

UPPER COLORADO RIVER ENDANGERED FISH RECOVERY PROGRAM

FY 2020 ANNUAL REPORT

PROJECT: C-20

Project Title:

Operation, maintenance, and evaluation of fish escapement barriers in Colorado (Highline Lake and Elkhead Reservoir)

Bureau of Reclamation Agreement Number:

No agreement currently in place. Previous agreement number was R12AP40001.

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Is this the final report? Yes _____ No X

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Abstract:

This project includes the operation, maintenance, and evaluation of the Highline Lake and Elkhead Reservoir spillway nets, designed to control escapement of non-native, warmwater fishes. Overall, both spillway nets appear to be in good shape and performing as designed. CPW is anticipating that the Highline Lake spillway net will need to be replaced no later than FY 2021, while the Elkhead Reservoir spillway net has no anticipated near-time replacement timeline. Operation and maintenance of both spillway nets were fully performed in 2020, including 5 underwater cleanings at Highline Lake and 4 at Elkhead Reservoir. Long, hot summer days with very little precipitation supported algal growth and necessitated five cleanings of the Highline Lake spillway net in 2020. The Highline Lake spillway net was partially submerged twice in 2020 by high inflows and excessive algal growth on the net. The Elkhead Reservoir spillway net was partially submerged (120 feet of net) during high flows in spring, but cleaning returned the net to buoyancy for the remainder of the year. Crews were unable to complete spring (pre-spill) evaluation of both the Highline Lake and Elkhead Reservoir spillway nets in 2020 due to COVID-19 health concerns and agency guidelines that restricted their ability to complete this work.

Study Schedule:

1999 - Ongoing

Relationship to RIPRAP:

This report provides details on the operation and maintenance of the Highline Lake spillway net, and fish monitoring to determine spillway net performance. The report also provides details on the operation and 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

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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)

Accomplishment of FY 2020 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY 2020 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 2020 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. Survey conducted in August 2020 instead of the spring (pre-spill conditions) due to COVID-19 agency guidelines. This survey occurred during irrigation season while the lake was not spilling due to reduced inflows as a result of irrigation demand.

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)

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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 2020 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 2020 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 partially completed (during post-spill conditions only) due to COVID-19 agency guidelines.

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 partially completed (during post-spill conditions only) due to COVID-19 agency guidelines.

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

Schedule: March-November/December

Deliverable: Task completed; Annual Report completed.

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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, which Highline Lake drains into.

Operations and Maintenance

Study Methods/Approach

Formerly, the operations and maintenance of the original Highline Lake 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. CPW expended \$6,500 for five spillway net inspections/cleanings and maintenance at Highline Lake in FY 2020. If annual costs exceed \$10,000, then CPW may request the Colorado River Recovery Program cover the additional costs. This scenario has not occurred to date at Highline Lake.

Results and Discussion

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 until the second 2020 spillway net inspection on May 22, when a high inflow of water was observed at Highline Lake. The safety buoys were partially submerged until the spillway net was cleaned, offering some relief from the high volume of water moving through the spillway net. This same scenario, i.e. buoys submerged, was also observed during the August 1 spillway net inspection/cleaning. Monthly spillway net inspections and cleanings occurred in August and September to try and combat the excessive algae growth on the spillway net as a presumed result of additional high inflow to Highline Lake and algae-favorable environmental conditions later in the summer.

Task 2. Spillway net cleaning and repair operations (in water): Five spillway net inspections/cleanings were performed by United Under Water Contractors (UUWC) in 2020: April 3, May 22, August 1, September 19, and November 9. The first inspection/cleaning of the spillway net in 2020 occurred ten days earlier than in 2019. The remaining inspections/cleanings occurred about one to two months apart. The extreme weather conditions (long, hot summer days with very little precipitation) later in the 2020 season facilitated additional algae growth, resulting in the need for monthly cleanings in August and September, as well as a fifth cleaning in November. The spillway net was cleaned manually on all five occasions by divers from UUWC. As the spillway net ages, there will be a continual increase in algal buildup. CPW plans to continue with at least four and perhaps five spillway net cleanings/inspections in 2021. Reports from the five 2020 spillway net inspections/cleanings follow.

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The highlights of the April 3 spillway net inspection/cleaning were: 1) Cleaning was completed and there were no significant holes, cuts, or gaps found in the spillway net. Extra time was spent with an additional diver cleaning both sides of the upper skirt. 2) Canal water was just starting to flow into the lake (day 3 of inflow). The spillway net was very dirty and heavily covered with mats of growing algae and miscellaneous debris. Debris and lures were removed. 3) All cables, anchors, manta bolts, shackles, and thimbles were inspected and found to be tight, in good condition, and working well.

The highlights of the May 22 spillway net inspection/cleaning were: 1) Cleaning was completed and one, 6" hole was observed on the east corner of the spillway net. That hole was repaired on the following inspection/cleaning. Otherwise, there were no significant holes, cuts, or gaps found in the spillway net. 2) Canal water was flowing into the lake, and there was a strong flow. Nine buoys were just below the water level. The spillway net was extremely dirty especially on the upper half of the spillway net. After cleaning the spillway net, and removing debris and lures from the skirt of the spillway net, most of the nine buoys resurfaced. 3) All cables, anchors, manta bolts, shackles, and thimbles were inspected and found to be tight, in good condition, and working well.

The highlights of the August 1 spillway net inspection/cleaning were: 1) Cleaning was completed, and two holes the size of a baseball were observed in the spillway net, in the area where the spillway net lays against the rocks along the dam. This area of the spillway net receives more wear from boat wakes, and is not problematic for fish escapement at this time. These holes were repaired, and there were no significant holes, cuts, or gaps observed in the spillway net. 2) Canal water was flowing into the lake, and there continued to be a strong flow. Seven buoys were just below the water level. The spillway net was extremely dirty especially on the upper half of the spillway net. After cleaning the spillway net, and removing debris and lures from the skirt of the spillway net, most of the seven buoys resurfaced. 3) All cables, anchors, manta bolts, shackles, and thimbles were inspected, found to be tight, in good condition, and working well.

The highlights of the September 19 spillway net inspection/cleaning were: 1) Cleaning was completed, and there were several holes starting to form in the same area of the spillway net where it lays against the rocks along the dam. As was the case in August, this area of the spillway net receives more wear from boat wakes, and is not problematic for fish escapement at this time. These holes were repaired, and there were no significant holes, cuts, or gaps found in the spillway net. 2) The spillway net was covered with matted algae, especially on the top half and in the skirt area. Most of this algae was removed with heavy scrubbing. Brush and tumble weeds were entangled in the upper skirt of the spillway net, and removed. A "no boats" buoy was floating in the spillway net and removed for the Park to retrieve. 3) All cables, anchors, manta bolts, shackles, and thimbles were inspected, found to be tight, in good condition, and working well.

The highlights of the November 9 spillway net inspection/cleaning were: 1) Cleaning was completed, and there were several holes continuing to form in the same area of the spillway net where it lays against the rocks along the dam. As was the case in August and September, this area of the spillway net receives more wear from boat wakes, and is not problematic for fish escapement at this time. These holes were repaired, and there were no significant holes, cuts, or gaps found in the spillway net. 2) The spillway net was covered with matted algae, especially on the top half and in the skirt area. Most of this algae was removed with heavy scrubbing. Brush, tumble weeds, and lures were entangled in the upper skirt of the spillway net, and removed. Ten total divers were used to get the spillway net as clean as

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possible for the season. 3) All cables, anchors, manta bolts, shackles, and thimbles were inspected and found to be tight, in good condition, and working well.

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, CPW would examine the spillway net from the water surface.

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. UUWC prepared reports for each of these spillway net inspections/cleanings, which are available at the Park or on request.

Fish Monitoring

Highline Lake

Study Methods/Approach

CPW biologists completed fish surveys within Highline Lake between the spillway net and the spillway in March 2012, March 2013, March 2016, March 2017, March 2018, November 2018, on two occasions in March 2019, and in August 2020. In March 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. Timing of the sampling between the spillway net and spillway was delayed in 2020 due to COVID-19 agency protocols. However, due to a temporary reduction in inflows into Highline Lake, the reservoir did not spill for several days in August. This presented a unique opportunity to complete a survey between the spillway net and the spillway in August of 2020, which was unexpected because the reservoir typically spills during the entire irrigation season (April through October). The summary that follows is focused on the analysis of fish data gathered in 2018, 2019, and 2020. Please refer to previous years' Annual Reports for Project C-20 for summaries of the pre-2018 data for Highline Lake.

CPW surveyed Highline Lake between the spillway net and the spillway on August 25, 2020. This survey, which is typically conducted in the spring prior to irrigation season, was delayed due to COVID-19 agency guidelines. Highline Lake typically spills throughout the entire irrigation season (early-April to late-October) but irrigation demand and canal inputs into Highline Lake during a several day period in late August allowed a survey to be conducted at that time when the reservoir was not spilling. The August 25 survey consisted of nighttime boat electrofishing (ETS unit, 1 netter) and daytime sets of two, 150' experimental mesh gill nets. The objectives of the survey were to determine fish species composition and relative abundance within the lake between the spillway net and the spillway. All fish were identified to species, measured in length to the nearest mm, and weighed to the nearest g. Fish collected were released back into Highline Lake upstream of the spillway net with the exception of gizzard shad and common carp, which were lethally removed.

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Results and Discussion

A total of 130 fish were collected during the survey between the spillway net and the spillway conducted on August 25, 2020 (Table 1). Nine fish were captured using gill nets while the remaining 121 fish were captured using nighttime boat electrofishing. Green sunfish dominated the catch, comprising 68.4% of the fish captured (Figure 1). Other species collected in the 2020 survey included largemouth bass, bluegill, gizzard shad, common carp, rainbow trout, channel catfish, and yellow perch. One juvenile yellow perch (75 mm total length) was captured in 2020. Although low densities of yellow perch are regularly documented in the annual surveys conducted in the main body of Highline Lake, this is the first yellow perch ever captured between the spillway net and the spillway. One channel catfish (521 mm total length) was captured in 2020. Only one other channel catfish (73 mm total length, captured in 2018 fall survey) had been previously documented between the spillway net and the spillway. Multiple size classes of largemouth bass (Figure 2), green sunfish (Figure 3), and bluegill (Figure 4) were captured. Five gizzard shad (all adults) were captured compared to 362 gizzard shad (diverse size structure with considerable numbers of adults and sub-adults) collected in the spring 2018 survey, and three adult gizzard shad collected in the spring 2019 survey (Figure 5). The high abundance of gizzard shad in 2018 was addressed through increased removal efforts on the first spring survey and also through a second spring survey to further decrease abundance of gizzard shad between the spillway net and the spillway prior to the reservoir spilling. Significant depletion was seen in gizzard shad catch rates during those removal efforts in 2018, which presumably reduced chances of gizzard shad escapement and also resulted in lower gizzard shad catch rates in 2019 and 2020.

Catch per unit effort between the spillway net and the spillway in 2020 was lower (relative to 2019) for green sunfish, bluegill, and largemouth bass, while catch per unit effort was slightly higher in 2020 (also relative to 2019) for gizzard shad and common carp (no common carp were collected in 2019) (Table 1, Figure 6). The catch rate for all fish over 100 mm in total length was slightly higher than that observed in 2019, but was only 24% of the highest catch rate observed in the spring of 2018 (Figure 7). One adult channel catfish was captured between the spillway net and the spillway and a second adult channel catfish was captured in Mack Wash immediately downstream of Highline Lake at Site #1. Only one other channel catfish (73 mm total length, captured in 2018) has ever been caught between the spillway net and the spillway while the last channel catfish captured at Site #1 in Mack Wash was in 2015. The capture of these two fish suggest that there may have been increased escapement of channel catfish from Highline Lake into the area behind the net and also into Mack Wash in 2020 relative to previous years.

Mack Wash

Study Methods/Approach

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 past the spillway net and/or through the bottom release on the dam when no anti-escapement device is in place. Irrigation water is delivered

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annually 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 between the spillway net and the spillway 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 (Figure 8) in the month of November from 2011-2020. Please refer to previous years' Annual Reports for Project C-20 for summaries of the pre-2018 data for Mack Wash. The summary that follows is focused on the analysis of fish data gathered in 2018, 2019, and 2020. CPW biologists conducted single-pass, bank electrofishing surveys at two sites on Mack Wash downstream of Highline Lake on November 14, 2018, November 19, 2019, and November 17, 2020. 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, CPW was interested in identifying potential escapement of non-native fishes from Highline Lake. All fish were identified to species, measured in length to the nearest millimeter (mm), and weighed to the nearest gram (g). All largemouth bass and rainbow trout from Site #1 were relocated to Highline Lake. Otherwise, all non-native fish collected were lethally removed.

An additional sampling technique was utilized at Site #1 in 2020. The upstream end of Site #1 is a deep pool at the downstream end of the spillway, which often makes it difficult to capture fish in the deeper water. In previous years, adult fish were observed in the spillway pool following the survey due to electrofishing efficiency limitations in deep water and difficulty accessing the deeper water. There appeared to be a higher number of fish than usual remaining in the deep pool following the 2020 electrofishing survey. CPW conducted an overnight gill net survey in the pool at the top of Site #1 using a 125' experimental gill net on November 18-19, 2020 to remove as many of the fish remaining as possible.

Results and Discussion

The 2020 electrofishing survey at Site #1 on Mack Wash consisted of channel catfish, largemouth bass, green sunfish, and white sucker (Table 2, Figure 9). The gill netting survey completed at Site #1 consisted of largemouth bass, rainbow trout, and green sunfish. The 2020 survey at Site #2 on Mack Wash consisted of red shiner, white sucker/hybrid sucker, speckled dace, green sunfish, largemouth bass, and black bullhead (Table 2, Figure 10). No gizzard shad were collected in Mack Wash at either site in 2020 (Table 2), and this species has never been documented historically at either site (Tables 3 and 4), despite their continued high abundance within Highline Lake.

Multiple size-classes of largemouth bass were observed in the electrofishing survey at Site #1 (Figure 11), while two green sunfish of a similar size class were also captured (Figure 12). The size structure of largemouth bass consisted of juvenile fish ranging in total length from 58 mm to 101 mm. Largemouth bass size structure was similar to that observed in previous surveys; the only exception was 2018 in which several larger adults were collected. Green sunfish electrofishing catch per unit effort at Site #1 in 2020 was lower than 2018 and 2019 (Tables 2-4). Largemouth bass electrofishing catch per unit effort in 2020 was the same as 2019, which was less than in 2018 (Tables 2-4). Catch rates for largemouth bass were much lower than those observed in 2011 and 2012 when these surveys were first

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implemented which was also when canal surges had recently compromised the spillway net (Figure 13). One adult channel catfish (543 mm total length) was surveyed at Site #1 in 2020. This is the first channel catfish that had been surveyed at this site since 2015.

An overnight set of an experimental gill net was very effective at capturing fish that remained in the spillway pool at the upstream end of Site #1 following the electrofishing survey. The gill net survey resulted in the capture of an additional 31 fish following the electrofishing survey. The fish captured during the gill net survey consisted of largemouth bass, rainbow trout, and green sunfish. The majority of fish captured during the gill net survey were adults. This was the first time this technique had been utilized at Site #1, which limited the ability to compare these data to previous years' data.

Largemouth bass captured at Site #2 included larger fish than in previous years, with five fish over 130 mm total length being captured while no largemouth bass over 130 mm total length were surveyed in 2018 or 2019 (Figure 11). Green sunfish size structure at Site #2 was similar to previous years' data with total length of green sunfish ranging from 58 mm to 152 mm (Figure 12). Catch per unit effort for both green sunfish and largemouth bass were the highest observed at this site across all years by a wide margin (Figure 13). There has been an increasing trend in green sunfish and largemouth bass catch rates since 2018.

Electrofishing data gathered from Mack Wash immediately downstream of the reservoir at Site #1 were encouraging in the sense that 2020 catch rates for green sunfish were the lowest ever observed while the largemouth bass catch rates were also relatively low (although just slightly higher than the catch rate in 2019). Anecdotally, there seemed to be more fish (many of which were adult fish) remaining in the spillway pool than in previous years' surveys following the electrofishing survey. Although not reflected in the electrofishing catch rates, this apparent increased density of fish in the spillway pool may be indicative of increased numbers of fish at Site #1 that were holding in water that could not be effectively surveyed using electrofishing. It is recommended that future surveys incorporate gill netting to remove as many fish as possible. This will allow for comparisons of both electrofishing and gill netting catch rates at Site #1 to compare trends through time, and will also more effectively remove fish at Site #1.

The spillway net was potentially compromised during portions of the late summer and into fall in each of the last three years during canal surges in which the amount of water going over the spillway resulted in a portion of the top of the spillway net and protective skirt going under the surface of the water (see *Operations and Maintenance* section). These surges from the canal were a result of heavy rains, and irrigators not diverting water from the canal but rather conveying surplus water through the system and finally into Highline Lake. No fish surveys were conducted between the spillway net and the spillway following these canal surges in 2019. Spring surveys were not conducted in 2020 due to COVID-19 agency guidelines so it is possible that fish escapement was higher than usual in early 2020 due to fall canal surges in 2019 followed by a lack of removal efforts in the fall of 2019 and spring of 2020. However, electrofishing catch rates for green sunfish and largemouth bass at Site #1 immediately below the reservoir remained low. It is possible that fish from the upstream portions of Mack Wash near Highline Lake were flushed downstream during periods of higher releases from Highline Lake, which would partially explain why catch rates only increased at Site #2. However, species that are less frequently surveyed at Site #1 such as common carp, channel catfish, bluegill, black crappie, and rainbow trout have not been surveyed at Site #2 since the spillway net was installed. Therefore, it is

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possible that these high green sunfish and largemouth bass catch rates at Site #2 are indicative of trends in resident populations of those two species in Mack Wash, which is not necessarily reflective of fish escapement out of Highline Lake.

Conclusions

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 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 2014 after dredging activities within Highline Lake were completed.
- 3) Adjustment of the skirt and maintenance of several cables and hardware appear to be holding the spillway net in better position, keeping the skirt from washing over the spillway net, and improving the effectiveness of 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. Furthermore, an anti-escapement net is deployed on the outlet structure to prevent fish escapement when the outlet is operated.

Overall, based on data gathered between the spillway net and the spillway in Highline Lake and the data from Mack Wash at Site #1, the spillway net continues to prevent the majority of fish from escaping Highline Lake, and fish escapement has been greatly reduced compared to years in which the spillway net had been significantly compromised. The considerably higher catch rates of green sunfish and largemouth bass, and observation of adult largemouth bass at Mack Wash Site #2 merits continued monitoring and evaluation.

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.

Operations and Maintenance

Study Methods/Approach

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

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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 Colorado River Recovery Program, subject to the mutual agreement of CPW and the Colorado River 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 Colorado River 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. At the end of the useful life cycle of the spillway net, the Colorado River 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.

CPW did expend a total of \$13,200 for cleaning/inspection of the spillway net in 2020. This was \$3,200 beyond the \$10,000 CPW committed to. At this time, CPW has determined no need for the Colorado River Recovery Program to reimburse its 50:50 share of \$3,200 (which would be a cost of \$1,600) to CPW for operations and maintenance costs.

Results and Discussion

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). All materials and connections were in good working order. CPW staff did determine that the hardware reportedly missing from two joints on the debris is missing for a reason. This is designed to be open so staff can access this area behind the debris boom as needed. No hardware is in need of replacement as documented in previous reports. A barrier fence was installed in 2020 to serve as a physical reminder for folks to stay away from the spillway net area. Signage was also installed with the message of "keep off, keep out".

Task 2. Spillway net cleaning and repair operations (in water): Four spillway net inspections/cleanings were performed by UUWC in 2020: May 2, June 19, July 31, and August 31. The first inspection/cleaning of the spillway net in 2020 occurred in May, approximately 2 weeks earlier than in 2019. The remaining inspections/cleanings occurred about one month apart until the end of August. This more frequent cleaning schedule seemed to stay ahead of the algae growth. The spillway net was cleaned manually on all four occasions by divers from UUWC. CPW plans to continue with at least four spillway net inspections/cleanings in 2021. Reports from the four 2020 spillway net inspections/cleanings follow.

The highlights of the May 2 spillway net inspection/cleaning were: 1) Cleaning was completed and there were no significant holes, cuts, or gaps observed in the spillway net. 2) UUWC observed the water flow to be strong, and over 120' in length of the spillway net including the buoys and upper skirt were under water. Six divers focused on cleaning the center 50% of the spillway net, and by the time the cleaning was complete, all buoys were back on the water surface. The spillway net had a large amount of algae and debris from spring run-off. There also was wood and debris held in the upper spillway net skirt and at the debris boom. The wood and debris that build-up in the spillway net zone appear to work their way along the shore and past the debris barrier with the help of water level, wind, and wakes. 3) Hardware and the buoy system were inspected and in good condition. The bars holding the bottom skirts on the debris barrier are starting to show wear.

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The highlights of the June 19 inspection/cleaning were: 1) Cleaning was completed, and there were no significant holes, cuts, or gaps observed in the spillway net. 2) UUWC observed the water flow to be at a medium rate, and all buoys were above the water surface. These conditions made for an ideal cleaning situation. The bottom half of the spillway net skirt was not as bad as the top half which had a thick layer of algae present. There was very little wood, debris, or lures observed in the spillway net area. 3) Anglers hold on to the debris barrier to fish, and don't appear to be causing any damage to anything. 4) Hardware and the buoy system were inspected and in good condition. The bars holding the bottom skirts on the debris barrier are continuing to show wear.

The highlights of the July 31 inspection/cleaning were: 1) Cleaning was completed, and there were no significant holes, cuts, or gaps observed in the spillway net. 2) UUWC observed the water flow to be at a low rate, and all buoys were above the water surface. These conditions made for an ideal cleaning situation. The bottom half of the spillway net skirt was not as bad as the top half which had a thick layer of circular algae present. Some wood, debris, and lures were observed and removed in the spillway net area. Large schools of smallmouth bass mixed with a few largemouth bass were on the upstream side of the spillway net. A few bluegill were observed on the downstream side of the spillway net. 3) Hardware and the buoy system were inspected and in good condition. The bars holding the bottom skirts on the debris barrier are continuing to show wear.

The highlights of the August 31 inspection/cleaning were: 1) Cleaning was completed, and there were no significant holes, cuts, or gaps observed in the spillway net. 2) UUWC experienced no water flow, and so were able to spend extra time focusing on cleaning the upper half (double layered section) of the spillway net which appears to hold a large amount of algae and crayfish. UUWC spent additional time cleaning the upper half of the spillway net skirt which had a thick layer of circular algae. Some wood, debris, and lures were observed and removed in the spillway net area. 3) Hardware and the buoy system were inspected and in good condition. The bars holding the bottom skirts on the debris barrier are continuing to show wear.

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. In June and September, staff did note that high water may be creating shoreline erosion where the spillway net anchors into the shore. This could potentially create a large opening for fish to move through at the shoreline. This will need to be addressed before high water in the following spring.

Task 4. Underwater survey: The spillway net was inspected during each cleaning by UUWC. See Task 2 above for details. UUWC prepared reports for each of these inspections/cleanings, which are available at the Park or on request.

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. Elkhead Reservoir was expanded in 2006, roughly doubling the water surface acreage. During the expansion, a ¼" mesh screen was installed on the outlet

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of the reservoir to drastically reduce fish escapement through the outlet when water is released from the reservoir. Fish escapement was still possible over the spillway when the reservoir spilled. 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.

Study Methods/Approach

In October 2020, CPW biologists completed fish surveys within Elkhead Reservoir, between the spillway net and the spillway, as well as within the stilling basin downstream of the spillway (Figure 14). The objectives of the fish surveys were to determine fish species composition and relative abundance in Elkhead Reservoir between the spillway net and the spillway, and also downstream of the reservoir's spillway net. Experimental gill nets were set after water was released over the spillway. One, 150' experimental gill net was set at the "spillway site," which included the area between the spillway net and spillway. Additionally, CPW surveyed the stilling basin using one, 150' 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. All fish were identified to species, measured in length to the nearest mm, and weighed to the nearest g.

Results and Discussion

Crews were unable to sample the spillway site or the stilling basin before Elkhead Reservoir spilled water over the spillway in 2020 because of agency guidelines and health concerns related to COVID-19. Crews were able to sample both the spillway site and the stilling basin after the reservoir finished spilling and that sampling event occurred on October 22 and October 23. Water level within the reservoir was notably lower in 2020 compared to 2019 and only a small, isolated pool of water was present at the spillway site. One, 150' experimental gill net was set across the pool present at the spillway site for 24 hours. Fish collected included one black crappie with a total length of 122 mm, and three smallmouth bass with total lengths that ranged from 257 mm to 266 mm (Table 5). The black crappie was returned to the reservoir upstream of the spillway net, while the three smallmouth bass collected were lethally removed. The number of fish collected at the spillway site is comparable to 2019 post-spill sampling and suggests that the Elkhead Reservoir spillway net continues to be an effective tool at greatly reducing the opportunity for fish to leave the reservoir over the spillway (Table 5). It is likely that crews captured most, if not all, of the fish present in the spillway site in October 2020 because the fish were forced to congregate into the small pool of water present due to the receded water level within the reservoir.

The stilling basin was also sampled on October 22 and October 23 when crews set one, 150' experimental gill net that spanned the width of the stilling basin and for 25 hours. Fish collected included 12 white suckers with total lengths that ranged from 226 mm to 382 mm (Table 5). Fewer fish were captured during post-spill sampling in 2020 compared to 2019, likely because the stilling basin spent less time connected to Elkhead Creek in 2020 than it did in 2019 (Table 5).

Sampling effort has varied between years and between pre-spill and post-spill sampling trips in the same year. Therefore, catch rate (number of fish captured per overnight gill net set) was calculated for each pre-spill and post-spill sampling trip from 2017-2020 (Figure 15). Post-spill catch rate was relatively low at the spillway site (four fish per overnight gill net set) in 2020 as it has been in years past,

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indicating that the few fish were able to make it past the spillway net. Post-spill catch rate at the stilling basin decreased from 2019 to 2020, likely because the stilling basin spent less time connected to Elkhead Creek in 2020 than it did in 2019.

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. However, it is unlikely that gizzard shad were introduced from the Government Highline Canal; U.S. Fish and Wildlife Service (FWS) crews did not encounter gizzard shad during the FWS' extensive post-irrigation annual fish salvage operations in the canal prior to the discovery of the fish in Highline Lake. Gizzard shad were first collected between the spillway net and spillway in March 2017. Gizzard shad have been found in every subsequent survey between the spillway net and the spillway, including the pre-irrigation survey in 2018 in which 362 gizzard shad were removed. Only four gizzard shad were removed during the post-irrigation survey in 2018, while four gizzard shad were captured in 2019 and 5 gizzard shad were captured in 2020. The majority of the fish surveyed behind the spillway net from 2018-2020 following the depletion in gizzard shad were juvenile green sunfish. No gizzard shad have been captured in Mack Wash downstream of Highline Lake.

CPW manages Highline Lake to provide warmwater fishing opportunities to anglers while also ensuring that stocked fish are compatible with native species present in the drainage. Therefore, CPW is only stocking fish species in Highline Lake that are approved by the U.S. Fish and Wildlife Service (USFWS) and states of Utah, Wyoming, and Colorado, and that are compatible with native fishes. In 2020, bluegill, largemouth bass, channel catfish, and rainbow trout were stocked into Highline Lake (Table 6).

Elkhead Reservoir

Elkhead Reservoir was well below storage capacity during 2020 post-spill sampling efforts, which reduced the amount of water available to survey between the spillway net and the spillway to a small pool. This presented an opportunity for crews to exploit the fish present as fish had much less area available to avoid capture by the gill net. It is likely that most, if not all of the fish present between the spillway net and spillway were captured during the post-spill sampling effort in October.

CPW manages Elkhead Reservoir to provide warmwater fishing opportunities to anglers while also ensuring that stocked fish are compatible with native fish species present in the drainage. Therefore, CPW is only stocking fish species in Elkhead Reservoir that are approved by the USFWS and states of Utah, Wyoming, and Colorado, and that are compatible with native fishes. In 2020, bluegill, black crappie, and largemouth bass were stocked into Elkhead Reservoir (Table 7).

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Recommendations:

Highline Lake/Mack Wash

Operations and Maintenance

CPW is anticipating that the Highline Lake spillway net will need to be replaced no later than FY 2021. This next season in 2021 will be the eighth year of the spillway net's operation. CPW will be seeking funds through the Colorado River Recovery Program to cover the costs associated with removal of the current spillway net, as well as replacement and installation of a new spillway net. CPW is currently working with several vendors to determine approximate costs for replacing and installing a new spillway net. CPW recommends the Colorado River Recovery Program continue preparing for spillway net replacement in FY 2021.

CPW is currently preparing a new contract for spillway net inspections and cleanings in 2021. Once the contract is awarded, CPW will meet with the contractor during the first portion of 2021 to discuss the inspection/cleaning schedule for 2021, etc. CPW will continue with at least four spillway net inspections/cleanings in 2021, following a similar schedule as past years. Monthly and bimonthly (twice a month) cleanings may be required, beginning in July. The first inspection/cleaning is expected to begin in late March/early April so that a clean spillway net is in place when the lake begins filling. March is the preferred month for the first annual spillway net inspection/cleaning, but may not be feasible if a contract has not been awarded yet or if environmental conditions prohibit the inspection/cleaning from occurring. At least one cleaning will occur in the spring, followed by two cleanings during the summer, and a final cleaning before the inlet water is shut off. If additional cleanings are required in 2021, CPW may request financial assistance from the Colorado River Recovery Program as part of the current agreement between the two entities.

Highline Lake State Park staff will continue to monitor the spillway net and debris washing into the lake in the spring, and will inform divers when cleaning of the spillway net will need to take place. This may include additional collaboration with water operators related to inflow rates.

Fish Monitoring

CPW will continue to complete fish surveys in Highline Lake between the spillway net and spillway, and at the two sites within Mack Wash downstream of Highline Lake, at least once annually. This sampling will be prioritized around the irrigation season to maximize the continued evaluation of the spillway net effectiveness at preventing fish escapement, pre- and post-spill.

Historically, surveys between the spillway net and spillway have typically occurred in the spring prior to irrigation season. However, surveys in this area were also conducted in the fall of 2018 and only in the summer of 2020. There are likely differences in electrofishing efficiency due to water temperature and fish behavior based on the differences in seasonality of the survey between years. Anecdotally, electrofishing in August 2020 seemed to be more efficient than previous spring surveys based on depletion seen throughout the night and the apparent increased effective fishing depth. Based on these observations, it is recommended that in addition to the pre-spill surveys, additional surveys be considered during the summer should the spillway net be compromised and when/if the lake is not spilling during irrigation season. Furthermore, fall surveys following the irrigation season should be

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considered when necessary and feasible based on spillway net function throughout the irrigation season and results of the pre-spill surveys for that year.

The use of overnight gill netting in 2020 at Site #1 on Mack Wash was extremely effective at removing fish remaining after the electrofishing survey was completed. As observed in previous years' surveys as well, there are often fish that remain in the spillway pool following the electrofishing survey which are not vulnerable to capture through electrofishing, resulting in an underestimation of non-native fish abundance at Site #1 based on electrofishing data alone. Future gill net surveys at Site #1 will allow for a more thorough removal effort, as well as comparison of catch rates at Site #1 using two survey techniques.

Elkhead Reservoir

Operations and Maintenance

CPW is currently preparing a new contract for spillway net inspections and cleanings in 2021. Once the contract is awarded, CPW will meet with the contractor during the first portion of 2021 to discuss the inspection/cleaning schedule for 2021, etc. CPW will continue with at least four spillway net inspections/cleanings in 2021, following a similar schedule as past years. Monthly and bimonthly (twice a month) cleanings may be required, beginning in July. The first inspection/cleaning is expected to begin in April so that a clean spillway net is in place when the lake begins filling. April is the preferred month for the first annual spillway net inspection/cleaning, but may not be feasible if environmental conditions prohibit the inspection/cleaning from occurring. At least one cleaning will occur in the spring, followed by two cleanings during the summer, and a final cleaning once the reservoir is either no longer or minimally spilling. If additional cleanings are required in 2021, CPW may request financial assistance from the Colorado River Recovery Program as part of the current agreement between the two entities.

Elkhead Reservoir State Park staff will continue to monitor the spillway net and debris washing into the reservoir in the spring, and will inform divers when cleaning of the spillway net will need to take place. Staff will plan to address the potential opening for fish at high water where the shoreline is eroding at the spillway net anchor points prior to spring runoff.

Fish Monitoring

CPW will continue to complete fish surveys in Elkhead Reservoir between the spillway net and spillway, and within the stilling basin at least once annually. This sampling will be prioritized around the irrigation season to maximize the continued evaluation of the spillway net effectiveness at preventing fish escapement, pre- and post-spill.

Project Status:

This project is considered on track and ongoing.

FY 2020 Budget Status:

Funds Provided: ---

Funds Expended: No Colorado River Recovery Program dollars were expended in this fiscal year.

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\$6,500 was expended by CPW for five spillway net inspections/cleanings and maintenance at Highline Lake in FY 2020 (CPW covers annual operations and maintenance up to \$10,000). \$13,200 was expended by CPW for four spillway net inspection/cleaning at Elkhead Reservoir in FY 2020 (CPW covers annual operations and maintenance up to \$10,000). At this time, CPW has determined no need for the Colorado River Recovery Program to reimburse its 50:50 cost share of \$3,200 (which would be a cost of \$1,600) to CPW for operations and maintenance costs.

Difference: ---

Percent of the FY 2020 work completed, and projected costs to complete: ---

Colorado River Recovery Program funds spent for publication charges: ---

Status of Data Submission:

Not applicable

Signed:

Lori Martin

Program Manager

January 22, 2021

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Appendix: Figures and Tables

Table 1. Summary of fish surveys (species composition, total number of fish collected, total length range, and catch per unit effort) of fish collected between the spillway net and the spillway in Highline Lake in spring 2018, fall 2018, spring 2019, and summer 2020. See previous years' Annual Reports for summaries of pre-2018 data.

Collection Method	Fish Species Collected	Total # of Fish Collected	Total Length Size Range in Millimeters	Catch per Unit Effort (# of fish/hour)
Spring 2018 (673 Fish Collected)				
Electrofishing	Black Crappie	2	86 and 92	1.01
	Bluegill	57	46-166	28.9
	Common Carp	4	421-531	2.0
	Gizzard Shad	340	114-342	172.6
	Largemouth Bass	45	70-334	22.8
	Rainbow Trout	1	266	0.5
	Smallmouth Bass	2	208 and 240	1.02
	Green Sunfish	197	43-160	100.0
Gill Nets	Black Crappie	1	65	0.1
	Gizzard Shad	22	171-331	3.1
	Largemouth Bass	1	268	0.1
	Rainbow Trout	1	325	0.1
Fall 2018 (135 Fish Collected)				
Electrofishing	Bluegill	14	86-150	14.1
	Channel Catfish	1	73	1.0
	Gizzard Shad	4	311-355	4.0
	Largemouth Bass	11	72-142	11.1
	Green Sunfish	105	57-156	106.1
Spring 2019 (397 Fish Collected)				
Electrofishing	Bluegill	49	70-179	23.8
	Black Crappie	8	53-82	3.9

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	Gizzard Shad	3	291-383	1.5
	Largemouth Bass	29	68-324	14.1
	Green Sunfish	307	30-191	149.0
Gill Nets	Gizzard Shad	1	322	0.2
Summer 2020 (130 Fish Collected)				
Electrofishing	Bluegill	14	71-163	10.9
	Common Carp	7	428-551	5.4
	Gizzard Shad	5	362-407	3.9
	Largemouth Bass	9	61-399	7.0
	Green Sunfish	85	22-202	65.9
	Yellow Perch	1	75	0.8
Gill Nets	Bluegill	3	119-148	0.3
	Channel Catfish	1	521	0.1
	Rainbow Trout	1	214	0.1
	Green Sunfish	4	127-182	0.4

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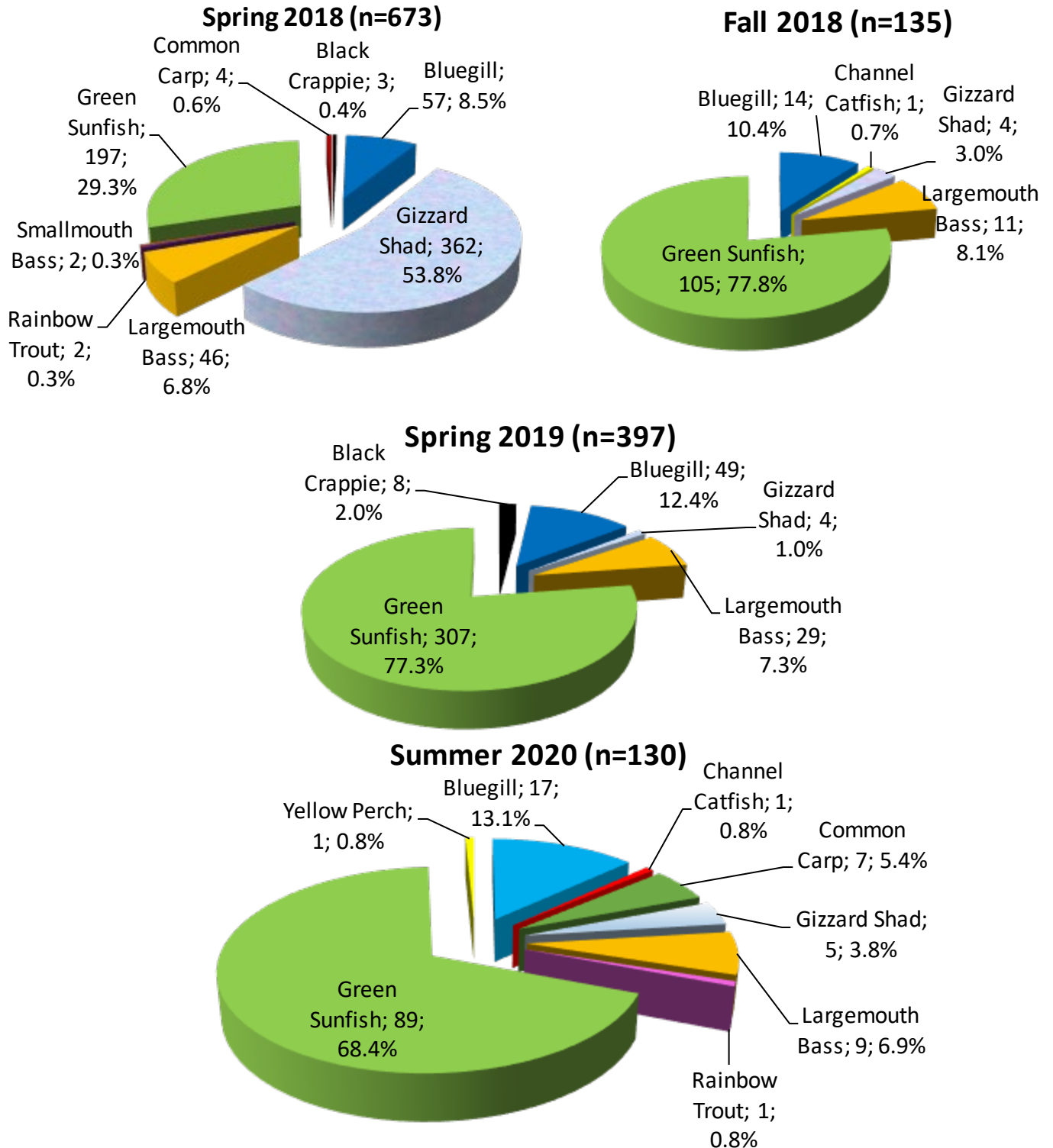


Figure 1. Species composition of fish surveyed (number of fish sampled and percentage of overall sample) in Highline Lake between the spillway net and the spillway from 2018-2020. Charts include fish captured using both gill nets and electrofishing. No gill netting was conducted during the fall 2018 survey. See previous years' Annual Reports for summaries of pre-2018 data.

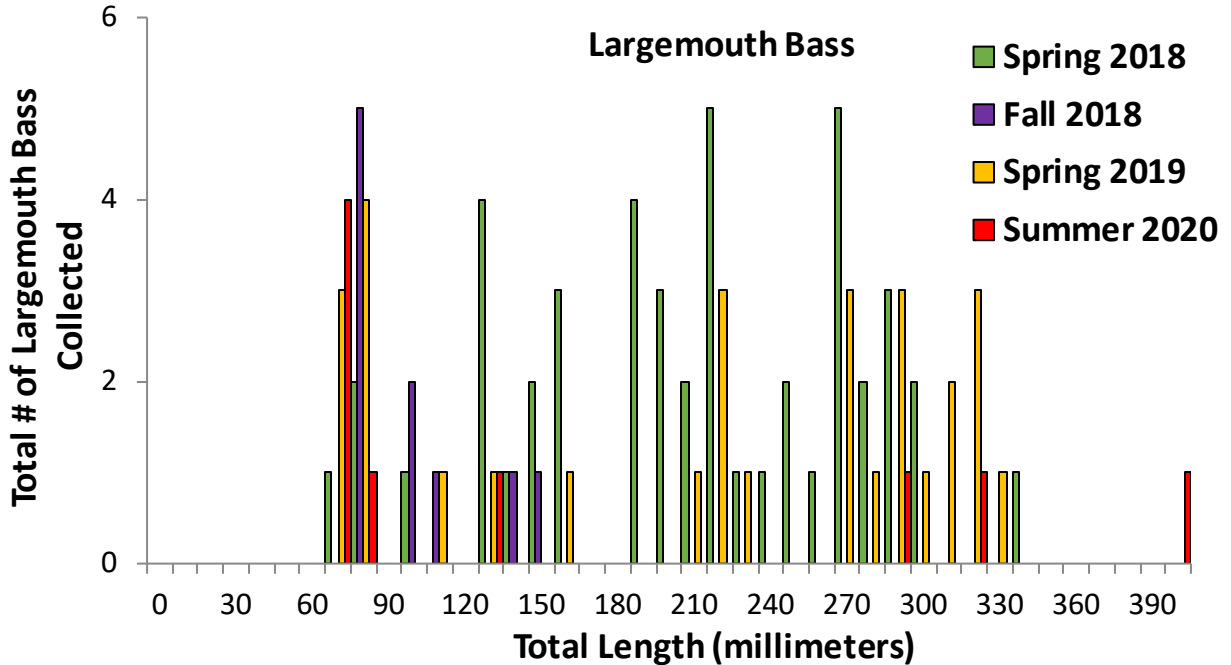


Figure 2. Length frequency histogram of largemouth bass surveyed in Highline Lake between the spillway net and the spillway from 2018-2020. Histogram includes fish captured using both gill nets and electrofishing. No gill netting was conducted during the fall 2018 survey. See previous years' Annual Reports for summaries of pre-2018 data.

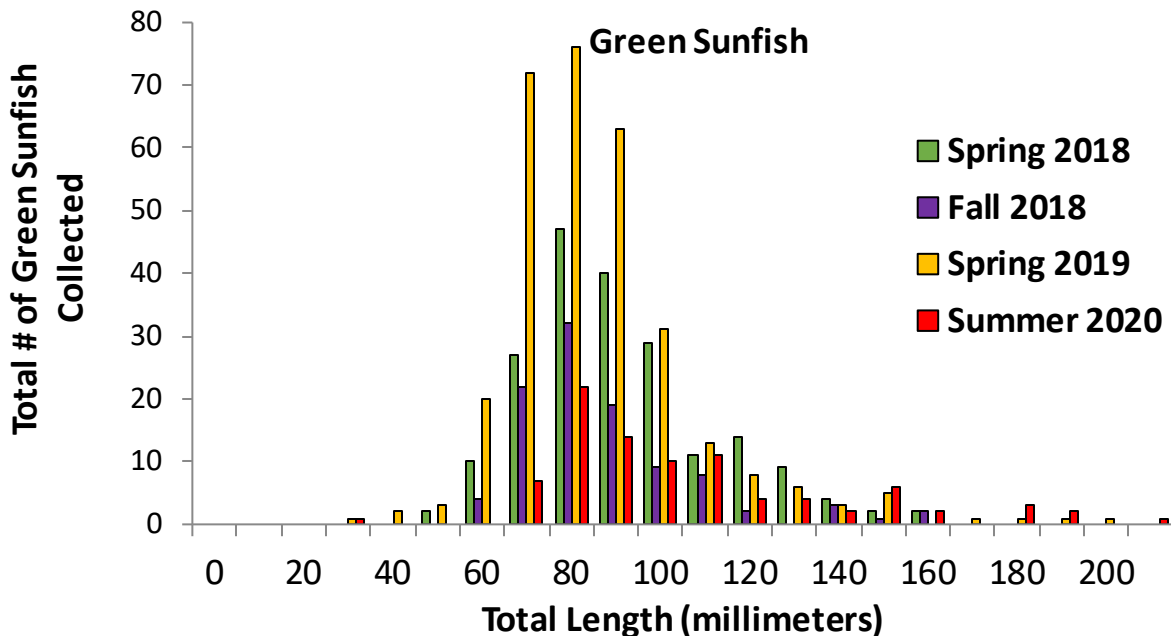


Figure 3. Length frequency histogram of green sunfish surveyed in Highline Lake between the spillway net and the spillway from 2018-2020. Histogram includes fish captured using both gill nets and electrofishing. No gill netting was conducted during the fall 2018 survey. See previous years' Annual Reports for summaries of pre-2018 data.

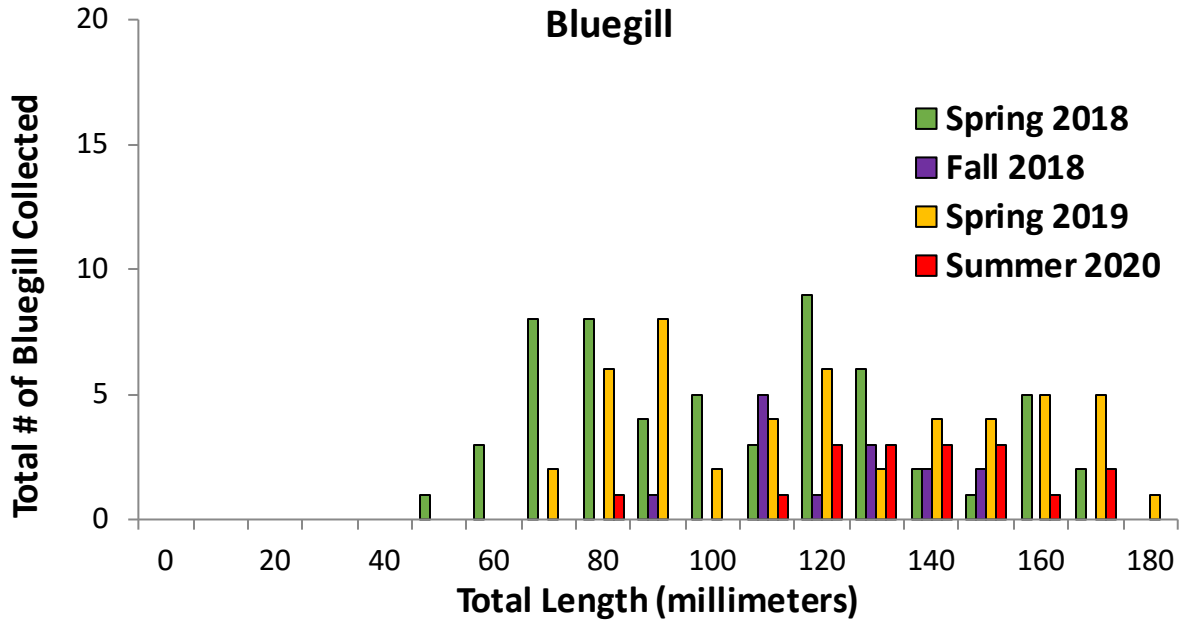


Figure 4. Length frequency histogram of bluegill surveyed in Highline Lake between the spillway net and the spillway from 2018-2020. Histogram includes fish captured using both gill nets and electrofishing. No gill netting was conducted during the fall 2018 survey. See previous years’ Annual Reports for summaries of pre-2018 data.

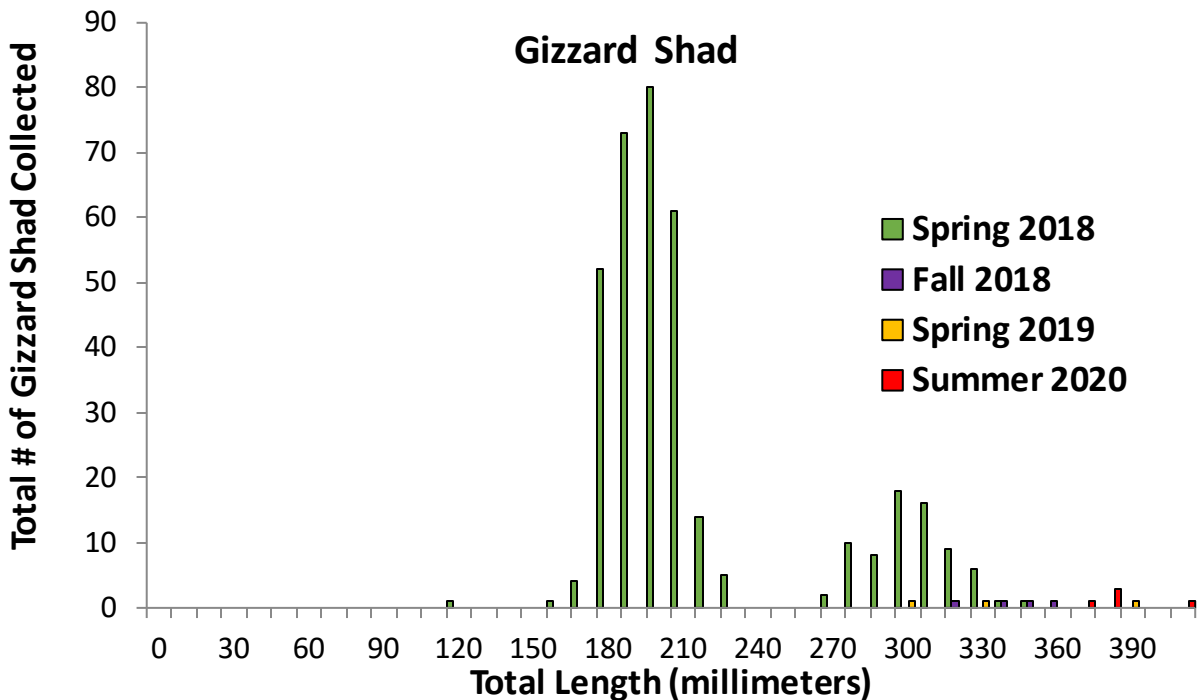


Figure 5. Length frequency histogram of gizzard shad surveyed in Highline Lake between the spillway net and the spillway from 2018-2020. Histogram includes fish captured using both gill nets and electrofishing. No gill netting was conducted during the fall 2018 survey. See previous years’ Annual Reports for summaries of pre-2018 data.

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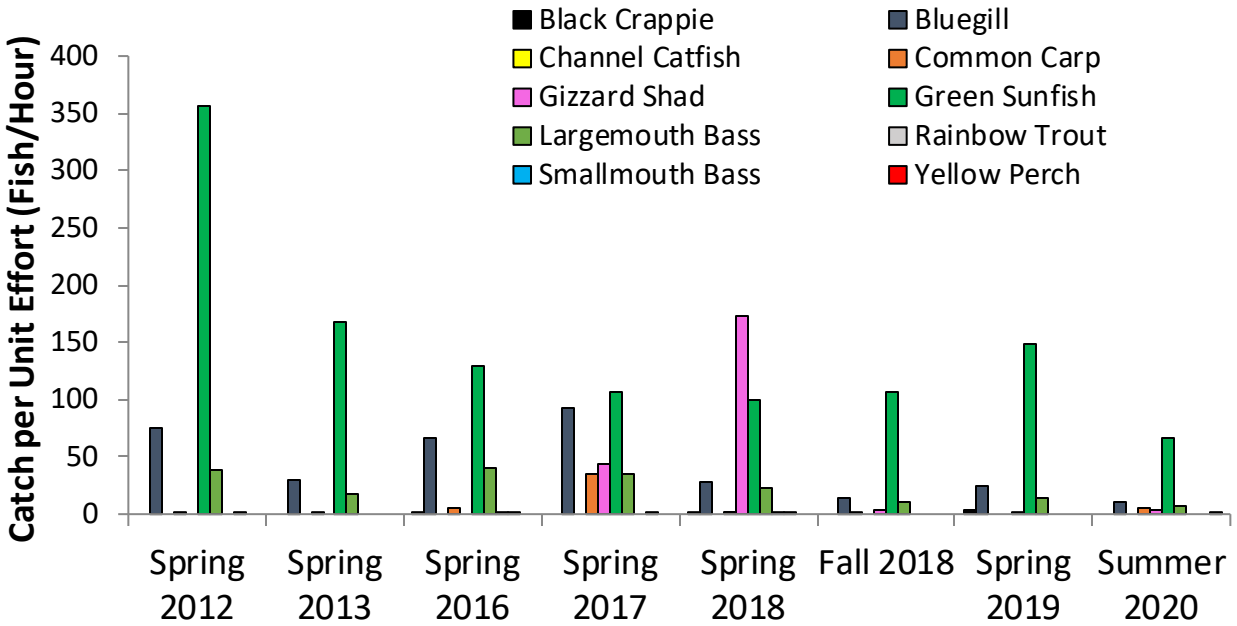


Figure 6. Historical electrofishing catch per unit effort (number of fish captured per hour) of black crappie, bluegill, channel catfish, common carp, gizzard shad, green sunfish, largemouth bass, rainbow trout, smallmouth bass, and yellow perch in Highline Lake between the spillway net and the spillway from 2012 through 2020.

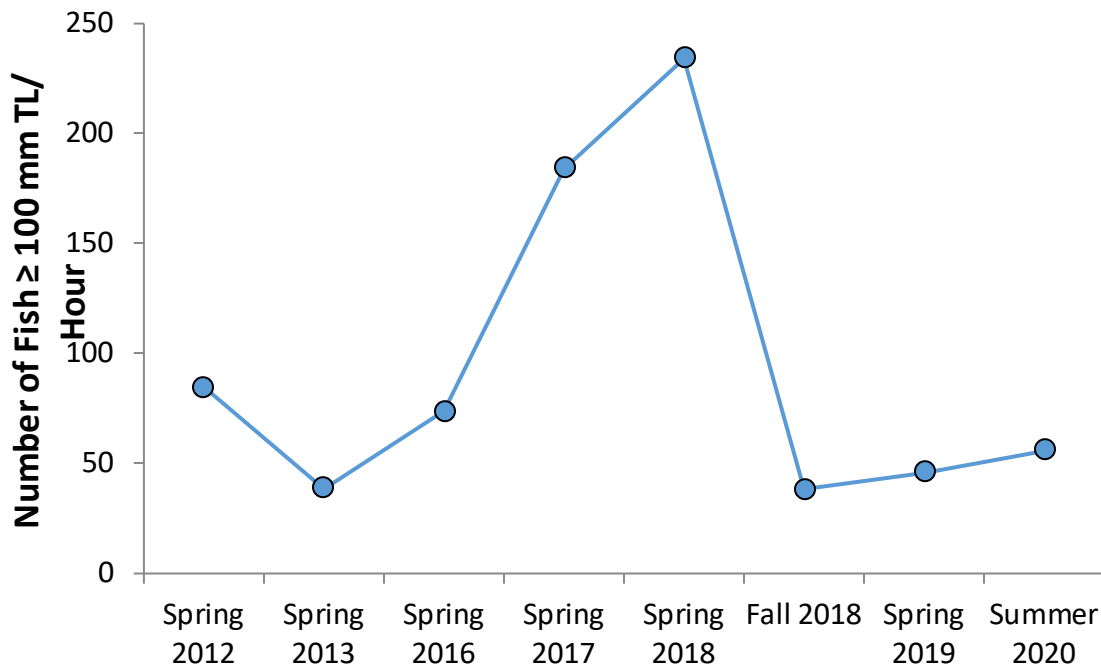


Figure 7. Historical electrofishing catch per unit effort (number of fish captured per hour) of individuals ≥ 100 millimeters (mm) in total length for all fish species combined (i.e. black crappie, bluegill, channel catfish, common carp, gizzard shad, green sunfish, largemouth bass, rainbow trout, smallmouth bass, and yellow perch) in Highline Lake between the spillway net and the spillway from 2012 through 2020.

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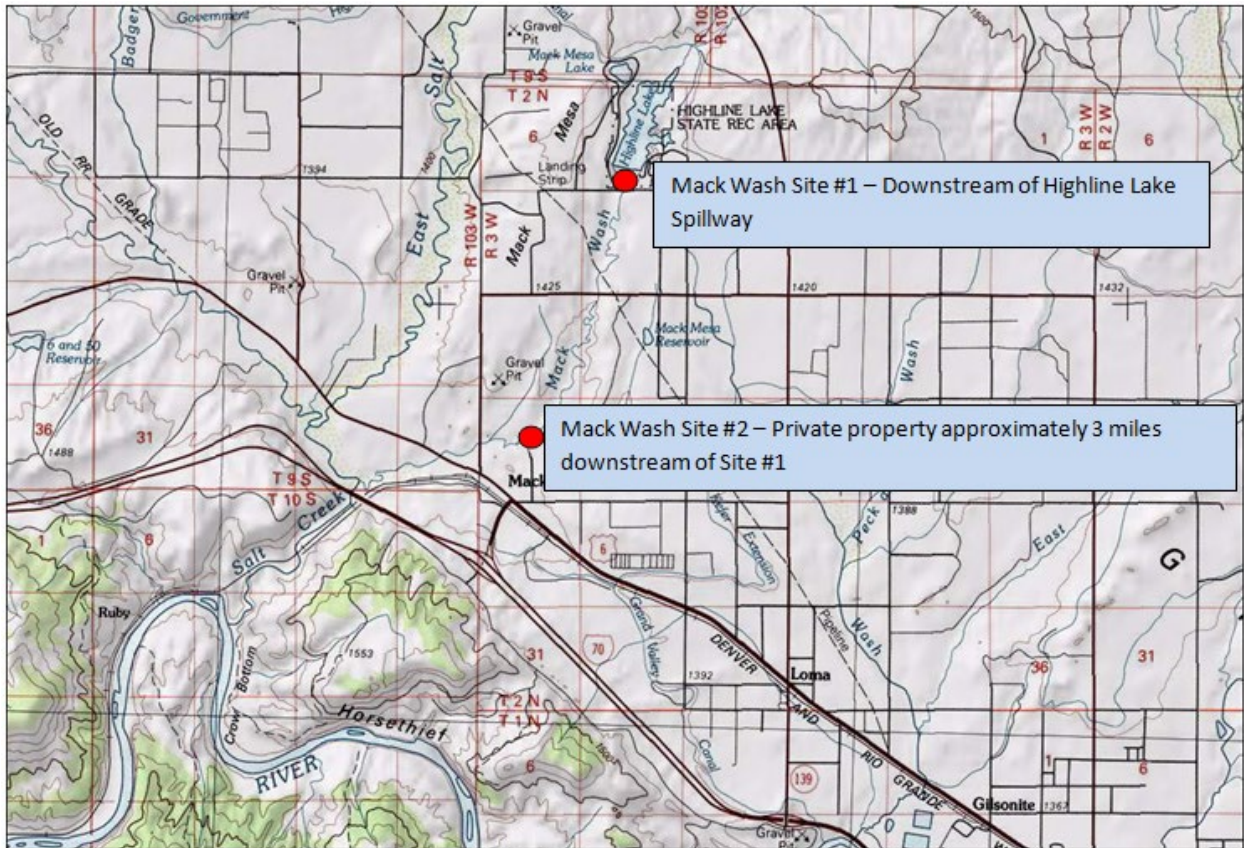


Figure 8. Map of sampling locations on Mack Wash surveyed in November 2018, 2019, and 2020 using a single-pass survey technique with a bank electrofishing unit. An overnight gill netting survey was also conducted at Site #1 following the electrofishing survey in 2020.

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Table 2. Total number of fish collected; total length size range in millimeters (mm); catch per unit effort (# of 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 **2020**. Native fish species identified by *.

Fish Species Collected	<u>Site #1</u> (Electrofishing)	<u>Site #1</u> (Gill Netting)	<u>Site #2</u>
Black Bullhead	0 fish	0 fish	2 fish; 214 and 237mm; 3.9/hour
Bluehead Sucker*	0 fish	0 fish	0 fish
Bluegill	0 fish	0 fish	0 fish
Channel Catfish	1 fish; 543 mm; 1.4/hour	0 fish	0 fish
Common Carp	0 fish	0 fish	0 fish
Fathead Minnow	0 fish	0 fish	0 fish
Flannelmouth Sucker*	0 fish	0 fish	0 fish
Green Sunfish	2 fish; 122 and 148 mm; 2.9/hour	26 fish, 114-222 mm; 1.3/hour	34 fish; 58-152mm; 66.3/hour
Largemouth Bass	9 fish; 58-101 mm; 13.0/hour	3 fish; 253-360mm; 0.2/hour	11 fish; 63-202mm; 21.5/hour
Rainbow Trout	0 fish	2 fish; 330 and 421mm; 0.1/hour	0 fish
Red Shiner	0 fish	0 fish	90 fish; 52-89mm; 175.6/hour
Speckled Dace*	0 fish	0 fish	4 fish; 72-92mm; 7.8/hour
White Sucker / Hybrid Sucker	1 fish; 156 mm; 1.4 fish/hour	0 fish	74 fish; 79-299mm; 144.4/hour
Yellow Perch	0 fish	0 fish	0 fish
<u>Total Number of Fish Collected</u>	13	31	215

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Table 3. Total number of fish collected; total length size range in millimeters (mm); catch per unit effort (# of 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 **2019**. Native fish species identified by *.

Fish Species Collected	Site #1	Site #2
Black Bullhead	0 fish	0 fish
Bluehead Sucker*	0 fish	0 fish
Bluegill	0 fish	0 fish
Channel Catfish	0 fish	0 fish
Common Carp	1 fish; 493 mm; 1.4/hour	0 fish
Fathead Minnow	0 fish	2 fish; 54 and 79 mm; 3.9/hour
Flannelmouth Sucker*	0 fish	0 fish
Green Sunfish	7 fish; 78-202 mm; 10.1/hour	15 fish; 41-144 mm; 29.4/hour
Largemouth Bass	9 fish; 91-161 mm; 13.0/hour	3 fish; 86-121 mm; 5.9/hour
Rainbow Trout	0 fish	0 fish
Red Shiner	0 fish	142 fish; 38-77 mm; 278.4/hour
Speckled Dace*	0 fish	1 fish; 76 mm; 2.0/hour
White Sucker / Hybrid Sucker	1 fish; 200 mm; 1.4/hour	49 fish; 77-239 mm; 96.1/hour
Yellow Perch	0 fish	0 fish
<u>Total Number of Fish Collected</u>	18	212

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Table 4. Total number of fish collected; total length size range in millimeters (mm); catch per unit effort (# of 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 **2018**. Native fish species identified by *. See previous years' Annual Reports for summaries of pre-2018 data.

Fish Species Collected	Site #1	Site #2
Black Bullhead	0 fish	0 fish
Bluehead Sucker*	0 fish	8 fish; 71-171 mm; 7.6/hour
Bluegill	1 fish; 189 mm; 1.3/hour	0 fish
Channel Catfish	0 fish	0 fish
Common Carp	3 fish; 369-567 mm; 4.0/hour	0 fish
Fathead Minnow	0 fish	1 fish; 56 mm; 1.0/hour
Flannelmouth Sucker*	0 fish	4 fish; 75-197 mm; 3.8/hour
Green Sunfish	14 fish; 40-196 mm; 18.8/hour	3 fish; 52-162 mm; 2.6/hour
Largemouth Bass	15 fish; 55-382 mm; 20.2/hour	1 fish; 96 mm; 1.0/hour
Rainbow Trout	0 fish	0 fish
Red Shiner	0 fish	211 fish; 24-82 mm; 201.0/hour
Speckled Dace*	0 fish	39 fish; 50-94 mm; 37.1/hour
White Sucker / Hybrid Sucker	0 fish	80 fish; 54-298 mm; 76.2/hour
Yellow Perch	0 fish	0 fish
<u>Total Number of Fish Collected</u>	33	347

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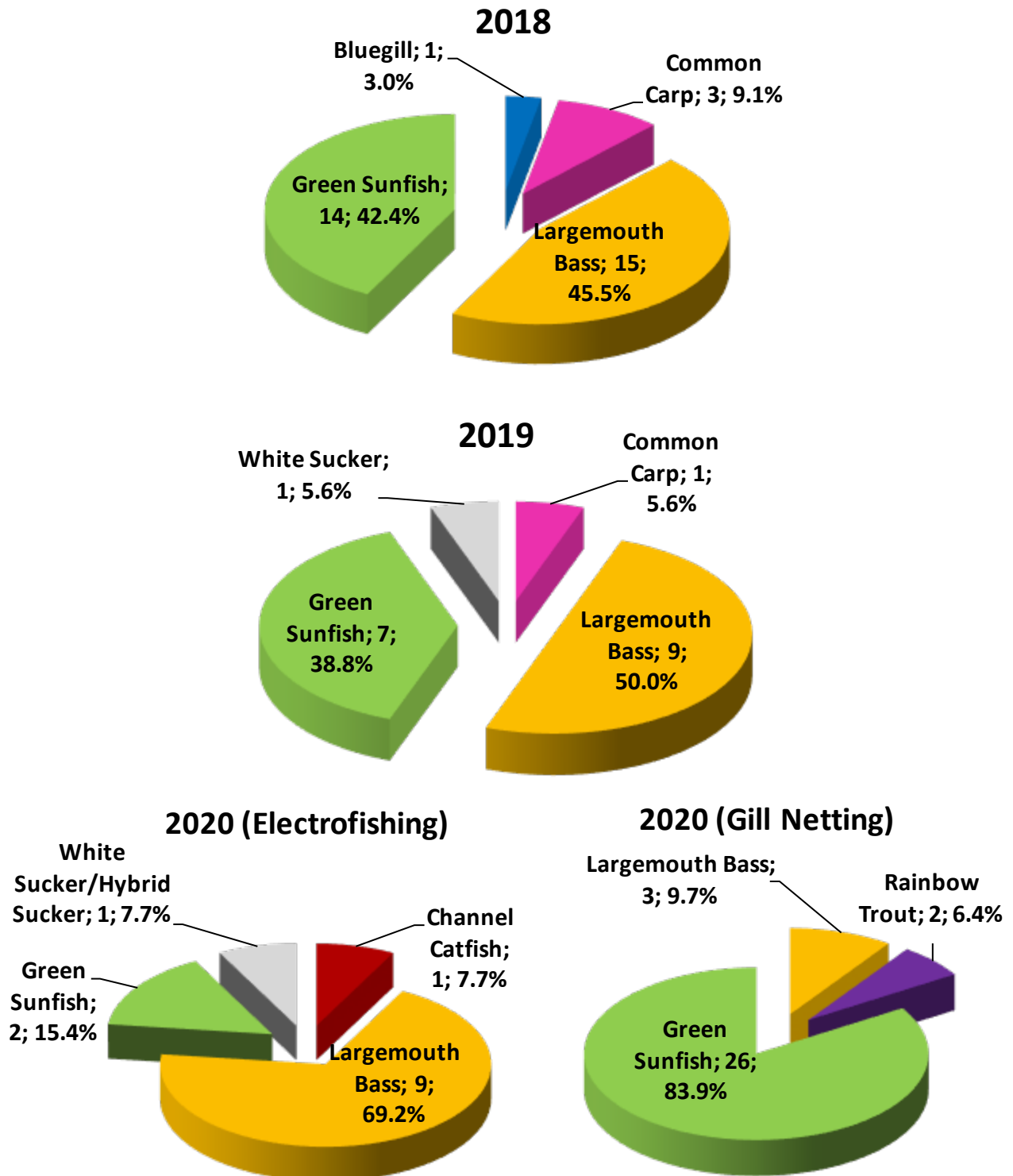


Figure 9. Species composition of fish surveyed (number of fish sampled and percentage of overall sample) in Mack Wash at Site #1 (immediately downstream of Highline Lake spillway) in 2018, 2019, and 2020. See previous years' Annual Report for summaries of pre-2018 data.

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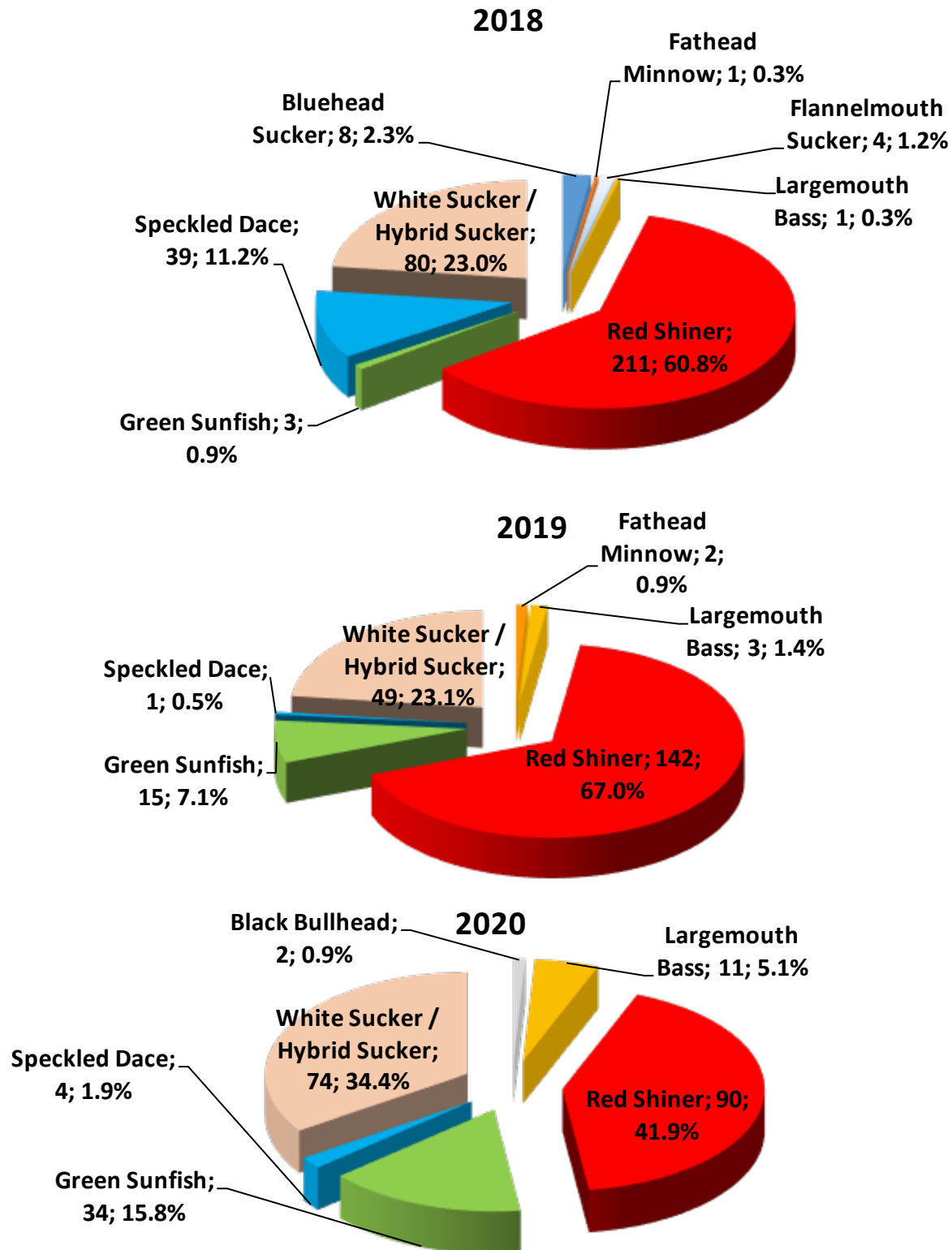


Figure 10. Species composition of fish surveyed (number of fish sampled and percentage of overall sample) in Mack Wash at Site #2 (approximately 3 miles downstream of Highline Lake spillway) in 2018, 2019, and 2020. See previous years' Annual Reports for summaries of pre-2018 data.

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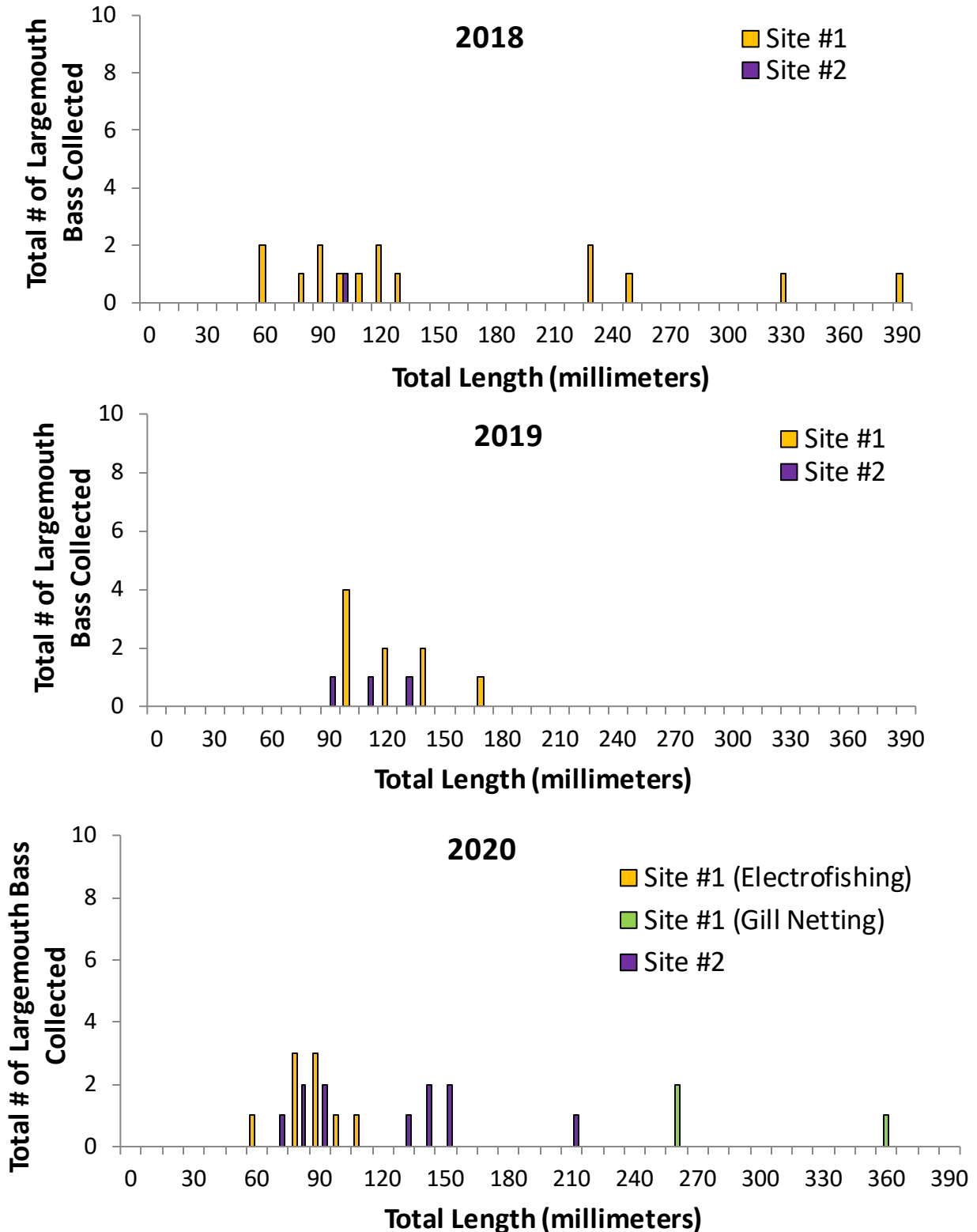


Figure 11. Length frequency histograms of largemouth bass surveyed in Mack Wash at Site #1 and Site #2 in 2018, 2019, and 2020. See previous years' Annual Reports for summaries of pre-2018 data.

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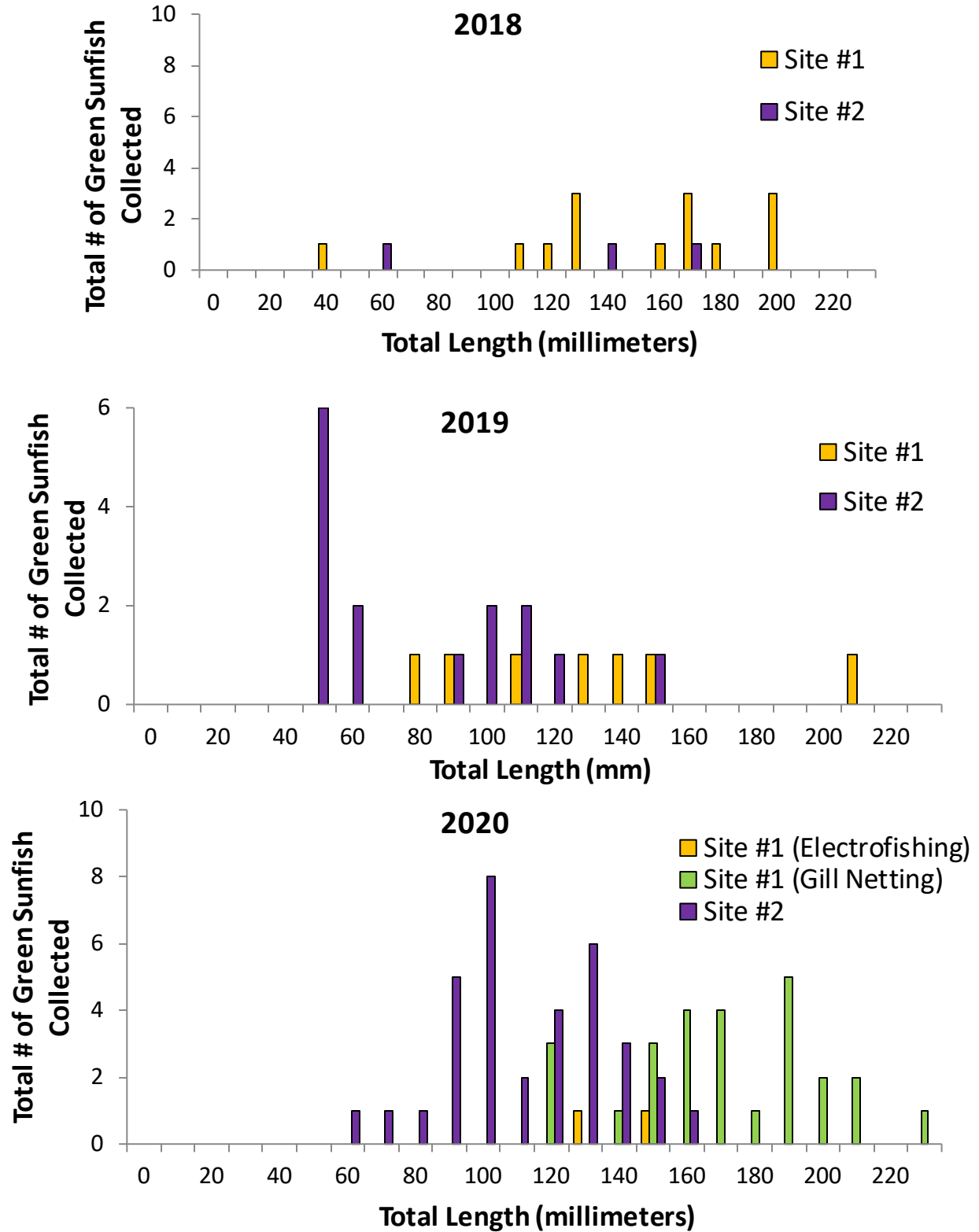


Figure 12. Length frequency histograms of green sunfish surveyed in Mack Wash at Site #1 and Site #2 in 2018, 2019, and 2020. See previous years' Annual Reports for summaries of pre-2018 data.

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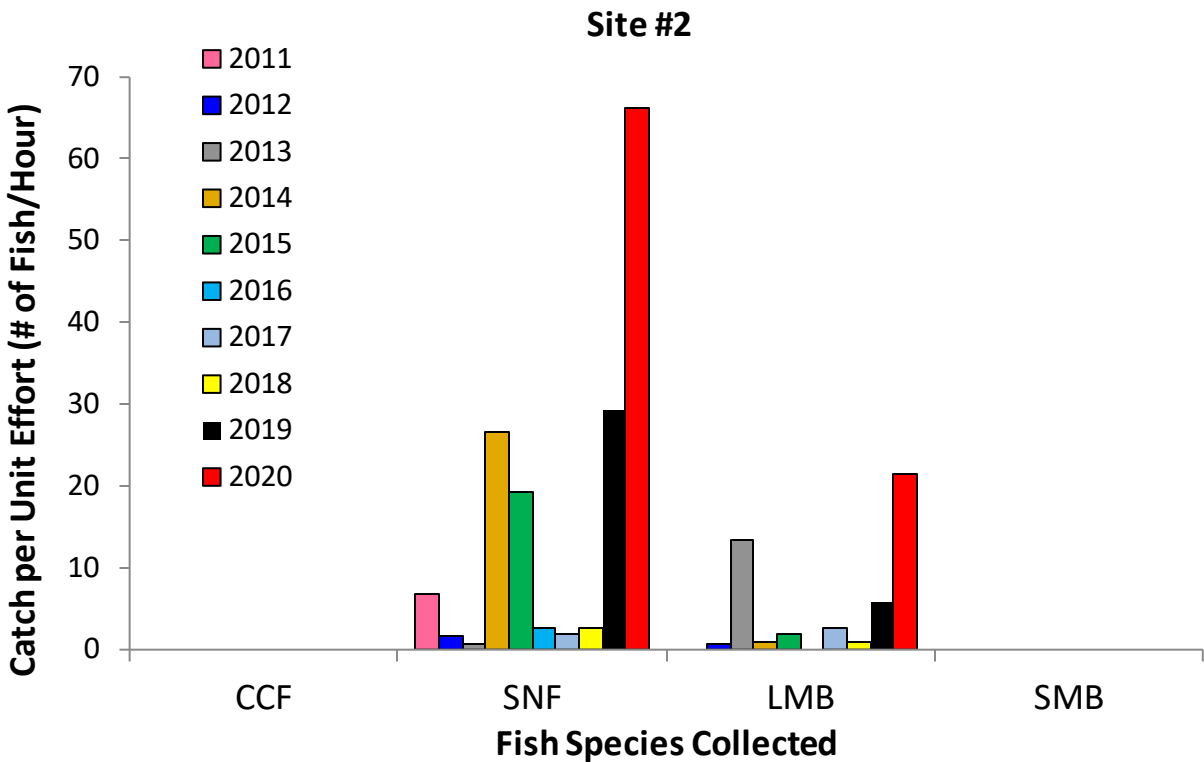
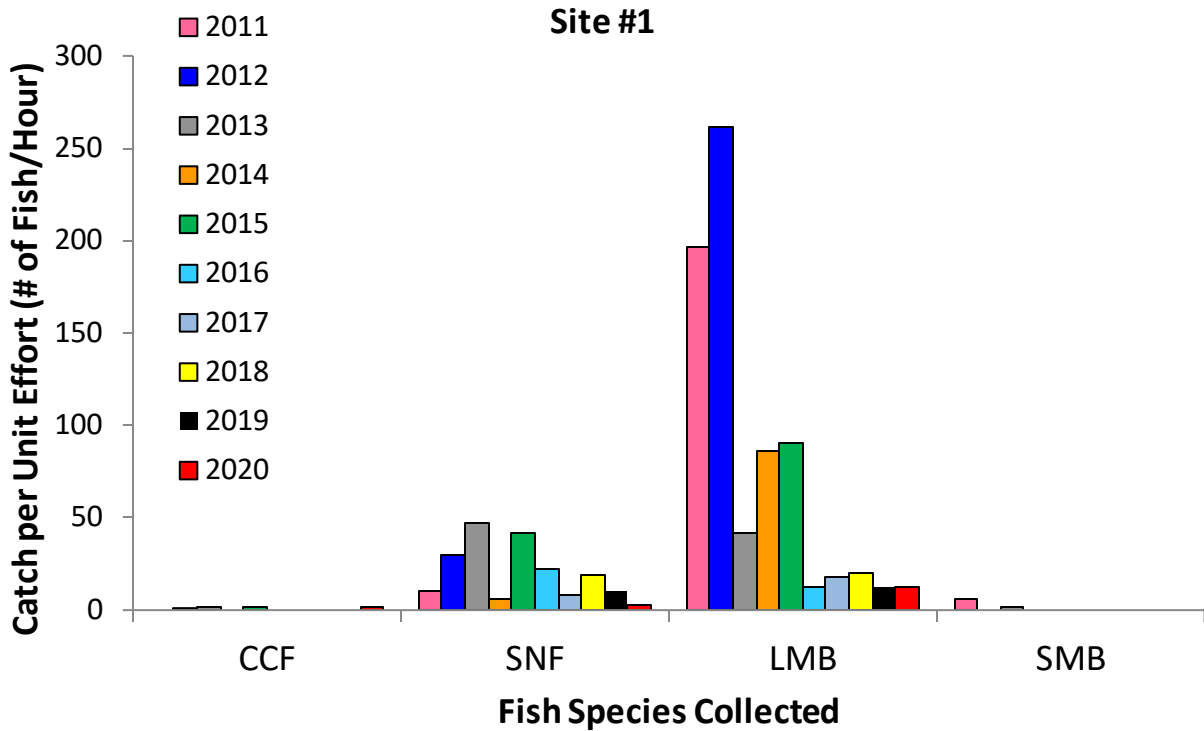


Figure 13. Historical electrofishing catch per unit effort (number of fish captured per hour) of channel catfish (CCF), green sunfish (SNF), largemouth bass (LMB), and smallmouth bass (SMB) in Mack Wash at Site #1 and Site #2 from 2011-2020.



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

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Table 5. Summary of fish collected (species composition, total number of fish collected, and total length size range in millimeters (mm)) pre-spill and post-spill at the spillway site and in the stilling basin of Elkhead Reservoir from 2017 to 2020. N/A=Not Applicable

Year	Species Collected	Pre Spill		Post Spill	
		Spillway Site	Stilling Basin	Spillway Site	Stilling Basin
2020	Black Crappie	N/A	N/A	1 fish (122 mm)	0
-	Smallmouth Bass	N/A	N/A	3 fish (257-266 mm)	0
-	White Sucker	N/A	N/A	0	12 fish (226-382 mm)
2019	Smallmouth Bass	0	3 fish (258-324 mm)	0	0
-	White Sucker	0	0	0	28 fish (unmeasured)
2018	Black Crappie	0	0	2 fish (unmeasured)	0
-	Bluegill	0	0	8 fish (120-189 mm)	0
-	Largemouth Bass	0	0	4 fish (121-180 mm)	0
-	Smallmouth Bass	0	3 fish (221-320 mm)	27 fish (96-257 mm)	6 fish (221-320 mm)
-	White Sucker	0	1 fish (unmeasured)	0	0
2017	Black Crappie	0	0	2 fish (106-209 mm)	0
-	Bluegill	0	2 fish (124-150 mm)	0	0
-	Largemouth Bass	0	0	1 fish (195 mm)	1 fish (191 mm)
-	Northern Pike	1 fish (unmeasured)	0	0	0
-	Smallmouth Bass	0	2 fish (254-344 mm)	12 fish (168-294 mm)	0
-	White Sucker	0	16 fish (115-366 mm)	0	0

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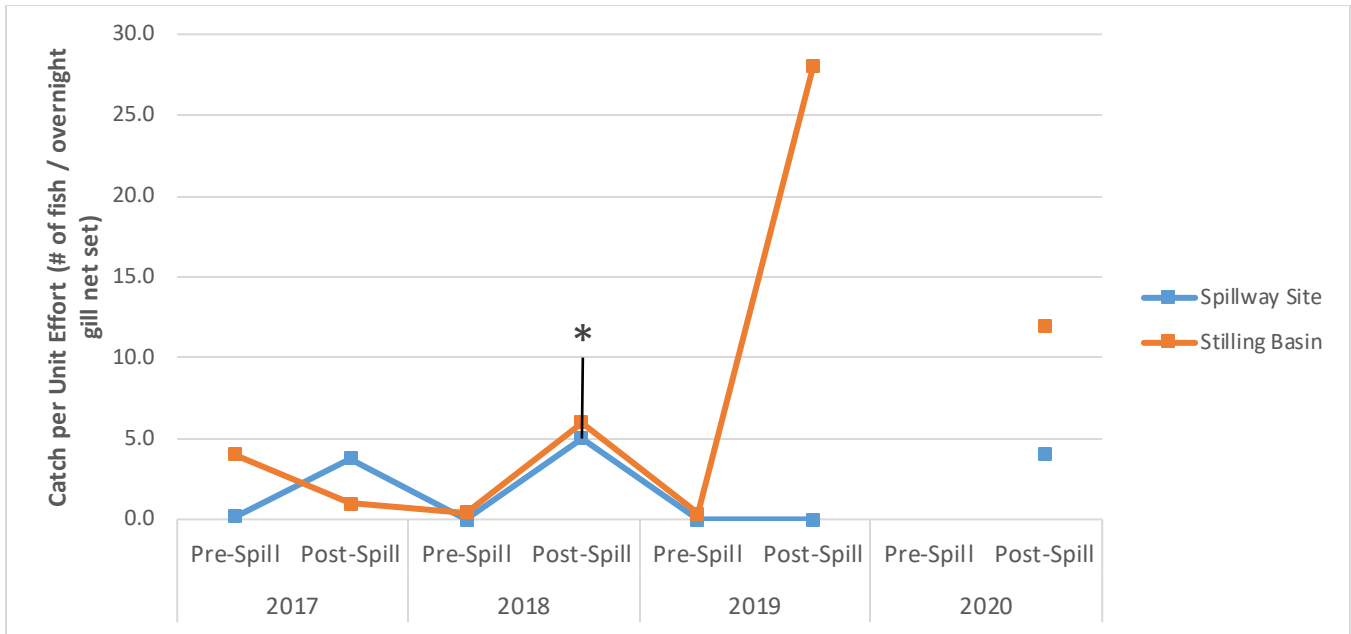


Figure 15. Historical catch per unit effort (number of fish captured per overnight gill net set) of individuals of all fish species combined (i.e. black crappie, bluegill, smallmouth bass, largemouth bass, and white sucker) in Elkhead Reservoir at the spillway site and in the stilling basin. * indicates a bias in 2018 post-spill catch rate at the spillway site because two methods of sampling were used where crews captured fish using boat electrofishing prior to setting gillnets. Pre-spill sampling did not occur in 2020 at both sites due to COVID-19 health concerns and agency guidelines.

Table 6. Summary of fish stocked by Colorado Parks and Wildlife into Highline Lake in 2020 (species, number of fish stocked, and length (inches)).

Species	Number of Fish Stocked	Length (Inches)
Bluegill	12,000	1.5
Channel Catfish	2,012	2.7
Largemouth Bass	7,500	1.5
Rainbow Trout	7,743	9.3-11.1

Table 7. Summary of fish stocked into Elkhead Reservoir in 2020 (species, number of fish stocked, and length (inches)).

Species	Number of Fish Stocked	Length (Inches)
Black Crappie	30,015	0.9
Bluegill	30,001	1.7
Largemouth Bass	155	11.4-16.5
Largemouth Bass	30,072	1.5

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ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: No agreement currently in place.

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: C-20

Project Title:

Operation, maintenance, and evaluation of fish escapement barriers in Colorado (Highline Lake and Elkhead Reservoir)

Bureau of Reclamation Agreement Number:

No agreement currently in place. Previous agreement number was R12AP40001.

Project/Grant Period:

Start date: 09/22/2017

End date: 09/30/2022

Reporting period end date: 12/31/2020

Is this the final report? Yes _____ No X

Performance:

This project includes the operation, maintenance, and evaluation of the Highline Lake and Elkhead Reservoir spillway nets, designed to control escapement of non-native, warmwater fishes. Overall, both spillway nets appear to be in good shape and performing as designed. CPW is anticipating that the Highline Lake spillway net will need to be replaced no later than FY 2021, while the Elkhead Reservoir spillway net has no anticipated near-time replacement timeline. Operation and maintenance of both spillway nets were fully performed in 2020, including 5 underwater cleanings at Highline Lake and 4 at Elkhead Reservoir. Long, hot summer days with very little precipitation supported algal growth and necessitated five cleanings of the Highline Lake spillway net in 2020. The Highline Lake spillway net was partially submerged twice in 2020 by high inflows and excessive algal growth on the net. The Elkhead Reservoir spillway net was partially submerged (120 feet of net) during high flows in spring, but cleaning returned the net to buoyancy for the remainder of the year. Crews were unable to complete spring (pre-spill) evaluation of both the Highline Lake and Elkhead Reservoir spillway nets in 2020 due to COVID-19 health concerns and agency guidelines that restricted their ability to complete this work.