

I. Project Title: **Operation, maintenance, and fish escapement evaluation of the Highline Lake and Elkhead Reservoir spillway nets (fish barriers)**

II. Bureau of Reclamation Agreement Number(s): R12AP40001

Project/Grant Period: Start date: December 28, 2011
End date: September 30, 2017
Reporting period end date: December 31, 2017
Is this the final report? This is the final report for this period, but the study is ongoing within a new grant period.

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IV. Abstract:

This project includes the operation and maintenance of the Highline Lake spillway net, designed to control escapement of non-native, warm water fishes from Highline Lake; and evaluation of that spillway net as an anti-fish escapement device. Beginning in 2017, we have also included the operation and maintenance of the Elkhead Reservoir spillway net, designed to control escapement of non-native, warm water fishes from Elkhead Reservoir; and evaluation of that spillway net as an anti-fish escapement device. Overall, both spillway nets appear to be in good shape and performing as designed.

- V. Study Schedule:
Initial Year: 1999
Final Year: Ongoing

VI. Relationship to RIPRAP:

This study reports on the maintenance and periodic replacement of the Highline Lake spillway net, instances of outlet structure/bottom release openings, and fish monitoring to determine net performance. Beginning in 2017, we have also included the maintenance of the Elkhead Reservoir spillway net, and fish monitoring to determine spillway net performance.

General Recovery Program Support Action Plan

- III. Reduce negative impacts of nonnative fishes and sportfish management activities (nonnative and sportfish management).
III.A. Reduce negative interactions between nonnative and endangered fishes.
III.A.2. Identify and implement viable active control measures.
III.A.2.c. Evaluate the effectiveness (e.g., nonnative and native fish response) and develop and implement an integrated, viable active control program.
III.B. Reduce negative impacts to endangered fishes from sportfish management activities

Colorado River Action Plan: Mainstem

- III.B. Reduce negative impacts to endangered fishes from sportfish management activities
III.B.1. Evaluate control options and implement measures to control nonnative fish escapement from Highline Reservoir
III.B.1.a. Operate and maintain Highline Reservoir net

Green River Action Plan: Yampa and Little Snake Rivers

- III.B.1. Prevent nonnative fish introduction; reduce invasion and recruitment
III.B.1.a.(2) Implement control measures as needed to control escapement (during and after Elkhead expansion construction). Post-construction: monitor and maintain Elkhead screens (YS C-1)

VII. Accomplishment of FY 2017 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. *FY 2017 Tasks and Deliverables-Highline Lake Operations and Maintenance*

Task 1. Maintain protective buoy line
Schedule: March/April - October
Deliverable: **Task Completed**

Task 2. Spillway net cleaning and repair operations (in water)
Schedule: March/April - October
Deliverable: **Task Completed**

Task 3. Weekly visual survey

Schedule: March/April - October
Deliverable: **Task Completed**

Task 4. Underwater survey
Schedule: March/April – October
Deliverable: **Task Completed**

Task 5. Preparation of final report documenting operations and maintenance, and related costs
Schedule: November/December
Deliverable: **Task Completed**; Annual Report completed

A. *FY 2017 Tasks and Deliverables-Highline Lake Fish Monitoring*

Task 1. Fish sampling to monitor fish escapement downstream of the spillway net (within the reservoir, between the spillway net and spillway)
Schedule: February/March (pre-spill conditions)
Deliverable: **Task Completed**

Task 2. Fish sampling to monitor fish escapement downstream of the spillway net (outside of the reservoir, within Mack Wash and/or Salt Creek)
Schedule: November (post-spill conditions)
Deliverable: **Task Completed**

Task 3. Equipment maintenance, data entry, data analysis, and preparation of fisheries final report
Schedule: February/March-November/December
Deliverable: **Task Completed**. Annual Report completed.

A. *FY 2017 Tasks and Deliverables-Elkhead Reservoir Operations and Maintenance*

Task 1. Maintain protective debris boom
Schedule: March/April - September
Deliverable: **Task Completed**

Task 2. Spillway net cleaning and repair operations (in water)
Schedule: March/April - September
Deliverable: **Task Completed**

Task 3. Weekly visual survey
Schedule: March/April - September
Deliverable: **Task Completed**

Task 4. Underwater survey
Schedule: March/April - September
Deliverable: **Task Completed**

Task 5. Preparation of final report documenting operations and maintenance, and related costs

Schedule: November/December
Deliverable: **Task Completed.** Annual Report completed.

A. *FY 2017 Tasks and Deliverables-Elkhead Reservoir Fish Monitoring*

Task 1. Fish sampling to monitor fish escapement downstream of the spillway net (within the reservoir, between the spillway net and spillway)

Schedule: March (pre-spill conditions) and September/October (post-spill conditions)

Deliverable: **Task Completed**

Task 2. Fish sampling to monitor fish escapement downstream of the spillway net (outside of the reservoir, within the stilling basin and prior to and post-connection with Elkhead Creek)

Schedule: March (pre-spill conditions) and September/October (post-spill conditions)

Deliverable: **Task Completed**

Task 3. Equipment maintenance, data entry, data analysis, and preparation of fisheries final report

Schedule: March-November/December

Deliverable: **Task Completed.** Annual Report completed.

B. *Discussion of Initial Findings and Shortcomings-Highline Lake first, followed by Elkhead Reservoir*

Highline Lake/Mack Wash

Study Area

The study area for this project is Highline Lake State Park, Loma, Colorado, including Mack Wash, into which Highline Lake drains.

Study Methods/Approach and Results

Operations and Maintenance

Formerly, the operations and maintenance of the original spillway net were funded via a cooperative agreement between Colorado State Parks and the Colorado Division of Wildlife (CDOW) to cover up to \$10,000 in annual costs incurred by Highline Lake State Park. Colorado State Parks and the CDOW merged to form Colorado Parks and Wildlife (CPW) in 2011. As of July 1, 2011, CPW has been responsible for covering the operations and maintenance costs of the spillway net up to \$10,000 annually, contingent on availability of funds. If annual costs exceed \$10,000, then CPW will request the Recovery Program cover the additional costs. This scenario has not occurred to date.

Task 1. Maintain protective buoy line: The buoy line was inspected on a weekly schedule with the Park's patrol boat during the summer season. No issues or problems were identified. The connecting cable, shackles, and U bolts were all in good working order.

Task 2. Spillway net cleaning and repair operations (in water): Four spillway net inspections/cleanings were performed by United UnderWater Contractors (UUWC) in 2017: March 30, June 15, August 18, and November 2. The first inspection of the spillway net this year took place earlier than last year due to an unexpectedly high number and relatively large size of fish collected between the spillway net and spillway during the March 2017 fish survey. The remaining inspections/cleanings took place about two months apart to control the algae growth. The spillway net was cleaned manually all four times by divers from UUWC. As the spillway net ages, there will be a continual increase in algal buildup. We plan to continue with four net cleanings in 2018.

The highlights of the March 30 inspection were: 1) Cleaning was completed and there were no holes found in the spillway net. 2) On the south end of the spillway net where it crawls up the dam, gaps were present under the bottom skirt. Here, the boulders on the dam are up to 4 feet across and create a challenge for the lower skirt to cover. We worked the spillway net and lower skirt around, up and over, and tucked them in tight so that no swim through gaps were present. Five gaps were found that fish could have easily swam through, and those were all sealed up. The top edge of the spillway net does sag off the buoys and creates swim through areas of about 2"x 3" along both buoy lines of the spillway net and top skirt. After further investigation, Park Manager Martinez indicated the 2" x 3" openings are on the surface of the water and do not appear to be a concern at this time. 3) All shackles, thimbles, and manta ray bolts were inspected and found to be tight and in good condition.

The highlights of the June 15 inspection were: 1) Cleaning was completed and there were no holes found in the spillway net. However, numerous hooks and lures were found and removed. 2) The net cleaned up well, but had a lot of growth on it. 3) All shackles, thimbles, and manta ray bolts were inspected and found to be tight and in good condition. 4) The west end of the spillway net had six buoys cut free from the spillway net. The buoys were all out of the water on the shoreline. This is the first incident of vandalism we have observed. Park Manager Martinez continued to monitor activity around the spillway net throughout the season. Signage or other methods may be required if vandalism continues.

The highlights of the August 18 inspection were: 1) Cleaning was completed and there were no holes found in the spillway net. However, numerous hooks and lures were found and removed. There were also numerous tumble weeds entangled in the spillway net, and those were also removed. 2) The spillway net was covered with matted algae, especially on the top half and the skirt area. Most of the algae were removed with heavy scrubbing. 3) All shackles, thimbles, and manta bolts were inspected and found to be tight and in good condition. The stainless steel wire on the shackles is still holding.

The highlights of the November 2 inspection were: 1) Cleaning was completed and there were no holes found in the spillway net. However, there were tumble weeds and brush entangled in the spillway net which were removed. 2) The spillway net was covered with matted algae, especially on the top half and the skirt area. Most of the algae were removed with heavy scrubbing. 3) All shackles, thimbles, and manta bolts were inspected and found to be tight and in good condition. The stainless steel wire on the

shackles is still holding. 4) The poly suspenders installed a year ago are half gone and need to be replaced to keep the upper skirt spread away from the main spillway net. The skirt fills with algae and debris to the point that it only acts as a double drag on the top 3 feet of the spillway net. The poly suspenders will be replaced in early 2018 during the next spillway net inspection and cleaning.

Task 3. Weekly visual survey: The spillway net top line and floats along with the skirt were visually checked on a weekly basis with the Park's patrol boat. On weekends, the patrol boat would be deployed for several hours and when time permitted, we would examine the spillway net from the water surface. The ¼" poly line that was installed to keep the skirt stretched from the safety line held up until late summer when it started to break, likely due to sun rot. The ¼" poly line will be reinstalled in 2018 to keep the skirt stretched out to reduce escapement over the top of the spillway net.

Task 4. Underwater survey: The spillway net was inspected during each cleaning by UUWC, the same divers that have been checking the spillway net for the last several years. See Task 2 above for details. They prepared reports for each of their inspections, which are available at the Park or on request.

Fish Monitoring

Mack Wash originates from Highline Lake and flows approximately five miles downstream to the confluence with Salt Creek. Salt Creek flows approximately two miles before the confluence with the Colorado River. The Colorado River and its 100-year floodplain (including Salt Creek at the confluence of the Colorado River), are considered critical habitat for state and federally listed fish species, as well as other native, non-listed fishes.

Fish can escape into Mack Wash from Highline Lake by moving over the spillway net and/or through the bottom release on the dam when no anti-escapement device is in place. Irrigation water is delivered to water users downstream of Highline Lake typically from the beginning of April through the end of October. Thus, fish surveys in both Mack Wash downstream of Highline Lake as well as Highline Lake downstream of the spillway net occur annually when water is not being delivered downstream.

CPW biologists completed annual fish surveys at two sites in Mack Wash downstream of Highline Lake in the month of November from 2011-2017. Additionally, CPW biologists completed fish surveys within Highline Lake between the spillway net and the spillway in March of 2012, March of 2013, March of 2016, and March of 2017. In March of 2014, the spillway net was replaced with a new net, and no sampling was completed in Highline Lake between the spillway net and the spillway. Sampling for this same area was scheduled for the spring of 2015, but water delivery from Highline Lake downstream into Mack Wash began earlier than anticipated, preventing CPW crews from sampling.

This summary focused on the data gathered in 2016 and 2017, while some previous years' data were also included. Please refer to the 2015 Annual Report for Project C-20 for extensive summaries of the 2011 through 2015 data for both Mack Wash and Highline Lake. A map (Figure 1) of the Mack Wash fish survey sites follow, with 2016 and 2017 fish survey results from both Mack Wash (Tables 1-2, Figures 2-6) and Highline Lake (Table 3, Figures 7-13).

Mack Wash

CPW biologists conducted single-pass, bank electrofishing surveys at two sites on Mack Wash downstream of Highline Lake on November 15 and 16, 2016, and on November 15, 2017. Site #1 was located immediately downstream of the Highline Lake spillway and Site #2 was located on private property approximately three miles downstream of Site #1. The objectives of the fish surveys were to determine fish species composition and relative abundance downstream of the Highline Lake spillway net. Specifically, we were interested in identifying potential escapement of non-native fishes from Highline Lake. Non-native, non-salmonid fishes collected were lethally removed.

Highline Lake

CPW biologists surveyed Highline Lake between the spillway net and the spillway using a combination of night-time boat-electrofishing and day-time experimental gill net sets in the spring of 2017. The objective of the fish survey was to determine fish species composition and relative abundance within the lake downstream of the spillway net. Surveys were completed prior to water being delivered to downstream water users. Fish collected were released back into Highline Lake upstream of the spillway net with the exception of smallmouth bass, common carp, and gizzard shad which were all lethally removed.

Discussion

The spillway net at Highline Lake was compromised during canal surges across 2011, 2012 and 2013, and during an extended bottom release in 2013 in preparation for lake dredging across 2013-2014. The spillway net was replaced in March of 2014 after dredging of the lake was completed and has been operational since its replacement. After our survey in the spring of 2017 showed an unexpectedly high number of fish present behind the spillway net, including multiple age classes of gizzard shad, the spillway net was inspected and re-adjusted in March 2017. The inspection revealed that the spillway net was not damaged, but there were multiple gaps under the bottom skirt through which fish could enter. The skirt was re-positioned during the inspection to close these gaps prior to irrigation season. Although this was the first time gizzard shad had been documented between the spillway net and the spillway, gizzard shad were first documented in Highline Lake in 2015. No gizzard shad have been found in Mack Wash downstream of Highline Lake since the fish were illicitly introduced. Despite the potential for fish to pass under the skirt of the spillway net before the readjustment, catch per unit effort of largemouth bass and green sunfish remained low at both survey sites in Mack Wash. No smallmouth bass or channel catfish were surveyed at either site. These data suggest that the spillway net continues to prevent the vast majority of fish from escaping Highline Lake, and that fish escapement has been greatly reduced compared to years in which the spillway net had been compromised.

CPW staff have taken several actions to reduce the chance of fish escaping from Highline Lake. These actions include:

- 1) Continuing coordination and communication efforts with operators of the Government Highline canal system to ensure operation of the spillway net is not hindered as a result of water delivery practices.

2) Cleaning the spillway net more frequently and with a shorter time frame between cleanings to reduce strain and wear and tear of the spillway net. The existing spillway net was replaced in March of 2014 after dredging activities within Highline Lake were completed.

3) Readjustment of the poly-line from the skirt to safety cable appears to be holding the spillway net in better position, and keeping the skirt from washing over the spillway net.

4) Operating the outlet structure/bottom release only when dissolved oxygen concentrations are minimal, and fish are less likely to be present in the water column near the outlet structure.

Elkhead Reservoir

Study Area

The study area for this project is Elkhead Reservoir State Park, Craig, Colorado, including the stilling basin downstream of the reservoir's spillway.

Study Methods/Approach and Results/Discussion

Operations and Maintenance

Per a May 20, 2015 CPW letter to the U.S. Bureau of Reclamation (BOR) outlining CPW's obligations related to the "Elkhead Reservoir Fish Escapement Net," CPW will be responsible for covering the operations and maintenance costs of the spillway net up to \$10,000 annually, contingent on the availability of funds. Operations and maintenance costs exceeding the \$10,000 per year limit will be cost shared equally (50:50) between CPW and the Recovery Program, subject to the mutual agreement of CPW and the Recovery Program. If mutual agreement on the expenditure of funds exceeding the first \$10,000 in any calendar year cannot be obtained, the issue will be referred to the Recovery Program's Implementation Committee for resolution. Resolution will occur in a timely manner, to avoid impacting the safe and prudent operation of Elkhead Reservoir. CPW anticipates that this scenario may be likely, based on the large-scale size of the spillway net and additional intricacies that are not applicable to the Highline Lake spillway net.

At the end of the useful life cycle of the spillway net, the Recovery Program, CPW, Colorado River Water Conservation District (CRWCD), and BOR will consult on the need to replace the spillway net, and if needed, who will assume responsibility for installation, operations, and maintenance.

Task 1. Maintain protective debris boom: The debris boom was inspected several times weekly throughout the open-water season from land and water (the shoreline near the spillway and using the Park's patrol boat). In late October, the debris boom was inspected more closely when we took the lights off of the buoys. All materials and connections were in good working order.

Task 2. Net cleaning and repair operations (in water): Two spillway net inspections were performed in 2017; the first inspection was completed by Pacific Netting Products (PNP) on July

25 as the first year of their two annual warranty inspections, and the second inspection and cleaning were completed by UUWC on October 17. Reports follow from both of those inspections.

PNP is the manufacturer and installer of the spillway net. They completed diver and surface inspections of the spillway net and debris boom at the time the reservoir was full, and the spillway net was deployed to near full height (about 2 feet above the spillway). PNP reported the spillway net to be in good condition and not in need of cleaning at that time. The bottom of the spillway net was becoming buried in the reservoir bottom sealing it off effectively. Two divers worked along the spillway net from east to west, and then from west to east. A video was recorded by the divers. The cork lines and the wave skirt at the top of the spillway net were inspected by hand from a boat. No tears or other signs of wear of the spillway net were noted. The debris "boat gate" on the east side was used to access the spillway net, and was a little challenging to navigate. Numerous crawfish were observed on the spillway net and in the wave skirt. Fish, some nearing 1.5 feet long, were observed just outside of the spillway net. The ends of the spillway net where they attach to the bank were inspected. The west end appeared to be a little far from high water on its anchor chain, and was pulled closer to shore and anchored further up the anchor chain with assistance from CPW and a small backhoe on July 31. If additional height on the west end is desired, the first underwater anchor point can be attached using a small length of chain and the slack taken out of the second 25 foot panel of spillway net assembly. In addition to the spillway net and debris boom inspection, 270 pound clump weights were added to the crown buoys on the inside of the debris boom to make them float more erectly. The outside crown buoys have 500 pound clump weights.

UUWC utilized four divers to complete their first inspection and cleaning of the spillway net, debris boom, and hardware. The spillway net had a couple of small tears that had been repaired. All of the hardware appeared to be functional and in good condition with the exception of galvanized chain used throughout. The chain was of poor quality and has begun to rust through. Most of the thimbles, shackles, and cotter pins had no rust. Many of the shackles did not have a locking system (cotter pins), and did not appear to have been tightly locked on. If not addressed, these will be an issue. All of the manta ray bolts for the spillway net were set deep and had 6"-12" of bolt exposed. Many of these anchors were set into rock and the rock was exposed by 1-2 feet. Anchors for the debris boom had 2-3 feet of shaft exposed, and appeared to be strong and secured, though it was difficult to determine how much each anchor was actually buried. All aspects of the debris boom were inspected and appeared to be in good working order. The bottom skirt appeared to be designed to lie south toward the dam. The skirt had slid downhill to the manta bolts and stopped there. The slope here will cause this to occur for a big portion of the spillway net. The upper skirt was so packed with algae and debris that it sinks and will rarely spread away from the main big buoys, unless a strong wind occurs from the right direction or spreaders are installed to keep the skirt out and flat. As the water level lowers, the spillway net lies to the south. On the west end, stumps and brush that were not removed may cause an entangle issue when the water level rises again.

Overall, the spillway net needed cleaning badly. The east end of the spillway net had 20-40% of the holes closed with algae. The west end of the spillway net had 50-70% of the flow slowed down. Numerous sticks and debris were removed from the entangled area on the west quarter of the spillway net. The spillway net was cleaned and most of the new growth came off easy. However, there were several varieties of algae (yellow or red in color and usually 2"-6" in

diameter) that were almost like a flat, hardened coral that were near impossible to remove. Increased algae limits the flexibility of the spillway net and water flow. A spring 2018 inspection and, if necessary, cleaning are recommended.

Task 3. Weekly visual survey: The spillway net top line and floats along with the skirt were visually checked on a weekly basis with the Park's patrol boat, and they were also visually inspected from shore. Nothing adverse was noted from above the waterline.

Task 4. Underwater survey: The net was inspected in early October by UUWC. See Task 2 above for details.

Fish Monitoring

Elkhead Reservoir drains into Elkhead Creek and continues for approximately nine miles, where it connects with the Yampa River between river mile 148 and 149. Beginning at Colo. Hwy. 394, the Yampa River and its 100-year floodplain are considered critical habitat for state and federal listed fish species, as well as other native, non-listed fishes. A spillway net was installed upstream of the reservoir's spillway on September 23, 2016 to control non-native fish escapement when the reservoir spills.

In 2017, CPW biologists completed fish surveys within Elkhead Reservoir, between the spillway net and the spillway, as well as in the stilling basin downstream of the spillway (Figure 14). Experimental gill nets were set before (in the spring), during (in the summer), and after (in the fall) water was released over the spillway. Between two and four, 150 foot experimental gill nets were set at the "spillway site," which included the area between the spillway net and spillway (Figure 14). Additionally, CPW surveyed the stilling basin using one, 150 foot experimental gill net that spanned from one side of the stilling basin pool to the other. Experimental gill nets were set overnight and checked the following day.

The spillway site was sampled on four occasions for a total of nine overnight sets throughout 2017. Two experimental gill nets were set for six nights each between March 21 and March 26, before the reservoir spilled. Three experimental gill nets were set at the spillway site from July 17 to July 18, four experimental gill nets were set from July 18 to July 19, and three experimental gill nets were set from September 20 to September 21. Elkhead Reservoir was spilling water on all sampling trips from July 17 to September 21. The spillway site was sampled again with four experimental gill nets October 31 through November 1, which was after the reservoir stopped spilling. The stilling basin was sampled on two occasions with one experimental gill net from March 21 through March 26 and October 31 through November 1, for a total of six overnight sets.

A total of four species and 16 fish were captured at the spillway site (Table 4). Four species and 21 total fish were captured in the stilling basin (Table 4). Smallmouth bass and largemouth bass were the only species encountered at both the spillway site and the stilling basin. Largemouth bass captured at each site were similar in size, while smallmouth bass captured in the stilling basin were all adult fish (>200mm). Smallmouth bass captured at the spillway site included both juvenile and adult fish. Additionally, all of the smallmouth bass captured in the spillway site were captured after Elkhead Reservoir started to spill (Table 5). The majority of fish (75%) captured at the spillway site were smallmouth bass, while mostly white suckers (76%) were encountered in the stilling basin (Figures 15 and 16).

Sampling effort included 24 net-nights (combined number of nights that each gillnet was set) at the spillway site, and six net-nights in the stilling basin. Catch per unit effort (# of fish captured per net-night) was calculated for all species captured at both the spillway site and the stilling basin (Table 5, Figure 17). The highest catch rate was observed in the stilling basin at 2.67 white suckers per net-night. The second highest catch rate was at the spillway site with 0.50 smallmouth bass per net-night.

Discussion

The spillway net at Elkhead Reservoir was installed in the fall of 2016. This was the first year of fish sampling between the spillway net and the spillway. Ten net-nights of sampling in March produced one northern pike, while seven net-nights of additional sampling in July produced a total of eight smallmouth bass. The increase in catch rate observed in July prompted additional sampling in September along with the already scheduled post-spill sampling, which occurred in November. It is unclear whether fish collected behind the spillway net were present before the spillway net was installed, or if the spillway net was compromised after installation, presumably during spill conditions. In 2018, CPW will continue fish sampling to monitor escapement of fish at the spillway site and stilling basin.

VIII. Additional Noteworthy Observations:

Highline Lake/Mack Wash

Gizzard shad were first discovered in Highline Lake during standard annual sampling in October 2015, and continue to be very abundant. Possible sources include the Government Highline Canal, illegal introductions and/or illegal use of live fish as bait. Gizzard shad were first collected between the spillway net and spillway in March 2017. The spillway net was inspected shortly thereafter and though the spillway net had no damage, there were multiple gaps present that fish could move through. Those gaps in the spillway net were addressed during the March 2017 inspection. No gizzard shad were collected in Mack Wash downstream of Highline Lake in 2015, 2016, or 2017 suggesting the net has been effective in preventing escapement from Highline Lake. The lake outlet structure/bottom release was not operated in 2017.

Elkhead Reservoir

Since this was the first season post-installation of the spillway net, there were some challenges to work through resulting from the installation process. These issues have been addressed.

IX. Recommendations:

Highline Lake/Mack Wash

Operations and Maintenance

- CPW will continue with four spillway net inspections/cleanings in 2018. Inspections will take place at approximately the same time as in 2017 so that we have a clean spillway net when the lake begins filling. Two cleanings will occur during the summer, followed by a final cleaning before the inlet water is shut off.

- Park staff will continue to monitor the spillway net and debris being washed into the reservoir in the spring, and will inform divers when the cleaning of the spillway net will need to take place.
- The poly suspenders will be replaced in the spring of 2018.
- No additional vandalism of the spillway net has occurred to date. Park staff will continue to monitor this situation, and will consider the next course of action should vandalism continue.

Fish Monitoring

- CPW biologists will continue to complete annual fish surveys in Highline Lake between the spillway net and spillway in the spring prior to irrigation season, as well as at the two sites in Mack Wash downstream of the Highline Lake spillway net in the fall, post-irrigation season.

Elkhead Reservoir

Operations and Maintenance

- CPW will meet with the CRWCD, PNP, and UUWC over the winter of 2017-2018 and before the spring of 2018 to discuss UUWC's October 2017 inspection of the spillway net, and if anything needs to be addressed in 2018.
- Park staff will continue to monitor the spillway net and debris being washing into the reservoir in the spring, and will inform divers when the cleaning of the spillway net will need to take place.
- A barrier fence will be installed in 2018 to serve as a physical reminder for folks to stay away from the net area (coordination between CPW and CRWCD).

Fish Monitoring

- CPW biologists will continue to complete annual fish surveys in Elkhead Reservoir between the spillway net and spillway and in the stilling basin in the spring prior to the reservoir spilling and in the fall, post-spill.

X. Project Status: This project is on-track and on-going.

XI. FY 2017 Budget Status:

- A. Funds Provided: \$0.00
- B. Funds Expended: No Recovery Program dollars were expended in this fiscal year. \$4,000 was expended by CPW for four spillway net inspections/cleanings (\$1,000 each) at Highline Lake in FY 2017 (CPW covers annual operations and maintenance up to \$10,000). \$3,000 was expended by CPW for one spillway net inspection/cleaning at Elkhead Reservoir in FY 2017 (CPW covers annual operations and maintenance up to \$10,000).
- C. Difference: ---
- D. Percent of the FY 2017 work completed, and projected costs to complete: 100%; \$4,000 at Highline Lake and \$3,000 at Elkhead Reservoir
- E. Recovery Program funds spent for publication charges: \$0

XII. Status of Data Submission (Where applicable): N/A

XIII. Signed: Lori Martin
Program Manager

January 4, 2018
Date

Appendix: Figures and Tables

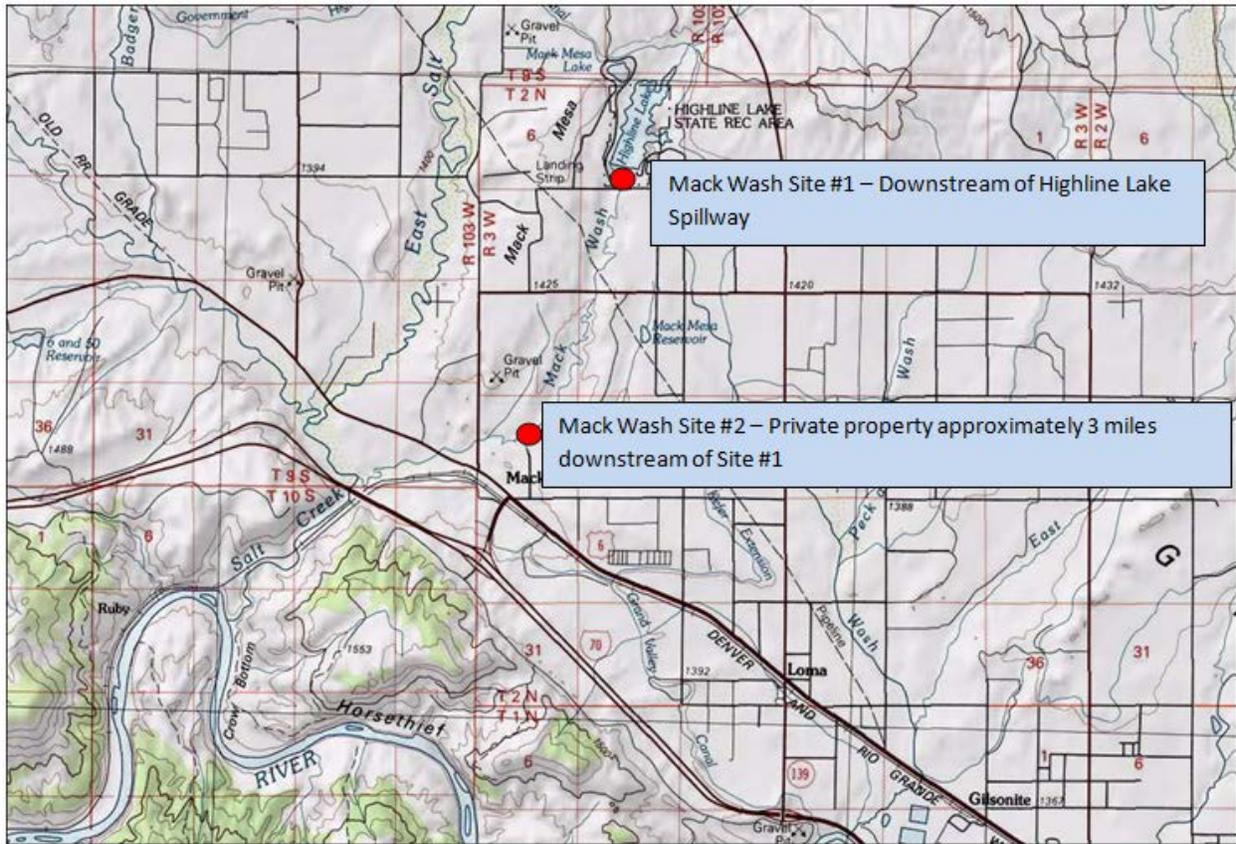


Figure 1. Map of sampling locations on Mack Wash surveyed in November 2016 and 2017 using a single-pass survey technique with a bank electrofishing unit.

Table 1. Total number of fish collected; total length size range in millimeters; catch per unit effort (# fish/hour) by species at Site #1 (immediately downstream of Highline Lake spillway; station length 0.12 mile) and Site #2 (Private property approximately 3 miles downstream of Site #1; station length 0.15 mile) in Mack Wash in **2016**. Native fish species identified by *.

Fish Species Collected	Site #1	Site #2
Black Bullhead	0 fish	0 fish
Bluehead Sucker*	0 fish	29 fish; 49-262mm; 39.2/hour
Common Carp	5 fish; 449-521 mm; 7.0/ hour	0 fish
Fathead Minnow	0 fish	1 fish ; 52 mm; 1.4/hour
Flannelmouth Sucker*	0 fish	72 fish; 48-112 mm; 97.3/hour
Green Sunfish	16 fish; 72-170 mm; 22.5/hour	2 fish; 105-122mm; 2.7/hour
Largemouth Bass	9 fish; 75-100 mm; 12.7/hour	0 fish
Red Shiner	0 fish	48 fish; 21-85 mm; 114.9/hour
Speckled Dace*	0 fish	18 fish; 34-65 mm; 25.3/hour
White Sucker / Hybrid	1 fish; 185 mm; 1.4/hour	22 fish; 32-125 mm; 29.7/hour
Yellow Perch	0 fish	0 fish
<u>Total Number of Fish Collected</u>	31 fish	192 fish

Table 2. Total number of fish collected; total length size range in millimeters; catch per unit effort (# fish/hour) by species at Site #1 (immediately downstream of Highline Lake spillway; station length 0.12 mile) and Site #2 (Private property approximately 3 miles downstream of Site #1; station length 0.15 mile) in Mack Wash in **2017**. Native fish species identified by *.

Fish Species Collected	Site #1	Site #2
Black Bullhead	0 fish	2 fish; 71-77 mm; 1.8/hour
Bluehead Sucker*	0 fish	14 fish; 64-192 mm; 12.6/hour
Common Carp	3 fish; 168-497 mm; 4.2/hour	0 fish
Fathead Minnow	0 fish	1 fish; 40 mm; 0.9/hour
Flannelmouth Sucker*	0 fish	12 fish; 81-112 mm; 10.8/hour
Green Sunfish	6 fish; 108-175 mm; 8.5/hour	2 fish; 72-77 mm; 1.8/hour
Largemouth Bass	13 fish; 61-150 mm; 18.3/hour	3 fish; 98-160 mm; 2.7/hour
Red Shiner	0 fish	175 fish; 27-76 mm; 157.7/hour
Speckled Dace*	0 fish	22 fish; 53-91 mm; 19.8/hour
White Sucker / Hybrid	0 fish	64 fish; 52-242 mm; 57.7/hour
Yellow Perch	0 fish	0 fish
<u>Total Number of Fish Collected</u>	22	295

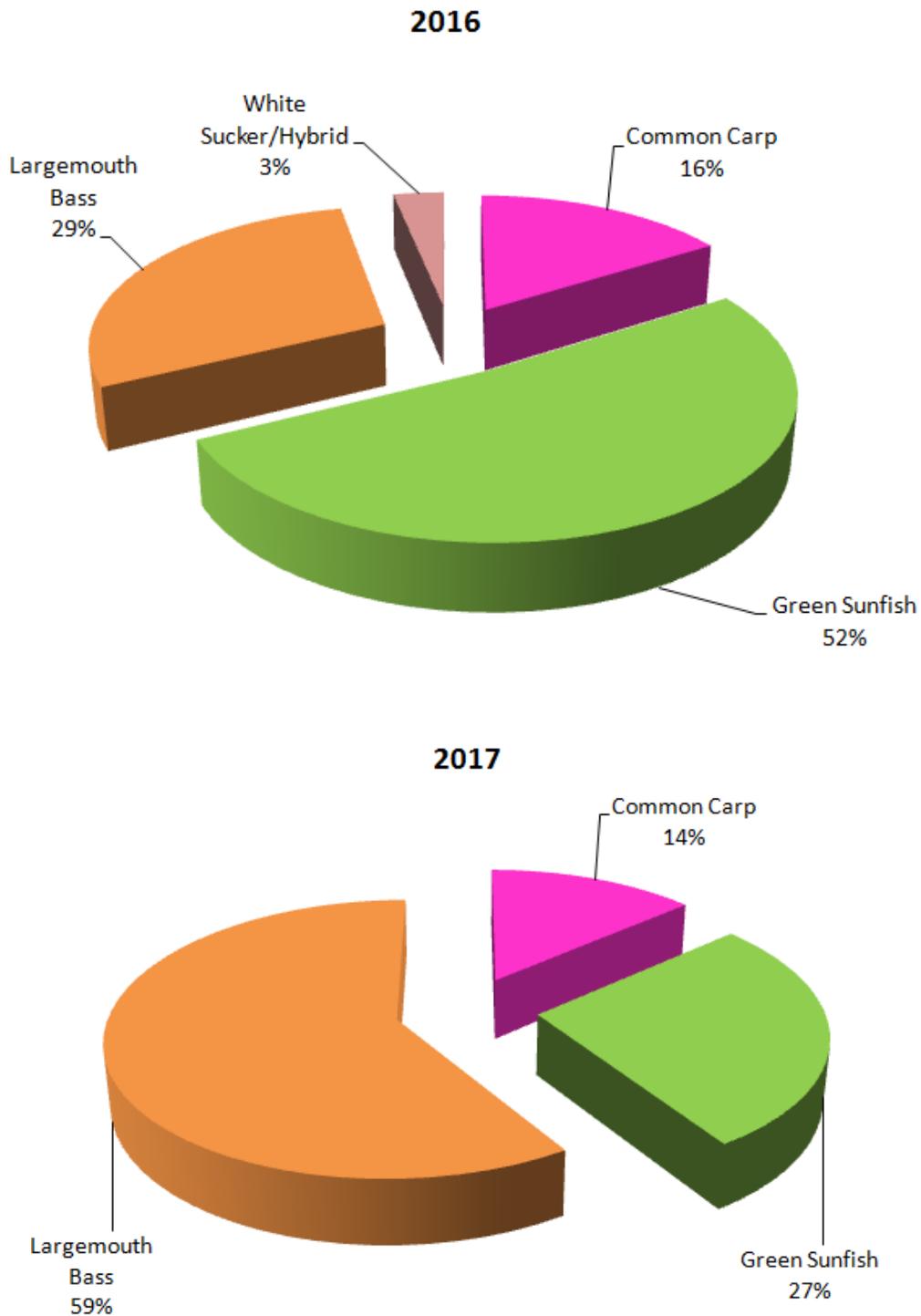


Figure 2. Species composition of fish surveyed in Mack Wash at Site #1 (immediately downstream of Highline Lake spillway) in 2016 and 2017.

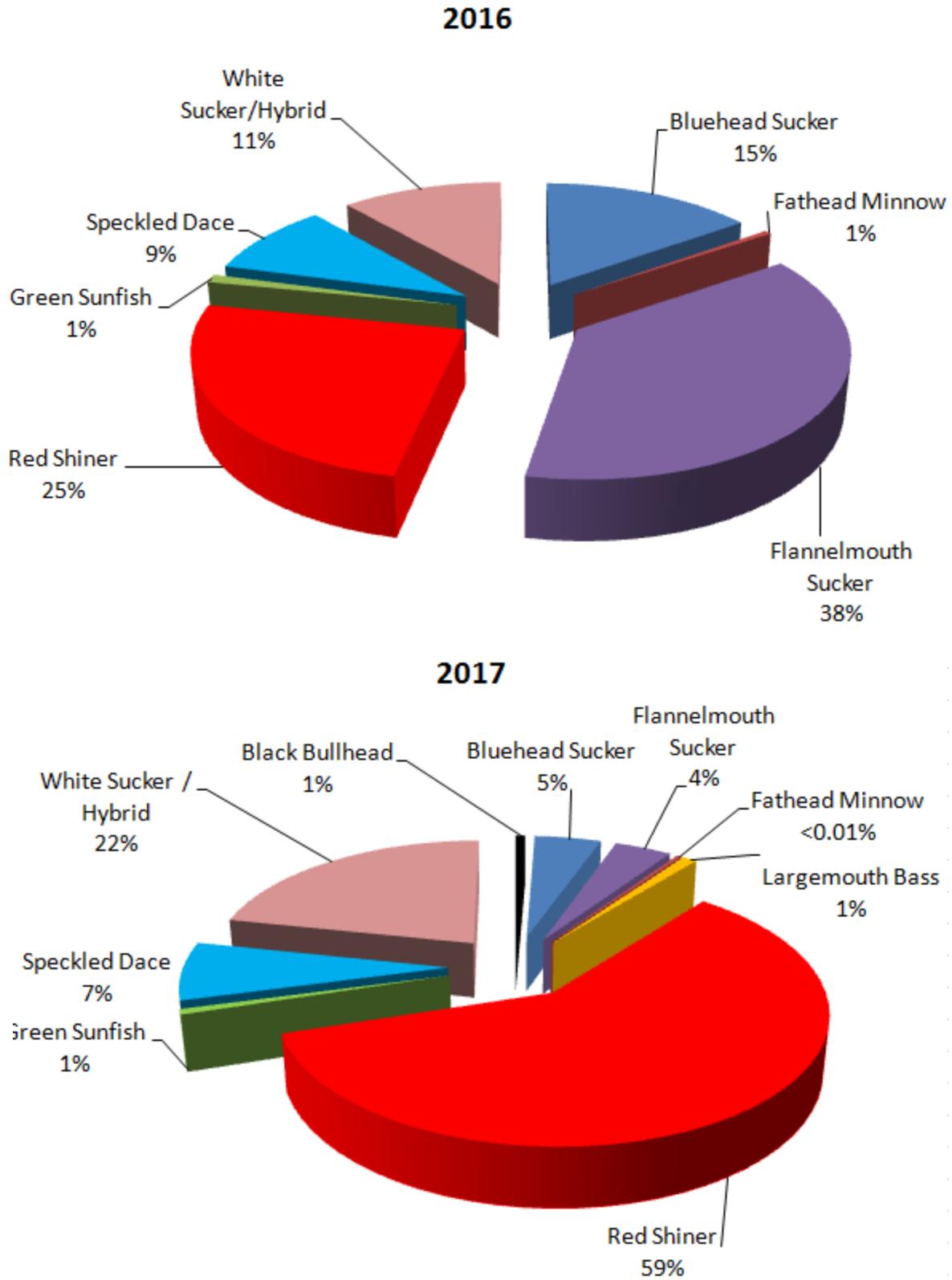


Figure 3. Species composition of fish surveyed in Mack Wash at Site #2 (approximately 3 miles downstream of Highline Lake spillway) in 2016 and 2017.

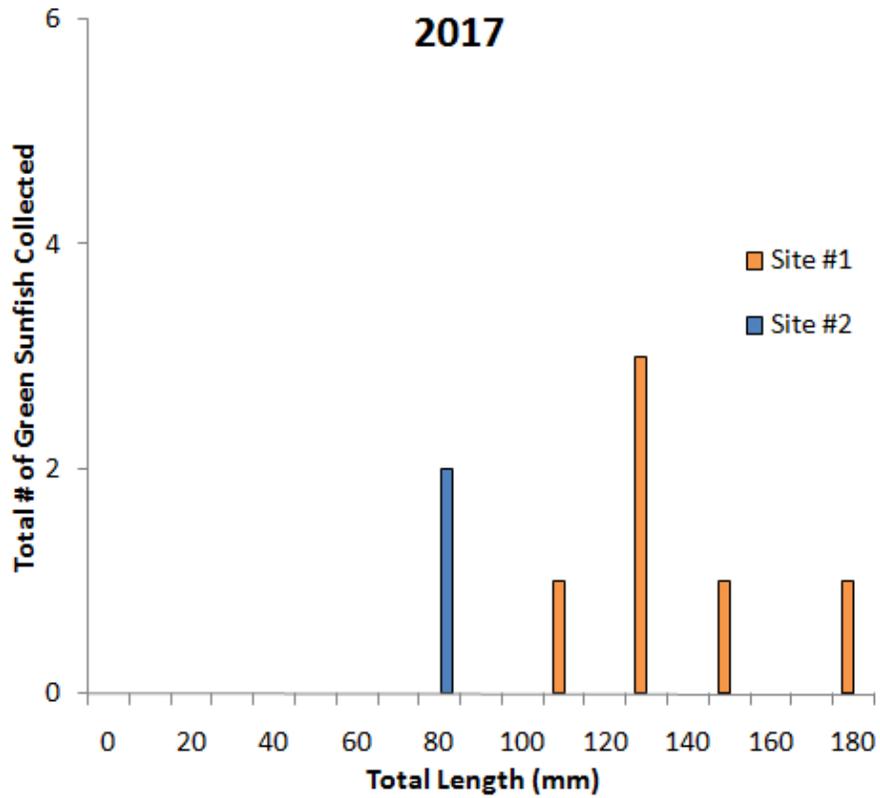
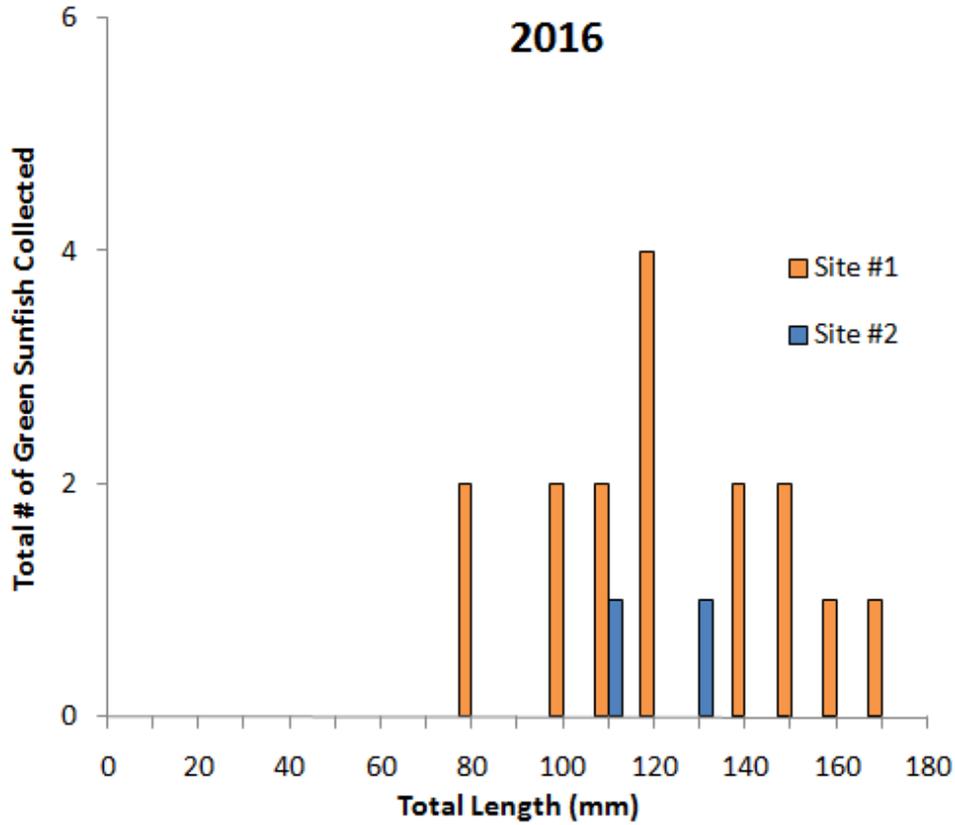


Figure 4. Length frequency histogram of green sunfish surveyed in Mack Wash at Site #1 and Site #2 in 2016 and 2017.

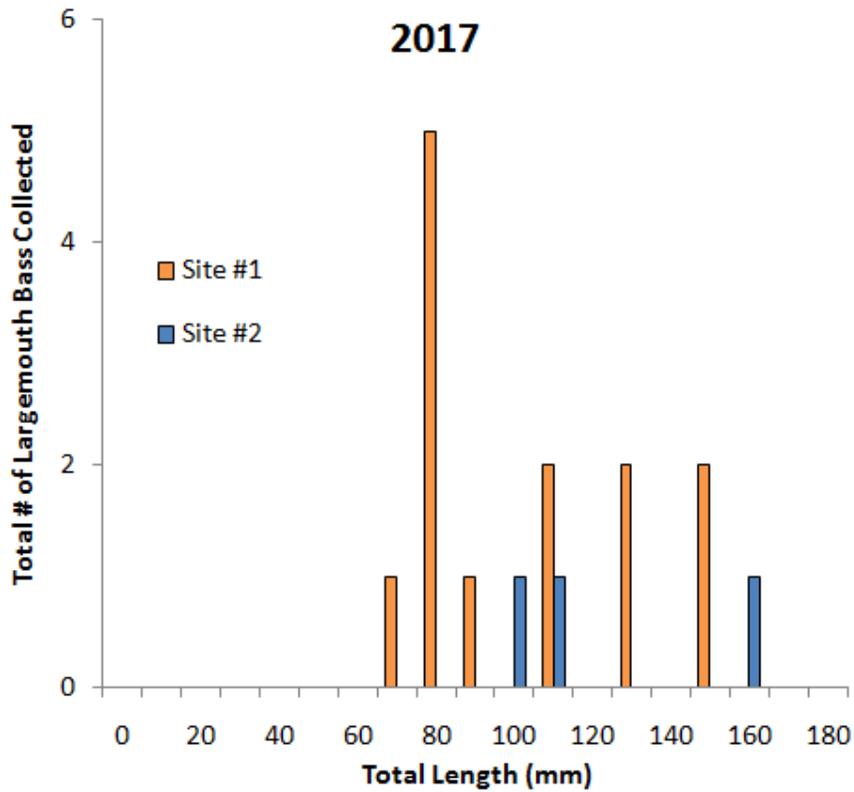
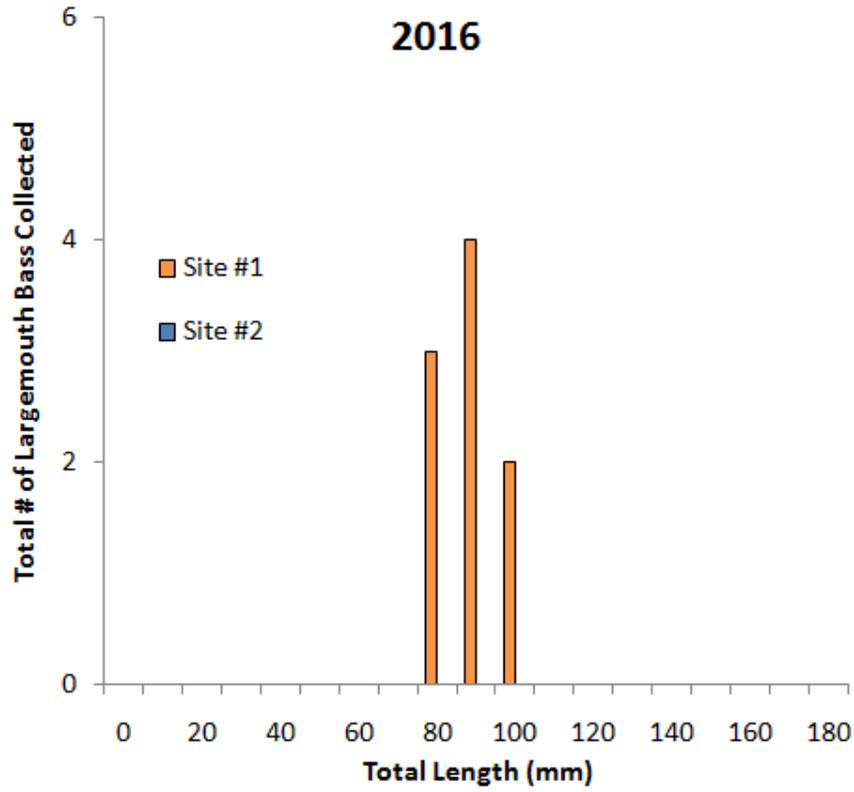


Figure 5. Length frequency histogram of largemouth bass surveyed in Mack Wash at Site #1 and Site #2 in 2016 and 2017.

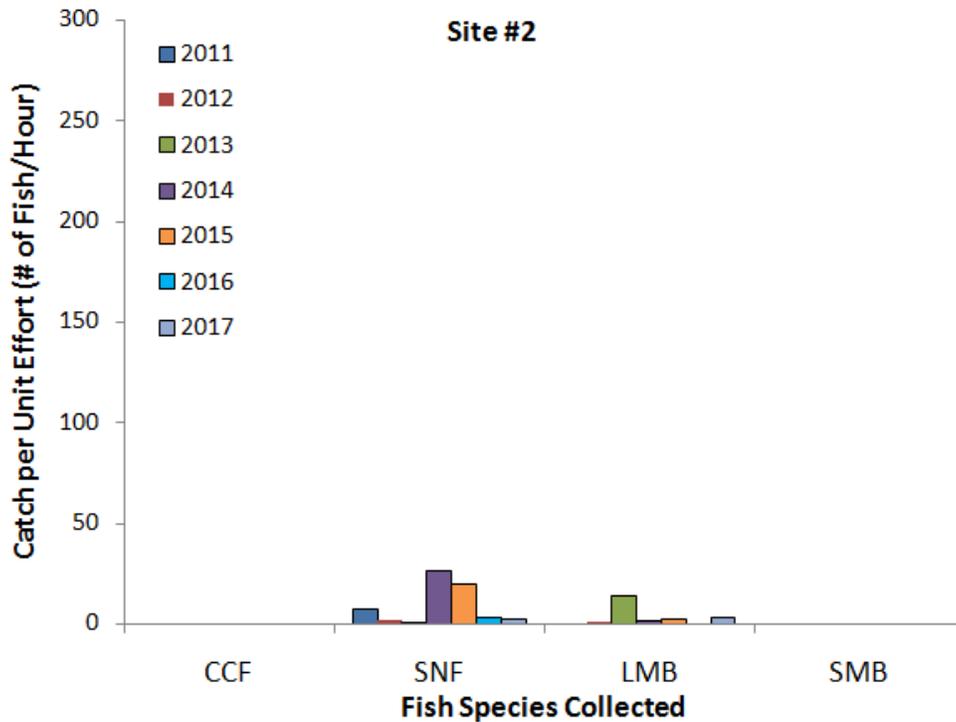
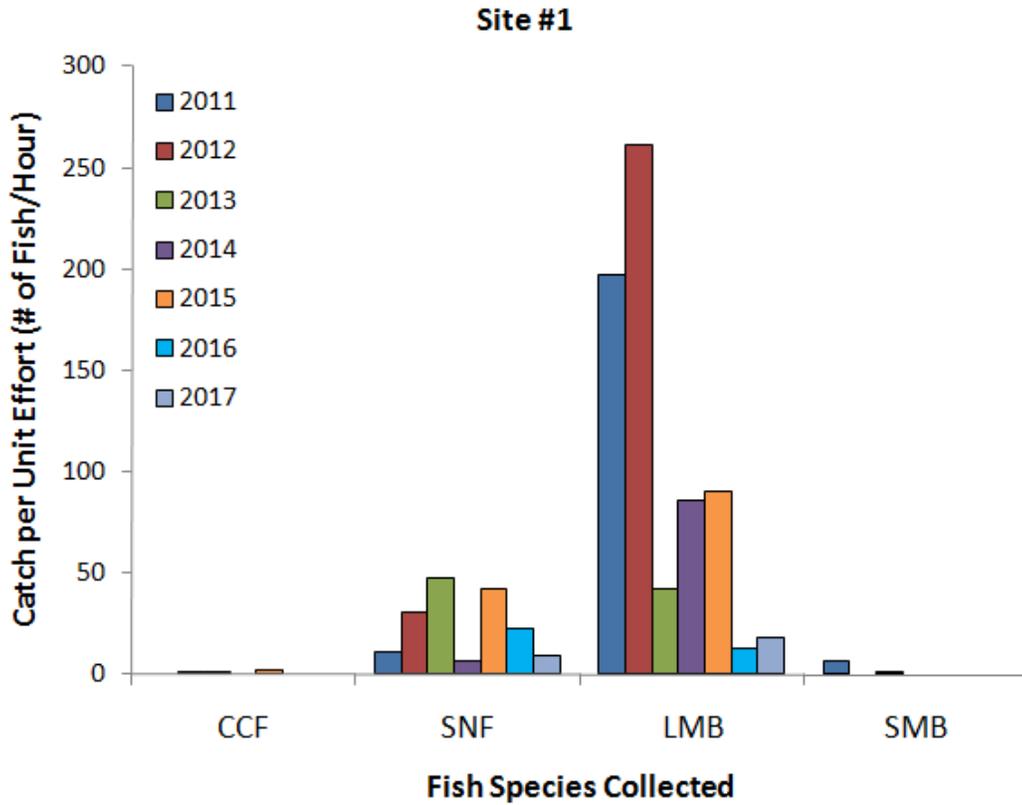


Figure 6. Historical (2011-2017) catch per unit effort of channel catfish (CCF), green sunfish (SNF), largemouth bass (LMB), and smallmouth bass (SMB) in Mack Wash at Site #1 & Site #2.

Table 3. Summary of

sample (species

composition, number of fish collected, length range, and catch per unit effort) of fish gathered between the spillway net and the spillway in Highline Lake in March of 2012, 2013, 2016, and 2017.

Collection Method	Fish Species Collected	Total # Fish Collected	Total Length Size Range in Millimeters	Catch per Unit Effort (# fish/hour)
2012 (300 fish collected)				
Electrofishing	Bluegill	47	57-188	75.0
	Common Carp	1	483	1.6
	Green Sunfish	223	42-157	355.9
	Largemouth Bass	24	56-296	38.3
	Red Shiner	3	58-71	4.8
	Smallmouth Bass	1	77	1.6
	Gill Nets	Rainbow Trout	1	284
2013 (163 Fish Collected)				
Electrofishing	Bluegill	23	47-170	30.7
	Common Carp	1	502	1.3
	Green Sunfish	126	40-190	168.0
	Largemouth Bass	13	67-123	17.3
	2016 (205 Fish Collected)			
Electrofishing	Black Crappie	1	119-119	1.2
	Bluegill	55	63-144	66
	Common Carp	5	443-510	6
	Largemouth Bass	34	57-281	40.8
	Rainbow Trout	1	259-259	1.2
	Smallmouth Bass	1	127-127	1.2
	Green Sunfish	108	53-166	129.6
2017 (309 Fish Collected)				
Electrofishing	Bluegill	91	65-159	93.0
	Common Carp	35	120-495	35.8
	Gizzard Shad	42	94-345	42.9
	Largemouth Bass	35	55-289	35.8
	Smallmouth Bass	1	167	1.0
	Green Sunfish	104	51-185	106.3
	Gill Nets	Rainbow Trout	1	297

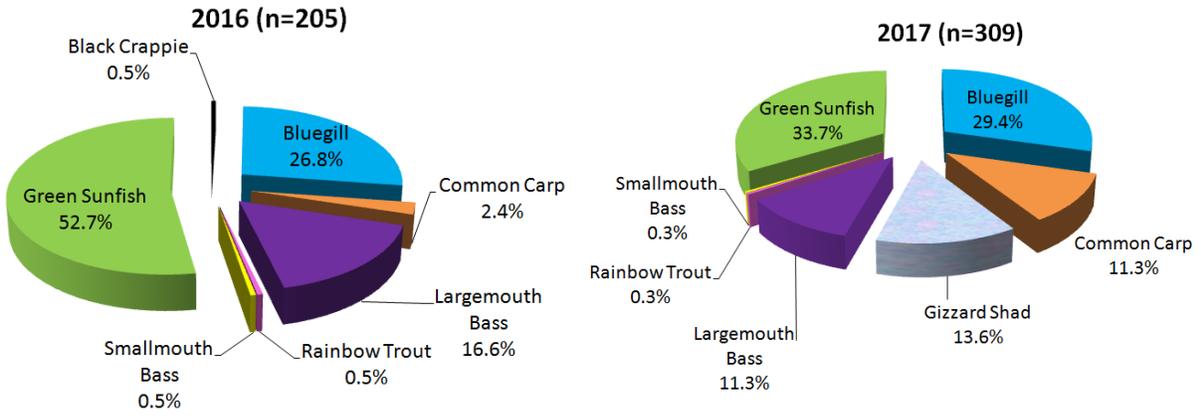


Figure 7. Species composition of Highline lake survey between the spillway net and the spillway in 2016 and 2017.

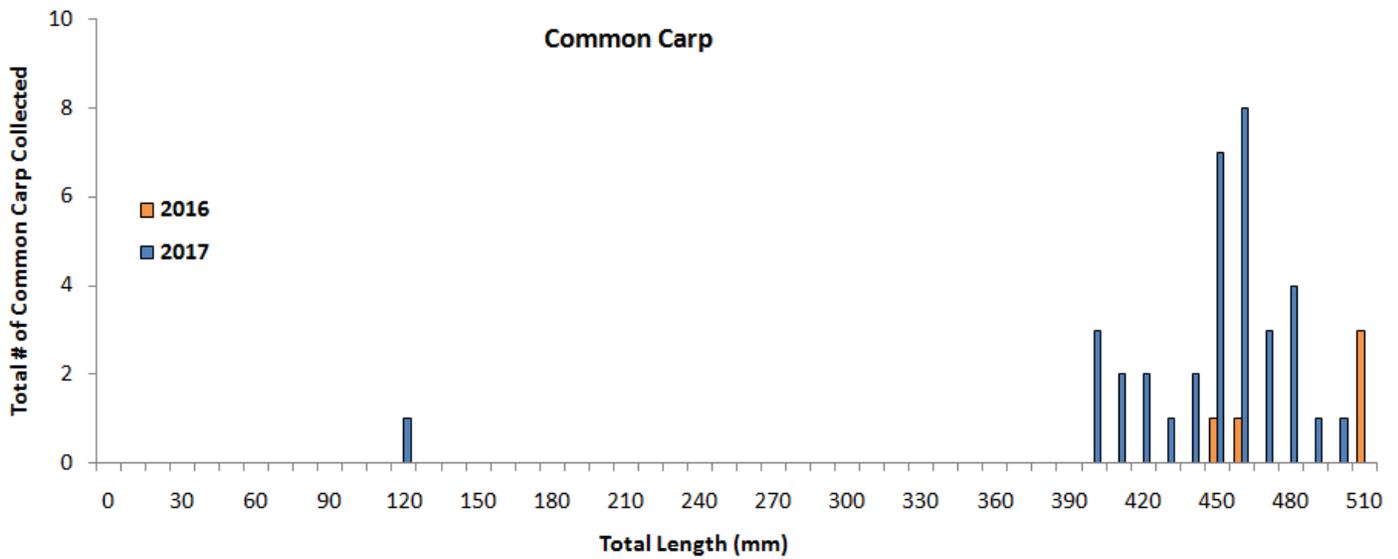


Figure 8. Length frequency histogram of common carp surveyed in Highline Lake between the spillway net and the spillway in 2016 and 2017.

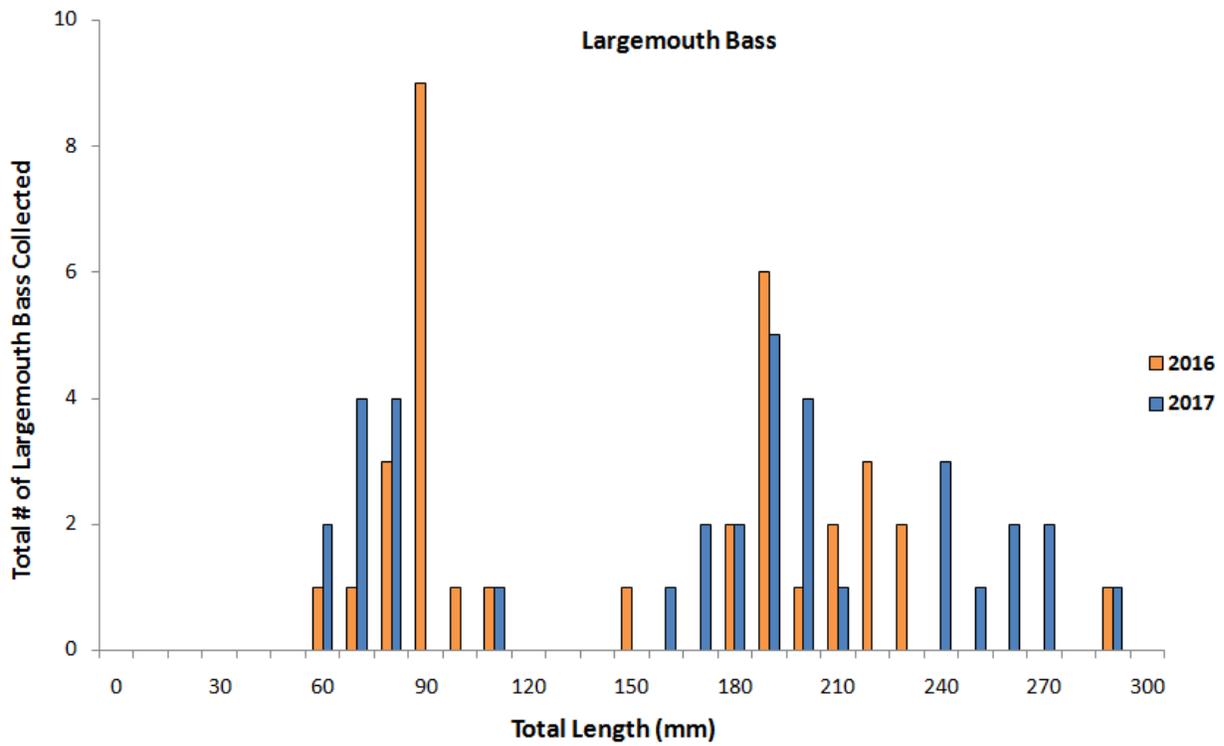


Figure 9. Length frequency histogram of largemouth bass surveyed in Highline Lake between the spillway net and the spillway in 2016 and 2017.

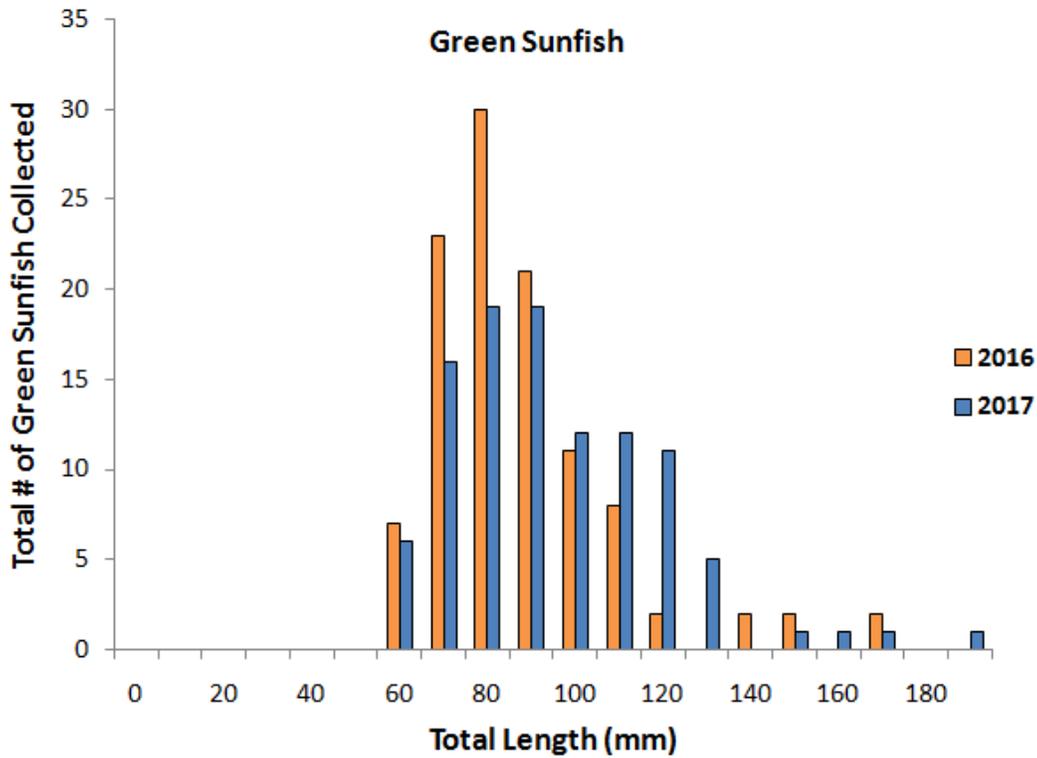


Figure 10. Length frequency histogram of green sunfish surveyed in Highline Lake between the spillway net and the spillway in 2016 and 2017.

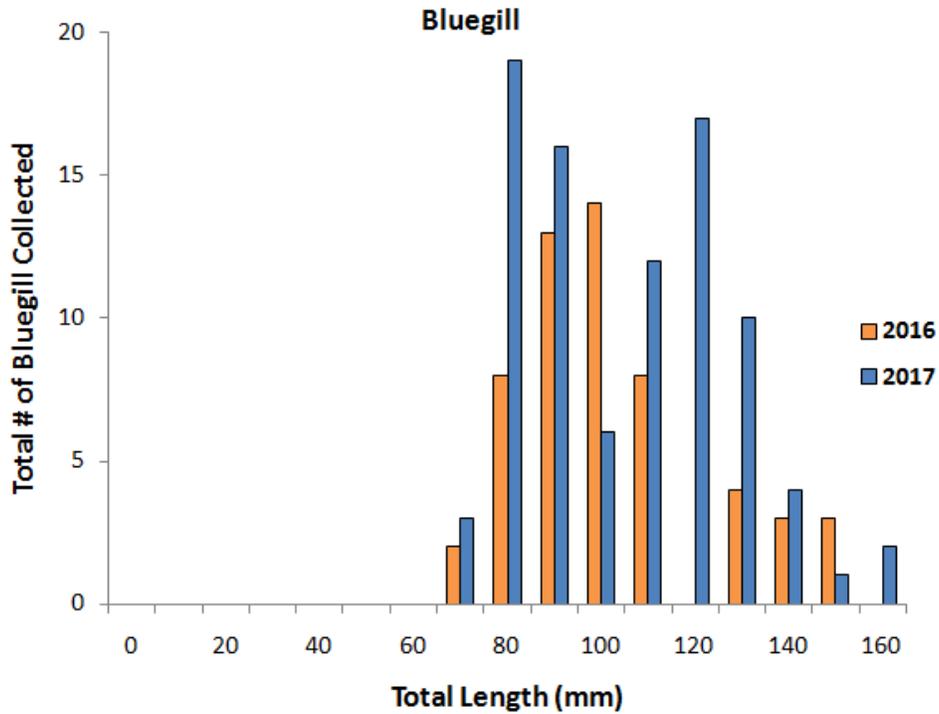


Figure 11. Length frequency histogram of bluegill surveyed in Highline Lake between the spillway net and the spillway in 2016 and 2017.

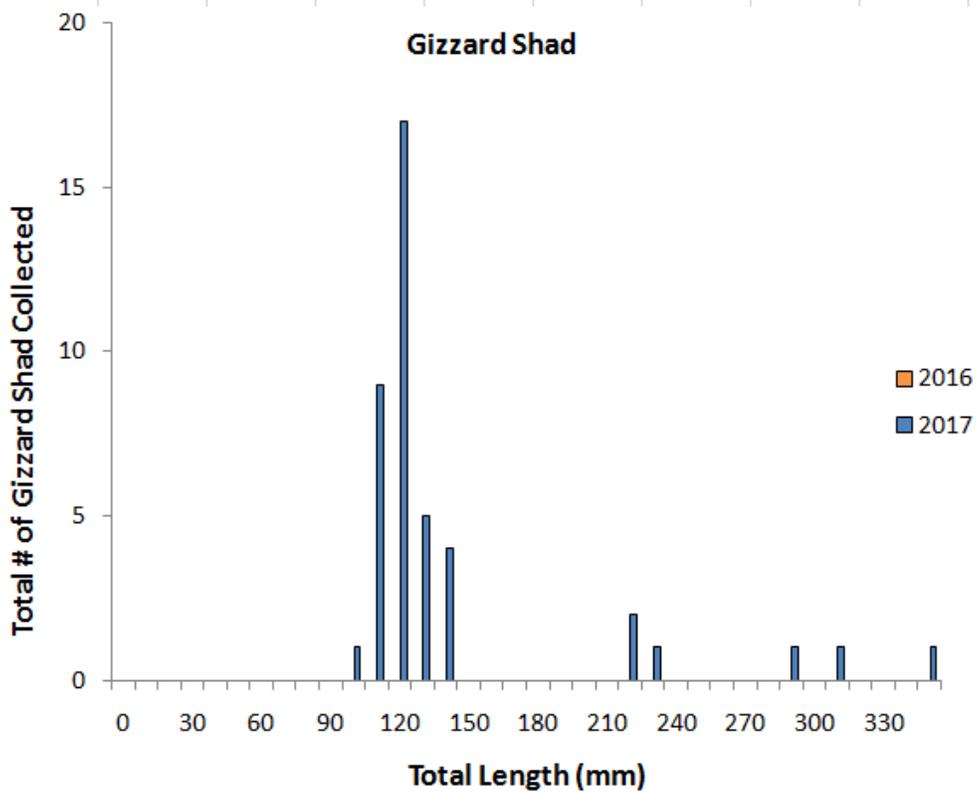


Figure 12. Length frequency histogram of gizzard shad surveyed in Highline Lake between the spillway net and the spillway in 2016 and 2017. No gizzard shad were surveyed in 2016.

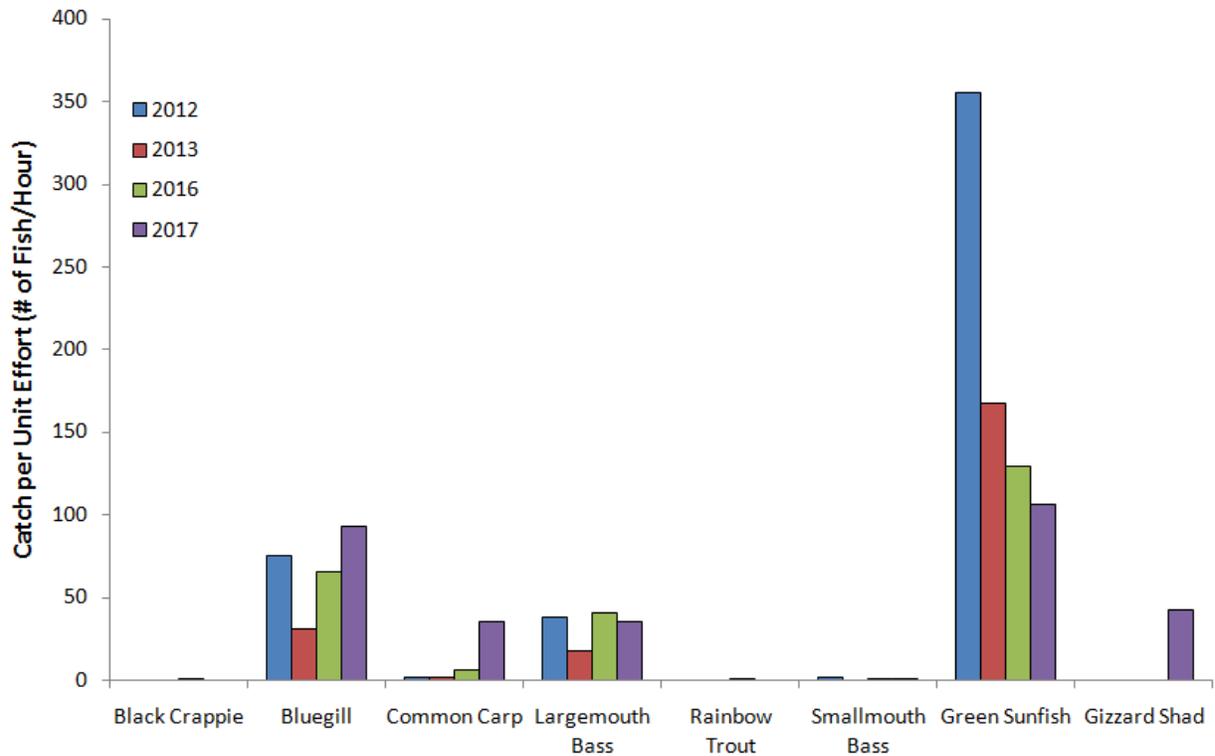


Figure 13. Historical electrofishing catch per unit effort (in number of fish captured per hour) of black crappie, bluegill, common carp, largemouth bass, rainbow trout, smallmouth bass, and green sunfish in Highline Lake between the spillway net and the spillway.



Figure 14. Satellite image of the Elkhead Reservoir spillway, fish sampling locations, and approximate location of the spillway net. Image courtesy of Google Earth.

Table 4. Summary of all species captured, with length ranges, during 2017 sampling efforts at the spillway site and in the stilling basin at Elkhead Reservoir.

<u>Fish Species Collected</u>	<u>Spillway Site</u>	<u>Stilling Basin</u>
Black Crappie	2 fish; 106-209 mm	0 fish
Bluegill	0 fish	2 fish; 124-150 mm
Largemouth Bass	1 fish; 195 mm	1 fish 191 mm
Northern Pike	1 fish; partially eaten	0 fish
Smallmouth Bass	12 fish; 168-294 mm	2 fish; 254-344 mm
White Sucker	0 fish	16 fish; 115-366 mm
<u>Total Number of Fish Collected</u>	16	21

Table 5. Overall catch per unit effort and total fish of each species captured in 2017 before compared to during/after Elkhead Reservoir started to spill water over the spillway.

<u>Location</u>	<u>Species</u>	<u>Total # Fish Collected</u>	<u># Fish Collected Pre-Spill</u>	<u># Fish Collected During/Post Spill</u>	<u>CPUE (# Fish/Net-Night)</u>
Spillway	Black Crappie	2	0	2	0.083
	Largemouth Bass	1	0	1	0.042
	Northern Pike	1	1	0	0.042
	Smallmouth Bass	12	0	12	0.5
Stilling Basin	Bluegill	2	2	0	0.33
	Largemouth Bass	1	0	1	0.16
	Smallmouth Bass	2	2	0	0.33
	White Sucker	16	16	0	2.67

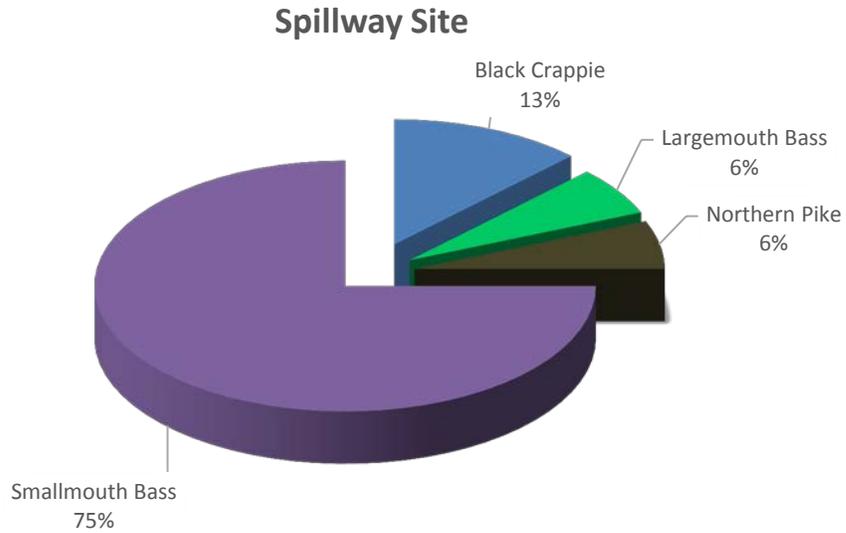


Figure 15. Species composition of fish sampled at the spillway site of Elkhead Reservoir in 2017.

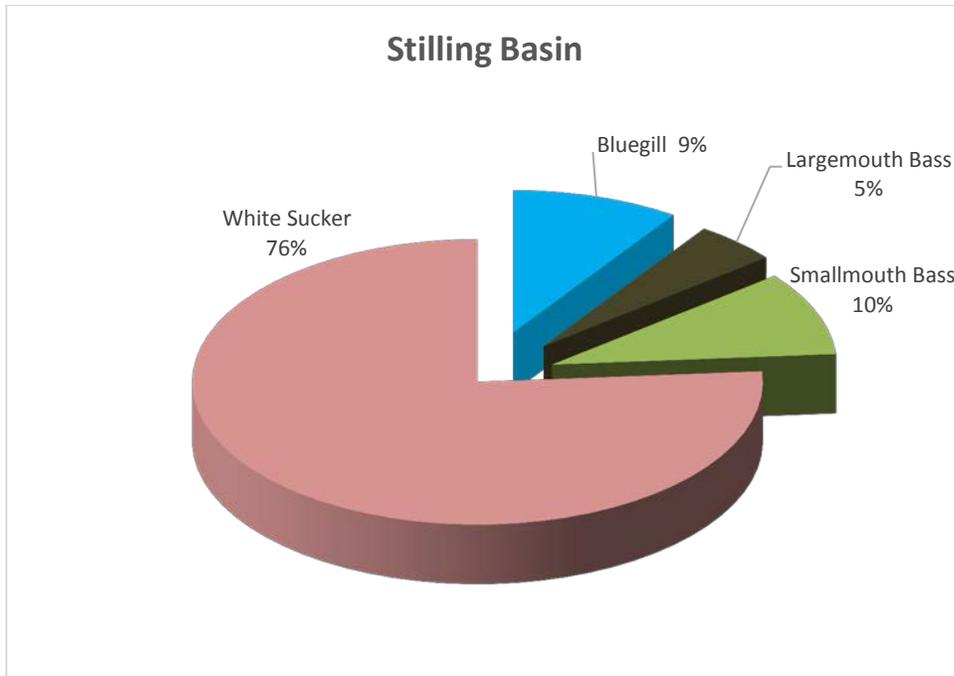


Figure 16. Species composition of fish sampled in the stilling basin below Elkhead Reservoir in 2017.

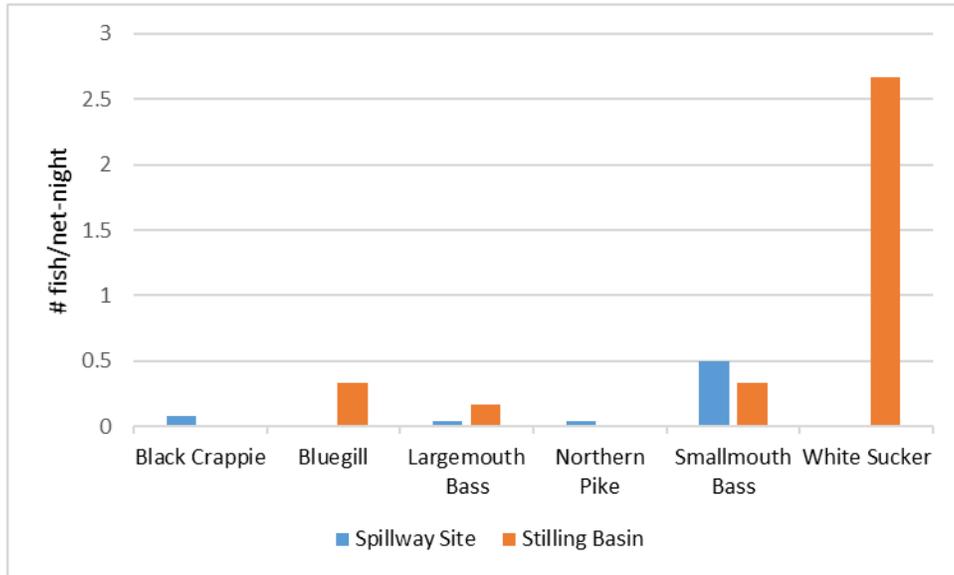


Figure 17. Number of fish captured per net-night of each species encountered at the spillway site and the stilling basin at Elkhead Reservoir in 2017.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R12AP40001

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: C-20

Project Title: Operation, maintenance, and fish escapement evaluation of the Highline Lake spillway net (fish barrier); we are also including the operation, maintenance, and fish escapement evaluation of the Elkhead Reservoir spillway net (fish barrier), though not technically a part of this Final Report until FY 2018

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Project/Grant Period: Start date: December 28, 2011
End date: September 30, 2017
Reporting period end date: December 31, 2017
Is this the final report? This is the final report for this period, but the study is ongoing within a new grant period.

Performance: All operations, maintenance, and fish sampling tasks were completed as outlined in the Scope of Work for this project.