013.

Prey Base Studies

Threadfin shad reproduction was monitored from mid-May through June in two basins of Lake Mead. A total of 34 separate standard transects were taken in the Overton Arm and the Boulder Basin (including Las Vegas Bay). The 2013 lake-wide larval shad production estimate (peak values) on Lake Mead was below average at 42.4 fish/3,531 ft^3 (100 m^3) [11-year average = 90.1 fish/3,531 ft^3 (100 m^3)] (Figure 12, Table 12). This year, Boulder Basin and Overton Arm had low shad production at 49.1 and 34.9 shad/3,531 ft^3 (100 m^3), respectively (Table 12). This is the third poor shad year for Boulder Basin and the fourth poor shad year for the Overton Arm. While Boulder Basin shad production increased in 2013, values were still below peak production numbers. Two or three years of low shad production followed by a year of peak production is the typical pattern observed on Lake Mead (Figure 12).

The second week of shad trawls in the Overton Arm, an angler reported dead carp up near the Virgin River inflow. A few days later, a story broke out about "mystery foam" and a fish kill in the Overton Arm. Initial reports cautioned visitors against swimming in the water or eating the fish, yet reported water samples of the area showed no toxins (Associated Press 2013). On June 6, the upper Overton Arm was investigated for dead fish. The highest concentration of dead fish was seen along the shores of The Meadows area. Most of these fish were dead carp; however, there were one or two dead channel catfish, largemouth bass, and striped bass. A few dead carp were seen in areas south of The Meadows. No dead gizzard shad were noted even though they are quite abundant near inflow areas. Though the cause of the mystery foam was not confirmed, it was thought to have come from a die-off of diatoms due to extreme heat conditions. It was believed that the die-off of diatoms then caused a low dissolved oxygen situation, which would have killed small numbers of fish. It is unknown whether the mystery foam had any impact on shad reproduction.

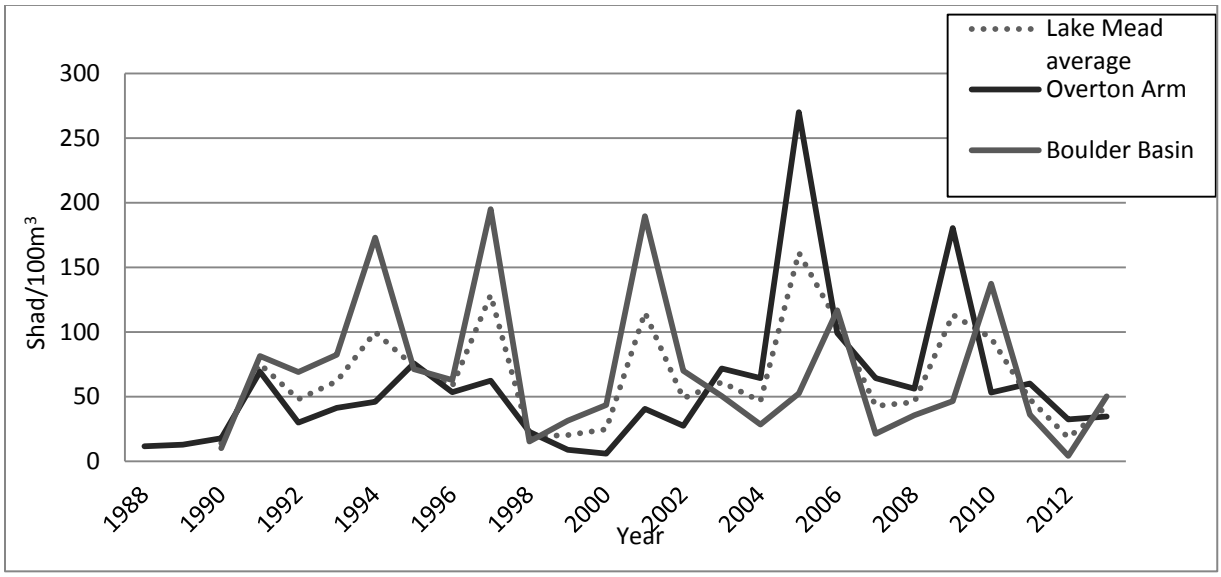

Figure 12. Shad densities during peak production periods, 1988-2013.

Striped Bass Fisheries Assessment:

Harvested striped bass were slightly larger this year averaging 16.6 in (422 mm) and 1.5 lbs (673 g), with an average condition factor of 1.04 K_{FL}, a drop from that observed in 2012 (1.05 K_{FL}). Of the 273 striped bass sampled (January through June) in the creel surveys, 80 (29.3%) had a condition factor less than 1.0 K_{FL} (a value considered to represent poor condition). Angling pressure on striped bass decreased to 80.2% (down from 84.8% last year), while angling pressure for black bass increased. Harvest rates dropped from last year to 0.55 fish/hr (compared to 0.84 fish/hr) for successful striped bass preference anglers. The striped bass percent of total observed harvest has remained high at 91.4%.

Table 12. Lake Mead average peak shad production, 2003-2013.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Period covered	5/21-6/26	5/13-6/23	5/17-6/23	5/23-5/29	5/9-7/2	6/10-6/26	6/02-7/1	6/02-7/7	5/24-7/5	6/6-7/5	5/13-6/27
Number of weeks (Overton/Boulder Basin)	4/5	4/5	4/5	4/5	6/7	2/3	5	5/4	4/5	5/4	5/5
Overton Arm Transects											
M-1	5.59	25.1	218	17.4	24.3	Dry	Dry	Dry	Dry	Dry	Dry
F-1	62.5	64.9	333	59.5	83.2	6.3	199.3	0.9	36.7	2.9	2.0
F-2	136.6	138.1	265	132.8	131.8	38.8	294.5	131.2	64.9	56.6	33.5
F-3	80.4	76.3	290	145.1	66.6	83.9	119.8	48.0	76.9	44.6	42.0
F-4	73.0	17.8	244	140.7	15.7	95.2	107.7	32.4	61.5	25.8	62.0
Overton Arm average	71.6	64.4	270	99.1	64.3	56.1	180.3	58.1	60	32.5	34.87
Las Vegas Bay and Boulder Basin Transects											
ILVB	61.2	49.7	75	238.3	25.9	44.2	83.67	118.5	11.7	2.0	73.4
MLVB	68.6	27.9	56	89.4	31.7	56.4	38.03	281.4	83.1	8.5	68.6
BB	21.8	7.55	26	22.4	5.9	5.9	17.79	12.0	13.2	1.6	5.4
Boulder Basin average	50.5	28.4	52.3	116.7	21.1	35.5	46.50	137.3	36.0	4.1	49.13
Lake wide average	61.1	46.4	161.2	107.9	42.7	45.8	113.4	95.2	48.0	18.3	42.4

In the fall gill net sample, 197 striped bass were caught. They averaged 14.6 in (372 mm), weighed an average of 1.1 lbs (501 g), and had an average condition factor of 1.13 K_{FL}, an increase from the 0.94 K_{FL} observed in 2012. Striped bass total length decreased by 1.3 in (33 mm) compared to 2012. CPUE in the gill net sample increased slightly for striped bass from 1.38 in 2012 to 1.58 fish/net-night in 2013 (Table 11). Striped bass proportional stock density (PSD) from the gill net survey shows the population is back to being comprised mostly of small striped bass after what appeared to be an increasing trend toward larger striped bass (20 in [508 mm] and greater) seen from 2006-2012 (Figure 13). The length frequency distribution further shows that the bulk of the striped bass population falls between 13-19 in (330-483 mm), with few fish 20 in (508 mm) and greater (Figure 14).

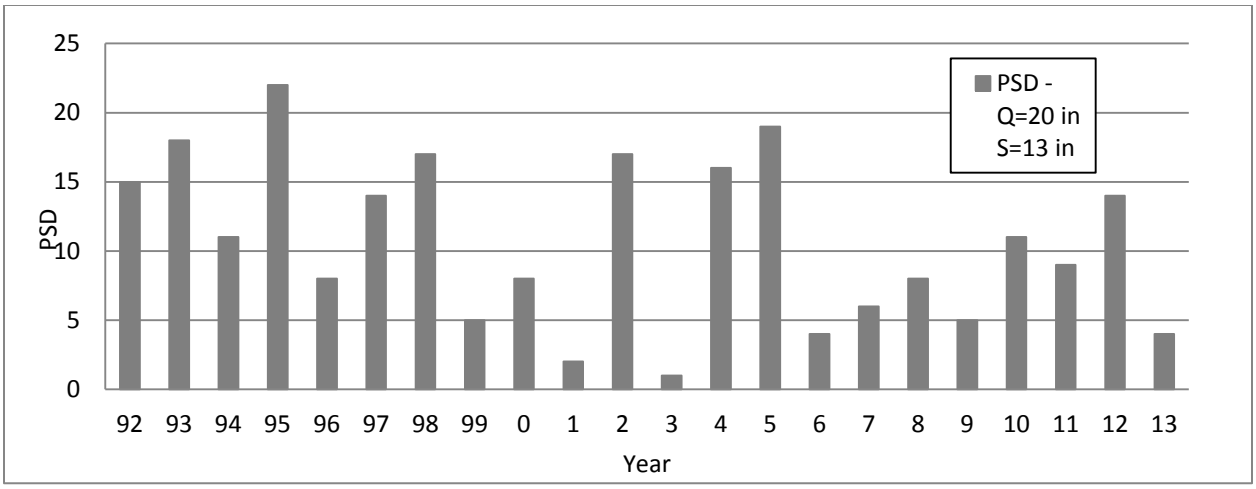

Figure 13. Striped bass proportional stock density (PSD) from Lake Mead gill net surveys, 1992-2013.

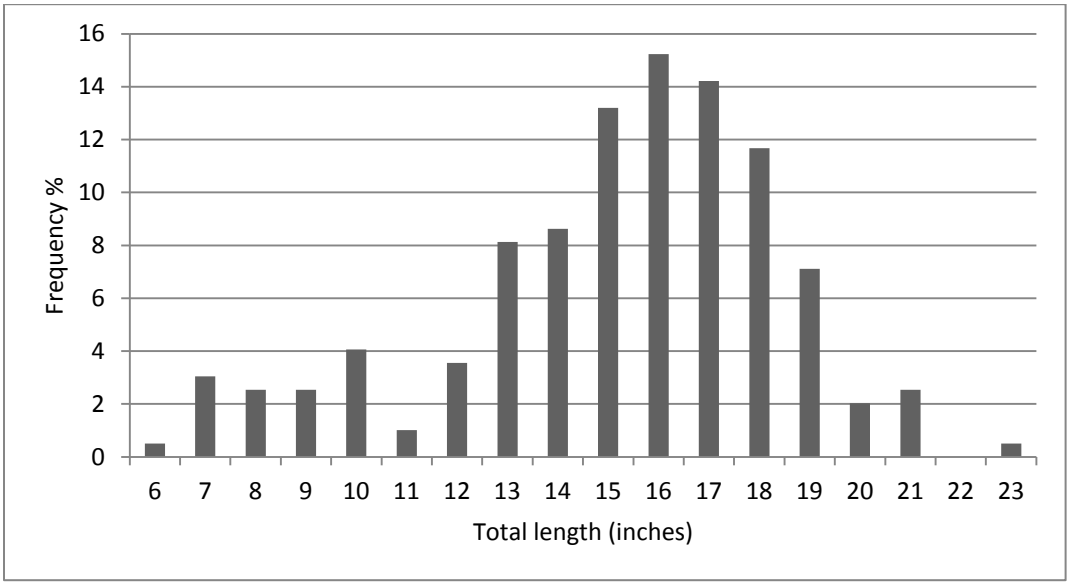

Figure 14. Striped bass length frequency distribution from the Lake Mead fall gill net survey, 2013.

In addition to the NDOW surveys, striped bass data was volunteered from three striped bass tournaments held by the Nevada Striper Club in 2013 (March 17, June 16, and September 15). A total of 164 striped bass were sampled during these events, averaging 19.3 in (490 mm) TL and 2.4 lbs (1,097 g) in weight (Table 13). Stomach samples were visually analyzed with estimates of content noted, as shown in Table 14. The 2013 catch information from the club volunteers showed no change in fish size compared to those sampled in 2012. The average condition factor K_{FL} decreased to 1.04 from the K_{FL} of 1.06 observed in 2012, and was consistent with that seen in the creel harvest (K_{FL} =1.04).

Table 13. Striped bass tournament data summary, 2013.

Date		Avg. TL in (mm)	Avg. weight lbs. (g)	Avg. K (FL)	% in Poor Condition (K (FL)=<1.0)
3/17/2013	n=64	20.5 (521)	3.1 (1,409)	1.06	26.56
6/16/2013	n=51	18.5 (470)	7.1 (931)	1.02	37.25
9/15/2013	n=49	18.2 (469)	1.9 (861)	1.03	34.7
Overall Average n=164		19.3 (490)	2.4 (1,097)	1.04	32.3

The analysis of gut samples has been reduced to a cursory inspection to note the major food items by season of occurrence. This will be used to provide a baseline for striped bass food habits by noting shifts in content composition or the use of sub-standard prey items. Because the inspection is of tournament caught fish, there are inherent biases with much of the stomach content reflecting what the anglers used as bait. Table 14 summarizes data for the 2008 through 2013 period. Due to the low productivity of threadfin shad in 2013, anchovy (Engraulidae) and crayfish *Probambarus clarkii* ranked high in their occurrence in stomach samples. The increasing number of gizzard shad in the diet reflects both their popularity as bait and as food for the striped bass (Table 14).

Table 14. Lake Mead striped bass ranked stomach content, 2008-2013.

Food item	2008		2009		2010		2011		2012		2013	
	#	Rank	#	Rank	#	Rank	#	Rank	#	Rank	#	Rank
Empty	140	1	65	1	163	1	87	1	183	1	62	1
Crayfish	23	4	22	3	10	5	11	5	23	4	17	3
Corn	14	5	14	4	4	6	2		21	5		
Shad	40	3	11	5	47	3	62	2	19	6		
Plant matter												
Striped bass	1						1		1			
Shad as bait	1				4	6	6	5	8		7	6
Unidentified fish	5		1		13	4	27	4	25	3	17	3
Anchovy	81	2	65	2	81	2	28	3	99	2	38	2
Trout	10	6										
Clams	2		2	6	2		1		3			
Quagga mussel	1		1		1				3			
Gizzard Shad							5	6	9		13	5
Gizzard shad as bait									10		14	4
Rock	3		1		1		1		11			
n(total)	286		149		324		230		372		164	

Black Bass Fisheries Assessment:

The black bass fishery is monitored through a variety of survey methods including general creel information, limited spring or summer dive surveys, gill netting, electroshocking, and data collection at professional bass tournaments. Data from creel surveys show the harvest of largemouth bass in 2013 has increased to 3.5% of the total reported harvest, and angling effort or percent of angler preference for largemouth bass also increased to 14.8% of the total. This appears to mark a renewed interest in the black bass fishery, considering that between 2007 and 2011, angler interest in largemouth bass has been less than 10% of the total angler preference. Harvest figures increased this year as well. Typically, harvest figures are less than 1% of the total harvest, mostly because of the catch-and-release practices of bass anglers.

Summer dive surveys showed decreases in abundance for both small- and largemouth bass YOY. The decrease in YOY may be due to dropping lake elevations, especially during the spawning period. The lake-wide gill net survey showed little change in black bass abundance for both small- and largemouth bass from 2011 to 2013. The electroshocking survey showed a slight decrease in CPUE for smallmouth bass and a slight increase in CPUE for largemouth bass.

Over the past 12 years, smallmouth bass have become well established in Lake Mead. Since their discovery in tournament catches on the lake in 1999, smallmouth bass abundance has grown. Currently, smallmouth bass make up over 30% of the tournament catch and are more prevalent in the catch during the cooler months. Samples taken from tournaments revealed largemouth bass averaged 15.6 in (396 mm) and 2.0 lbs (907 g), with a W_r of 90.0, and smallmouth bass averaged 15.8 in (401 mm) and 1.9 lbs (862 g), with a W_r of 85.1.

Black Crappie Fisheries Assessment:

A group of seven hoop nets was set in the Overton Arm area overnight on two occasions, on March 13 and April 3, for 14 net-nights of effort. No black crappie were captured. Species captured included bluegill (14), green sunfish (8), and smallmouth bass (2). Black crappie were found in gill nets and electroshocking surveys in the fall and two black crappie were reported in the creel surveys in May. The gill nets yielded 13 black crappie, mostly from the Overton Arm area with a few from Gregg Basin. They averaged 8.4 in (213 mm) TL and 0.4 lb (178 g). Two young black crappie were caught in the electrofishing survey, averaging 4.4 in (112 mm) TL and 0.04 lb (20 g). The black crappie fishery is small and mostly limited to the Overton Arm, with only a few captures in the Gregg Basin. Hoop nets set in the spring have been ineffective at catching black crappie. Gill nets, electroshocking, and creel surveys seem to be adequate in monitoring this species.

Salmonid Fisheries Assessment:

No trout were stocked in 2013, and no trout were captured using any survey method.

GENERAL MANAGEMENT REVIEW

The approaches for the general management objective were completed. The objectives were met through creel surveys, tournament data collection, gillnetting, electroshocking, dive surveys, shad trawls, hoop netting, and striped bass stomach content analysis.

LAKE MEAD STRIPED BASS SONIC TELEMETRY STUDY

Introduction

Striped bass are the most common, most harvested, and most sought after sport fish in Lake Mead. The striped bass is subject to multiple stressors including continued changes to habitat distribution and quality from long-term lake level declines and recent invasion of quagga mussels and gizzard shad. There is limited information concerning the recent impacts of environmental and biological changes in Lake Mead to the striped bass fishery. Most importantly, declines in angler use and harvest have corresponded with these changes. Better information is needed regarding seasonal movement and habitat uses of striped bass in order to help anglers better utilize this fishery. The objective of this study is to better identify habitat requirements, habitat use, and seasonal distribution of striped bass in Lake Mead through sonic telemetry.

Study Area

Lake Mead is located in southern Nevada and northern Arizona, and lies along the border between the two states (Figure 15). At full pool, the lake's elevation is 1,221 ft (372.3 m) at the spillway, and the maximum depth is 519 ft (158 m) (Holdren and Turner 2010). During the study period, long-term drought conditions had reduced the lake's elevation to 1,108 to 1,132 ft (338-345 m), which reduced the maximum depth by as much as 113 ft (34.3 m). Lake Mead begins to thermally stratify in May or June and destratifies in November (Holdren and Turner 2010; SNWA 2010). Lake Mead leans more toward an oligotrophic productivity status (SNWA 2010), with more nutrient-rich areas located at the inflow areas. These inflow areas are Las Vegas Bay (LVB), Virgin/Muddy River inflows, and the Colorado River inflow (CRI) (Holdren and Turner 2010). The lake is adequately oxygenated throughout the water column for the entire year (SNWA 2010).

The initial study areas included the Boulder Basin and Overton Arm areas of the lake. Study fish were released at Echo Bay and Boulder Harbor. Initial tracking efforts were directed to the LVB, Boulder Basin, and Overton Arm. As the fish were found to utilize the entire lake, areas of the Virgin Basin and Gregg Basin were occasionally

sampled through active tracking and through the use of submersible ultrasonic receivers (SURs).

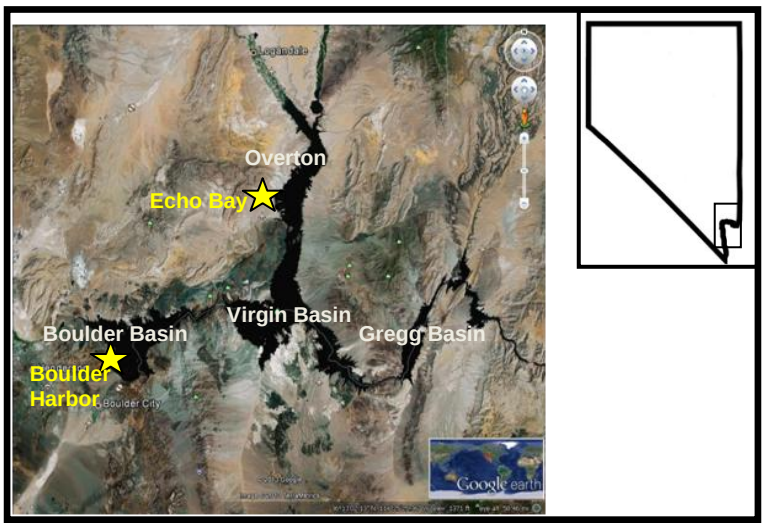

Figure 15. Satellite image of Lake Mead, NV/AZ. Google Earth. Accessed 02/26/13.

Methods

Striped bass were captured by hook-and-line with the aid of a local fishing guide, Mark Edison. Two fishing trips were necessary to capture enough striped bass of adequate size. After capture, the fish were held in live wells and transported to the Lake Mead Fish Hatchery where they were held in two raceways. The fishing trips were scheduled one week apart due to the availability of the fishing guide. Because of this, one group of fish was held for a week prior to surgery and the other group was captured on the same day as their tag surgery. The sonic telemetry tags (Sonotronics CT-05-36-I) were surgically implanted by NDOW wildlife veterinarian Peregrine Wolff. The fish were anesthetized with Benzocaine prior to surgery and returned to a post-operative recovery raceway after surgery. All fish were found to recover from the anesthetic rapidly once placed in the recovery tank. The sonic tagged fish averaged 18.4 in (467 mm) TL with a range of 15.4 to 21.3 in (392-540 mm) TL. They weighed an average of 2.1 lbs (961 g), with a range of 1.4 to 3.4 lbs (630-1530 g) (Table 15).The fish were held for a post-anesthetic 72 hr withdrawal period before being released back to the lake.

The sonic-tagged fish were released to Boulder Harbor and Echo Bay on December 2, 2011. The fish were tracked on a bi-weekly basis in Boulder Basin and Overton Arm using both active and passive tracking methods, with other areas of the lake sampled less frequently. Active tracking was accomplished using a Sonotronics Ultrasonic Receiver, model USR-08, a DH-4 directional hydrophone and headphones. Tracking was performed in mid-channel open water areas in one-mile (1.6 km) increments in a given area. If a tag was detected, efforts were made to pin point the location. Tag number, frequency, code, certainty of signal, time of day, water depth, temperature, location, and GPS coordinates were recorded. A YSI (Yellow Springs Instruments) model 556 multi-parameter probe was used to collect water quality profiles

in areas of fish detections (Appendix 1). Passive tracking was achieved with seven SURs located throughout the lake at narrow canyons that divide the lake's basins (Figure 16). These devices were submerged approximately 30 ft (9.1 m), with a cable attached to a rock on shore in both the Overton Arm and Las Vegas Bay areas. They were stationary and detect the sonic signals when fish are in the area. Data was retrieved by pulling up the SUR and downloading the data to a computer.

Table 15. Striped bass tag numbers, tag frequency, tag code, and length and weight of individually sonic-tagged fish.

Tag No.	Frequency (kHz)	Code	TL in (mm)	WT lb (g)
47	70	3365	20.1 (510)	2.4 (1110)
48	71	3366	16.1 (410)	1.4 (630)
49	72	3437	16.3 (415)	1.5 (690)
50	73	3438	16.7 (425)	1.6 (720)
51	74	3474	18.7 (475)	2.2 (990)
52	75	3475	21.3 (540)	3.0 (1370)
53	76	3557	18.6 (473)	2.2 (990)
54	77	3558	19.3 (490)	2.2 (990)
55	78	3636	20.1 (510)	2.4 (1090)
56	79	3637	18.3 (465)	1.9 (850)
122*	70	3567	20.1 (510)	2.6 (1190)
123*	71	3656	21.3 (540)	3.4 (1530)
124*	72	3657	17.1 (435)	1.9 (850)
125*	73	3758	19.3 (490)	2.2 (990)
126*	74	3767	19.3 (490)	2.4 (1090)
127*	75	4458	16.5 (420)	1.6 (710)
128*	76	4465	16.6 (422)	1.7 (770)
129*	77	4558	20.5 (520)	3.0 (1350)
130*	78	4566	16.1 (410)	1.4 (630)
131*	79	4677	15.4 (392)	1.5 (690)
Average			18.4 (467)	2.1 (961)
Range			15.4-21.3 (392-540)	1.4-3.4 (630-1530)

*Presumed mortality in first month of study.

Results

Active tracking began after fish were released at Boulder Harbor and Echo Bay (Figure 15). The beginning of the study was marked by a high level of mortality. One fish died post operatively at the hatchery and, in December, five other tagged striped bass were found throughout the lake exhibiting no movement and later presumed dead. Two fish found in January and February had no movement on subsequent detections, and two were never located. From the tag numbers of the dead fish, it was determined that these fish were from the group that was captured on the same day as their tag

implantation surgery. In the group that was captured one week prior to surgery, approximately 40% died during the week prior to surgery. It is thought that during this week-long waiting period, the weaker fish died, leaving the stronger fish to be tagged. It is this group that had the highest survival. Similarly, a study by Pelle and Paulson (1993) had high mortality rates of 40% within the first three weeks of their study.

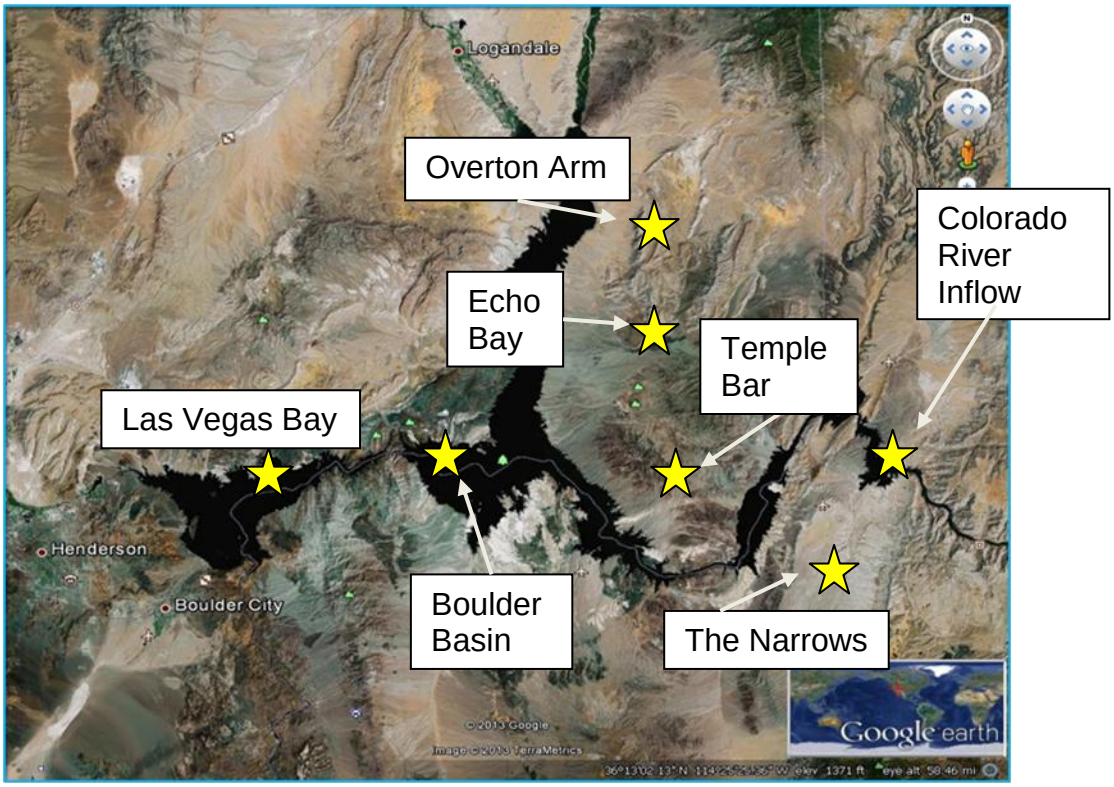

Figure 16. Satellite image of SUR locations. Google Earth. Accessed 1/2014.

<u>Movement</u>

With 8 fish dead by January 2012, and another 2 dead by February and April, 10 tagged fish were left to track. Early into the study, five tagged striped bass were found to travel large expanses of the lake. By February 2012, three fish released at Boulder Harbor and two fish released at Echo Bay had found their way approximately 40 mi upstream to the CRI area (Figure 17 and 18). Three additional fish moved to the inflow area by March and April. By April, no striped bass remained in the Overton Arm. The water temperature at the Las Vegas Bay in February was 13.73 to 14.31°C, and corresponded to the temperature associated with striped bass spawning (14°C) (Allan and Roden 1978, and references therein). The upper Overton Arm water temperature was cooler than that for spawning at 11.02 to 12.15°C at the end of January (Appendix 1). By April, three of the fish that went to the CRI returned to the Las Vegas Bay. Two of these fish were Echo Bay releases.

During the late spring and summer, seven fish were found to use the LVB and Boulder Basin area. These fish were most often found through SUR tracking and not active tracking. Fish using the LVB were found to be in deeper water than where they were found in the winter months. In late May as the thermocline was developing, striped bass were often tracked to areas where the water was 55 to 120 ft (16.8-36.6 m) deep. Fish in Boulder Basin were found in somewhat shallower water during this time period. Two fish were tracked to the Las Vegas Boat Harbor, with one located under the tire wall (40 ft [12.2 m] depth) and one located under the restaurant (29 ft (8.8 m) depth). The fish tracked to the tire wall was harvested by an angler on 4/23/2012. The tag tracked to the restaurant on 9/20/12 was later tracked to a cove near Beehive Island. This tag has been inactive since 12/4/12 and the fish was presumed dead. Another fish detected in the Boulder Basin was captured by an angler near Boulder Harbor. By December 2012, only one fish was detected in active or SUR tracking. Twelve of the fish at that point were known to be dead, though it is doubtful that eight fish remain alive. Some of these fish may have traveled upstream and found a cold-water refuge during the summer and may not have yet returned to the lake. However, it is possible that many of these fish were captured and harvested, and anglers did not report catching them. Tracking efforts ceased on May 7, 2013.

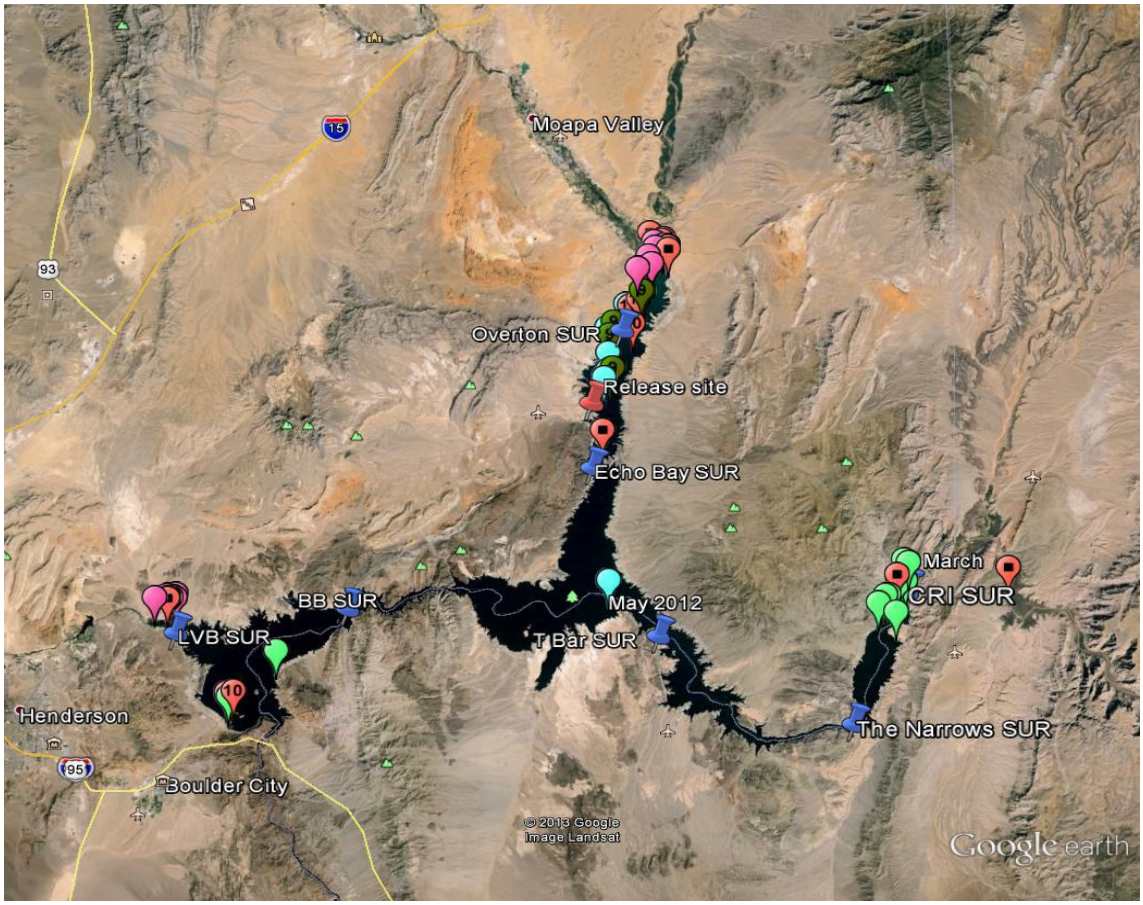

Figure 17. Tracked locations of sonic-tagged striped bass released to Echo Bay. Google Earth. Accessed 1/2014.

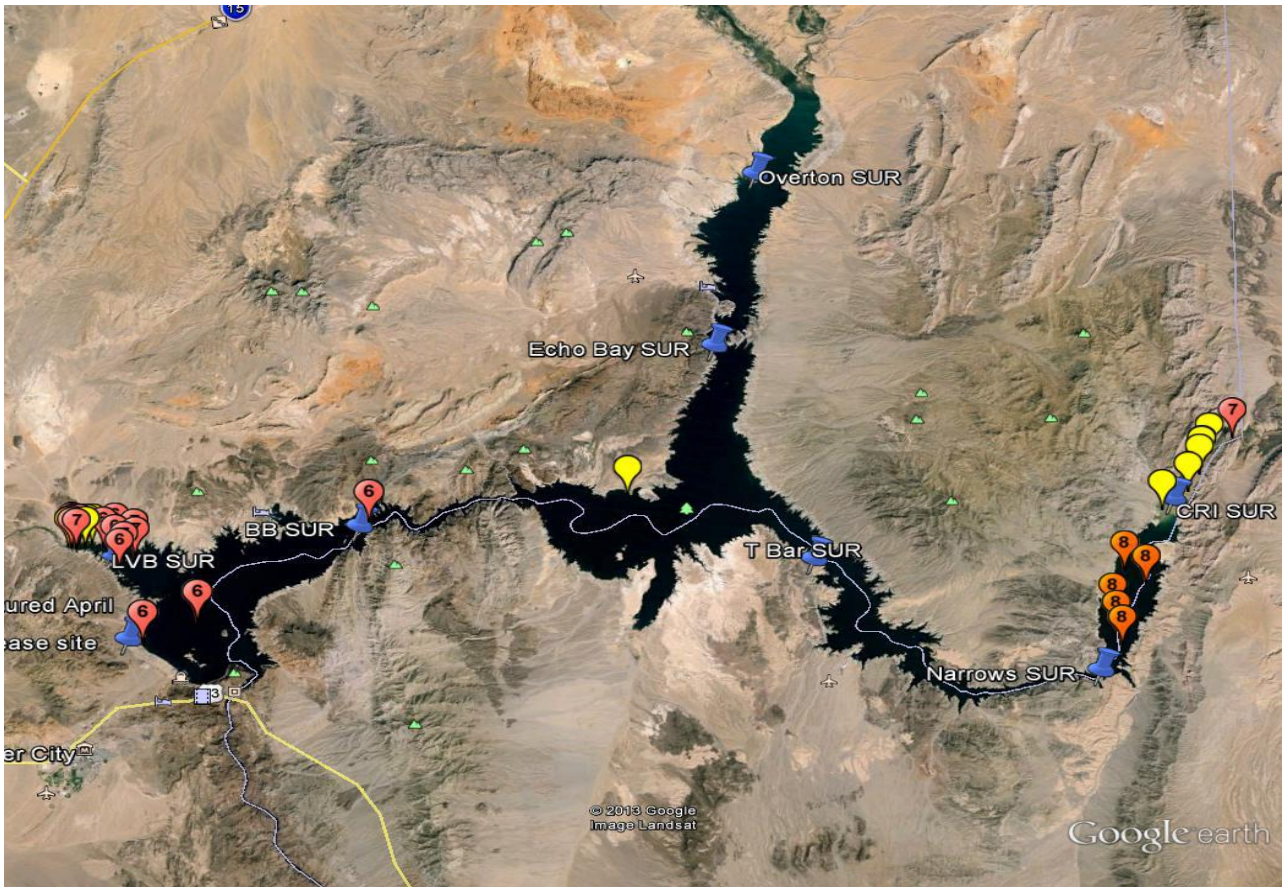

Figure 18. Tracked locations of sonic-tagged striped bass released to Boulder Harbor. Google Earth. Accessed 1/2014.

Tracked Locations of Individual Fish

Fish 47

This fish was released to Echo Bay. During the first week of release, fish 47 was located south of Echo Bay at Ramshead Island (Figure 19). The next week the fish moved up to the Virgin River inflow area and stayed in that area until the last week of February 2012. It was later detected by SURs and active tracking in the CRI area. Through active tracking, this fish was found to utilize the turbid riverine portions of the lake, almost up to Pierce Ferry. From the end of March to June 1, the fish was tracked to the LVB SUR on an almost daily basis. The fish was heard through active tracking once in April and three times in May in the LVB. The fish was not detected after June 1, 2012.

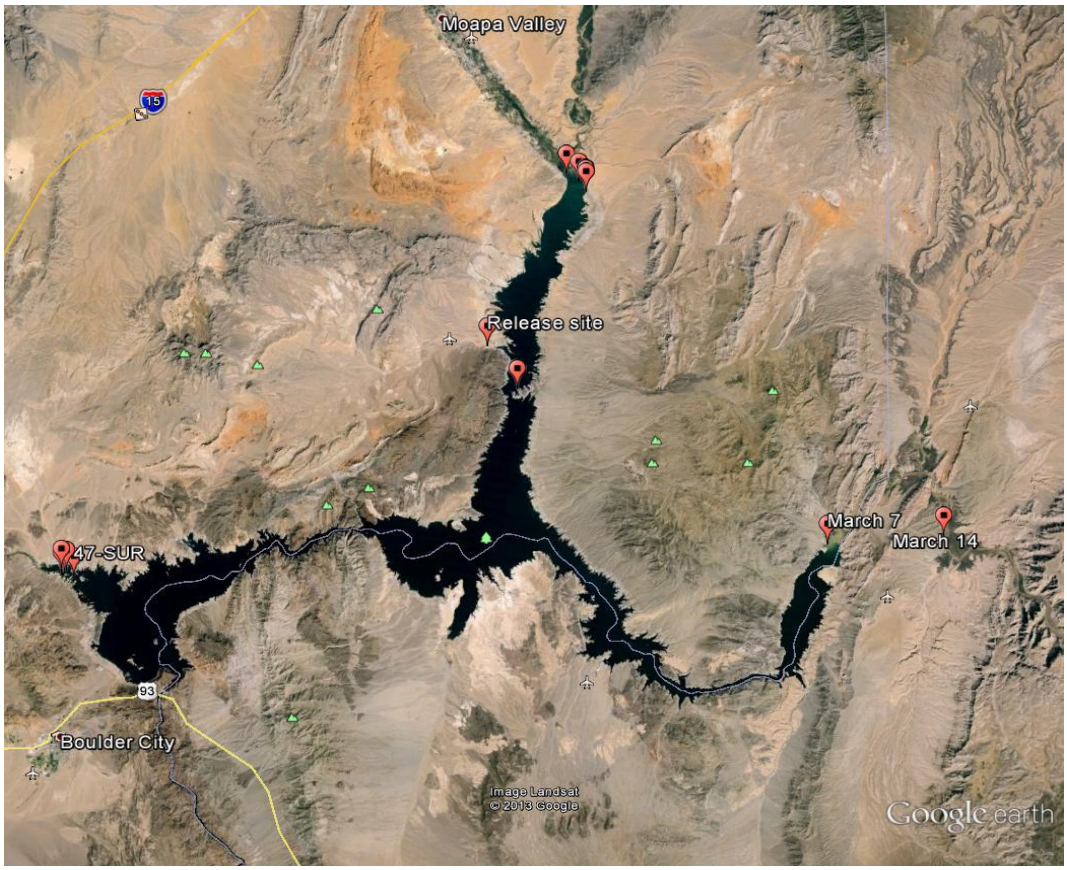

Figure 19. Satellite image of tracked locations of Fish 47. Google Earth. Accessed 1/2014.

Fish 48

Fish 48 was one of the smaller striped bass at 16 in (406 mm) and 1.4 lb (635 g), yet was tracked the longest. This fish was released to Boulder Harbor. Initial tracking efforts located this fish in the LVB from 12/12 to 12/28/2011 (Figure 20). By 1/6/2012, this fish was detected moving toward the CRI by pinging at SURs located at Boulder Basin and Temple Bar, and by 1/17/2013, the fish was tracked to the CRI area and was routinely detected from SURs in that area through the end of July 2012. On August 3, the fish was detected at the Boulder Basin SUR and the following day at the LVB SUR. From September through December 28, the fish was detected at the LVB SUR on an almost daily basis. On 1/2/13, the fish went back to the CRI for approximately one month with a visit to the Boulder Basin SUR once during that time period. By February 2, 2013, the fish was back in LVB, but only stayed a short while before returning to the CRI. The fish was detected in the Gregg Basin and CRI area through the use of the SURs through April 9, 2013. Between 4/18 and 4/19/13, the fish was detected at the Echo Bay SUR then the Overton SUR and back to the Echo Bay SUR. The fish was not heard from since 4/19/2013.

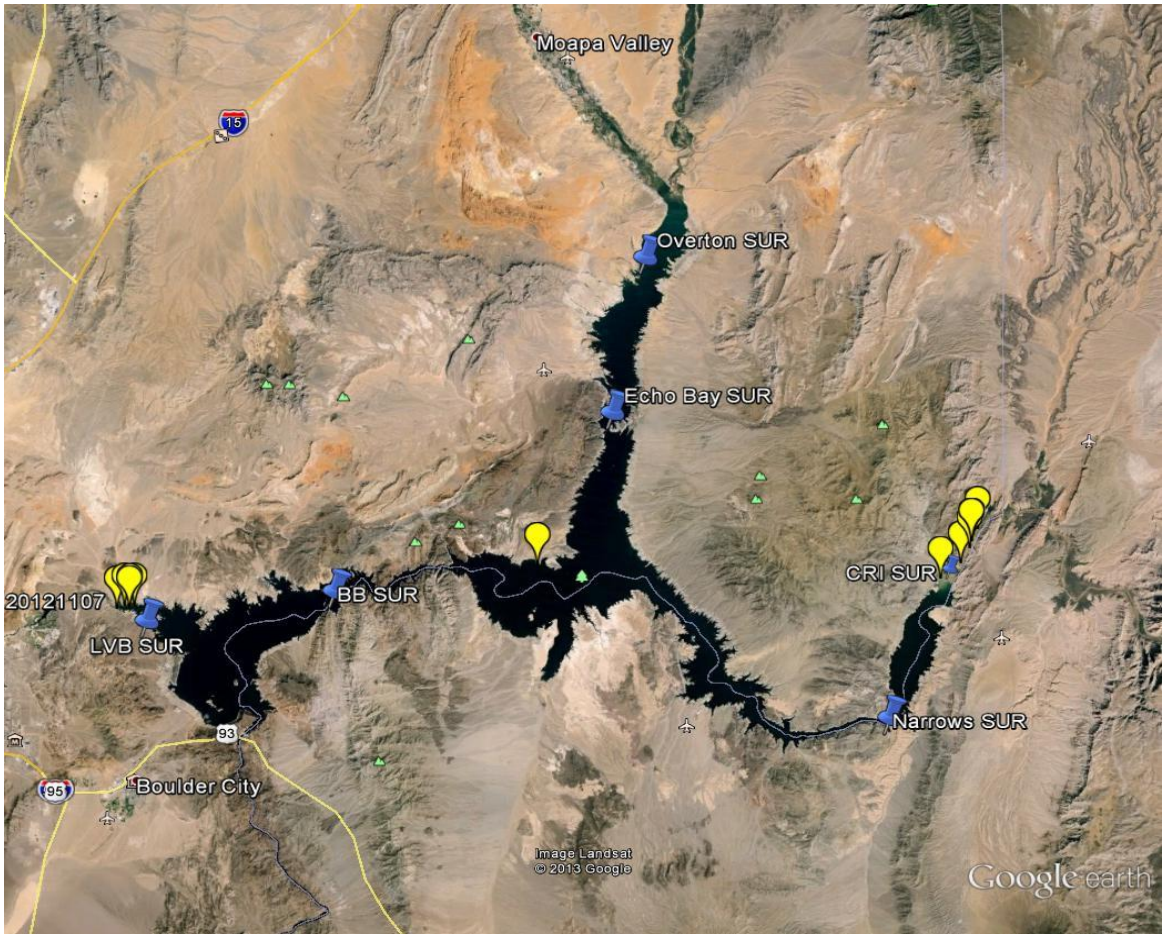

Figure 20. Satellite image of tracked locations of Fish 48. Google Earth. Accessed 1/2014.

Fish 49

Released to Echo Bay, this fish was tracked to the upper Overton Arm area near Overton Beach (Figure 21). The fish was detected by active tracking in the upper Overton Arm area and also passive tracking by both the Overton Arm and Echo Bay SURs through the end of March 2012. In April 2012, the fish was found in LVB and was routinely detected by the LVB SUR up until August 2012, after which time it was not heard from again.

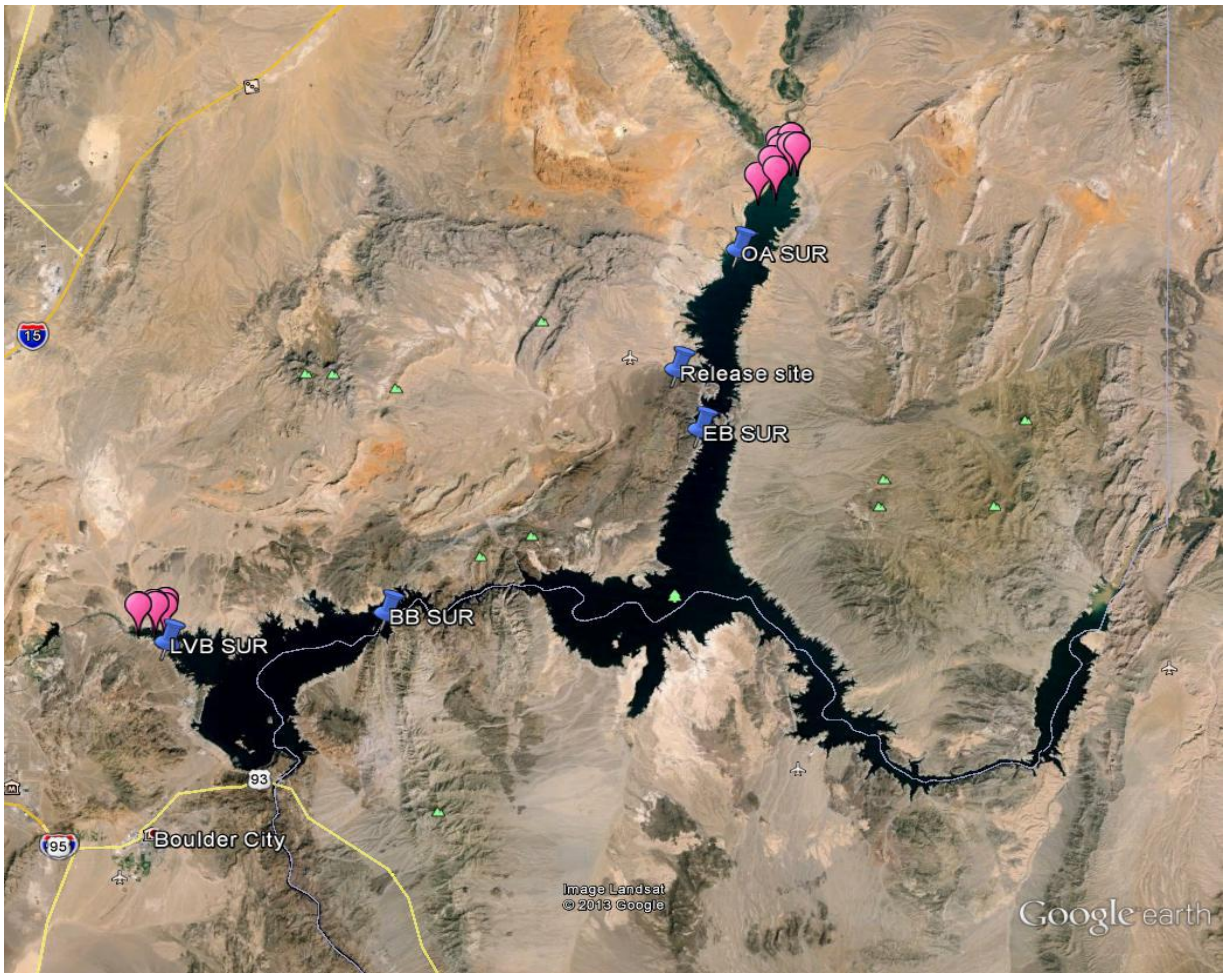

Figure 21. Satellite image of tracked locations of Fish 49. Google Earth. Accessed 1/2014.

Fish 50

Another Echo Bay release, fish 50 was tracked to the mid-channel area of Overton Arm utilizing the area from Blackridge Point south to Anchor Cove through March 10, 2012 (Figure 22). By March 12, fish 50 was detected by the SUR in the narrows region just downstream of Greggs Basin. It was detected back at the Echo Bay SUR in May, the Virgin Basin May 16, and the LVB SUR in August 2012. The fish has not been detected since August 11, 2012.

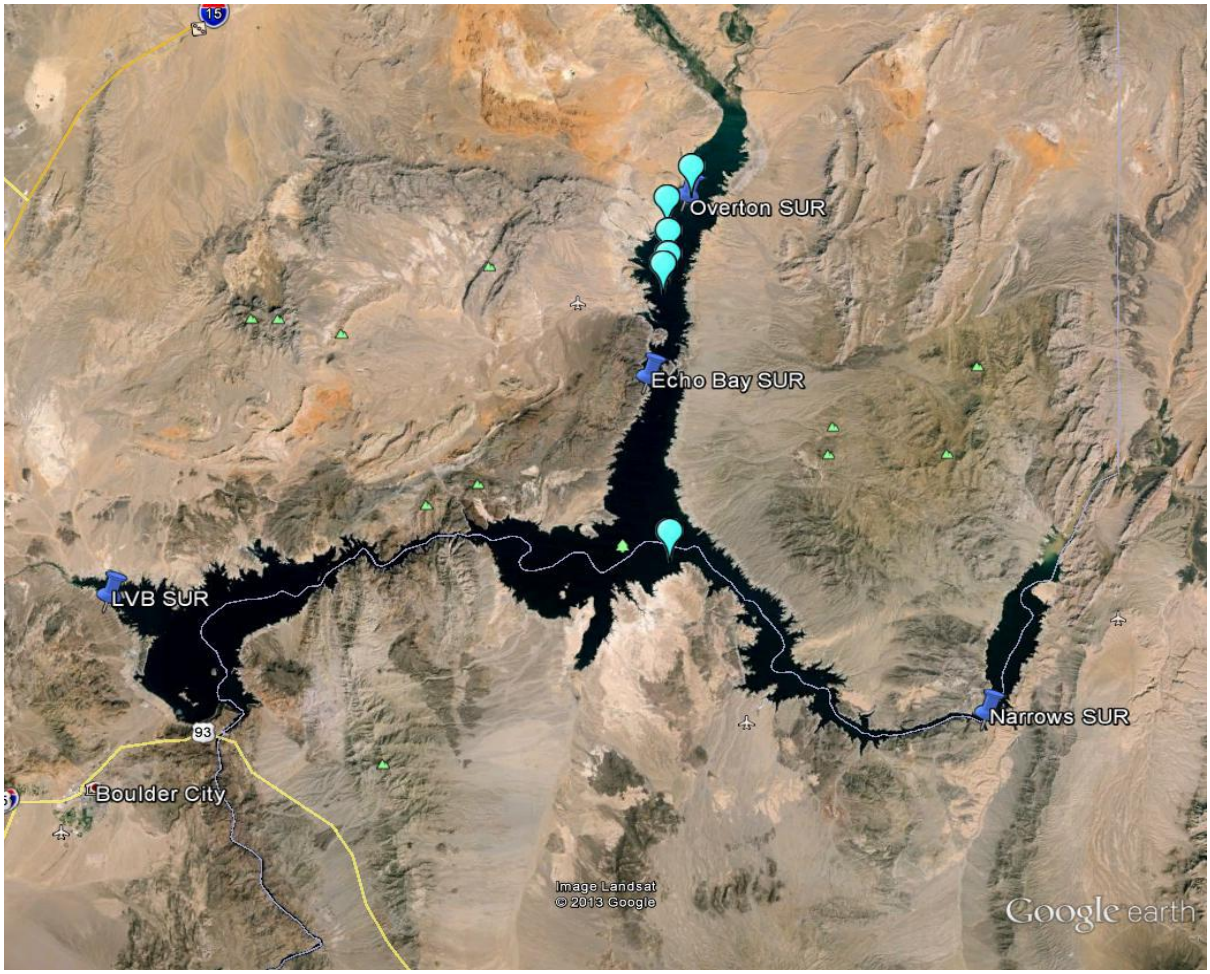

Figure 22. Satellite image of tracked locations of Fish 50. Google Earth. Accessed 1/2014.

Fish 51

This fish was released to Echo Bay. It was detected at the Echo Bay SUR on 12/3, then the Temple Bar SUR on 12/7. By 12/11/11, the fish was detected at the CRI SUR. Active tracking found this fish near Sandy Point and upstream into the turbid portion of the lake and at the river/lake interface January through the middle of February 2012 (Figure 23). By the first week of March, the fish travelled to the other side of the lake and then near the Boulder Basin SUR. The fish was not heard from until September 2012 when it was tracked to the Las Vegas Boat Harbor near the restaurant. In October, it was detected by the LVB SUR and in December, the tag was tracked to Beehive Island in very shallow water. No fish were observed at that depth, and on subsequent visits the tag was heard but no fish were seen. The fish was then presumed dead.

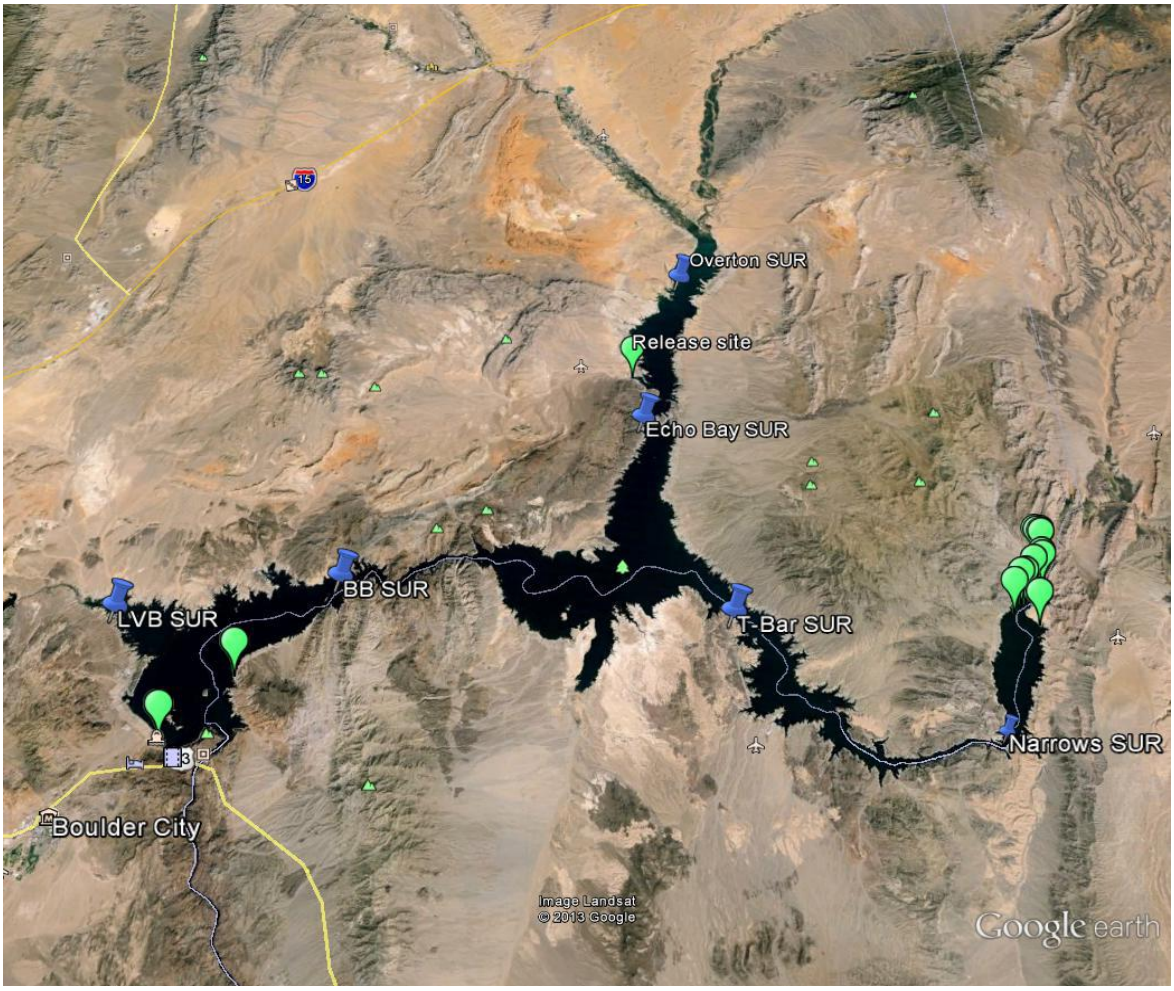

Figure 23. Satellite image of tracked locations of Fish 51. Google Earth. Accessed 1/2014.

Fish 52

Fish 52 was released to Boulder Harbor. From 12/12 to 12/28/11, the fish was tracked to Government Wash and an area east of Sand Island in the LVB (Figure 24). For two days, the fish was detected at the Boulder Basin SUR and then returned back to the LVB. From 1/9 to 3/5/12, fish 52 was found deep in the LVB, as shallow as 16 ft (4.9 m) of water near inundated tamarisk and other vegetation near Gypsum Wash. From 2/14 to 3/5, the fish was in essentially the same place and was thought to be dead, but was later found to have moved. On March 14, 2012, the fish was tracked to an area just south of Driftwood Cove in the CRI area. By March 29, fish 52 was back at the inundated tamarisk near Gypsum Wash. The fish was heard once more in the LVB in April 2012.

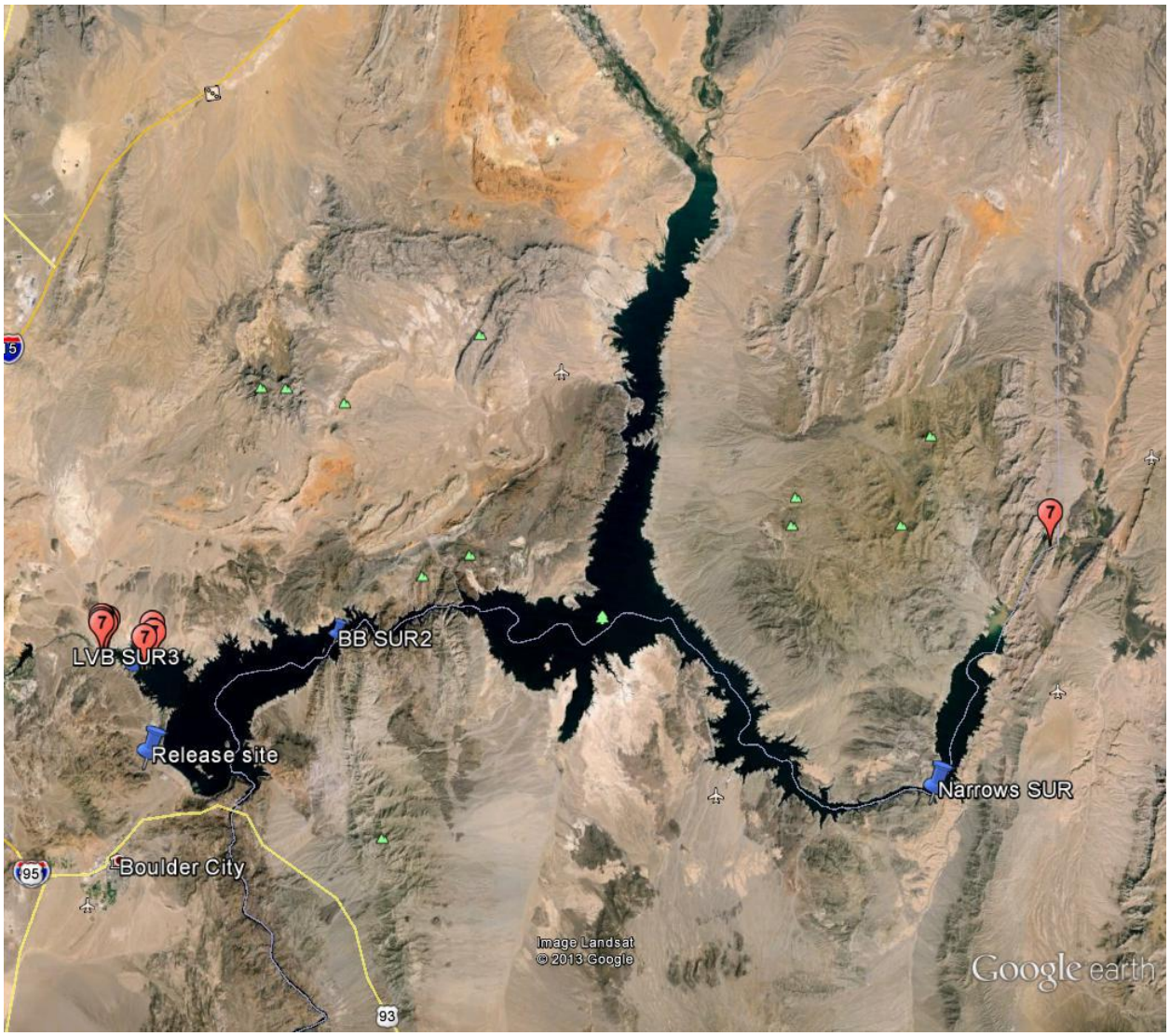

Figure 24. Satellite image of tracked locations of Fish 52. Google Earth. Accessed 1/2014.

Fish 53

Fish 53 was released to Boulder Harbor and was the only fish tracked in just one basin. For the first month after release, this fish was tracked to an area near Sand Island in the outer LVB and an open water area between Black Island and Boulder Islands (Figure 25). From the middle of January through the middle of February, Fish 53 was detected at the LVB SUR but was not tracked by boat. Detections were then made alternating between the Boulder Basin SUR and the LVB SUR. On August 3, the fish was tracked to the LVB and was found to utilize the deep water (about 86 ft, 26 m) near the LVB channel marker near the mouth of Government Wash. On 8/16/12, fish 53 was caught by an angler at Boulder Harbor.

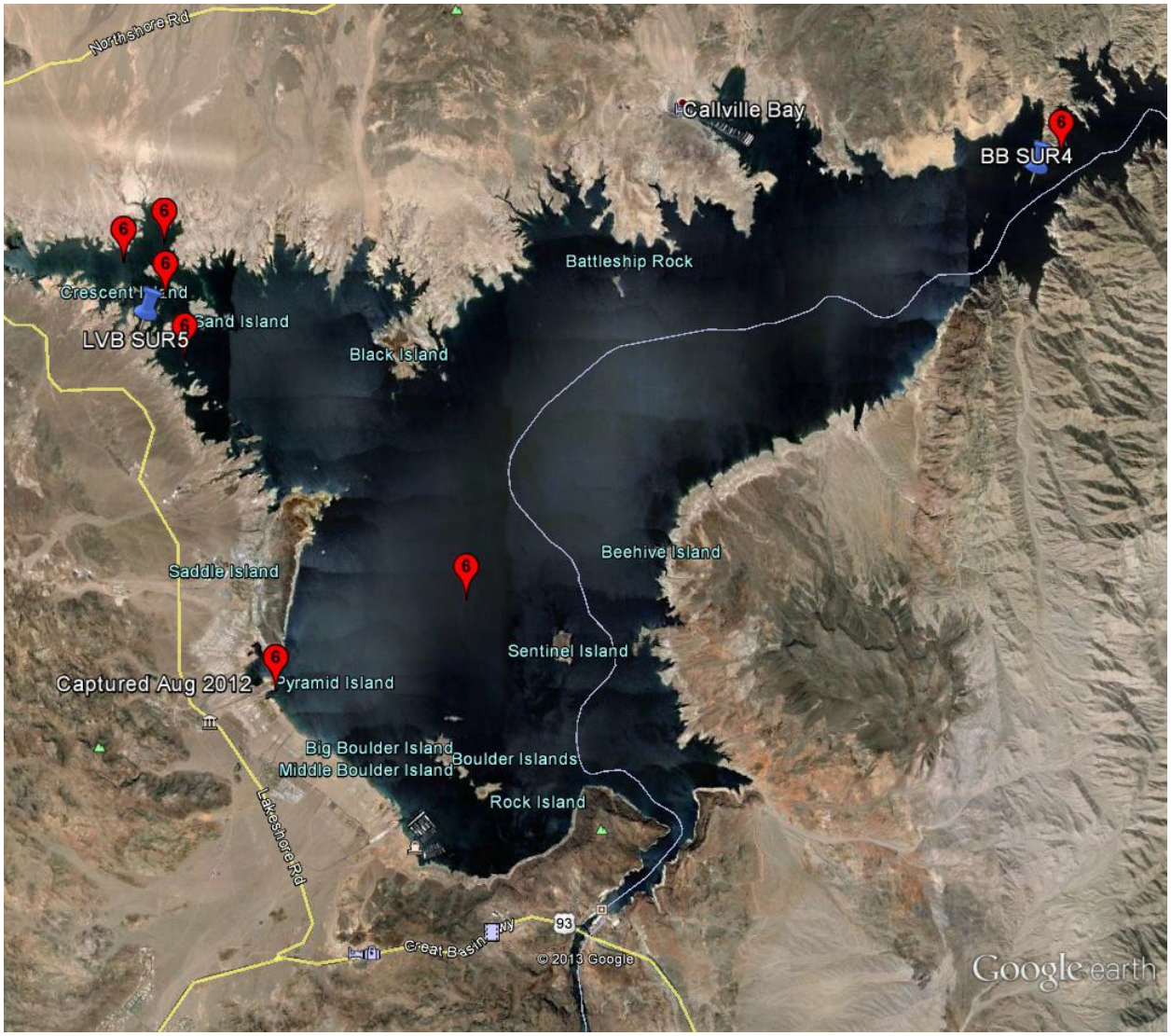

Figure 25. Satellite image of tracked locations of Fish 53. Google Earth. Accessed 1/2014.

Fish 54

Fish 54 rapidly made its way to the CRI. Released to Boulder Harbor, this fish was detected at SURs along the way. On 12/7, the fish was detected at the Boulder Basin SUR, on 12/8 the Temple Bar SUR, and on 12/9 at the Narrows SUR. Active tracking efforts located this fish in areas downstream of Sandy Point to the Narrows region leaving Gregg Basin (Figure 26). The fish was detected in that area through March 2012 and was not heard since.

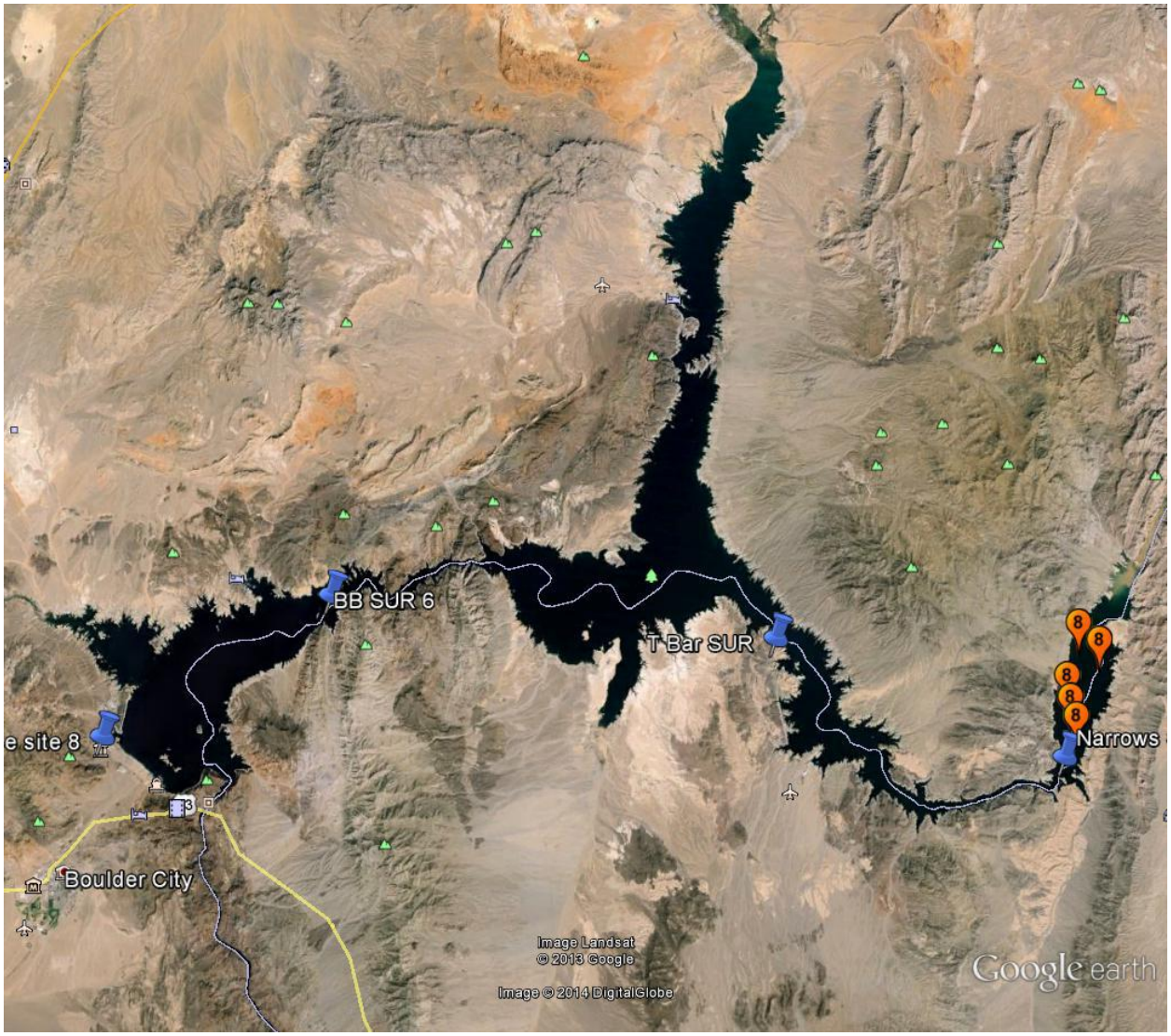

Figure 26. Satellite image of tracked locations of Fish 54. Google Earth. Accessed 1/2014.

Fish 55

Released to Echo Bay, fish 55 was found to utilize the mid-channel of Overton Arm from Blackridge Point south to Twin Peaks from 12/8/11 to 4/1/12 (Figure 27). From 4/5 to 4/9, the fish was detected at the Narrows SUR near Gregg Basin and then was back at the Overton Arm SUR by April 16. The fish was not detected since then.

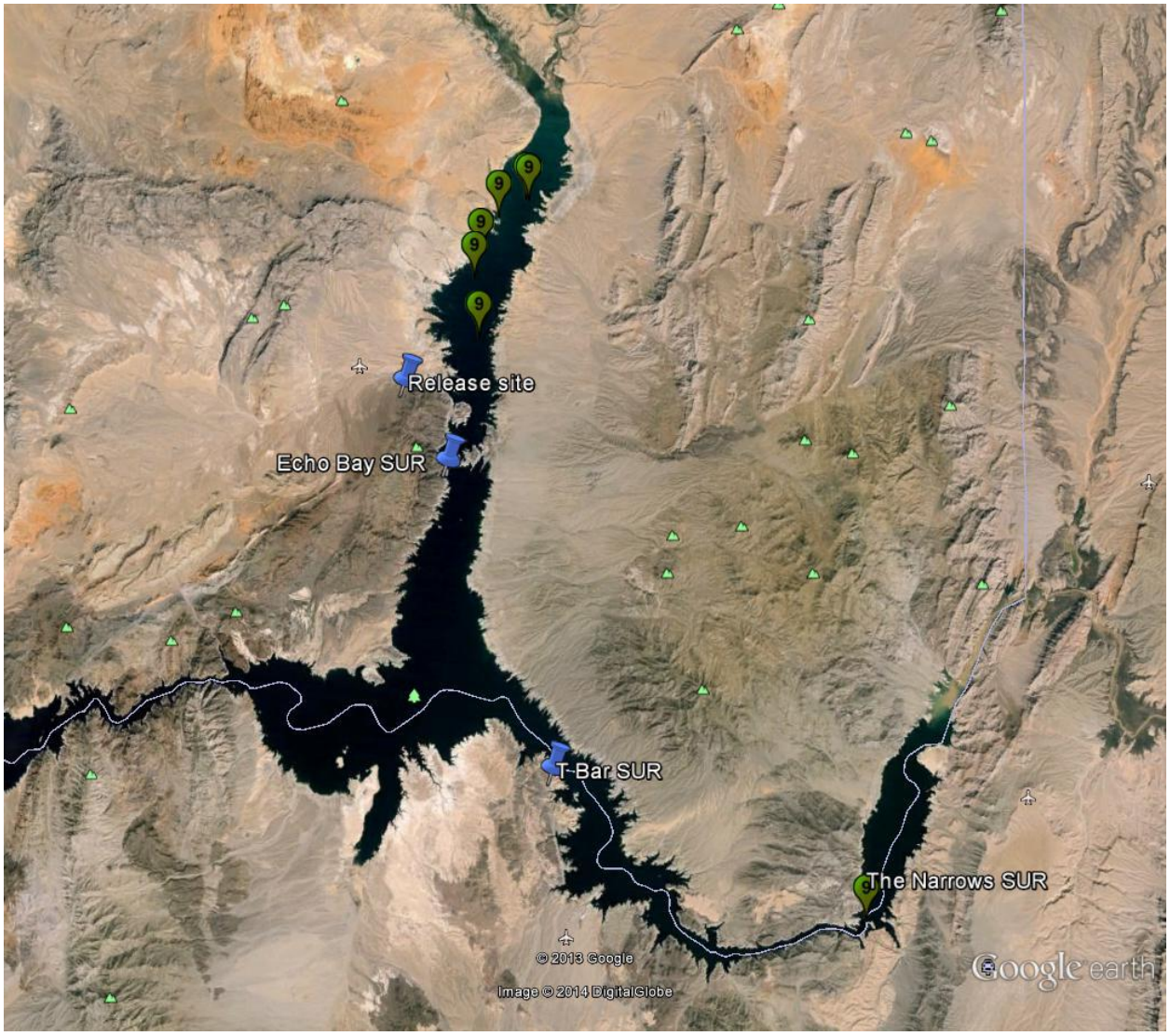

Figure 27. Satellite image of tracked locations of fish 55. Google Earth. Accessed 1/2014.

Fish 56

Fish 56 was an Echo Bay release. This fish stayed in the Overton Arm until the end of February 2012. The fish was tracked in this area to the mid-channel outside Salt Point south to Glory Hole (Figure 28). By March, the fish was detected at the Boulder Basin SUR. From 4/9-4/17 the fish was tracked to the tire wall at the Las Vegas Boat Harbor. On 4/23/12, the fish was caught and harvested by an angler.

Figure 28. Satellite image of tracked locations of Fish 56. Google Earth. Accessed 1/2014.

Discussion

Initially the study was designed to look at striped bass habitat use in two areas of Lake Mead, the Boulder Basin, and Overton Arm. It was soon discovered that these fish were using the entire lake and not confining themselves to one basin, except for one fish. Migrations from Boulder Basin to the CRI were often greater than 40 mi (64

km). Because of the timing and water temperature, it is thought that these migrations were associated with the spawning period, although much of this movement was in January and February and seemed a little too early for spawning. The ages of the tagged fish were likely two and three years old. In Lake Mead, striped bass have been found to be sexually mature at three years old for females and as young as two years old for males (Allan and Roden 1978). Striped bass are also known to require flow to keep their eggs suspended so they do not suffocate (Alan and Roden 1978). This supports the migration pattern we observed to flowing waters for reproduction.

While the fish moved throughout the lake, most habitat use was recorded at inflow sites. These areas are more nutrient-rich with higher densities of forage fish than other areas. This suggests that food availability has a strong influence on striped bass movement. After migrating to the CRI, both Boulder Harbor and Echo Bay released fish returned to LVB. Recent monitoring of the shad population found low shad production in the Overton Arm, which may explain why no fish returned or stayed in the Overton Arm. Another explanation may be site fidelity and the fact that the study fish were all captured in the LVB.

With Echo Bay released striped bass returning to the LVB, the LVB being the most nutrient-rich site due to wastewater releases may be the place striped bass go to when food availability is scarce in other parts of the lake. Our results may have been different had this been a peak shad production year in Overton Arm. Striped bass were also tracked to mid-channel areas or near points. They were never tracked to coves unless it was an inactive tag. Pelle and Paulson (1993) also tracked striped bass to mid-channel areas instead of near shore areas. Striped bass may use coves during the evening hours as our tracking efforts were during the daytime hours and may not reflect striped bass movements during the evening.

Coutant and Carroll (1980) have found striped bass to have a thermal niche between 20 to 24°C that influences habitat use. They note that larger striped bass are separated from their prey base during the summer resulting from differences in temperature preferences of their prey. Younger striped bass, however, are not constrained by temperature in the way adult striped bass are (Coutant and Carroll 1980). During the winter when the lake was isothermal, the tagged striped bass were found in shallower water than in the spring. As summer approached, tagged striped bass were found to use areas of deeper water in the LVB between 55 ft (16.8 m) and 120 ft (36.6 m) deep.

This study helped to identify the habitat needs of striped bass in Lake Mead. Striped bass utilize the entire lake. It appears they need to spawn in flowing waters from January through March. Due to thermal constraints, adult striped bass need to occupy deeper areas during the spring and summer as water temperatures increase. The inflow areas, especially the LVB, are important for foraging, and food availability may have a strong influence on habitat use by striped bass. Mid-channel areas and points are preferred to coves. A study that tracks striped bass movements in the

evening hours using fish of different size classes may further expand the knowledge of striped bass habitat use at Lake Mead.

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GENERAL STRIPED BASS SONIC TELEMETRY STUDY REVIEW

The objective was to identify habitat use and seasonal distribution of striped bass.

The approaches for the Striped bass sonic telemetry study objective were completed. The objectives were met through active and passive tracking of sonic tagged striped bass. Depth, water temperature, and GPS coordinates were collected. No underwater observations were made through SCUBA diving due to the turbidity and depth of the water in which the striped bass were utilizing.

RECOMMENDATIONS

- The creel program should continue under the present format to track trends in angler use and success. At least 100 days of creel should be conducted at angler access points.
- Seasonal gill netting surveys and summer dive investigations should be continued.
- Continue collecting black bass biological data at tournaments to track trends in the black bass fishery.
- Continue with assigned electroshocking transects during the fall survey.
- Continue the quarterly checking of stomach samples of tournament striped bass to detect changes in diet.
- Continue weekly shad trawl transects during the peak spawning season.
- Investigate the feasibility and effectiveness of moveable underwater habitat structures for future deployment to Lake Mead.
- Consider changing the part-time Conservation Aid position back to a 9-month full-time position to provide more assistance during the busy field season.

Submitted by: Debora Y. Herndon
Fisheries Biologist, Southern Region

Date: February 28, 2014

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APPENDIX 1

Water Quality Profiles for the Parameters of Temperature (Temp), Conductivity (Cond), Dissolved Oxygen (DO), and pH taken at various locations generally in close proximity to where fish were tracked to.

Date: 12/14/11
Time: 1259

Location: Las Vegas Bay
UTM: 11S 693737 3999170
Secchi depth:

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	15.40	898	95.6	9.50	7.86
5	15.02	901	92.9	9.35	7.70
10	14.74	1080	90.0	9.10	7.59
14	15.26	1327	89.5	8.95	7.56

Date: 12/15/11

Time: 1230

Location: Overton Arm, south of Bighorn Island
UTM: 11S 733776 4016900
Secchi depth:

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	14.49	840	94.3	9.59	7.83
5	14.48	841	94.5	9.62	7.84
10	14.46	842	94.9	9.67	7.81
13	14.44	842	95.0	9.69	7.86

Date: 12/21/11

Time: 1400

Location: Las Vegas Bay, west of Sand Island
UTM: 11S 0695439 3998375
Secchi depth:

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	15.02	894	93.4	9.39	7.56
5	14.83	894	92.3	9.33	7.53
10	14.74	894	92.8	9.39	7.52
15	14.64	895	94.5	9.58	7.52
19	14.63	897	87.1	8.83	7.50

Date: 12/28/11
Time: 1331

Location: Las Vegas Bay, near Sand Island
UTM: 11S 697178 3999052
Secchi depth: 11 m

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	14.43	891	93.4	9.51	7.43
5	14.23	891	93.5	9.57	7.41
10	14.05	890	94.8	9.74	7.45

Date: 12/29/11
Time: 1301

Location: North Overton Arm
UTM: 11S 0738617 4035856
Secchi depth: 7 m

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	12.57	877	99.7	10.58	7.66
5	11.94	880	99.8	10.75	7.67
10	11.72	884	99.8	10.81	7.71
13	9.93		67.1	7.53	7.27

Date: 1/26/12
Time: 1316

Location: Overton Arm, E. of Virgin R.
UTM: 0739123 4035481
Secchi depth:

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	12.15	856	100.4	10.77	6.70
5	11.23	858	100.6	11.00	6.81
10	11.02	866	98.5	10.84	6.91

Date: 2/21/12
Time: 1532

Location: Las Vegas Bay
UTM:
Secchi depth:

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	13.73	1000	96.3	9.95	7.29
5	13.67	1024	96.2	9.96	7.22
10	14.31	1397	88.9	9.06	7.17

Date: 3/29/12
Time: 1532

Location: Las Vegas Bay
UTM:
Secchi depth:

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	13.73	1000	96.3	9.95	7.29
5	13.67	1024	96.2	9.96	7.22
10	14.31	1397	88.9	9.06	7.17

Date: 4/18/12
Time: 1006

Location: Las Vegas Boat Harbor Tire Wall
UTM: 11S 700505 3989667
Secchi depth: 10 m

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	18.58	909	94.9	8.86	7.63
5	15.29	904	96.3	9.62	7.63
10	14.48	906	98.0	9.97	7.58
15	14.18	905	100.0	10.24	7.51

Date: 4/19/12
Time: 1147

Location: Outside Greggs Hideout
UTM: 11S 0749075 3988602
Secchi depth: 6 m

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	19.04	829	97.8	9.06	7.74
5	15.64	824	92.9	9.22	7.47
10	14.38	824	95.5	9.75	7.28
15	14.09	819	96.4	9.90	7.15

Date: 5/16/12
Time: 1253

Location: Near Government Wash
UTM: 11S 0695550 3999162
Secchi depth: 3.7 m

Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	23.20	1213	137.3	11.72	7.16
5	20.41	1075	132.7	11.93	7.09
10	19.27	964	135.2	12.44	7.05
15	18.23	1095	129.4	12.14	6.93

Date: 5/24/12			Location: Las Vegas Bay		
Time: 1020			UTM: 11S 0695709 3999205		
			Secchi depth: 7 m		
Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	24.19	1115	113.3	9.48	7.55
5	21.47	984	114.7	10.11	7.55
10	20.71	1034	115.4	10.31	7.52
15	18.07	1002	115.4	10.87	7.34

Date: 9/7/12			Location: Las Vegas Bay, near the wash		
Time: 0946			UTM: 11S 0738617 4035856		
			Secchi depth:		
Depth (m)	Temp °C	Cond µS/cm	DO% (saturation)	DO mg/l	pH
0	29.90	1148	103.1	7.78	7.67
5	29.54	1323	75.3	5.71	7.89